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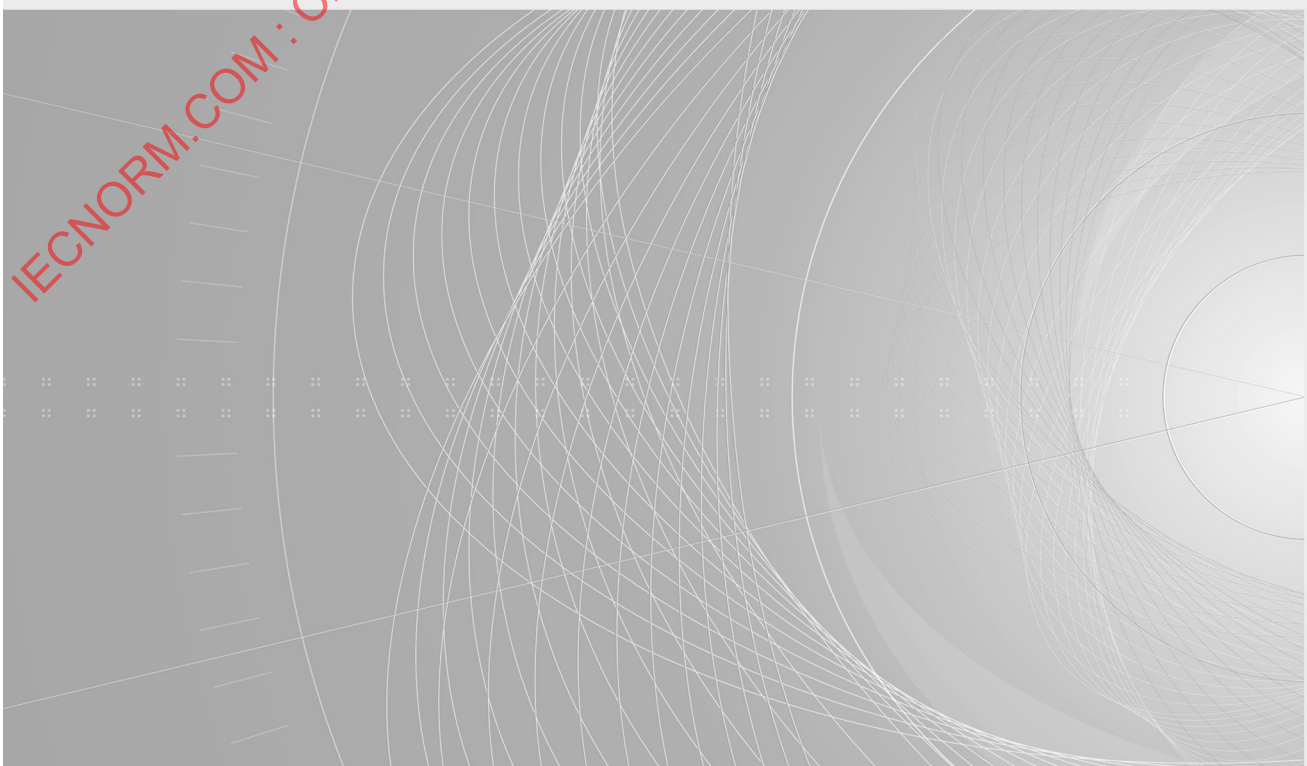
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Energy management system application program interface (EMS-API) – Part 301: Common information model (CIM) base

Interface de programmation d'application pour système de gestion d'énergie (EMS-API) – Partie 301: Base de modèle d'information commun (CIM)



IEC 61970-301:2020-06+AMD1:2022-02 CSV(en-fr)

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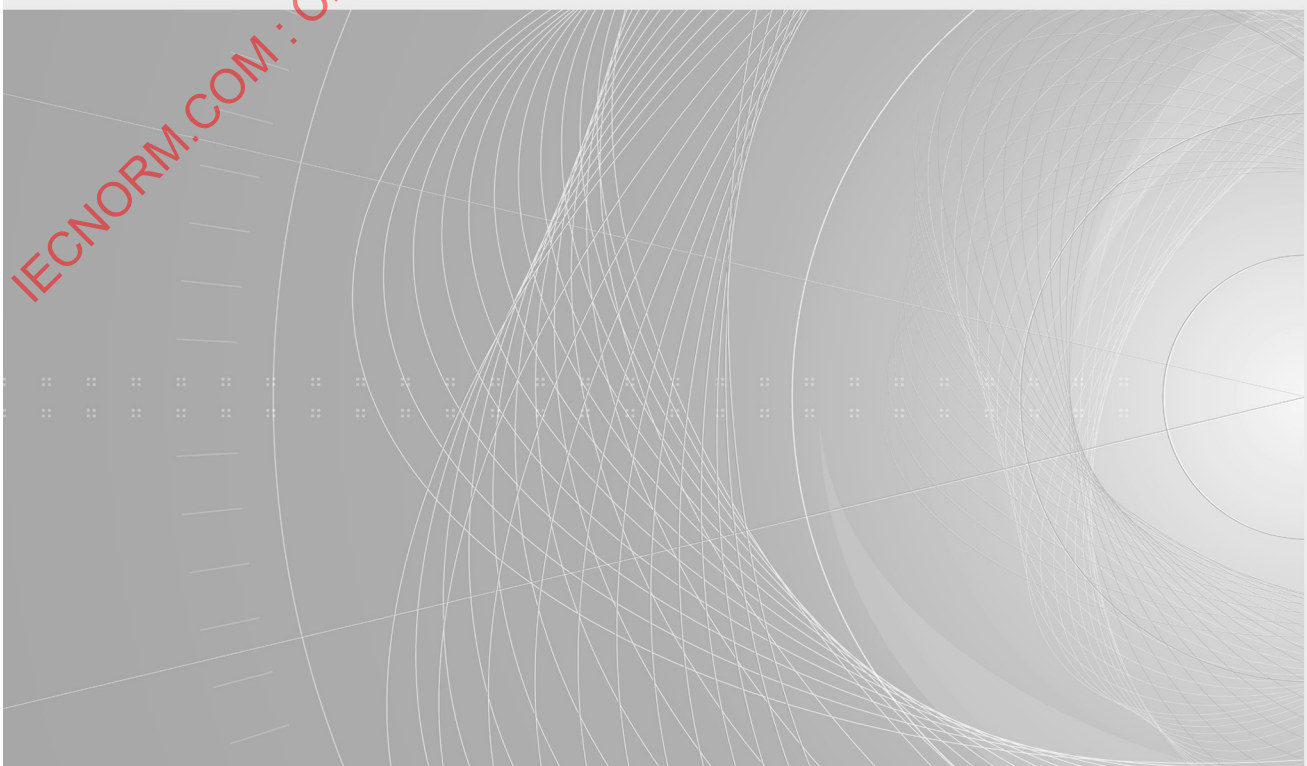
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CONTENTS

FOREWORD 35
INTRODUCTION 37
1 Scope 39
2 Normative references 39
3 Terms and definitions 40
4 CIM specification 40
4.1 Overview 40
4.2 CIM modelling notation 41
4.3 CIM packages 41
4.4 CIM classes and relationships 43
4.4.1 Classes 43
4.4.2 Generalization 44
4.4.3 Simple association 45
4.4.4 Aggregation 46
4.5 CIM model concepts and examples 46
4.5.1 Concepts 46
4.5.2 Containment, equipment hierarchies and naming 47
4.5.3 Names model 48
4.5.4 Connectivity model 49
4.5.5 Inheritance hierarchy 52
4.5.6 Transformer model 54
4.5.7 Transformer tap modelling 57
4.5.8 Phase wire modelling 70
4.5.9 Grounding devices modelling 72
4.5.10 Cuts, clamps and jumpers model 76
4.5.11 Measurements and controls 80
4.5.12 Regulating control models 85
4.5.13 DC model for CIM 87
4.5.14 Static Var Compensator Voltage Regulation 109
4.5.15 ICCP Configuration Model 110
4.5.16 Feeder Model 117
4.5.17 Control area modelling 117
4.6 Modelling guidelines 119
4.6.1 Modelling for change 119
4.6.2 Process for amendments to the CIM 119
4.6.3 Changes to the CIM UML model 120
4.6.4 Changes to the CIM standards documents 120
4.6.5 Deprecations 120
4.6.6 CIM profiles 120
4.7 Modelling tools 121
4.8 User implementation conventions 121
4.8.1 Conventions beyond UML 121
4.8.2 Number of terminals for ConductingEquipment objects 121
4.8.3 Nominal quantities 122
4.8.4 Datatypes 122
4.9 CIM modelling examples 122

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5 Detailed model 122
5.1 Overview 122
5.2 Context 122
6 Package Base 124
6.1 General 124
6.2 Package Domain 124
6.2.1 General 124
6.2.2 ActivePower datatype 130
6.2.3 ActivePowerChangeRate datatype 131
6.2.4 ActivePowerPerCurrentFlow datatype 131
6.2.5 ActivePowerPerFrequency datatype 131
6.2.6 Admittance datatype 131
6.2.7 AngleDegrees datatype 132
6.2.8 AngleRadians datatype 132
6.2.9 ApparentPower datatype 132
6.2.10 Area datatype 132
6.2.11 Boolean primitive 133
6.2.12 Capacitance datatype 133
6.2.13 CapacitancePerLength datatype 133
6.2.14 Classification datatype 133
6.2.15 Conductance datatype 133
6.2.16 ConductancePerLength datatype 134
6.2.17 CostPerEnergyUnit datatype 134
6.2.18 CostPerHeatUnit datatype 134
6.2.19 CostPerVolume datatype 134
6.2.20 CostRate datatype 135
6.2.21 Currency enumeration 135
6.2.22 CurrentFlow datatype 139
6.2.23 Damping datatype 139
6.2.24 Date primitive 139
6.2.25 DateInterval compound 139
6.2.26 DateTime primitive 140
6.2.27 DateTimeInterval compound 140
6.2.28 Decimal primitive 140
6.2.29 DecimalQuantity compound 140
6.2.30 Displacement datatype 140
6.2.31 Duration primitive 141
6.2.32 Emission datatype 141
6.2.33 Float primitive 141
6.2.34 FloatQuantity compound 141
6.2.35 Frequency datatype 141
6.2.36 HeatRate datatype 142
6.2.37 Hours datatype 142
6.2.38 Impedance datatype 142
6.2.39 Inductance datatype 142
6.2.40 InductancePerLength datatype 143
6.2.41 Integer primitive 143
6.2.42 IntegerQuantity compound 143
6.2.43 KiloActivePower datatype 143

IECNORM.COM : Click to view the full PDF of IEC 61970-301:2020+AMD1:2022 CSV

6.2.44 Length datatype 144
6.2.45 Mass datatype 144
6.2.46 Minutes datatype 144
6.2.47 Money datatype 144
6.2.48 MonthDay primitive 145
6.2.49 MonthDayInterval compound 145
6.2.50 PU datatype 145
6.2.51 PerCent datatype 145
6.2.52 Pressure datatype 145
6.2.53 Reactance datatype 146
6.2.54 ReactancePerLength datatype 146
6.2.55 ReactivePower datatype 146
6.2.56 RealEnergy datatype 146
6.2.57 Resistance datatype 147
6.2.58 ResistancePerLength datatype 147
6.2.59 RotationSpeed datatype 147
6.2.60 Seconds datatype 148
6.2.61 Speed datatype 148
6.2.62 String primitive 148
6.2.63 StringQuantity compound 148
6.2.64 Susceptance datatype 148
6.2.65 SusceptancePerLength datatype 149
6.2.66 Temperature datatype 149
6.2.67 Time primitive 149
6.2.68 TimeInterval compound 149
6.2.69 UnitMultiplier enumeration 150
6.2.70 UnitSymbol enumeration 151
6.2.71 Voltage datatype 156
6.2.72 VoltagePerReactivePower datatype 156
6.2.73 Volume datatype 156
6.2.74 VolumeFlowRate datatype 157
6.2.75 WaterLevel datatype 157
6.3 Package Core 157
6.3.1 General 157
6.3.2 ACDCTerminal 162
6.3.3 BaseFrequency 163
6.3.4 BasePower 164
6.3.5 BaseVoltage 164
6.3.6 BasicIntervalSchedule 165
6.3.7 Bay 165
6.3.8 BreakerConfiguration enumeration 166
6.3.9 BusbarConfiguration enumeration 167
6.3.10 ConductingEquipment 167
6.3.11 ConnectivityNode 168
6.3.12 ConnectivityNodeContainer 169
6.3.13 Curve 169
6.3.14 CurveData root class 170
6.3.15 CurveStyle enumeration 171
6.3.16 Equipment 171

IECNORM.COM : Click to view the full PDF of IEC 61970-301:2020+AMD1:2022 CSV

6.3.17 EquipmentContainer 172
6.3.18 Feeder 173
6.3.19 GeographicalRegion 174
6.3.20 IdentifiedObject root class 175
6.3.21 IrregularIntervalSchedule 176
6.3.22 IrregularTimePoint root class 176
6.3.23 Name root class 177
6.3.24 NameType root class 177
6.3.25 NameTypeAuthority root class 178
6.3.26 OperatingParticipant 178
6.3.27 OperatingShare root class 179
6.3.28 PSRType 179
6.3.29 PhaseCode enumeration 180
6.3.30 PowerSystemResource 181
6.3.31 RegularIntervalSchedule 181
6.3.32 RegularTimePoint root class 182
6.3.33 ReportingGroup 183
6.3.34 ReportingSuperGroup 183
6.3.35 SubGeographicalRegion 184
6.3.36 Substation 185
6.3.37 Terminal 186
6.3.38 VoltageLevel 187
6.4 Package Wires 188
6.4.1 General 188
6.4.2 AsynchronousMachineKind enumeration 203
6.4.3 ACLineSegment 204
6.4.4 ACLineSegmentPhase 205
6.4.5 AsynchronousMachine 206
6.4.6 Breaker 208
6.4.7 BusbarSection 210
6.4.8 Clamp 211
6.4.9 CompositeSwitch 212
6.4.10 Conductor 213
6.4.11 Connector 214
6.4.12 CoolantType enumeration 215
6.4.13 Cut 215
6.4.14 Disconnector 217
6.4.15 DisconnectingCircuitBreaker 218
6.4.16 EarthFaultCompensator 219
6.4.17 EnergyConnection 220
6.4.18 EnergyConsumer 221
6.4.19 EnergyConsumerPhase 223
6.4.20 EnergySchedulingType 224
6.4.21 EnergySource 224
6.4.22 EnergySourcePhase 226
6.4.23 ExternalNetworkInjection 227
6.4.24 FrequencyConverter 229
6.4.25 Fuse 230
6.4.26 Ground 231

IECNORM.COM : Click to view the full PDF of IEC 61970-301:2020+AMD1:2022 CSV

6.4.27 GroundingImpedance 232
6.4.28 GroundDisconnector 233
6.4.29 Jumper 234
6.4.30 Junction 236
6.4.31 Line 236
6.4.32 LinearShuntCompensator 237
6.4.33 LinearShuntCompensatorPhase 239
6.4.34 LoadBreakSwitch 239
6.4.35 MutualCoupling 241
6.4.36 NonlinearShuntCompensator 242
6.4.37 NonlinearShuntCompensatorPhase 243
6.4.38 NonlinearShuntCompensatorPhasePoint root class 244
6.4.39 NonlinearShuntCompensatorPoint root class 245
6.4.40 PerLengthImpedance 245
6.4.41 PerLengthLineParameter 246
6.4.42 PerLengthPhaseImpedance 246
6.4.43 PerLengthSequenceImpedance 247
6.4.44 PetersenCoil 248
6.4.45 PetersenCoilModeKind enumeration 249
6.4.46 PhaseImpedanceData root class 249
6.4.47 PhaseShuntConnectionKind enumeration 250
6.4.48 PhaseTapChanger 251
6.4.49 PhaseTapChangerAsymmetrical 252
6.4.50 PhaseTapChangerLinear 253
6.4.51 PhaseTapChangerNonLinear 254
6.4.52 PhaseTapChangerSymmetrical 256
6.4.53 PhaseTapChangerTable 257
6.4.54 PhaseTapChangerTablePoint 257
6.4.55 PhaseTapChangerTabular 258
6.4.56 Plant 259
6.4.57 PowerElectronicsConnection 260
6.4.58 PowerElectronicsConnectionPhase 261
6.4.59 PowerTransformer 262
6.4.60 PowerTransformerEnd 264
6.4.61 ProtectedSwitch 266
6.4.62 RatioTapChanger 268
6.4.63 RatioTapChangerTable 269
6.4.64 RatioTapChangerTablePoint 269
6.4.65 ReactiveCapabilityCurve 270
6.4.66 Recloser 271
6.4.67 RegulatingCondEq 272
6.4.68 RegulatingControl 273
6.4.69 RegulatingControlModeKind enumeration 275
6.4.70 RegulationSchedule 275
6.4.71 RotatingMachine 276
6.4.72 Sectionaliser 278
6.4.73 SeriesCompensator 279
6.4.74 ShortCircuitRotorKind enumeration 280
6.4.75 ShuntCompensator 280

IECNORM.COM : Click to view the full PDF of IEC 61970-301:2020+AMD1:2022 CSV

6.4.76 ShuntCompensatorPhase 282
6.4.77 SinglePhaseKind enumeration 283
6.4.78 StaticVarCompensator 284
6.4.79 SVCControlMode enumeration 285
6.4.80 Switch 285
6.4.81 SwitchPhase 287
6.4.82 SwitchSchedule 288
6.4.83 SynchronousMachine 289
6.4.84 SynchronousMachineOperatingMode enumeration 292
6.4.85 SynchronousMachineKind enumeration 292
6.4.86 TapChanger 292
6.4.87 TapChangerControl 294
6.4.88 TapChangerTablePoint root class 295
6.4.89 TapSchedule 296
6.4.90 TransformerControlMode enumeration 297
6.4.91 TransformerCoreAdmittance 297
6.4.92 TransformerEnd 298
6.4.93 TransformerMeshImpedance 299
6.4.94 TransformerStarImpedance 300
6.4.95 TransformerTank 301
6.4.96 TransformerTankEnd 301
6.4.97 VoltageControlZone 302
6.4.98 WireSegment 303
6.4.99 WireSegmentPhase 304
6.4.100 WindingConnection enumeration 305
6.5 Package LoadModel 305
6.5.1 General 305
6.5.2 ConformLoad 306
6.5.3 ConformLoadGroup 308
6.5.4 ConformLoadSchedule 308
6.5.5 DayType 309
6.5.6 EnergyArea 310
6.5.7 LoadArea 310
6.5.8 LoadGroup 311
6.5.9 LoadResponseCharacteristic 311
6.5.10 NonConformLoad 313
6.5.11 NonConformLoadGroup 314
6.5.12 NonConformLoadSchedule 315
6.5.13 PowerCutZone 316
6.5.14 Season 316
6.5.15 SeasonDayTypeSchedule 317
6.5.16 StationSupply 317
6.5.17 SubLoadArea 319
6.6 Package Generation 319
6.6.1 General 319
6.6.2 Package GenerationTrainingSimulation 320
6.6.3 Package Production 336
6.7 Package DC 388
6.7.1 General 388

IECNORM.COM : Click to view the full PDF of IEC 61970-301:2020+AMD1:2022 CSV

6.7.2 ACDCConverter 392
6.7.3 ACDCConverterDCTerminal 395
6.7.4 CsConverter 396
6.7.5 DCTopologicalNode 398
6.7.6 CsOperatingModeKind enumeration 399
6.7.7 CsPpccControlKind enumeration 399
6.7.8 DCBaseTerminal 399
6.7.9 DCBreaker 400
6.7.10 DCBusbar 401
6.7.11 DCChopper 402
6.7.12 DCConductingEquipment 403
6.7.13 DCConverterOperatingModeKind enumeration 404
6.7.14 DCConverterUnit 404
6.7.15 DCDisconnector 405
6.7.16 DCEquipmentContainer 406
6.7.17 DCGround 407
6.7.18 DCLine 408
6.7.19 DCLineSegment 409
6.7.20 DCNode 410
6.7.21 DCPolarityKind enumeration 411
6.7.22 DCSeriesDevice 411
6.7.23 DCShunt 412
6.7.24 DCSwitch 413
6.7.25 DCTerminal 414
6.7.26 DCTopologicalIsland 415
6.7.27 PerLengthDCLineParameter 415
6.7.28 VsCapabilityCurve 416
6.7.29 VsConverter 416
6.7.30 VsPpccControlKind enumeration 419
6.7.31 VsQpccControlKind enumeration 419
6.8 Package Equivalents 420
6.8.1 General 420
6.8.2 EquivalentBranch 421
6.8.3 EquivalentEquipment 424
6.8.4 EquivalentInjection 425
6.8.5 EquivalentNetwork 427
6.8.6 EquivalentShunt 428
6.9 Package AuxiliaryEquipment 429
6.9.1 General 429
6.9.2 AuxiliaryEquipment 430
6.9.3 CurrentTransformer 431
6.9.4 FaultIndicator 432
6.9.5 PostLineSensor 433
6.9.6 PotentialTransformer 434
6.9.7 PotentialTransformerKind enumeration 435
6.9.8 Sensor 436
6.9.9 SurgeArrester 437
6.9.10 WaveTrap 437
6.10 Package Meas 438

IECNORM.COM : Click to view the full PDF of IEC 61970-301:2020+AMD1:2022 CSV

6.10.1 General 438
6.10.2 Accumulator 442
6.10.3 AccumulatorLimit 443
6.10.4 AccumulatorLimitSet 443
6.10.5 AccumulatorReset 444
6.10.6 AccumulatorValue 445
6.10.7 Analog 446
6.10.8 AnalogControl 446
6.10.9 AnalogLimit 447
6.10.10 AnalogLimitSet 448
6.10.11 AnalogValue 448
6.10.12 Command 449
6.10.13 Control 450
6.10.14 Discrete 451
6.10.15 DiscreteValue 452
6.10.16 IOPoint 453
6.10.17 Limit 454
6.10.18 LimitSet 454
6.10.19 Measurement 455
6.10.20 MeasurementValue 456
6.10.21 MeasurementValueQuality 457
6.10.22 MeasurementValueSource 458
6.10.23 Quality61850 root class 458
6.10.24 RaiseLowerCommand 459
6.10.25 SetPoint 460
6.10.26 StringMeasurement 461
6.10.27 StringMeasurementValue 462
6.10.28 Validity enumeration 462
6.10.29 ValueAliasSet 463
6.10.30 ValueToAlias 464
6.11 Package Topology 464
6.11.1 General 464
6.11.2 BusNameMarker 466
6.11.3 TopologicalIsland 466
6.11.4 TopologicalNode 467
6.12 Package DiagramLayout 468
6.12.1 General 468
6.12.2 Diagram 469
6.12.3 DiagramObject 470
6.12.4 DiagramObjectGluePoint root class 471
6.12.5 DiagramObjectPoint root class 472
6.12.6 DiagramObjectStyle 472
6.12.7 DiagramStyle 473
6.12.8 OrientationKind enumeration 473
6.12.9 TextDiagramObject 474
6.12.10 VisibilityLayer 475
6.13 Package OperationalLimits 475
6.13.1 General 475
6.13.2 ActivePowerLimit 477

IECNORM.COM : Click to view the full PDF of IEC 61970-301:2020+AMD1:2022 CSV

6.13.3 ApparentPowerLimit 478
6.13.4 BranchGroup 478
6.13.5 BranchGroupTerminal root class 479
6.13.6 CurrentLimit 480
6.13.7 OperationalLimit 480
6.13.8 OperationalLimitDirectionKind enumeration 481
6.13.9 OperationalLimitSet 481
6.13.10 OperationalLimitType 482
6.13.11 VoltageLimit 483
6.14 Package ControlArea 483
6.14.1 General 483
6.14.2 AltGeneratingUnitMeas 485
6.14.3 AltTieMeas 486
6.14.4 ControlArea 487
6.14.5 ControlAreaGeneratingUnit 488
6.14.6 ControlAreaTypeKind enumeration 489
6.14.7 TieFlow 489
6.15 Package Contingency 490
6.15.1 General 490
6.15.2 Contingency 490
6.15.3 ContingencyElement 491
6.15.4 ContingencyEquipment 491
6.15.5 ContingencyEquipmentStatusKind enumeration 492
6.16 Package StateVariables 492
6.16.1 General 492
6.16.2 StateVariable root class 493
6.16.3 SvInjection 493
6.16.4 SvPowerFlow 494
6.16.5 SvShuntCompensatorSections 494
6.16.6 SvStatus 495
6.16.7 SvSwitch 495
6.16.8 SvTapStep 496
6.16.9 SvVoltage 496
6.17 Package Protection 497
6.17.1 General 497
6.17.2 CurrentRelay 498
6.17.3 ProtectionEquipment 499
6.17.4 RecloseSequence 500
6.17.5 SynchrocheckRelay 501
6.18 Package Faults 502
6.18.1 General 502
6.18.2 EquipmentFault 503
6.18.3 Fault 503
6.18.4 FaultCauseType 504
6.18.5 FaultImpedance compound 504
6.18.6 LineFault 505
6.18.7 PhaseConnectedFaultKind enumeration 505
6.19 Package SCADA 506
6.19.1 General 506

IECNORM.COM : Click to view the full PDF of IEC 61970-301:2020+AMD1:2022 CSV

6.19.2 CommunicationLink 507
6.19.3 RemoteControl 508
6.19.4 RemotePoint 508
6.19.5 RemoteSource 509
6.19.6 RemoteUnit 510
6.19.7 RemoteUnitType enumeration 510
6.19.8 Source enumeration 511
6.20 Package ICCPConfiguration 511
6.20.1 General 511
6.20.2 ApplicationSecurityKind enumeration 513
6.20.3 BilateralExchangeActor 514
6.20.4 BilateralExchangeAgreement 514
6.20.5 ICCPAccessPrivilegeKind enumeration 515
6.20.6 ICCPInformationMessage 515
6.20.7 ICCPPointKind enumeration 516
6.20.8 ICCPProvidedPoint 516
6.20.9 ICCPQualityKind enumeration 517
6.20.10 ICCPScopeKind enumeration 518
6.20.11 ICCPVCC 518
6.20.12 ICCPVirtualControlCentre 519
6.20.13 IOPointSource 520
6.20.14 IPAccessPoint 521
6.20.15 IPAddressKind enumeration 522
6.20.16 ISOUpperLayer 522
6.20.17 ProvidedBilateralPoint 523
6.20.18 PublicX509Certificate root class 523
6.20.19 TASE2BilateralTable 524
6.20.20 TCPAccessPoint 525
Annex A (normative) Custom extensions 527
A.1 Overview 527
A.2 European extensions 527
A.2.1 General 527
A.2.2 Package ExtEuCore 527
A.2.3 Package ExtEuOperationalLimits 531
A.2.4 Package ExtEuGeneration 533
Annex B (informative) Examples of PST transformer modelling 536
B.1 General 536
B.2 Detailed calculations and examples 536
B.2.1 Symmetrical phase shifters with two cores 536
B.2.2 Quadrature boosters 540
B.2.3 Asymmetrical phase shifter 544
Annex C (informative) Use cases HVDC representation 551
C.1 Overview 551
C.2 Back-to-back installations 551
C.3 Monopole with ground return 552
C.4 Monopole with metallic return 553
C.5 Voltage source converter 554
Bibliography 556

IECNORM.COM : Click to view the full PDF of IEC 61970-301:2020+AMD1:2022 CSV

Figure 1 – Defined dependencies between CIM packages and packages' versions information 42
Figure 2 – CIM IEC 61970-301 package diagram 43
Figure 3 – Example of generalization 45
Figure 4 – Example of simple association 46
Figure 5 – Example of aggregation 46
Figure 6 – Equipment containers 48
Figure 7 – Names 49
Figure 8 – Connectivity model 50
Figure 9 – Simple network example 51
Figure 10 – Simple network connectivity modelled with CIM Topology 52
Figure 11 – Equipment inheritance hierarchy 53
Figure 12 – Transformer and Tank model 55
Figure 13 – Transformer model 57
Figure 14 – Transformer tap model 58
Figure 15 – Phasor diagram and equations 61
Figure 16 – Symmetrical phase shifter impedance variation 62
Figure 17 – Core organization 63
Figure 18 – Phasor diagram and equations 63
Figure 19 – Core organization 64
Figure 20 – Phasor diagram and equations 65
Figure 21 – Core organization 66
Figure 22 – Phasor diagram and equations 66
Figure 23 – Phasor diagrams and equations 68
Figure 24 – Core organization 69
Figure 25 – Phase wire data model 71
Figure 26 – Phase connectivity 72
Figure 27 – Grounding device data model 74
Figure 28 – Station including Petersen coils drawing example 75
Figure 29 – Instance diagram objects with one terminal coil 76
Figure 30 – Cuts, clamps, and jumpers UML model 77
Figure 31 – Example before cuts and jumpers are applied 78
Figure 32 – Example after cuts and jumpers are applied 79
Figure 33 – Example of jumper without cut or clamp 80
Figure 34 – Navigating from PSR to MeasurementValue 82
Figure 35 – Measurement placement 85
Figure 36 – Regulating control models 87
Figure 37 – Simplified example of HVDC model representation 89
Figure 38 – Detailed example of HVDC model representation with fictitious HVDC substations 90
Figure 39 – Detailed example of HVDC model representation with no fictitious HVDC substations 91
Figure 40 – HVDC bi-polar link from IEC 60633 92

IECNORM.COM : Click to view the full PDF of IEC 61970-301:2020+AMD1:2022 CSV

Figure 41 – A point-to-point VSC transmission scheme 92
Figure 42 – HVDC power flow model 93
Figure 43 – Detailed HVDC power flow model 94
Figure 44 – Current Source Converter power flow 94
Figure 45 – Voltage Source Converter power flow 95
Figure 46 – Power flow cases 96
Figure 47 – VSC transmission with a symmetrical monopole illustrated with capacitive earthing on the DC side (IEC 62747) 97
Figure 48 – VSC P-Q capability curve 97
Figure 49 – Bipolar VSC transmission with earth return (IEC 62747) 98
Figure 50 – Object instances for a bi-polar current source HVDC line 99
Figure 51 – Object instances for symmetric monopole VSC HVDC data model 100
Figure 52 – Containment structure for a bipolar HVDC line 101
Figure 53 – Containment structure for a bipolar back-to-back HVDC station 102
Figure 54 – The Basic topology in package Core 103
Figure 55 – DC and AC topology 104
Figure 56 – Equipment model 105
Figure 57 – HVDC line model 106
Figure 58 – Legend 107
Figure 59 – Simple monopole with measurements 107
Figure 60 – Simple bipolar 108
Figure 61 – Monopole one side with detailed model 108
Figure 62 – V-I Characteristic of SVC 109
Figure 63 – ICCP measurements and network models 111
Figure 64 – ICCP configuration and start up 111
Figure 65 – Measurement value provider and consumer example 112
Figure 66 – Generalized bilateral exchange agreement data model 114
Figure 67 – ICCP bilateral exchange agreement data model 116
Figure 68 – Feeder data model 117
Figure 69 – Orientation of the Terminal flow 118
Figure 70 – Several ways to describe control area ties 119
Figure 71 – CIM top level packages 123
Figure 72 – Class diagram Domain::CombinedElectricalDatatypes 125
Figure 73 – Class diagram Domain::BasicDatatypes 125
Figure 74 – Class diagram Domain::ElectricityDatatypes 126
Figure 75 – Class diagram Domain::EnumeratedUnitDatatypes 127
Figure 76 – Class diagram Domain::GeneralDatatypes 128
Figure 77 – Class diagram Domain::MonetaryDatatypes 129
Figure 78 – Class diagram Domain::TimeDatatypes 130
Figure 79 – Class diagram Core::Main 158
Figure 80 – Class diagram Core::Names 159
Figure 81 – Class diagram Core::CurveSchedule 159
Figure 82 – Class diagram Core::Datatypes 160
IECNORM.COM : Click to view the full PDF of IEC 61970-301:2020+AMD1:2022 CSV

Figure 83 – Class diagram Core::FeederContainment 161
Figure 84 – Class diagram Core::Reporting 161
Figure 85 – Class diagram Core::OperatingShare 162
Figure 86 – Class diagram Wires::CutsAndJumpers 189
Figure 87 – Class diagram Wires::Datatypes 190
Figure 88 – Class diagram Wires::EarthFaultCompensator 191
Figure 89 – Class diagram Wires::InheritanceHierarchy 192
Figure 90 – Class diagram Wires::LineModel 193
Figure 91 – Class diagram Wires::MutualCoupling 194
Figure 92 – Class diagram Wires::NamingHierarchyPart1 195
Figure 93 – Class diagram Wires::NamingHierarchyPart2 196
Figure 94 – Class diagram Wires::RegulatingEquipment 197
Figure 95 – Class diagram Wires::Schedules 198
Figure 96 – Class diagram Wires::ShuntCompensator 198
Figure 97 – Class diagram Wires::SwitchingEquipment 199
Figure 98 – Class diagram Wires::TapChanger 200
Figure 99 – Class diagram Wires::VoltageControl 201
Figure 100 – Class diagram Wires::WiresPhaseModel 202
Figure 101 – Class diagram Wires::Transformer 203
Figure 102 – Class diagram LoadModel::Main 306
Figure 103 – Class diagram Generation::Main 320
Figure 104 – Class diagram GenerationTrainingSimulation::Main 320
Figure 105 – Class diagram GenerationTrainingSimulation::Datatypes 321
Figure 106 – Class diagram Production::PowerElectronics 336
Figure 107 – Class diagram Production::Nuclear 337
Figure 108 – Class diagram Production::Main 338
Figure 109 – Class diagram Production::Datatypes 339
Figure 110 – Class diagram Production::Hydro 340
Figure 111 – Class diagram Production::Thermal 341
Figure 112 – Class diagram DC::DCContainment 388
Figure 113 – Class diagram DC::DCEquipment 389
Figure 114 – Class diagram DC::DCLineModel 390
Figure 115 – Class diagram DC::ACDCConverter 391
Figure 116 – Class diagram DC::ACDCConnectivityModel 392
Figure 117 – Class diagram Equivalents::Main 421
Figure 118 – Class diagram AuxiliaryEquipment::AuxiliaryEquipment 430
Figure 119 – Class diagram Meas::Control 439
Figure 120 – Class diagram Meas::Datatypes 439
Figure 121 – Class diagram Meas::Measurement 440
Figure 122 – Class diagram Meas::MeasurementInheritance 441
Figure 123 – Class diagram Meas::Quality 442
Figure 124 – Class diagram Topology::Main 465
Figure 125 – Class diagram Topology::TopologyReporting 465
IECNORM.COM : Click to view the full PDF of IEC 61970-301:2020+AMD1:2022 CSV

Figure 126 – Class diagram DiagramLayout::DiagramLayout 469
Figure 127 – Class diagram OperationalLimits::OperationalLimits 476
Figure 128 – Class diagram OperationalLimits::BranchGroup 477
Figure 129 – Class diagram ControlArea::ControlArea 484
Figure 130 – Class diagram ControlArea::ControlAreaInheritance 485
Figure 131 – Class diagram ControlArea::Datatypes 485
Figure 132 – Class diagram Contingency::Contingency 490
Figure 133 – Class diagram StateVariables::StateVariables 493
Figure 134 – Class diagram Protection::Main 497
Figure 135 – Class diagram Faults::Faults 502
Figure 136 – Class diagram SCADA::Datatypes 506
Figure 137 – Class diagram SCADA::Main 507
Figure 138 – Class diagram ICCPConfiguration::GenericBilateralExchange 512
Figure 139 – Class diagram ICCPConfiguration::ICCP 513
Figure A.1 – Class diagram ExtEuBase::ExtEuBase 527
Figure A.2 – Class diagram ExtEuCore::ExtEuCore 528
Figure A.3 – Class diagram ExtEuOperationalLimits::ExtEuOperationalLimits 531
Figure A.4 – Class diagram ExtEuProduction::ExtEuProduction 533
Figure B.1 – Symmetrical phase shifters with two cores 536
Figure B.2 – Detailed three phase diagram 537
Figure B.3 – Detailed three phase diagram 540
Figure B.4 – Single phase diagram 541
Figure B.5 – Phasor diagram 542
Figure B.6 – Detailed three phase diagram 543
Figure B.7 – Phasor diagram 544
Figure B.8 – Asymmetrical phase shifter with two cores 544
Figure B.9 – Detailed three phase diagram 545
Figure B.10 – Phasor diagram 546
Figure B.11 – Asymmetrical phase shifter with a single core 547
Figure B.12 – Phasor diagram 548
Figure B.13 – Example of detailed three-phase diagram of voltage regulating auto-transformer and quadrature booster 549
Figure B.14 – Example of detailed winding diagram of voltage regulating auto-transformer and quadrature booster 550
Figure C.1 – Representation of a 12-p back-to-back installation 552
Figure C.2 – Representation of a 12-p monopole installation with ground return 553
Figure C.3 – Representation of a 12-p monopole installation with metallic return 554
Figure C.4 – Representation of a voltage source converter 555

Table 1 – Mapping of phase shift transformers to CIM classes 59
Table 2 – Mapping of symbols used in formulas to CIM attributes 60
Table 3 – Impedance variations in a phase shift transformer 60
Table 4 – Description of variables 61
Table 5 – Tap changer control options 70
IECNORM.COM : Click to view the full PDF of IEC 61970-301:2020+AMD1:2022 CSV

Table 6 – measurementType naming conventions 83
Table 7 – MeasurementValueSource naming conventions 84
Table 8 – Attributes of Package1::Class1 123
Table 9 – Association ends of Package1::Class1 with other classes 124
Table 10 – Literals of Package1::Enumeration1 124
Table 11 – Attributes of Domain::ActivePower 130
Table 12 – Attributes of Domain::ActivePowerChangeRate 131
Table 13 – Attributes of Domain::ActivePowerPerCurrentFlow 131
Table 14 – Attributes of Domain::ActivePowerPerFrequency 131
Table 15 – Attributes of Domain::Admittance 131
Table 16 – Attributes of Domain::AngleDegrees 132
Table 17 – Attributes of Domain::AngleRadians 132
Table 18 – Attributes of Domain::ApparentPower 132
Table 19 – Attributes of Domain::Area 132
Table 20 – Attributes of Domain::Capacitance 133
Table 21 – Attributes of Domain::CapacitancePerLength 133
Table 22 – Attributes of Domain::Classification 133
Table 23 – Attributes of Domain::Conductance 134
Table 24 – Attributes of Domain::ConductancePerLength 134
Table 25 – Attributes of Domain::CostPerEnergyUnit 134
Table 26 – Attributes of Domain::CostPerHeatUnit 134
Table 27 – Attributes of Domain::CostPerVolume 135
Table 28 – Attributes of Domain::CostRate 135
Table 29 – Literals of Domain::Currency 135
Table 30 – Attributes of Domain::CurrentFlow 139
Table 31 – Attributes of Domain::Damping 139
Table 32 – Attributes of Domain::DateInterval 140
Table 33 – Attributes of Domain::DateTimeInterval 140
Table 34 – Attributes of Domain::DecimalQuantity 140
Table 35 – Attributes of Domain::Displacement 141
Table 36 – Attributes of Domain::Emission 141
Table 37 – Attributes of Domain::FloatQuantity 141
Table 38 – Attributes of Domain::Frequency 142
Table 39 – Attributes of Domain::HeatRate 142
Table 40 – Attributes of Domain::Hours 142
Table 41 – Attributes of Domain::Impedance 142
Table 42 – Attributes of Domain::Inductance 143
Table 43 – Attributes of Domain::InductancePerLength 143
Table 44 – Attributes of Domain::IntegerQuantity 143
Table 45 – Attributes of Domain::KiloActivePower 143
Table 46 – Attributes of Domain::Length 144
Table 47 – Attributes of Domain::Mass 144
Table 48 – Attributes of Domain::Minutes 144
IECNORM.COM : Click to view the full PDF of IEC 61970-301:2020+AMD1:2022 CSV

Table 49 – Attributes of Domain::Money 144
Table 50 – Attributes of Domain::MonthDayInterval 145
Table 51 – Attributes of Domain::PU 145
Table 52 – Attributes of Domain::PerCent 145
Table 53 – Attributes of Domain::Pressure 146
Table 54 – Attributes of Domain::Reactance 146
Table 55 – Attributes of Domain::ReactancePerLength 146
Table 56 – Attributes of Domain::ReactivePower 146
Table 57 – Attributes of Domain::RealEnergy 147
Table 58 – Attributes of Domain::Resistance 147
Table 59 – Attributes of Domain::ResistancePerLength 147
Table 60 – Attributes of Domain::RotationSpeed 147
Table 61 – Attributes of Domain::Seconds 148
Table 62 – Attributes of Domain::Speed 148
Table 63 – Attributes of Domain::StringQuantity 148
Table 64 – Attributes of Domain::Susceptance 149
Table 65 – Attributes of Domain::SusceptancePerLength 149
Table 66 – Attributes of Domain::Temperature 149
Table 67 – Attributes of Domain::TimeInterval 149
Table 68 – Literals of Domain::UnitMultiplier 150
Table 69 – Literals of Domain::UnitSymbol 151
Table 70 – Attributes of Domain::Voltage 156
Table 71 – Attributes of Domain::VoltagePerReactivePower 156
Table 72 – Attributes of Domain::Volume 156
Table 73 – Attributes of Domain::VolumeFlowRate 157
Table 74 – Attributes of Domain::WaterLevel 157
Table 75 – Attributes of Core::ACDCTerminal 162
Table 76 – Association ends of Core::ACDCTerminal with other classes 163
Table 77 – Attributes of Core::BaseFrequency 163
Table 78 – Association ends of Core::BaseFrequency with other classes 164
Table 79 – Attributes of Core::BasePower 164
Table 80 – Association ends of Core::BasePower with other classes 164
Table 81 – Attributes of Core::BaseVoltage 164
Table 82 – Association ends of Core::BaseVoltage with other classes 165
Table 83 – Attributes of Core::BasicIntervalSchedule 165
Table 84 – Association ends of Core::BasicIntervalSchedule with other classes 165
Table 85 – Attributes of Core::Bay 166
Table 86 – Association ends of Core::Bay with other classes 166
Table 87 – Literals of Core::BreakerConfiguration 167
Table 88 – Literals of Core::BusbarConfiguration 167
Table 89 – Attributes of Core::ConductingEquipment 167
Table 90 – Association ends of Core::ConductingEquipment with other classes 168
Table 91 – Attributes of Core::ConnectivityNode 168
IECNORM.COM : Click to view the full PDF of IEC 61970-301:2020+AMD1:2022 CSV

Table 92 – Association ends of Core::ConnectivityNode with other classes 169
Table 93 – Attributes of Core::ConnectivityNodeContainer 169
Table 94 – Association ends of Core::ConnectivityNodeContainer with other classes 169
Table 95 – Attributes of Core::Curve 170
Table 96 – Association ends of Core::Curve with other classes 170
Table 97 – Attributes of Core::CurveData 170
Table 98 – Association ends of Core::CurveData with other classes 171
Table 99 – Literals of Core::CurveStyle 171
Table 100 – Attributes of Core::Equipment 171
Table 101 – Association ends of Core::Equipment with other classes 172
Table 102 – Attributes of Core::EquipmentContainer 172
Table 103 – Association ends of Core::EquipmentContainer with other classes 173
Table 104 – Attributes of Core::Feeder 173
Table 105 – Association ends of Core::Feeder with other classes 174
Table 106 – Attributes of Core::GeographicalRegion 174
Table 107 – Association ends of Core::GeographicalRegion with other classes 175
Table 108 – Attributes of Core::IdentifiedObject 175
Table 109 – Association ends of Core::IdentifiedObject with other classes 175
Table 110 – Attributes of Core::IrregularIntervalSchedule 176
Table 111 – Association ends of Core::IrregularIntervalSchedule with other classes 176
Table 112 – Attributes of Core::IrregularTimePoint 176
Table 113 – Association ends of Core::IrregularTimePoint with other classes 177
Table 114 – Attributes of Core::Name 177
Table 115 – Association ends of Core::Name with other classes 177
Table 116 – Attributes of Core::NameType 177
Table 117 – Association ends of Core::NameType with other classes 178
Table 118 – Attributes of Core::NameTypeAuthority 178
Table 119 – Association ends of Core::NameTypeAuthority with other classes 178
Table 120 – Attributes of Core::OperatingParticipant 178
Table 121 – Association ends of Core::OperatingParticipant with other classes 179
Table 122 – Attributes of Core::OperatingShare 179
Table 123 – Association ends of Core::OperatingShare with other classes 179
Table 124 – Attributes of Core::PSRType 179
Table 125 – Association ends of Core::PSRType with other classes 180
Table 126 – Literals of Core::PhaseCode 180
Table 127 – Attributes of Core::PowerSystemResource 181
Table 128 – Association ends of Core::PowerSystemResource with other classes 181
Table 129 – Attributes of Core::RegularIntervalSchedule 182
Table 130 – Association ends of Core::RegularIntervalSchedule with other classes 182
Table 131 – Attributes of Core::RegularTimePoint 182
Table 132 – Association ends of Core::RegularTimePoint with other classes 183
Table 133 – Attributes of Core::ReportingGroup 183
Table 134 – Association ends of Core::ReportingGroup with other classes 183
IECNORM.COM : Click to view the full PDF of IEC 61970-301:2020+AMD1:2022 CSV

Table 135 – Attributes of Core::ReportingSuperGroup 184
Table 136 – Association ends of Core::ReportingSuperGroup with other classes 184
Table 137 – Attributes of Core::SubGeographicalRegion 184
Table 138 – Association ends of Core::SubGeographicalRegion with other classes 184
Table 139 – Attributes of Core::Substation 185
Table 140 – Association ends of Core::Substation with other classes 185
Table 141 – Attributes of Core::Terminal 186
Table 142 – Association ends of Core::Terminal with other classes 186
Table 143 – Attributes of Core::VoltageLevel 187
Table 144 – Association ends of Core::VoltageLevel with other classes 188
Table 145 – Literals of Wires::AsynchronousMachineKind 204
Table 146 – Attributes of Wires::ACLineSegment 204
Table 147 – Association ends of Wires::ACLineSegment with other classes 205
Table 148 – Attributes of Wires::ACLineSegmentPhase 206
Table 149 – Association ends of Wires::ACLineSegmentPhase with other classes 206
Table 150 – Attributes of Wires::AsynchronousMachine 207
Table 151 – Association ends of Wires::AsynchronousMachine with other classes 208
Table 152 – Attributes of Wires::Breaker 209
Table 153 – Association ends of Wires::Breaker with other classes 209
Table 154 – Attributes of Wires::BusbarSection 210
Table 155 – Association ends of Wires::BusbarSection with other classes 210
Table 156 – Attributes of Wires::Clamp 211
Table 157 – Association ends of Wires::Clamp with other classes 212
Table 158 – Attributes of Wires::CompositeSwitch 212
Table 159 – Association ends of Wires::CompositeSwitch with other classes 213
Table 160 – Attributes of Wires::Conductor 213
Table 161 – Association ends of Wires::Conductor with other classes 214
Table 162 – Attributes of Wires::Connector 214
Table 163 – Association ends of Wires::Connector with other classes 215
Table 164 – Literals of Wires::CoolantType 215
Table 165 – Attributes of Wires::Cut 216
Table 166 – Association ends of Wires::Cut with other classes 216
Table 167 – Attributes of Wires::Disconnector 217
Table 168 – Association ends of Wires::Disconnector with other classes 217
Table 169 – Attributes of Wires::DisconnectingCircuitBreaker 218
Table 170 – Association ends of Wires::DisconnectingCircuitBreaker with other classes 219
Table 171 – Attributes of Wires::EarthFaultCompensator 219
Table 172 – Association ends of Wires::EarthFaultCompensator with other classes 220
Table 173 – Attributes of Wires::EnergyConnection 220
Table 174 – Association ends of Wires::EnergyConnection with other classes 221
Table 175 – Attributes of Wires::EnergyConsumer 221
Table 176 – Association ends of Wires::EnergyConsumer with other classes 222
Table 177 – Attributes of Wires::EnergyConsumerPhase 223
IECNORM.COM : Click to view the full PDF of IEC 61970-301:2020+AMD1:2022 CSV

Table 178 – Association ends of Wires::EnergyConsumerPhase with other classes 224
Table 179 – Attributes of Wires::EnergySchedulingType 224
Table 180 – Association ends of Wires::EnergySchedulingType with other classes 224
Table 181 – Attributes of Wires::EnergySource 225
Table 182 – Association ends of Wires::EnergySource with other classes 226
Table 183 – Attributes of Wires::EnergySourcePhase 226
Table 184 – Association ends of Wires::EnergySourcePhase with other classes 227
Table 185 – Attributes of Wires::ExternalNetworkInjection 227
Table 186 – Association ends of Wires::ExternalNetworkInjection with other classes 228
Table 187 – Attributes of Wires::FrequencyConverter 229
Table 188 – Association ends of Wires::FrequencyConverter with other classes 230
Table 189 – Attributes of Wires::Fuse 230
Table 190 – Association ends of Wires::Fuse with other classes 231
Table 191 – Attributes of Wires::Ground 231
Table 192 – Association ends of Wires::Ground with other classes 232
Table 193 – Attributes of Wires::GroundingImpedance 232
Table 194 – Association ends of Wires::GroundingImpedance with other classes 233
Table 195 – Attributes of Wires::GroundDisconnector 233
Table 196 – Association ends of Wires::GroundDisconnector with other classes 234
Table 197 – Attributes of Wires::Jumper 235
Table 198 – Association ends of Wires::Jumper with other classes 235
Table 199 – Attributes of Wires::Junction 236
Table 200 – Association ends of Wires::Junction with other classes 236
Table 201 – Attributes of Wires::Line 237
Table 202 – Association ends of Wires::Line with other classes 237
Table 203 – Attributes of Wires::LinearShuntCompensator 237
Table 204 – Association ends of Wires::LinearShuntCompensator with other classes 238
Table 205 – Attributes of Wires::LinearShuntCompensatorPhase 239
Table 206 – Association ends of Wires::LinearShuntCompensatorPhase with other classes 239
Table 207 – Attributes of Wires::LoadBreakSwitch 240
Table 208 – Association ends of Wires::LoadBreakSwitch with other classes 240
Table 209 – Attributes of Wires::MutualCoupling 241
Table 210 – Association ends of Wires::MutualCoupling with other classes 242
Table 211 – Attributes of Wires::NonlinearShuntCompensator 242
Table 212 – Association ends of Wires::NonlinearShuntCompensator with other classes 243
Table 213 – Attributes of Wires::NonlinearShuntCompensatorPhase 243
Table 214 – Association ends of Wires::NonlinearShuntCompensatorPhase with other classes 244
Table 215 – Attributes of Wires::NonlinearShuntCompensatorPhasePoint 244
Table 216 – Association ends of Wires::NonlinearShuntCompensatorPhasePoint with other classes 244
Table 217 – Attributes of Wires::NonlinearShuntCompensatorPoint 245
IECNORM.COM : Click to view the full PDF of IEC 61970-301:2020+AMD1:2022 CSV

Table 218 – Association ends of Wires::NonlinearShuntCompensatorPoint with other classes 245
Table 219 – Attributes of Wires::PerLengthImpedance 245
Table 220 – Association ends of Wires::PerLengthImpedance with other classes 246
Table 221 – Attributes of Wires::PerLengthLineParameter 246
Table 222 – Association ends of Wires::PerLengthLineParameter with other classes 246
Table 223 – Attributes of Wires::PerLengthPhaseImpedance 246
Table 224 – Association ends of Wires::PerLengthPhaseImpedance with other classes 247
Table 225 – Attributes of Wires::PerLengthSequenceImpedance 247
Table 226 – Association ends of Wires::PerLengthSequenceImpedance with other classes 248
Table 227 – Attributes of Wires::PetersenCoil 248
Table 228 – Association ends of Wires::PetersenCoil with other classes 249
Table 229 – Literals of Wires::PetersenCoilModeKind 249
Table 230 – Attributes of Wires::PhaseImpedanceData 250
Table 231 – Association ends of Wires::PhaseImpedanceData with other classes 250
Table 232 – Literals of Wires::PhaseShuntConnectionKind 250
Table 233 – Attributes of Wires::PhaseTapChanger 251
Table 234 – Association ends of Wires::PhaseTapChanger with other classes 251
Table 235 – Attributes of Wires::PhaseTapChangerAsymmetrical 252
Table 236 – Association ends of Wires::PhaseTapChangerAsymmetrical with other classes 253
Table 237 – Attributes of Wires::PhaseTapChangerLinear 253
Table 238 – Association ends of Wires::PhaseTapChangerLinear with other classes 254
Table 239 – Attributes of Wires::PhaseTapChangerNonLinear 255
Table 240 – Association ends of Wires::PhaseTapChangerNonLinear with other classes 255
Table 241 – Attributes of Wires::PhaseTapChangerSymmetrical 256
Table 242 – Association ends of Wires::PhaseTapChangerSymmetrical with other classes 257
Table 243 – Attributes of Wires::PhaseTapChangerTable 257
Table 244 – Association ends of Wires::PhaseTapChangerTable with other classes 257
Table 245 – Attributes of Wires::PhaseTapChangerTablePoint 258
Table 246 – Association ends of Wires::PhaseTapChangerTablePoint with other classes 258
Table 247 – Attributes of Wires::PhaseTapChangerTabular 258
Table 248 – Association ends of Wires::PhaseTapChangerTabular with other classes 259
Table 249 – Attributes of Wires::Plant 259
Table 250 – Association ends of Wires::Plant with other classes 259
Table 251 – Attributes of Wires::PowerElectronicsConnection 260
Table 252 – Association ends of Wires::PowerElectronicsConnection with other classes 261
Table 253 – Attributes of Wires::PowerElectronicsConnectionPhase 262
Table 254 – Association ends of Wires::PowerElectronicsConnectionPhase with other classes 262
Table 255 – Attributes of Wires::PowerTransformer 263
IECNORM.COM : Click to view the full PDF of IEC 61970-301:2020+AMD1:2022 CSV

Table 256 – Association ends of Wires::PowerTransformer with other classes 264
Table 257 – Attributes of Wires::PowerTransformerEnd 265
Table 258 – Association ends of Wires::PowerTransformerEnd with other classes 266
Table 259 – Attributes of Wires::ProtectedSwitch 267
Table 260 – Association ends of Wires::ProtectedSwitch with other classes 267
Table 261 – Attributes of Wires::RatioTapChanger 268
Table 262 – Association ends of Wires::RatioTapChanger with other classes 269
Table 263 – Attributes of Wires::RatioTapChangerTable 269
Table 264 – Association ends of Wires::RatioTapChangerTable with other classes 269
Table 265 – Attributes of Wires::RatioTapChangerTablePoint 270
Table 266 – Association ends of Wires::RatioTapChangerTablePoint with other classes 270
Table 267 – Attributes of Wires::ReactiveCapabilityCurve 270
Table 268 – Association ends of Wires::ReactiveCapabilityCurve with other classes 271
Table 269 – Attributes of Wires::Recloser 271
Table 270 – Association ends of Wires::Recloser with other classes 272
Table 271 – Attributes of Wires::RegulatingCondEq 272
Table 272 – Association ends of Wires::RegulatingCondEq with other classes 273
Table 273 – Attributes of Wires::RegulatingControl 274
Table 274 – Association ends of Wires::RegulatingControl with other classes 275
Table 275 – Literals of Wires::RegulatingControlModeKind 275
Table 276 – Attributes of Wires::RegulationSchedule 276
Table 277 – Association ends of Wires::RegulationSchedule with other classes 276
Table 278 – Attributes of Wires::RotatingMachine 276
Table 279 – Association ends of Wires::RotatingMachine with other classes 277
Table 280 – Attributes of Wires::Sectionaliser 278
Table 281 – Association ends of Wires::Sectionaliser with other classes 278
Table 282 – Attributes of Wires::SeriesCompensator 279
Table 283 – Association ends of Wires::SeriesCompensator with other classes 280
Table 284 – Literals of Wires::ShortCircuitRotorKind 280
Table 285 – Attributes of Wires::ShuntCompensator 281
Table 286 – Association ends of Wires::ShuntCompensator with other classes 282
Table 287 – Attributes of Wires::ShuntCompensatorPhase 282
Table 288 – Association ends of Wires::ShuntCompensatorPhase with other classes 283
Table 289 – Literals of Wires::SinglePhaseKind 284
Table 290 – Attributes of Wires::StaticVarCompensator 284
Table 291 – Association ends of Wires::StaticVarCompensator with other classes 285
Table 292 – Literals of Wires::SVCControlMode 285
Table 293 – Attributes of Wires::Switch 286
Table 294 – Association ends of Wires::Switch with other classes 287
Table 295 – Attributes of Wires::SwitchPhase 287
Table 296 – Association ends of Wires::SwitchPhase with other classes 288
Table 297 – Attributes of Wires::SwitchSchedule 288
Table 298 – Association ends of Wires::SwitchSchedule with other classes 289

IECNORM.COM : Click to view the full PDF of IEC 61970-301:2020+AMD1:2022 CSV

Table 299 – Attributes of Wires::SynchronousMachine 289
Table 300 – Association ends of Wires::SynchronousMachine with other classes 291
Table 301 – Literals of Wires::SynchronousMachineOperatingMode 292
Table 302 – Literals of Wires::SynchronousMachineKind 292
Table 303 – Attributes of Wires::TapChanger 293
Table 304 – Association ends of Wires::TapChanger with other classes 294
Table 305 – Attributes of Wires::TapChangerControl 294
Table 306 – Association ends of Wires::TapChangerControl with other classes 295
Table 307 – Attributes of Wires::TapChangerTablePoint 295
Table 308 – Attributes of Wires::TapSchedule 296
Table 309 – Association ends of Wires::TapSchedule with other classes 297
Table 310 – Literals of Wires::TransformerControlMode 297
Table 311 – Attributes of Wires::TransformerCoreAdmittance 297
Table 312 – Association ends of Wires::TransformerCoreAdmittance with other classes 298
Table 313 – Attributes of Wires::TransformerEnd 298
Table 314 – Association ends of Wires::TransformerEnd with other classes 299
Table 315 – Attributes of Wires::TransformerMeshImpedance 299
Table 316 – Association ends of Wires::TransformerMeshImpedance with other classes 300
Table 317 – Attributes of Wires::TransformerStarImpedance 300
Table 318 – Association ends of Wires::TransformerStarImpedance with other classes 300
Table 319 – Attributes of Wires::TransformerTank 301
Table 320 – Association ends of Wires::TransformerTank with other classes 301
Table 321 – Attributes of Wires::TransformerTankEnd 302
Table 322 – Association ends of Wires::TransformerTankEnd with other classes 302
Table 323 – Attributes of Wires::VoltageControlZone 303
Table 324 – Association ends of Wires::VoltageControlZone with other classes 303
Table 325 – Attributes of Wires::WireSegment 303
Table 326 – Association ends of Wires::WireSegment with other classes 304
Table 327 – Attributes of Wires::WireSegmentPhase 304
Table 328 – Association ends of Wires::WireSegmentPhase with other classes 305
Table 329 – Literals of Wires::WindingConnection 305
Table 330 – Attributes of LoadModel::ConformLoad 307
Table 331 – Association ends of LoadModel::ConformLoad with other classes 307
Table 332 – Attributes of LoadModel::ConformLoadGroup 308
Table 333 – Association ends of LoadModel::ConformLoadGroup with other classes 308
Table 334 – Attributes of LoadModel::ConformLoadSchedule 309
Table 335 – Association ends of LoadModel::ConformLoadSchedule with other classes 309
Table 336 – Attributes of LoadModel::DayType 309
Table 337 – Association ends of LoadModel::DayType with other classes 310
Table 338 – Attributes of LoadModel::EnergyArea 310
Table 339 – Association ends of LoadModel::EnergyArea with other classes 310
Table 340 – Attributes of LoadModel::LoadArea 310
Table 341 – Association ends of LoadModel::LoadArea with other classes 311
IECNORM.COM : Click to view the full PDF of IEC 61970-301:2020+AMD1:2022 CSV

Table 342 – Attributes of LoadModel::LoadGroup 311
Table 343 – Association ends of LoadModel::LoadGroup with other classes 311
Table 344 – Attributes of LoadModel::LoadResponseCharacteristic 312
Table 345 – Association ends of LoadModel::LoadResponseCharacteristic with other classes 313
Table 346 – Attributes of LoadModel::NonConformLoad 313
Table 347 – Association ends of LoadModel::NonConformLoad with other classes 314
Table 348 – Attributes of LoadModel::NonConformLoadGroup 314
Table 349 – Association ends of LoadModel::NonConformLoadGroup with other classes 315
Table 350 – Attributes of LoadModel::NonConformLoadSchedule 315
Table 351 – Association ends of LoadModel::NonConformLoadSchedule with other classes 315
Table 352 – Attributes of LoadModel::PowerCutZone 316
Table 353 – Association ends of LoadModel::PowerCutZone with other classes 316
Table 354 – Attributes of LoadModel::Season 316
Table 355 – Association ends of LoadModel::Season with other classes 317
Table 356 – Attributes of LoadModel::SeasonDayTypeSchedule 317
Table 357 – Association ends of LoadModel::SeasonDayTypeSchedule with other classes 317
Table 358 – Attributes of LoadModel::StationSupply 318
Table 359 – Association ends of LoadModel::StationSupply with other classes 318
Table 360 – Attributes of LoadModel::SubLoadArea 319
Table 361 – Association ends of LoadModel::SubLoadArea with other classes 319
Table 362 – Attributes of GenerationTrainingSimulation::BWRSteamSupply 321
Table 363 – Association ends of GenerationTrainingSimulation::BWRSteamSupply with other classes 322
Table 364 – Literals of GenerationTrainingSimulation::BoilerControlMode 322
Table 365 – Attributes of GenerationTrainingSimulation::CTTempActivePowerCurve 323
Table 366 – Association ends of GenerationTrainingSimulation::CTTempActivePowerCurve with other classes 323
Table 367 – Attributes of GenerationTrainingSimulation::CombustionTurbine 323
Table 368 – Association ends of GenerationTrainingSimulation::CombustionTurbine with other classes 324
Table 369 – Attributes of GenerationTrainingSimulation::DrumBoiler 325
Table 370 – Association ends of GenerationTrainingSimulation::DrumBoiler with other classes 326
Table 371 – Attributes of GenerationTrainingSimulation::FossilSteamSupply 326
Table 372 – Association ends of GenerationTrainingSimulation::FossilSteamSupply with other classes 327
Table 373 – Attributes of GenerationTrainingSimulation::HeatRecoveryBoiler 327
Table 374 – Association ends of GenerationTrainingSimulation::HeatRecoveryBoiler with other classes 328
Table 375 – Attributes of GenerationTrainingSimulation::HydroTurbine 329
Table 376 – Association ends of GenerationTrainingSimulation::HydroTurbine with other classes 329

IECNORM.COM : Click to view the full PDF of IEC 61970-301:2020+AMD1:2022 CSV

Table 377 – Attributes of GenerationTrainingSimulation::PWRSteamSupply 330
Table 378 – Association ends of GenerationTrainingSimulation::PWRSteamSupply with other classes 330
Table 379 – Attributes of GenerationTrainingSimulation::PrimeMover 331
Table 380 – Association ends of GenerationTrainingSimulation::PrimeMover with other classes 331
Table 381 – Attributes of GenerationTrainingSimulation::SteamSupply 331
Table 382 – Association ends of GenerationTrainingSimulation::SteamSupply with other classes 332
Table 383 – Attributes of GenerationTrainingSimulation::SteamTurbine 332
Table 384 – Association ends of GenerationTrainingSimulation::SteamTurbine with other classes 333
Table 385 – Attributes of GenerationTrainingSimulation::Subcritical 333
Table 386 – Association ends of GenerationTrainingSimulation::Subcritical with other classes 334
Table 387 – Attributes of GenerationTrainingSimulation::Supercritical 334
Table 388 – Association ends of GenerationTrainingSimulation::Supercritical with other classes 335
Table 389 – Literals of GenerationTrainingSimulation::HydroTurbineKind 336
Table 390 – Attributes of Production::AirCompressor 341
Table 391 – Association ends of Production::AirCompressor with other classes 342
Table 392 – Literals of Production::BatteryStateKind 342
Table 393 – Attributes of Production::BatteryUnit 342
Table 394 – Association ends of Production::BatteryUnit with other classes 343
Table 395 – Attributes of Production::CAESPlant 343
Table 396 – Association ends of Production::CAESPlant with other classes 344
Table 397 – Attributes of Production::CogenerationPlant 344
Table 398 – Association ends of Production::CogenerationPlant with other classes 345
Table 399 – Attributes of Production::CombinedCyclePlant 345
Table 400 – Association ends of Production::CombinedCyclePlant with other classes 345
Table 401 – Attributes of Production::EmissionAccount 346
Table 402 – Association ends of Production::EmissionAccount with other classes 346
Table 403 – Attributes of Production::EmissionCurve 347
Table 404 – Association ends of Production::EmissionCurve with other classes 347
Table 405 – Literals of Production::EmissionType 348
Table 406 – Literals of Production::WindGenUnitKind 348
Table 407 – Literals of Production::EmissionValueSource 348
Table 408 – Attributes of Production::FossilFuel 349
Table 409 – Association ends of Production::FossilFuel with other classes 349
Table 410 – Attributes of Production::FuelAllocationSchedule 350
Table 411 – Association ends of Production::FuelAllocationSchedule with other classes 350
Table 412 – Literals of Production::FuelType 351
Table 413 – Attributes of Production::GenUnitOpCostCurve 351
Table 414 – Association ends of Production::GenUnitOpCostCurve with other classes 352
Table 415 – Attributes of Production::GenUnitOpSchedule 352
IECNORM.COM : Click to view the full PDF of IEC 61970-301:2020+AMD1:2022 CSV

Table 416 – Association ends of Production::GenUnitOpSchedule with other classes 352
Table 417 – Attributes of Production::GeneratingUnit 353
Table 418 – Association ends of Production::GeneratingUnit with other classes 355
Table 419 – Literals of Production::GeneratorControlMode 356
Table 420 – Literals of Production::GeneratorControlSource 356
Table 421 – Attributes of Production::GrossToNetActivePowerCurve 356
Table 422 – Association ends of Production::GrossToNetActivePowerCurve with other classes 357
Table 423 – Attributes of Production::HeatInputCurve 357
Table 424 – Association ends of Production::HeatInputCurve with other classes 358
Table 425 – Attributes of Production::HeatRateCurve 358
Table 426 – Association ends of Production::HeatRateCurve with other classes 358
Table 427 – Literals of Production::HydroEnergyConversionKind 359
Table 428 – Attributes of Production::HydroGeneratingEfficiencyCurve 359
Table 429 – Association ends of Production::HydroGeneratingEfficiencyCurve with other classes 360
Table 430 – Attributes of Production::HydroGeneratingUnit 360
Table 431 – Association ends of Production::HydroGeneratingUnit with other classes 361
Table 432 – Literals of Production::HydroPlantStorageKind 362
Table 433 – Attributes of Production::HydroPowerPlant 362
Table 434 – Association ends of Production::HydroPowerPlant with other classes 363
Table 435 – Attributes of Production::HydroPump 364
Table 436 – Association ends of Production::HydroPump with other classes 364
Table 437 – Attributes of Production::HydroPumpOpSchedule 365
Table 438 – Association ends of Production::HydroPumpOpSchedule with other classes 365
Table 439 – Attributes of Production::IncrementalHeatRateCurve 366
Table 440 – Association ends of Production::IncrementalHeatRateCurve with other classes 366
Table 441 – Attributes of Production::InflowForecast 366
Table 442 – Association ends of Production::InflowForecast with other classes 367
Table 443 – Attributes of Production::LevelVsVolumeCurve 367
Table 444 – Association ends of Production::LevelVsVolumeCurve with other classes 368
Table 445 – Attributes of Production::NuclearGeneratingUnit 368
Table 446 – Association ends of Production::NuclearGeneratingUnit with other classes 369
Table 447 – Attributes of Production::PenstockLossCurve 370
Table 448 – Association ends of Production::PenstockLossCurve with other classes 370
Table 449 – Attributes of Production::PhotoVoltaicUnit 371
Table 450 – Association ends of Production::PhotoVoltaicUnit with other classes 371
Table 451 – Attributes of Production::PowerElectronicsUnit 372
Table 452 – Association ends of Production::PowerElectronicsUnit with other classes 372
Table 453 – Attributes of Production::PowerElectronicsWindUnit 373
Table 454 – Association ends of Production::PowerElectronicsWindUnit with other classes 373
Table 455 – Attributes of Production::Reservoir 374
IECNORM.COM : Click to view the full PDF of IEC 61970-301:2020+AMD1:2022 CSV

Table 456 – Association ends of Production::Reservoir with other classes 374
Table 457 – Attributes of Production::ShutdownCurve 375
Table 458 – Association ends of Production::ShutdownCurve with other classes 375
Table 459 – Attributes of Production::SolarGeneratingUnit 376
Table 460 – Association ends of Production::SolarGeneratingUnit with other classes 377
Table 461 – Attributes of Production::StartIgnFuelCurve 378
Table 462 – Association ends of Production::StartIgnFuelCurve with other classes 378
Table 463 – Attributes of Production::StartMainFuelCurve 378
Table 464 – Association ends of Production::StartMainFuelCurve with other classes 379
Table 465 – Attributes of Production::StartRampCurve 379
Table 466 – Association ends of Production::StartRampCurve with other classes 380
Table 467 – Attributes of Production::StartupModel 380
Table 468 – Association ends of Production::StartupModel with other classes 381
Table 469 – Attributes of Production::SteamSendoutSchedule 381
Table 470 – Association ends of Production::SteamSendoutSchedule with other classes 381
Table 471 – Attributes of Production::TailbayLossCurve 382
Table 472 – Association ends of Production::TailbayLossCurve with other classes 382
Table 473 – Attributes of Production::TargetLevelSchedule 383
Table 474 – Association ends of Production::TargetLevelSchedule with other classes 383
Table 475 – Attributes of Production::ThermalGeneratingUnit 384
Table 476 – Association ends of Production::ThermalGeneratingUnit with other classes 385
Table 477 – Attributes of Production::WindGeneratingUnit 386
Table 478 – Association ends of Production::WindGeneratingUnit with other classes 387
Table 479 – Attributes of DC::ACDCConverter 393
Table 480 – Association ends of DC::ACDCConverter with other classes 394
Table 481 – Attributes of DC::ACDCConverterDCTerminal 395
Table 482 – Association ends of DC::ACDCConverterDCTerminal with other classes 395
Table 483 – Attributes of DC::CsConverter 396
Table 484 – Association ends of DC::CsConverter with other classes 398
Table 485 – Attributes of DC::DCTopologicalNode 398
Table 486 – Association ends of DC::DCTopologicalNode with other classes 399
Table 487 – Literals of DC::CsOperatingModeKind 399
Table 488 – Literals of DC::CsPpccControlKind 399
Table 489 – Attributes of DC::DCBaseTerminal 400
Table 490 – Association ends of DC::DCBaseTerminal with other classes 400
Table 491 – Attributes of DC::DCBreaker 400
Table 492 – Association ends of DC::DCBreaker with other classes 401
Table 493 – Attributes of DC::DCBusbar 401
Table 494 – Association ends of DC::DCBusbar with other classes 402
Table 495 – Attributes of DC::DCChopper 402
Table 496 – Association ends of DC::DCChopper with other classes 403
Table 497 – Attributes of DC::DCConductingEquipment 403
IECNORM.COM : Click to view the full PDF of IEC 61970-301:2020+AMD1:2022 CSV

Table 498 – Association ends of DC::DCConductingEquipment with other classes 404
Table 499 – Literals of DC::DCConverterOperatingModeKind 404
Table 500 – Attributes of DC::DCConverterUnit 404
Table 501 – Association ends of DC::DCConverterUnit with other classes 405
Table 502 – Attributes of DC::DCDisconnector 405
Table 503 – Association ends of DC::DCDisconnector with other classes 406
Table 504 – Attributes of DC::DCEquipmentContainer 406
Table 505 – Association ends of DC::DCEquipmentContainer with other classes 407
Table 506 – Attributes of DC::DCGround 407
Table 507 – Association ends of DC::DCGround with other classes 408
Table 508 – Attributes of DC::DCLine 408
Table 509 – Association ends of DC::DCLine with other classes 408
Table 510 – Attributes of DC::DCLineSegment 409
Table 511 – Association ends of DC::DCLineSegment with other classes 410
Table 512 – Attributes of DC::DCNode 410
Table 513 – Association ends of DC::DCNode with other classes 411
Table 514 – Literals of DC::DCPolarityKind 411
Table 515 – Attributes of DC::DCSeriesDevice 411
Table 516 – Association ends of DC::DCSeriesDevice with other classes 412
Table 517 – Attributes of DC::DCShunt 412
Table 518 – Association ends of DC::DCShunt with other classes 413
Table 519 – Attributes of DC::DCSwitch 413
Table 520 – Association ends of DC::DCSwitch with other classes 414
Table 521 – Attributes of DC::DCTerminal 414
Table 522 – Association ends of DC::DCTerminal with other classes 414
Table 523 – Attributes of DC::DCTopologicalIsland 415
Table 524 – Association ends of DC::DCTopologicalIsland with other classes 415
Table 525 – Attributes of DC::PerLengthDCLineParameter 415
Table 526 – Association ends of DC::PerLengthDCLineParameter with other classes 416
Table 527 – Attributes of DC::VsCapabilityCurve 416
Table 528 – Association ends of DC::VsCapabilityCurve with other classes 416
Table 529 – Attributes of DC::VsConverter 417
Table 530 – Association ends of DC::VsConverter with other classes 418
Table 531 – Literals of DC::VsPpccControlKind 419
Table 532 – Literals of DC::VsQpccControlKind 420
Table 533 – Attributes of Equivalents::EquivalentBranch 422
Table 534 – Association ends of Equivalents::EquivalentBranch with other classes 424
Table 535 – Attributes of Equivalents::EquivalentEquipment 424
Table 536 – Association ends of Equivalents::EquivalentEquipment with other classes 425
Table 537 – Attributes of Equivalents::EquivalentInjection 425
Table 538 – Association ends of Equivalents::EquivalentInjection with other classes 427
Table 539 – Attributes of Equivalents::EquivalentNetwork 427
Table 540 – Association ends of Equivalents::EquivalentNetwork with other classes 428
IECNORM.COM : Click to view the full PDF of IEC 61970-301:2020+AMD1:2022 CSV

Table 541 – Attributes of Equivalents::EquivalentShunt 428
Table 542 – Association ends of Equivalents::EquivalentShunt with other classes 429
Table 543 – Attributes of AuxiliaryEquipment::AuxiliaryEquipment 431
Table 544 – Association ends of AuxiliaryEquipment::AuxiliaryEquipment with other classes 431
Table 545 – Attributes of AuxiliaryEquipment::CurrentTransformer 432
Table 546 – Association ends of AuxiliaryEquipment::CurrentTransformer with other classes 432
Table 547 – Attributes of AuxiliaryEquipment::FaultIndicator 433
Table 548 – Association ends of AuxiliaryEquipment::FaultIndicator with other classes 433
Table 549 – Attributes of AuxiliaryEquipment::PostLineSensor 434
Table 550 – Association ends of AuxiliaryEquipment::PostLineSensor with other classes 434
Table 551 – Attributes of AuxiliaryEquipment::PotentialTransformer 435
Table 552 – Association ends of AuxiliaryEquipment::PotentialTransformer with other classes 435
Table 553 – Literals of AuxiliaryEquipment::PotentialTransformerKind 436
Table 554 – Attributes of AuxiliaryEquipment::Sensor 436
Table 555 – Association ends of AuxiliaryEquipment::Sensor with other classes 436
Table 556 – Attributes of AuxiliaryEquipment::SurgeArrester 437
Table 557 – Association ends of AuxiliaryEquipment::SurgeArrester with other classes 437
Table 558 – Attributes of AuxiliaryEquipment::WaveTrap 438
Table 559 – Association ends of AuxiliaryEquipment::WaveTrap with other classes 438
Table 560 – Attributes of Meas::Accumulator 442
Table 561 – Association ends of Meas::Accumulator with other classes 443
Table 562 – Attributes of Meas::AccumulatorLimit 443
Table 563 – Association ends of Meas::AccumulatorLimit with other classes 443
Table 564 – Attributes of Meas::AccumulatorLimitSet 444
Table 565 – Association ends of Meas::AccumulatorLimitSet with other classes 444
Table 566 – Attributes of Meas::AccumulatorReset 444
Table 567 – Association ends of Meas::AccumulatorReset with other classes 445
Table 568 – Attributes of Meas::AccumulatorValue 445
Table 569 – Association ends of Meas::AccumulatorValue with other classes 445
Table 570 – Attributes of Meas::Analog 446
Table 571 – Association ends of Meas::Analog with other classes 446
Table 572 – Attributes of Meas::AnalogControl 447
Table 573 – Association ends of Meas::AnalogControl with other classes 447
Table 574 – Attributes of Meas::AnalogLimit 447
Table 575 – Association ends of Meas::AnalogLimit with other classes 448
Table 576 – Attributes of Meas::AnalogLimitSet 448
Table 577 – Association ends of Meas::AnalogLimitSet with other classes 448
Table 578 – Attributes of Meas::AnalogValue 449
Table 579 – Association ends of Meas::AnalogValue with other classes 449
Table 580 – Attributes of Meas::Command 450
IECNORM.COM : Click to view the full PDF of IEC 61970-301:2020+AMD1:2022 CSV

Table 581 – Association ends of Meas::Command with other classes 450
Table 582 – Attributes of Meas::Control 451
Table 583 – Association ends of Meas::Control with other classes 451
Table 584 – Attributes of Meas::Discrete 452
Table 585 – Association ends of Meas::Discrete with other classes 452
Table 586 – Attributes of Meas::DiscreteValue 452
Table 587 – Association ends of Meas::DiscreteValue with other classes 453
Table 588 – Attributes of Meas::IOPoint 453
Table 589 – Association ends of Meas::IOPoint with other classes 453
Table 590 – Attributes of Meas::Limit 454
Table 591 – Association ends of Meas::Limit with other classes 454
Table 592 – Attributes of Meas::LimitSet 454
Table 593 – Association ends of Meas::LimitSet with other classes 455
Table 594 – Attributes of Meas::Measurement 455
Table 595 – Association ends of Meas::Measurement with other classes 456
Table 596 – Attributes of Meas::MeasurementValue 456
Table 597 – Association ends of Meas::MeasurementValue with other classes 457
Table 598 – Attributes of Meas::MeasurementValueQuality 457
Table 599 – Association ends of Meas::MeasurementValueQuality with other classes 458
Table 600 – Attributes of Meas::MeasurementValueSource 458
Table 601 – Association ends of Meas::MeasurementValueSource with other classes 458
Table 602 – Attributes of Meas::Quality61850 459
Table 603 – Attributes of Meas::RaiseLowerCommand 460
Table 604 – Association ends of Meas::RaiseLowerCommand with other classes 460
Table 605 – Attributes of Meas::SetPoint 460
Table 606 – Association ends of Meas::SetPoint with other classes 461
Table 607 – Attributes of Meas::StringMeasurement 461
Table 608 – Association ends of Meas::StringMeasurement with other classes 462
Table 609 – Attributes of Meas::StringMeasurementValue 462
Table 610 – Association ends of Meas::StringMeasurementValue with other classes 462
Table 611 – Literals of Meas::Validity 463
Table 612 – Attributes of Meas::ValueAliasSet 463
Table 613 – Association ends of Meas::ValueAliasSet with other classes 463
Table 614 – Attributes of Meas::ValueToAlias 464
Table 615 – Association ends of Meas::ValueToAlias with other classes 464
Table 616 – Attributes of Topology::BusNameMarker 466
Table 617 – Association ends of Topology::BusNameMarker with other classes 466
Table 618 – Attributes of Topology::TopologicalIsland 467
Table 619 – Association ends of Topology::TopologicalIsland with other classes 467
Table 620 – Attributes of Topology::TopologicalNode 467
Table 621 – Association ends of Topology::TopologicalNode with other classes 468
Table 622 – Attributes of DiagramLayout::Diagram 469
Table 623 – Association ends of DiagramLayout::Diagram with other classes 470
IECNORM.COM : Click to view the full PDF of IEC 61970-301:2020+AMD1:2022 CSV

Table 624 – Attributes of DiagramLayout::DiagramObject 470
Table 625 – Association ends of DiagramLayout::DiagramObject with other classes 471
Table 626 – Association ends of DiagramLayout::DiagramObjectGluePoint with other classes 472
Table 627 – Attributes of DiagramLayout::DiagramObjectPoint 472
Table 628 – Association ends of DiagramLayout::DiagramObjectPoint with other classes 472
Table 629 – Attributes of DiagramLayout::DiagramObjectStyle 473
Table 630 – Association ends of DiagramLayout::DiagramObjectStyle with other classes 473
Table 631 – Attributes of DiagramLayout::DiagramStyle 473
Table 632 – Association ends of DiagramLayout::DiagramStyle with other classes 473
Table 633 – Literals of DiagramLayout::OrientationKind 474
Table 634 – Attributes of DiagramLayout::TextDiagramObject 474
Table 635 – Association ends of DiagramLayout::TextDiagramObject with other classes 474
Table 636 – Attributes of DiagramLayout::VisibilityLayer 475
Table 637 – Association ends of DiagramLayout::VisibilityLayer with other classes 475
Table 638 – Attributes of OperationalLimits::ActivePowerLimit 477
Table 639 – Association ends of OperationalLimits::ActivePowerLimit with other classes 478
Table 640 – Attributes of OperationalLimits::ApparentPowerLimit 478
Table 641 – Association ends of OperationalLimits::ApparentPowerLimit with other classes 478
Table 642 – Attributes of OperationalLimits::BranchGroup 479
Table 643 – Association ends of OperationalLimits::BranchGroup with other classes 479
Table 644 – Attributes of OperationalLimits::BranchGroupTerminal 479
Table 645 – Association ends of OperationalLimits::BranchGroupTerminal with other classes 479
Table 646 – Attributes of OperationalLimits::CurrentLimit 480
Table 647 – Association ends of OperationalLimits::CurrentLimit with other classes 480
Table 648 – Attributes of OperationalLimits::OperationalLimit 480
Table 649 – Association ends of OperationalLimits::OperationalLimit with other classes 481
Table 650 – Literals of OperationalLimits::OperationalLimitDirectionKind 481
Table 651 – Attributes of OperationalLimits::OperationalLimitSet 481
Table 652 – Association ends of OperationalLimits::OperationalLimitSet with other classes 482
Table 653 – Attributes of OperationalLimits::OperationalLimitType 482
Table 654 – Association ends of OperationalLimits::OperationalLimitType with other classes 482
Table 655 – Attributes of OperationalLimits::VoltageLimit 483
Table 656 – Association ends of OperationalLimits::VoltageLimit with other classes 483
Table 657 – Attributes of ControlArea::AltGeneratingUnitMeas 486
Table 658 – Association ends of ControlArea::AltGeneratingUnitMeas with other classes 486
Table 659 – Attributes of ControlArea::AltTieMeas 486
IECNORM.COM : Click to view the full PDF of IEC 61970-301:2020+AMD1:2022 CSV

Table 660 – Association ends of ControlArea::AltTieMeas with other classes 487
Table 661 – Attributes of ControlArea::ControlArea 487
Table 662 – Association ends of ControlArea::ControlArea with other classes 488
Table 663 – Attributes of ControlArea::ControlAreaGeneratingUnit 488
Table 664 – Association ends of ControlArea::ControlAreaGeneratingUnit with other classes 489
Table 665 – Literals of ControlArea::ControlAreaTypeKind 489
Table 666 – Attributes of ControlArea::TieFlow 489
Table 667 – Association ends of ControlArea::TieFlow with other classes 490
Table 668 – Attributes of Contingency::Contingency 491
Table 669 – Association ends of Contingency::Contingency with other classes 491
Table 670 – Attributes of Contingency::ContingencyElement 491
Table 671 – Association ends of Contingency::ContingencyElement with other classes 491
Table 672 – Attributes of Contingency::ContingencyEquipment 492
Table 673 – Association ends of Contingency::ContingencyEquipment with other classes 492
Table 674 – Literals of Contingency::ContingencyEquipmentStatusKind 492
Table 675 – Attributes of StateVariables::SvInjection 494
Table 676 – Association ends of StateVariables::SvInjection with other classes 494
Table 677 – Attributes of StateVariables::SvPowerFlow 494
Table 678 – Association ends of StateVariables::SvPowerFlow with other classes 494
Table 679 – Attributes of StateVariables::SvShuntCompensatorSections 495
Table 680 – Association ends of StateVariables::SvShuntCompensatorSections with other classes 495
Table 681 – Attributes of StateVariables::SvStatus 495
Table 682 – Association ends of StateVariables::SvStatus with other classes 495
Table 683 – Attributes of StateVariables::SvSwitch 496
Table 684 – Association ends of StateVariables::SvSwitch with other classes 496
Table 685 – Attributes of StateVariables::SvTapStep 496
Table 686 – Association ends of StateVariables::SvTapStep with other classes 496
Table 687 – Attributes of StateVariables::SvVoltage 497
Table 688 – Association ends of StateVariables::SvVoltage with other classes 497
Table 689 – Attributes of Protection::CurrentRelay 498
Table 690 – Association ends of Protection::CurrentRelay with other classes 499
Table 691 – Attributes of Protection::ProtectionEquipment 499
Table 692 – Association ends of Protection::ProtectionEquipment with other classes 500
Table 693 – Attributes of Protection::RecloseSequence 500
Table 694 – Association ends of Protection::RecloseSequence with other classes 501
Table 695 – Attributes of Protection::SynchrocheckRelay 501
Table 696 – Association ends of Protection::SynchrocheckRelay with other classes 502
Table 697 – Attributes of Faults::EquipmentFault 503
Table 698 – Association ends of Faults::EquipmentFault with other classes 503
Table 699 – Attributes of Faults::Fault 503
Table 700 – Association ends of Faults::Fault with other classes 504

IECNORM.COM : Click to view the full PDF of IEC 61970-301:2020+AMD1:2022 CSV

Table 701 – Attributes of Faults::FaultCauseType 504
Table 702 – Association ends of Faults::FaultCauseType with other classes 504
Table 703 – Attributes of Faults::FaultImpedance 505
Table 704 – Attributes of Faults::LineFault 505
Table 705 – Association ends of Faults::LineFault with other classes 505
Table 706 – Literals of Faults::PhaseConnectedFaultKind 506
Table 707 – Attributes of SCADA::CommunicationLink 507
Table 708 – Association ends of SCADA::CommunicationLink with other classes 508
Table 709 – Attributes of SCADA::RemoteControl 508
Table 710 – Association ends of SCADA::RemoteControl with other classes 508
Table 711 – Attributes of SCADA::RemotePoint 509
Table 712 – Association ends of SCADA::RemotePoint with other classes 509
Table 713 – Attributes of SCADA::RemoteSource 509
Table 714 – Association ends of SCADA::RemoteSource with other classes 510
Table 715 – Attributes of SCADA::RemoteUnit 510
Table 716 – Association ends of SCADA::RemoteUnit with other classes 510
Table 717 – Literals of SCADA::RemoteUnitType 511
Table 718 – Literals of SCADA::Source 511
Table 719 – Literals of ICCPConfiguration::ApplicationSecurityKind 514
Table 720 – Attributes of ICCPConfiguration::BilateralExchangeActor 514
Table 721 – Association ends of ICCPConfiguration::BilateralExchangeActor with other classes 514
Table 722 – Attributes of ICCPConfiguration::BilateralExchangeAgreement 515
Table 723 – Association ends of ICCPConfiguration::BilateralExchangeAgreement with other classes 515
Table 724 – Literals of ICCPConfiguration::ICCPAccessPrivilegeKind 515
Table 725 – Attributes of ICCPConfiguration::ICCPInformationMessage 516
Table 726 – Association ends of ICCPConfiguration::ICCPInformationMessage with other classes 516
Table 727 – Literals of ICCPConfiguration::ICCPPointKind 516
Table 728 – Attributes of ICCPConfiguration::ICCPProvidedPoint 517
Table 729 – Association ends of ICCPConfiguration::ICCPProvidedPoint with other classes 517
Table 730 – Literals of ICCPConfiguration::ICCPQualityKind 518
Table 731 – Literals of ICCPConfiguration::ICCPScopeKind 518
Table 732 – Attributes of ICCPConfiguration::ICCPVCC 518
Table 733 – Association ends of ICCPConfiguration::ICCPVCC with other classes 519
Table 734 – Attributes of ICCPConfiguration::ICCPVirtualControlCentre 519
Table 735 – Association ends of ICCPConfiguration::ICCPVirtualControlCentre with other classes 520
Table 736 – Attributes of ICCPConfiguration::IOPointSource 520
Table 737 – Association ends of ICCPConfiguration::IOPointSource with other classes 521
Table 738 – Attributes of ICCPConfiguration::IPAccessPoint 521
Table 739 – Association ends of ICCPConfiguration::IPAccessPoint with other classes 521
Table 740 – Literals of ICCPConfiguration::IPAddressKind 522
IECNORM.COM : Click to view the full PDF of IEC 61970-301:2020+AMD1:2022 CSV

Table 741 – Attributes of ICCPConfiguration::ISOUpperLayer 522
Table 742 – Association ends of ICCPConfiguration::ISOUpperLayer with other classes 523
Table 743 – Attributes of ICCPConfiguration::ProvidedBilateralPoint 523
Table 744 – Association ends of ICCPConfiguration::ProvidedBilateralPoint with other classes 523
Table 745 – Attributes of ICCPConfiguration::PublicX509Certificate 524
Table 746 – Association ends of ICCPConfiguration::PublicX509Certificate with other classes 524
Table 747 – Attributes of ICCPConfiguration::TASE2BilateralTable 524
Table 748 – Association ends of ICCPConfiguration::TASE2BilateralTable with other classes 525
Table 749 – Attributes of ICCPConfiguration::TCPAccessPoint 525
Table 750 – Association ends of ICCPConfiguration::TCPAccessPoint with other classes 526
Table A.1 – Attributes of ExtEuCore::BoundaryPoint 529
Table A.2 – Association ends of ExtEuCore::BoundaryPoint with other classes 530
Table A.3 – Attributes of ExtEuCore::ExtEuIdentifiedObject 530
Table A.4 – Attributes of ExtEuOperationalLimits::ExtEuOperationalLimitType 531
Table A.5 – Literals of ExtEuOperationalLimits::LimitKind 532
Table A.6 – Attributes of ExtEuProduction::SolarPowerPlant 534
Table A.7 – Association ends of ExtEuProduction::SolarPowerPlant with other classes 534
Table A.8 – Attributes of ExtEuProduction::WindPowerPlant 535
Table A.9 – Association ends of ExtEuProduction::WindPowerPlant with other classes 535

IECNORM.COM : Click to view the full PDF of IEC 61970-301:2020+AMD1:2022 CSV

INTERNATIONAL ELECTROTECHNICAL COMMISSION

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ENERGY MANAGEMENT SYSTEM APPLICATION PROGRAM INTERFACE (EMS-API) –

Part 301: Common information model (CIM) base

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This consolidated version of the official IEC Standard and its amendment has been prepared for user convenience.

IEC 61970-301 edition 7.1 contains the seventh edition (2020-06) [documents 57/2210/FDIS and 57/2224/RVD] and its amendment 1 (2022-02) [documents 57/2439/FDIS and 57/2450/RVD].

In this Redline version, a vertical line in the margin shows where the technical content is modified by amendment 1. Additions are in green text, deletions are in strikethrough red text. A separate Final version with all changes accepted is available in this publication.

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International Standard IEC 61970-301 has been prepared by IEC technical committee 57: Power systems management and associated information exchange.

This seventh constitutes a technical revision.

This edition reflects the model content version ‘IEC61970CIM17v38’, dated ‘2020-01-21’, and includes the following significant technical changes with respect to the previous edition:

a) Added Feeder modelling;
b) Added ICCP configuration modelling;
c) Correction of issues found in interoperability testing or use of the standard;
d) Improved documentation;
e) Updated Annex A with custom extensions;
f) Added Annex B Examples of PST transformer modelling;
g) Added Annex C HVDC use cases.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

A list of all parts of the IEC 61970 series, under the general title: *Energy management system application program interface (EMS-API)*, can be found on the IEC website.

The committee has decided that the contents of the base publication and its amendment will remain unchanged until the stability date indicated on the IEC web site under webstore.iec.ch in the data related to the specific publication. At this date, the publication will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

IMPORTANT – The 'colour inside' logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

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INTRODUCTION

This document is part of the IEC 61970 series which define an application program interface (API) for an energy management system (EMS). IEC 61970 was originally based upon the work of the EPRI Control Center API (CCAPI) research project (RP-3654-1). The principle objectives of the EPRI CCAPI project were to:

- reduce the cost and time needed to add new applications to an EMS;
- protect the investment of existing applications or systems that are working effectively with an EMS.

The principal objective of the IEC 61970 series is to produce documents which facilitate the integration of EMS applications developed independently by different vendors, between entire EMS systems developed independently, or between an EMS system and other systems concerned with different aspects of power system operations, such as generation or distribution management systems (DMS). This is accomplished by defining application program interfaces to enable these applications or systems access to public data and exchange information independent of how such information is represented internally.

The Common Information Model (CIM) specifies the semantics for this API. The Component Interface Specifications (CIS), which are contained in other parts of the IEC 61970 series, specify the content of the messages exchanged.

The CIM is an abstract model that represents all the major objects in an electric utility enterprise typically needed to model the operational aspects of a utility. This model includes public classes and attributes for these objects, as well as the relationships between them.

This document defines the CIM Base set of packages which provide a logical view of the functional aspects of an Energy Management System including Supervisory Control and Data Acquisition (SCADA). Other functional areas are standardized in separate IEC documents that augment and reference this document. For example, IEC 61968-11 addresses distribution models and references this document. While there are multiple IEC standards dealing with different parts of the CIM, there is a single, unified information model comprising the CIM behind all these individual standards documents.

The International Electrotechnical Commission (IEC) draws attention to the fact that it is claimed that compliance with this document may involve the use of a patent concerning a computer-based implementation of an object-oriented power system model in a relational database. As such, it does not conflict with the development of any logical power system model including the Common Information Model (CIM), where implementation of the model is not defined.

The IEC takes no position concerning the evidence, validity and scope of this patent right.

The holder of this patent right has assured the IEC that he/she is willing to negotiate licences either free of charge or under reasonable and non-discriminatory terms and conditions with applicants throughout the world. In this respect, the statement of the holder of this patent right is registered with IEC. Information may be obtained from:

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ISO (www.iso.org/patents) and IEC (http://www.iec.ch/tctools/patent_decl.htm) maintain on-line data bases of patents relevant to their standards. Users are encouraged to consult the data bases for the most up to date information concerning patents.

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ENERGY MANAGEMENT SYSTEM APPLICATION PROGRAM INTERFACE (EMS-API) –

Part 301: Common information model (CIM) base

1 Scope

The common information model (CIM) is an abstract model that represents all the major objects in an electric utility enterprise typically involved in utility operations. By providing a standard way of representing power system resources as object classes and attributes, along with their relationships, the CIM facilitates the integration and interoperability of network applications developed independently by different vendors, between entire systems running network applications developed independently, or between a system running network applications and other systems concerned with different aspects of power system operations, such as generation or distribution management. SCADA is modelled to the extent necessary to support power system simulation and inter-control centre communication. The CIM facilitates integration by defining a common language (i.e. semantics) based on the CIM to enable these applications or systems to access public data and exchange information independent of how such information is represented internally.

The object classes represented in the CIM are abstract in nature and can be used in a wide variety of applications. The use of the CIM goes far beyond its application in an EMS. This document should be understood as a tool to enable integration in any domain where a common power system model is needed to facilitate interoperability and plug compatibility between applications and systems independent of any particular implementation.

Due to the size of the complete CIM, the object classes contained in the CIM are grouped into several logical Packages, each of which represents a certain part of the overall power system being modelled. Collections of these Packages are progressed as separate International Standards. This document specifies a Base set of packages which provide a logical view of the functional aspects of Energy Management System (EMS) and power system modelling information within the electric utility enterprise that is shared between all applications. Other standards specify more specific parts of the model that are needed by only certain applications. Subclause 4.3 of this document provides the current grouping of packages into standards documents.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 61850 (all parts), *Communication networks and systems for power utility automation*

IEC 61850-7-4:2010, *Communication networks and systems for power utility automation – Part 7-4: Basic communication structure – Compatible logical node classes and data object classes*

IEC 61968 (all parts), *Application integration at electric utilities – System interfaces for distribution management*

IEC TS 61970-2, *Energy management system application program interface (EMS-API) – Part 2: Glossary*

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Object Management Group: *UML 2.0 Specification* – http://www.omg.org

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC TS 61970-2 and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at http://www.electropedia.org/
- ISO Online browsing platform: available at http://www.iso.org/obp

3.1
energy management system
EMS
computer system comprising a software platform providing basic support services and a set of applications providing the functionality needed for the effective operation of electrical generation and transmission facilities so as to assure adequate security of energy supply at minimum cost

3.2
application program interface
API
set of public functions provided by an executable application component for use by other executable application components

3.3
unified modelling language
UML
formal and comprehensive descriptive language with diagramming techniques used to represent software systems, from requirements analysis, through design and implementation, to documentation

Note 1 to entry: UML has evolved from a collection of methods contributed by different practitioners into an International Standard (ISO/IEC 19505, published in 2012). The CIM relies on UML for defining the model, and automated tools generate the documentation, schemas, and other artefacts directly from the UML. A basic understanding of UML is necessary to understand the CIM.

3.4
profile
subset of CIM classes, associations and attributes needed to accomplish a specific type of interface

Note 1 to entry: This may be expressed in XSD, RDF, and/or OWL files. A profile can be tested between applications. A profile is necessary in order to “use” the CIM. Several profiles are defined in other parts of the IEC 61968 and IEC 62325 series.

4 CIM specification

4.1 Overview

The CIM model is described in the Unified Modelling Language (UML) which is maintained as a UML file managed by a UML editing tool. The UML file exists in two different formats:

- a tool proprietary format,
- a standardized xmi format.

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The CIM model is described in Clause 6, which is a report generated from the UML file. The name of the UML file use to generate Clause 6 is:

- ~~iec61970cim17v38_iec61968cim13v12_iec62325cim03v17a.eap.~~
- iec61970cim17v40_iec61968cim13v13a_iec62325cim03v17a.eap

This file can be obtained from CIM users group.

4.2 CIM modelling notation

The CIM is defined using object-oriented modelling techniques. Specifically, the CIM specification uses the UML notation, which defines the CIM as a group of packages.

Each package in the CIM contains one or more class diagrams showing graphically all the classes in that package and their relationships. Each class is then defined in text in terms of its attributes and relationships to other classes.

The UML notation is described in Object Management Group (OMG) documents and several published textbooks.

4.3 CIM packages

A package is a general purpose means of grouping related model elements. The packages have been chosen to make the model easier to design, understand and review. Entities may have associations that cross many package boundaries. Each application will use information represented in several packages.

Different groups of packages are assigned to different working groups within the IEC for convenience in managing and maintaining them.

WG13 packages are included in this document and contained under the IEC61970 package. The IEC61970 packages do not depend upon other outside packages. As shown in Figure 1, the IEC61970 package and its subpackages are used as a core or base model for other CIM packages. The dashed lines indicate dependency relationships, with the arrowhead pointing from the dependent package to the package on which it has a dependency. WG14 packages in the IEC 61968 series describe additional parts of the CIM that deal with other logical views of utility operations including assets, locations, activities, consumers, documentation, work management, and metering. WG16 packages in the IEC 62325 series describe electric energy markets.

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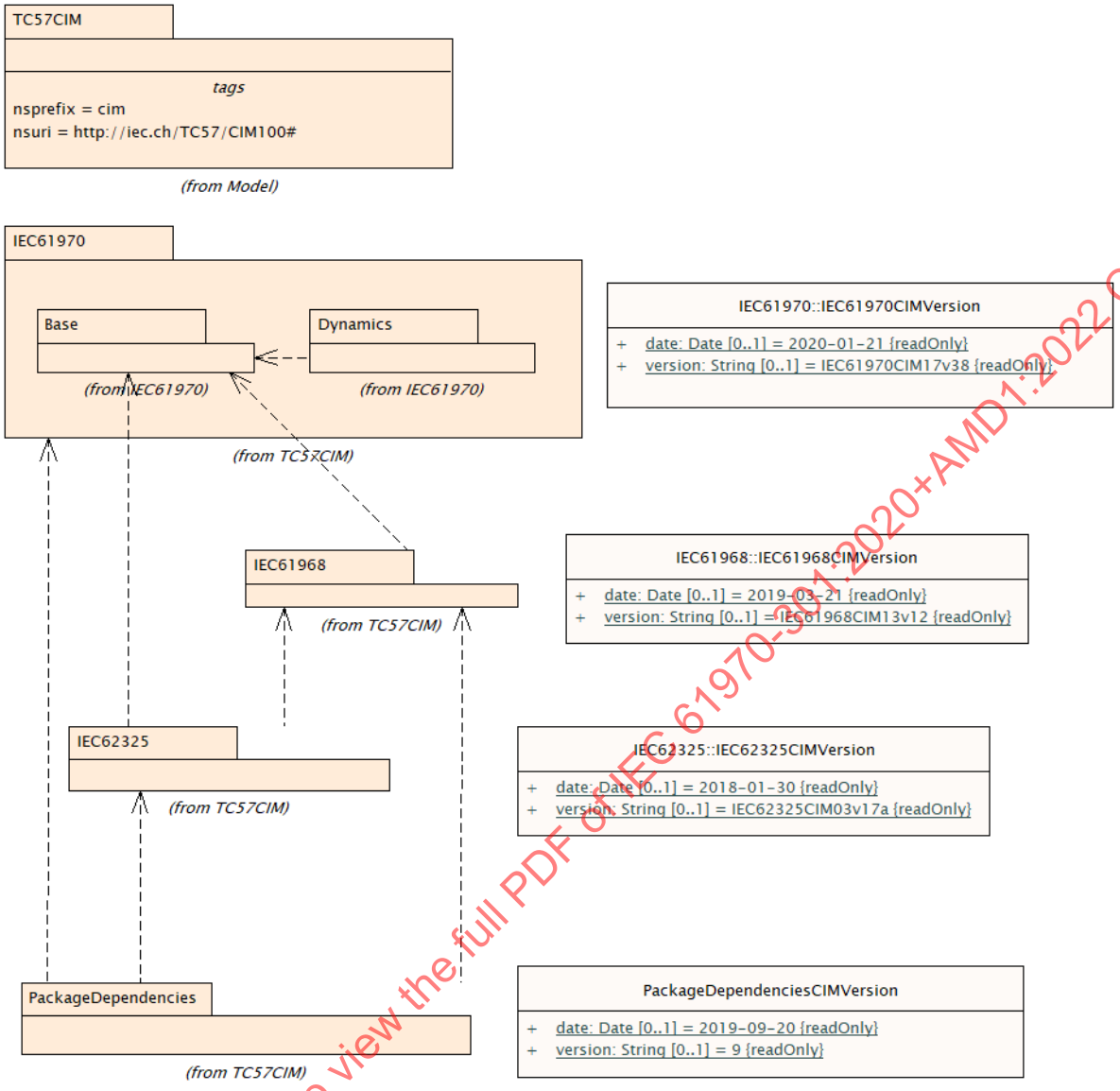


Figure 1 – Defined dependencies between CIM packages and packages' versions information

Note that the package boundaries do not imply application boundaries. An application may use CIM entities from several packages. It is also anticipated that CIM packages outside of this document will have dependencies upon some of the packages described in this document, and particularly the Domain and Core packages, though other dependencies will also exist.

Figure 2 shows the packages defined for IEC 61970-301 CIM Base and their dependency relationships.

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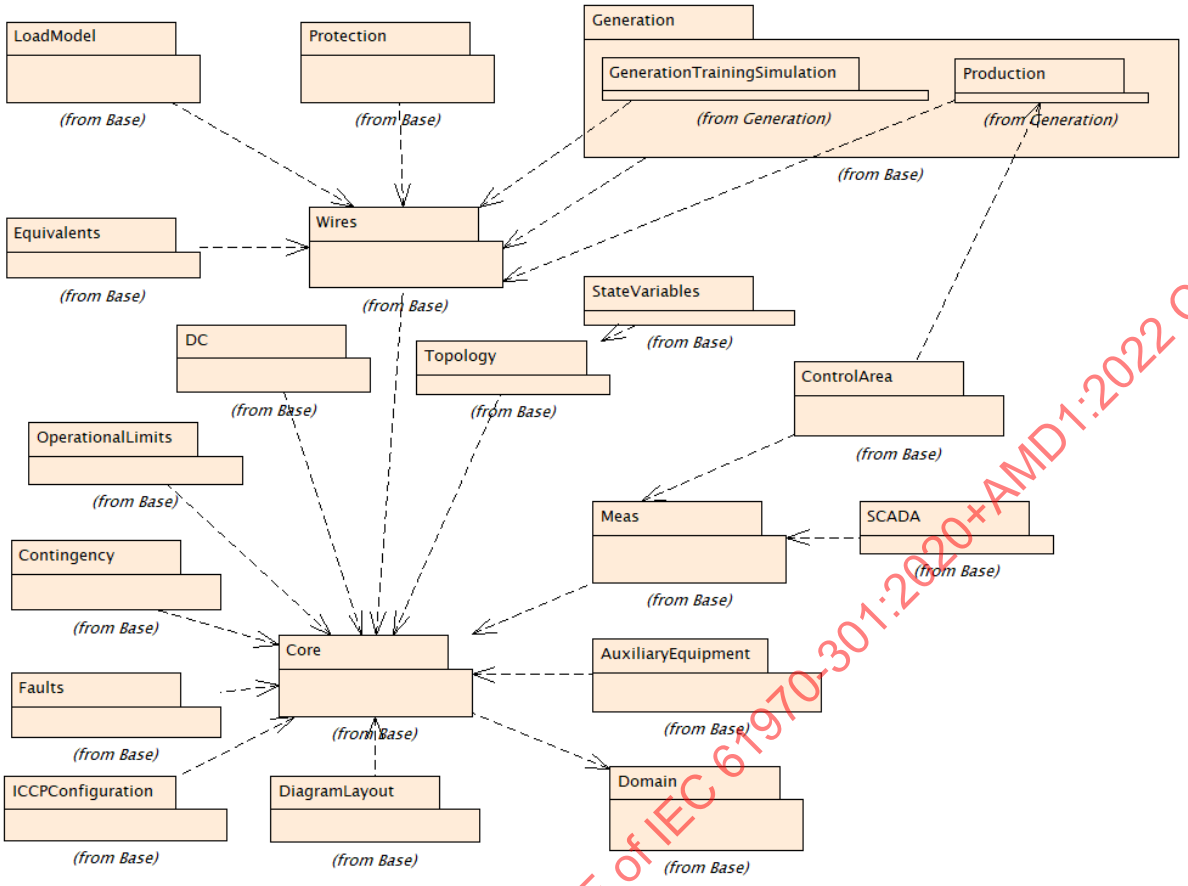


Figure 2 – CIM IEC 61970-301 package diagram

4.4 CIM classes and relationships

4.4.1 Classes

The class diagram(s) for each CIM package shows all the classes in the package and their relationships. Where relationships exist with classes in other packages, those classes may also be shown.

Classes and objects model what is in a power system that needs to be represented in a common way to power system applications. A class is a description of an object found in the real world, such as a power transformer, generator, or load that needs to be represented as part of the overall power system model in, for example, an EMS. Other types of objects include things such as schedules and measurements that EMS applications also need to process, analyse, and store. Such objects need a common representation to achieve the purposes of the EMS-API standard for plug-compatibility and interoperability. A particular object in a power system with a unique identity is modelled as an instance of the class to which it belongs.

It should also be noted that the CIM is defined to facilitate data exchange. As defined in this document, the properties of CIM entities are modelled, but not their behaviour. For a specific interface, a profile is defined consisting of subsets of CIM classes, attributes, and associations. A profile defines the message payload for an interface.

Classes have attributes that describe the characteristics of the objects. Each class in the CIM contains the attributes that describe and identify a specific instance of the class. Only the attributes that are important for the integration and interoperability of power system applications are included in the class descriptions.

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Each attribute has a type, which identifies what kind of attribute it is. Typical attributes are of type Integer, Float, Boolean, String, Date, and Decimal, which are called primitive types. However, many additional types are defined as part of the CIM specification. For example, ShuntCompensator has a "maxU" attribute of type Voltage. The definition of many shared types is contained in the Domain package. The UML stereotypes of Primitive, enumeration, CIMDatatype, and Compound are added to classes used as types. The CIMDatatype stereotype is used with a specific CIM semantics for a simple value with additional attributes describing the unit and multiplier of the value, e.g. unit, multiplier. This implies custom mapping to serialization artefacts such as RDFS, OWL, and XSD. Classes with these stereotypes do not participate in generalization or association relationships and are simply used as types for attributes. The enumeration stereotype is used to describe an attribute with an enumerated list of choices. The Compound stereotype is used to describe sets of related attributes that are commonly reused. Compound classes may consist of Primitive, enumeration, CIMDatatype or other Compound classes as long as the Compound classes do not recurse.

All CIM attributes are optional in the sense that profiles using the CIM may eliminate any attributes.

Relationships between classes reveal how they are structured in terms of each other. CIM classes are related in a variety of ways, as described in 4.4.2 to 4.4.4.

4.4.2 Generalization

A generalization is a relationship between a more general and a more specific class. The more specific class can contain only additional information. Generalization provides for the specific class to inherit attributes and relationships from all the more general classes above it.

Figure 3 is an example of generalization. In this example taken from the Wires package, a Breaker is a more specific type of ProtectedSwitch, which in turn is a more specific type of Switch, which is a more specific type of ConductingEquipment, etc. A PowerTransformer is another more specific type of ConductingEquipment. Note that PowerSystemResource inherits from class IdentifiedObject which is not on the diagram. Therefore, IdentifiedObject is shown in italic type in the upper right corner of class PowerSystemResource.

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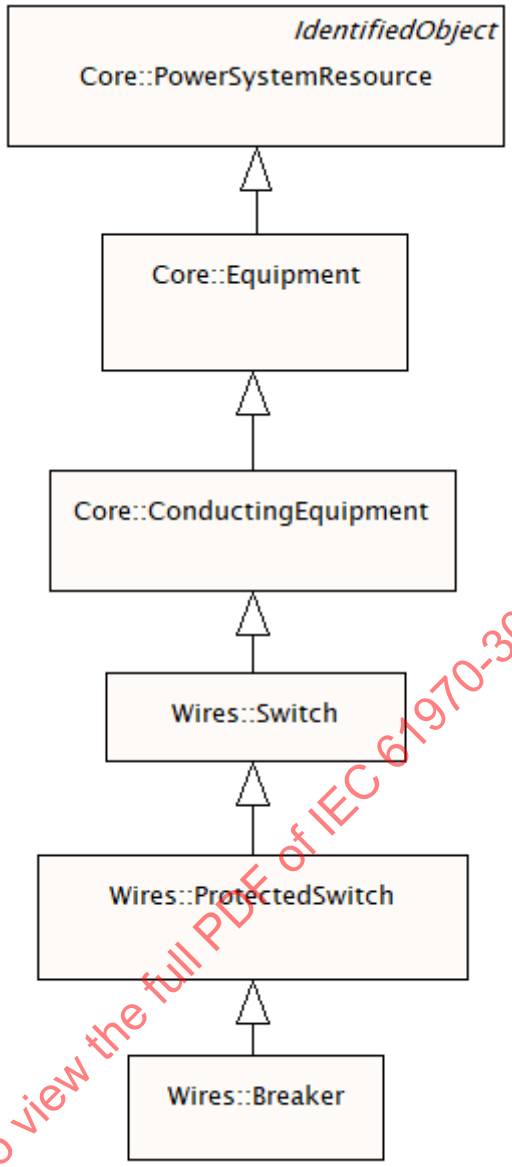


Figure 3 – Example of generalization

4.4.3 Simple association

An association is a conceptual connection between classes. Each association has two "association ends". The "association ends" were called "roles" prior to the UML 2.0 specification. Each association end describes the role the target class (i.e. the class the association end goes *to*) has in relation to the source class (i.e. the class the association end goes *from*). Association ends are usually given the name of the target class with or without a verb phrase. Each association end also has multiplicity/cardinality, which is an indication of how many objects may participate in the given relationship. In the CIM, associations are not named, only association ends are named. For example, as shown by Figure 4, in the CIM there is an association between a BaseVoltage and a VoltageLevel. Multiplicity is shown at both ends of the association. In this example, a VoltageLevel object may reference 1 BaseVoltage, and a BaseVoltage may be referenced by 0 or more VoltageLevel objects.

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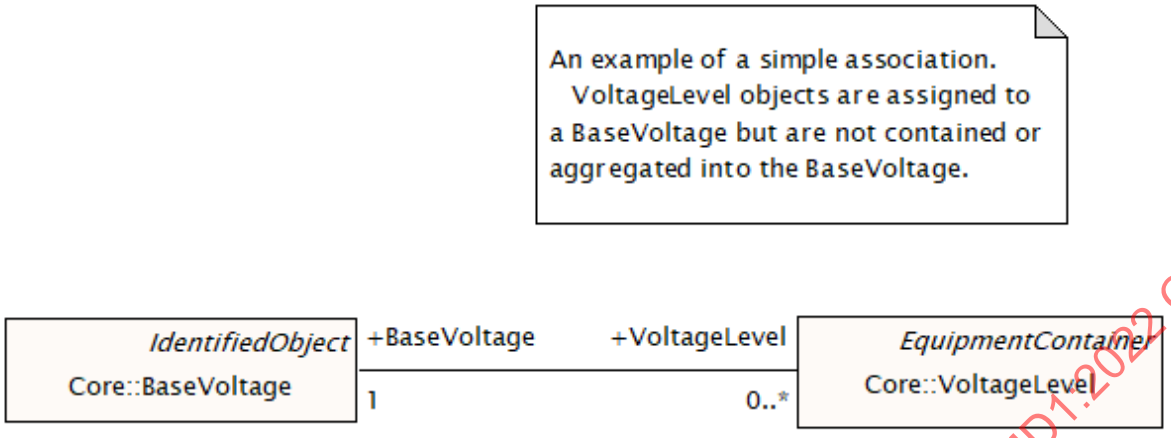


Figure 4 – Example of simple association

4.4.4 Aggregation

Aggregation is a special case of association. Aggregation indicates that the relationship between the classes is some sort of whole-part relationship, where the whole class "consists of" or "contains" the part class, and the part class is "part of" the whole class. The part class does not inherit from the whole class as in generalization. Figure 5 illustrates an aggregation between the EquipmentContainer class and the Equipment class, which is taken from the Core package. As shown, an Equipment can be a member of zero or one EquipmentContainer objects, but an EquipmentContainer object can contain any number of Equipment objects. In the context of using CIM as an information model, aggregation does not have a precise or formal interpretation beyond a simple association and is intended to visually assist in representing normal usage.

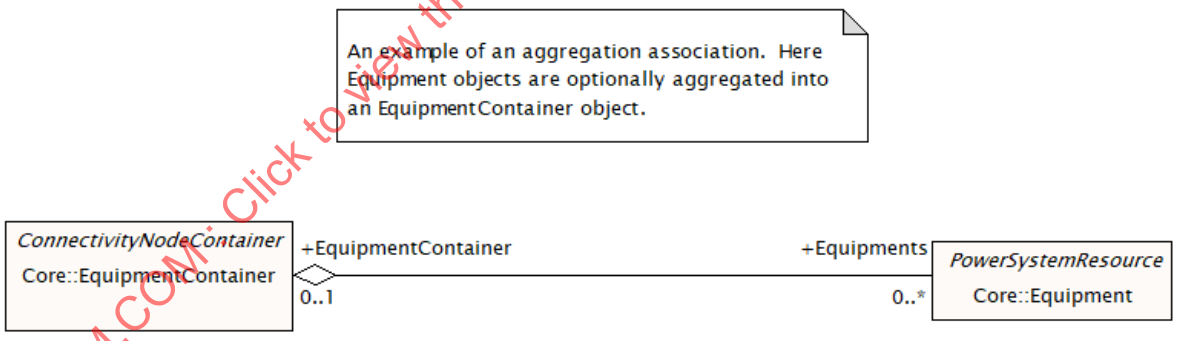


Figure 5 – Example of aggregation

4.5 CIM model concepts and examples

4.5.1 Concepts

To help understand how to interpret the CIM, some key model concepts used in the CIM are introduced and described in 4.5.2 to 4.5.16.

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4.5.2 Containment, equipment hierarchies and naming

4.5.2.1 Containment structure

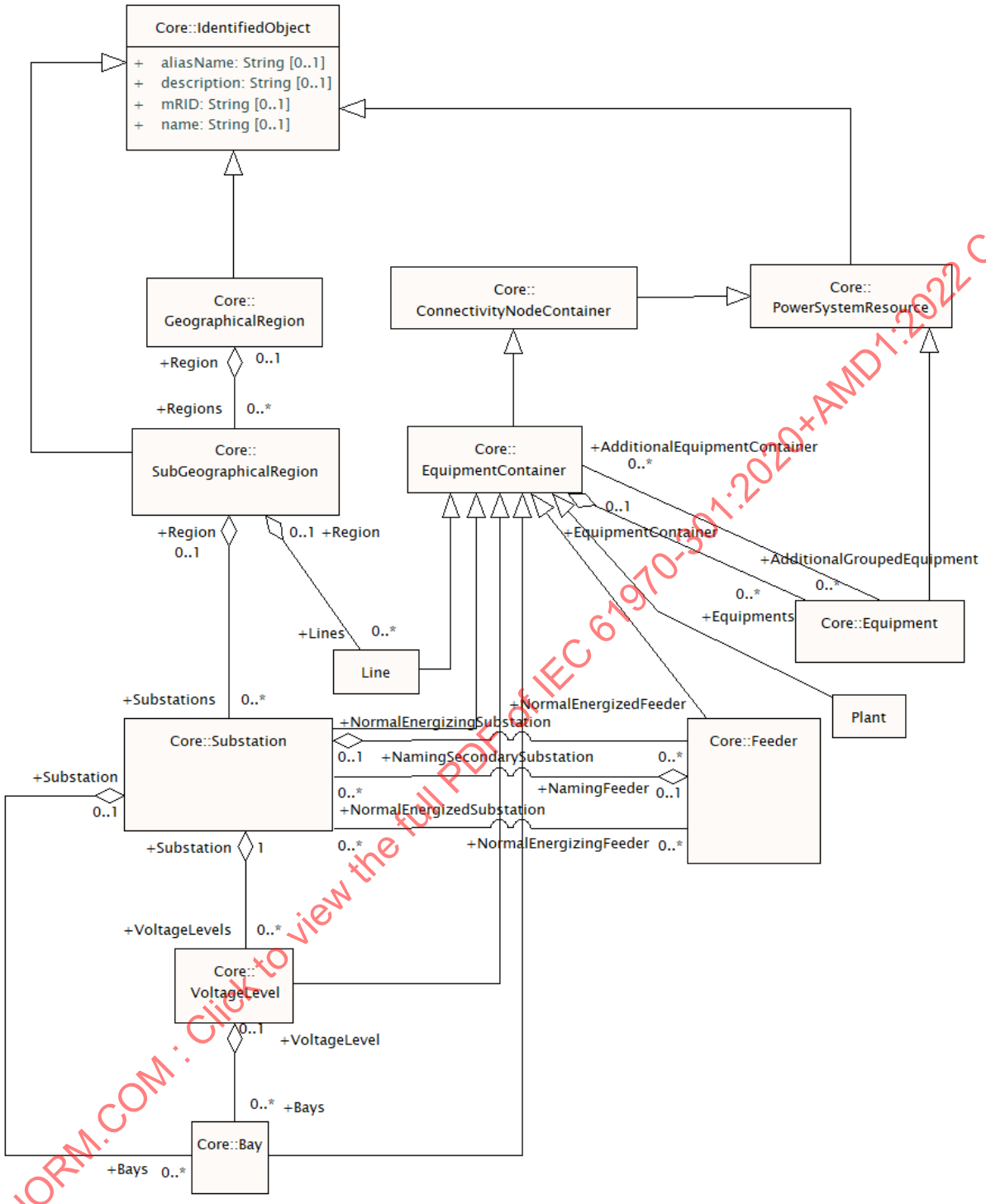
Figure 6 shows the concept of equipment containers to form hierarchies in the CIM. Equipment containers represent ways of organizing and naming equipment typically found within a substation. As may be seen, there is some flexibility provided in which containers are used in a specific application of the CIM in order to accommodate different international practices as well as differences typically found between transmission and distribution substations. Bay, VoltageLevel, Substation, Line, and Plant are all types of EquipmentContainer(s). In general, a Bay is contained within a specific VoltageLevel, which in turn is contained within a Substation. Substation(s) and Line(s) may be contained within SubGeographicalRegion(s) and GeographicalRegion(s).

One containment hierarchy is used with the IdentifiedObject class to create human readable hierarchical naming. This hierarchy is specifically used to name equipment according to its function in the power system. This is the functional naming hierarchy. Other common identifications beside functional names are asset serial numbers. The functional name is different from a serial number in that it relates to the function of a particular equipment position or location in the power system. Regardless of what specific piece of physical equipment is placed at a location, the functional name is the same but the serial number varies depending on the physical equipment currently used.

4.5.2.2 IdentifiedObject class

The IdentifiedObject class contained in the Core package is inherited by all PowerSystemResource and many other classes. This class has attributes and associations to be used for naming all CIM objects. Additional names can be defined by using name classes of 4.5.3 or by defining extensions. The mRID attribute of the IdentifiedObject class provides a straight forward and rigorous means of identity for CIM objects.

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Figure 6 – Equipment containers

The diagrams NamingHierarchyPart1 and NamingHierarchyPart2 in the Wires package show the functional naming hierarchy.

4.5.3 Names model

A flexible and extensible naming model is provided to specify alternate names for objects. A use cases where the names model is useful is when multiple applications or systems have different names for the same object. The names model then enables exchange of these names.

Figure 7 shows the class diagram for alternate names and how they can be associated to a specific user defined name type. This model allows for specific definition of names within a particular domain and enforces no specific naming rules. The concepts of alias names, path names, and local names can all be accommodated by this model. The CIM models do not enforce or promote specific naming conventions but allow for such naming conventions to be exchanged in a clear context.

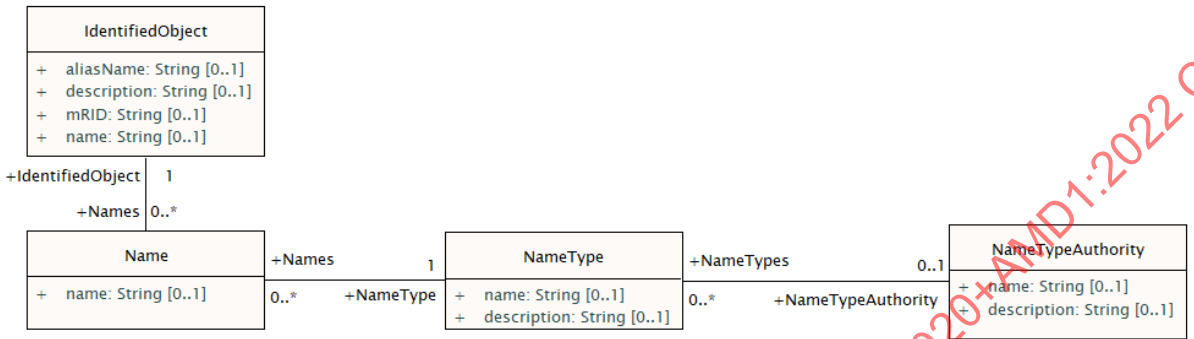


Figure 7 – Names

4.5.4 Connectivity model

4.5.4.1 Connectivity description

Figure 8 shows the Topology class diagram which models connectivity between different types of ConductingEquipment. Also included is a part of the Meas package class diagram dealing with measurements to illustrate how measurements are associated with conducting equipment.

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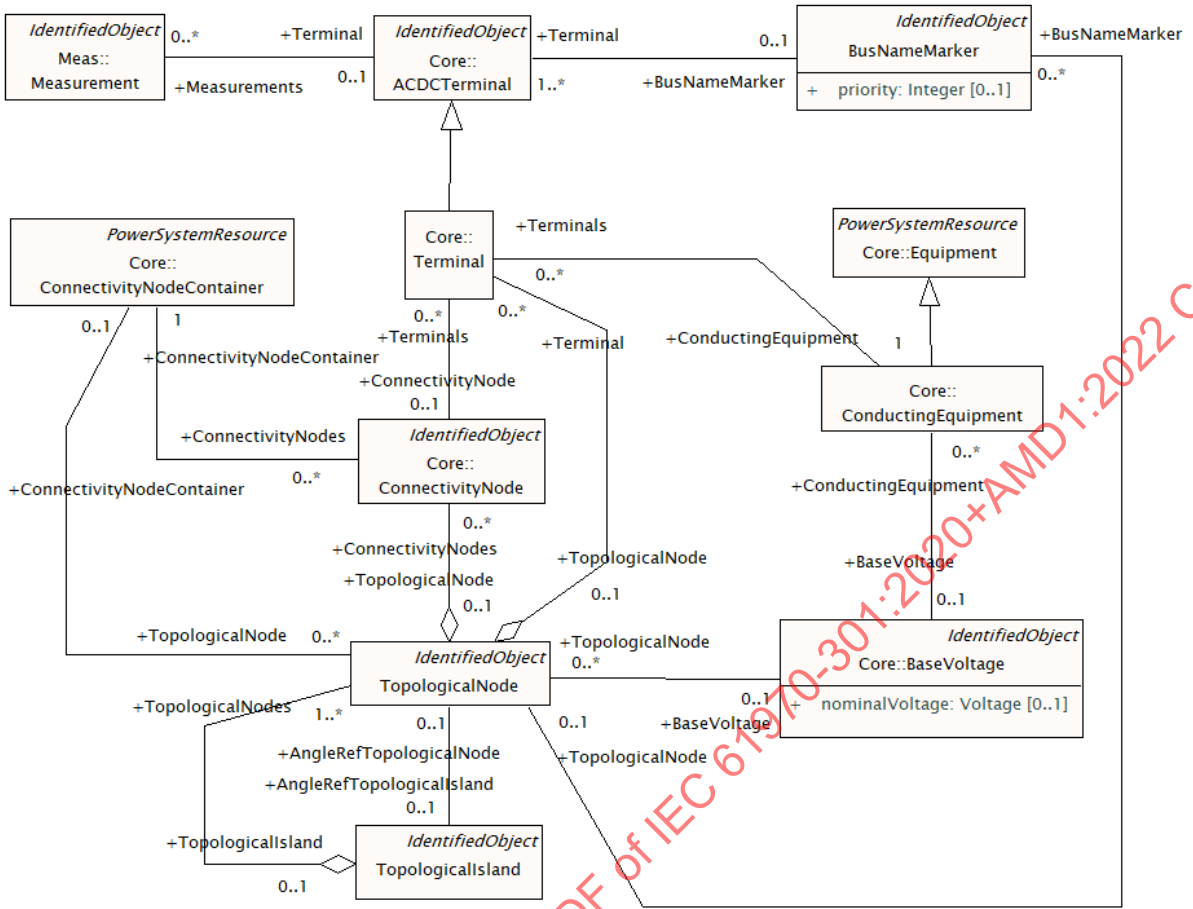


Figure 8 – Connectivity model

To model connectivity, Terminal and ConnectivityNode classes are defined. A Terminal belongs to one ConductingEquipment, although ConductingEquipment may have any number of Terminals. Each Terminal may be connected to a ConnectivityNode, which is a point where terminals of conducting equipment are connected together with zero impedance. A ConnectivityNode may have any number of terminals connected and may be a member of a TopologicalNode (i.e. a bus), which is in turn a member of a TopologicalIsland. TopologicalNode-s and TopologicalIsland-s are created as a result of a topology processor evaluating the “as built” connectivity and the actual Switch positions.

It is possible to exchange documents directly involving TopologicalNode and bypassing the ConnectivityNode details by using the TopologicalNode to Terminal association. This is often useful for exchanges involving models which do not contain switch detail. When the TopologicalNode model is exchanged it is useful to also exchange the “connected” attribute on the Terminal class. This allows for the topological structure of the model to be retained, yet indicate a terminal is not completely connected. Normally this disconnection is the result of one or more switches opening in the detailed model which is not represented in a model exchange without switch detail.

EquipmentContainer-s, which are a specialization of a ConnectivityNodeContainer, may contain zero or more ConnectivityNode-s. The associations, ConductingEquipment–Terminal and Terminal–ConnectivityNode, capture the as-built connectivity of an actual power system network. For each Terminal connected to a ConnectivityNode, the associations of the other Terminal(s) connected to the same ConnectivityNode identify the ConductingEqupment object(s) that are electrically connected. Similar connectivity at the “bus/branch” level of detail can be expressed using the TopologicalNode instead of the ConnectivityNode. The BusNameMarker class, which has an association to ConnectivityNode, is used to carry user bus names to be applied to TopologicalNode-s. TopologicalNode-s are created from

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ConnectivityNode-s as a result of topology processing and various names might be applied depending upon which ConnectivityNode instances are present.

To model the analog values such as voltage and power, each Terminal has an association with a Measurement class from the Meas package. Although not shown in Figure 8, a Measurement object is associated with at least one MeasurementValue object. Each MeasurementValue object is an instance of a measurement from a specific source, for example, a telemetered measurement.

4.5.4.2 Connectivity and containment example

To illustrate how the connectivity model and containment model would appear as objects, a small example is presented in Figure 9. The example shows a transmission line with a T-junction spanning two substations and a substation having two voltage levels with a transformer between them. The transmission line consists of two different cables. One of the voltage levels is shown with a busbar section having a single busbar and two very simple switchgear bays connecting to the busbar.

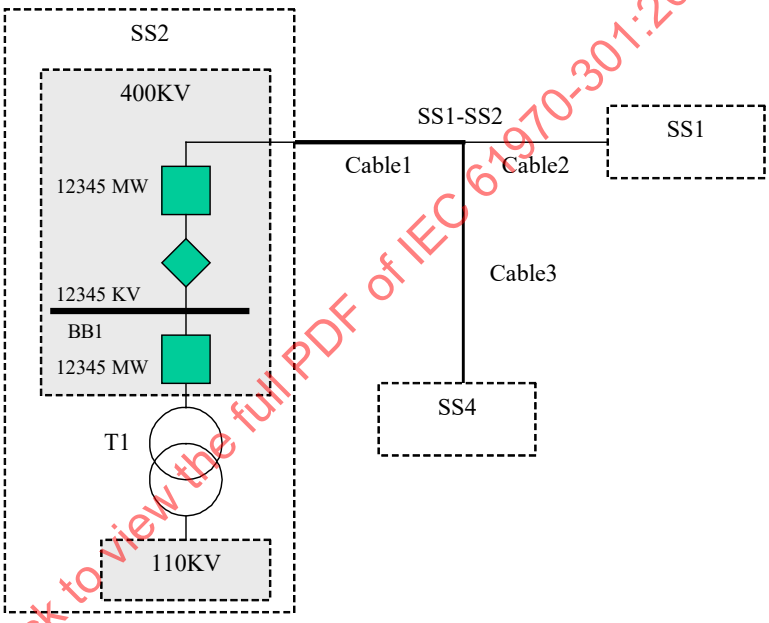


Figure 9 – Simple network example

Figure 10 shows how connectivity is modelled in the CIM as well as one way (but not necessarily the only way) containment is modelled for the diagram in Figure 9. The shaded square boxes represent EquipmentContainer-s, and the white square boxes represent ConductingEquipment. Darker shading indicates the EquipmentContainer is higher up in the containment hierarchy (i.e. Substation is highest, VoltageLevel next, etc.). White circles represent ConnectivityNode-s, and black small circles represent Terminals. A Terminal belongs to a ConductingEquipment, and a ConnectivityNode belongs to an EquipmentContainer. This means that the borders (or contact points) between ConductingEquipment are their Terminals interconnected via ConnectivityNode-s.

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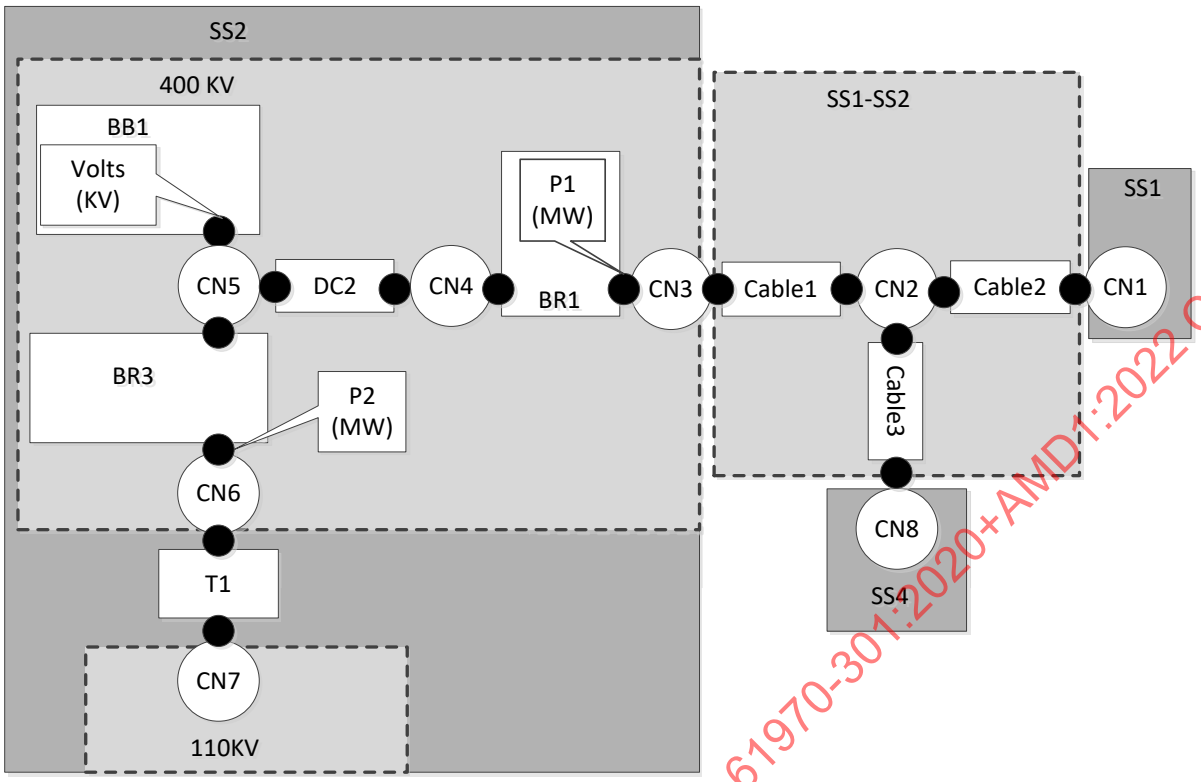


Figure 10 – Simple network connectivity modelled with CIM Topology

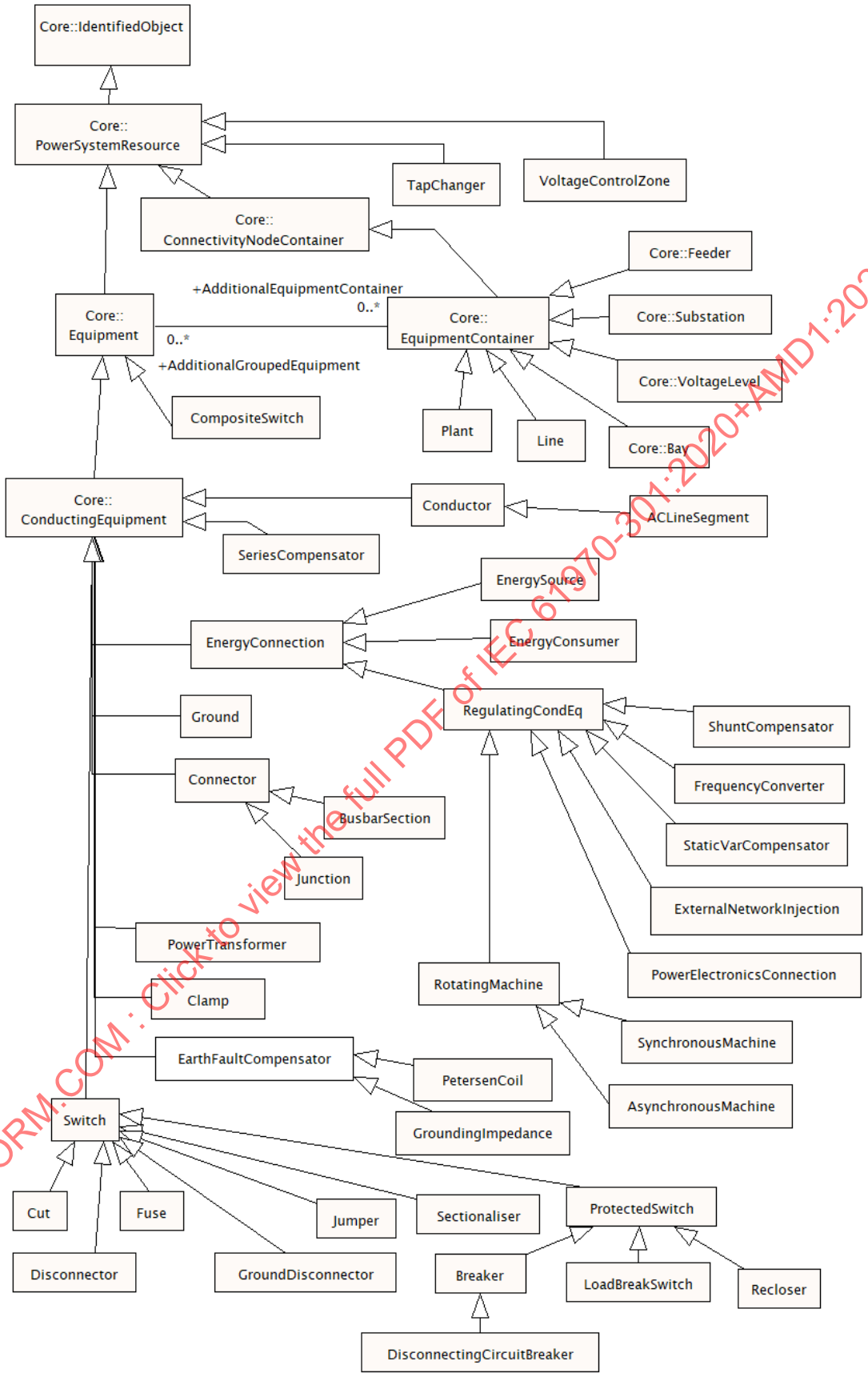
The Line SS1-SS2 contains three ACLineSegment-s (Cable1, Cable2, and Cable3) and associated ConnectivityNode (CN2) to model a T-junction, which provides a connection to SS4. This represents just one way that this configuration could be modelled. Each ACLineSegment has two Terminals. Cable1 is connected to CN3 and CN2 via these Terminals. CN3 is contained by the VoltageLevel 400KV. The breaker BR1 has two terminals one of which is connected to CN3.

Measurements are represented by square callouts where the arrow points to a Terminal. P1 is connected to the right Terminal belonging to Breaker BR1. Note that P1 is drawn inside the box representing BR1. This is because a Measurement may belong to a PowerSystemResource (PSR), as is the case with BR1. P2 is drawn inside the VoltageLevel 400 KV, which means it belongs to the 400 KV VoltageLevel instead of BR3.

4.5.5 Inheritance hierarchy

Figure 11 shows an overview of the inheritance hierarchy modelled in the CIM. This overview, which is included as one of the Wires package diagrams, spans several of the CIM packages.

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Figure 11 – Equipment inheritance hierarchy

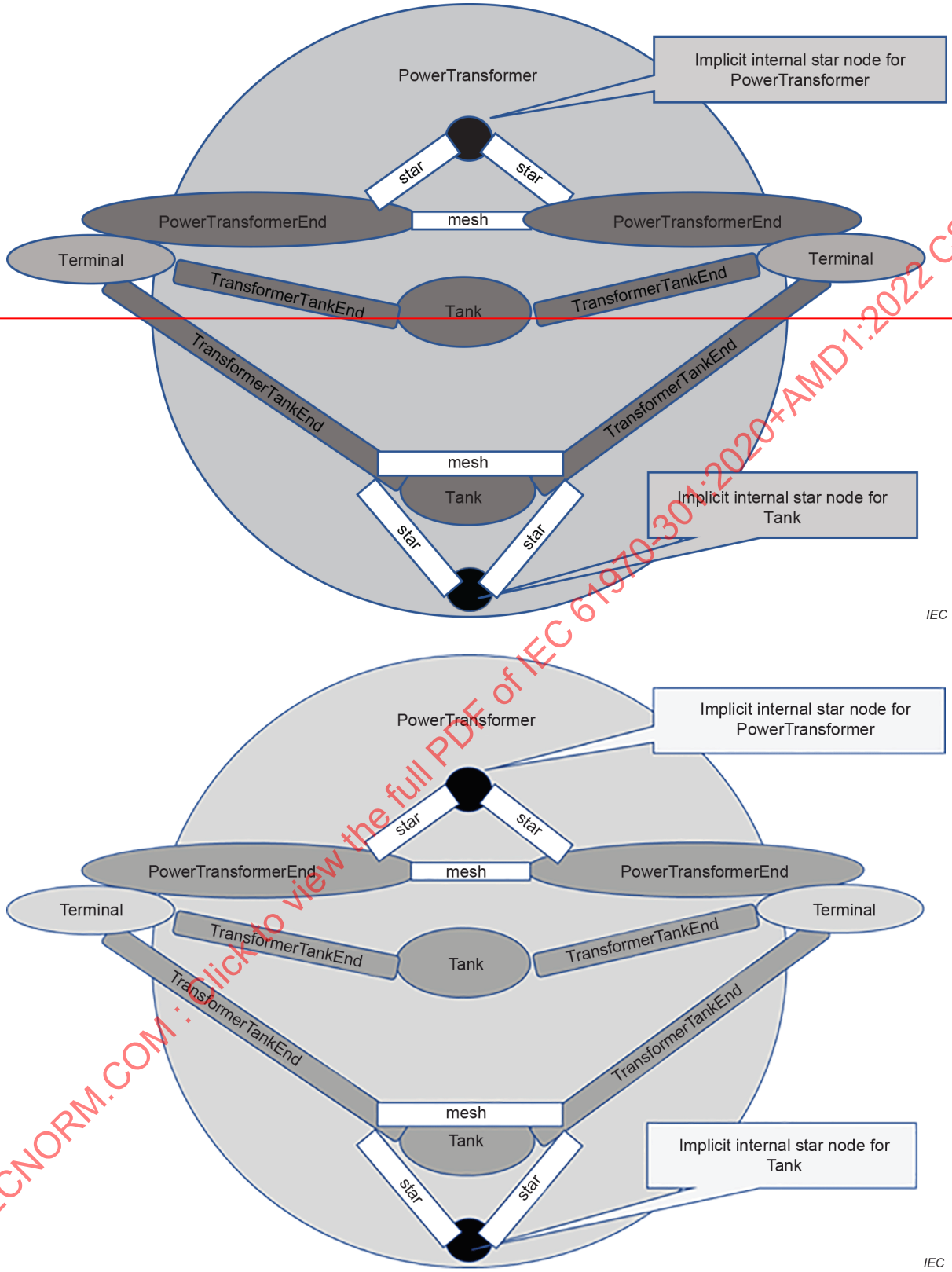
4.5.6 Transformer model

Figure 13 shows a part of the Wires package in a class diagram which models a PowerTransformer device.

The transformer model is applicable for both balanced and unbalanced models. Additionally the PowerTransformer itself is now a ConductingEquipment with potentially multiple terminals to more directly model transformers with one, two, three, or more terminals.

As shown in Figure 12, the PowerTransformer is also able to optionally model tank details, which can be used to describe in detail the transformer internal winding phase connections and imbalances. In all cases a PowerTransformer models a group of physical devices acting together to transform power among terminals and in one physical location. For transmission systems, three physical single phase devices are often represented by one PowerTransformer instance. If detail of the individual single phase devices were required, the TransformerTank objects should additionally be modelled.

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Figure 12 – Transformer and Tank model

Both a PowerTransformer and a TransformerTank can have impedance described in either an assumed star connection with implied centre connection or with mesh impedance form by using the optional TransformerMeshImpedance class. The mesh form of impedance is required to accurately model transformers with more than three terminals. If using the mesh impedance form, you would specify a TransformerMeshImpedance class for each possible terminal to

terminal connection, thus one instance for two terminals, three for three terminals, and six for four terminals and so on. If using the star connection, the impedance parameters can be specified directly on the PowerTransformerEnd class, or alternatively shared among transformers using the TransformerStarImpedance class.

As shown in Figure 11, a PowerTransformer is a specialized class of ConductingEquipment, which is a specialized class of Equipment. This is shown by the use of the generalization-type of relationship, which uses an arrow to point to the general class. The inheritance permits the PowerTransformer to inherit attributes from ConductingEquipment, Equipment, and all generalizations of Equipment that are not shown in Figure 11.

A PowerTransformer also has relationships to PowerTransformerEnd and TransformerTank which are modelled with association type relationships. As shown, a PowerTransformer may associate zero or more PowerTransformerEnd-s, but a PowerTransformerEnd may associate to only zero or one PowerTransformer. Similarly, the PowerTransformer may associate to zero or more TransformerTank objects, but a TransformerTank may associate to only zero or one PowerTransformer object.

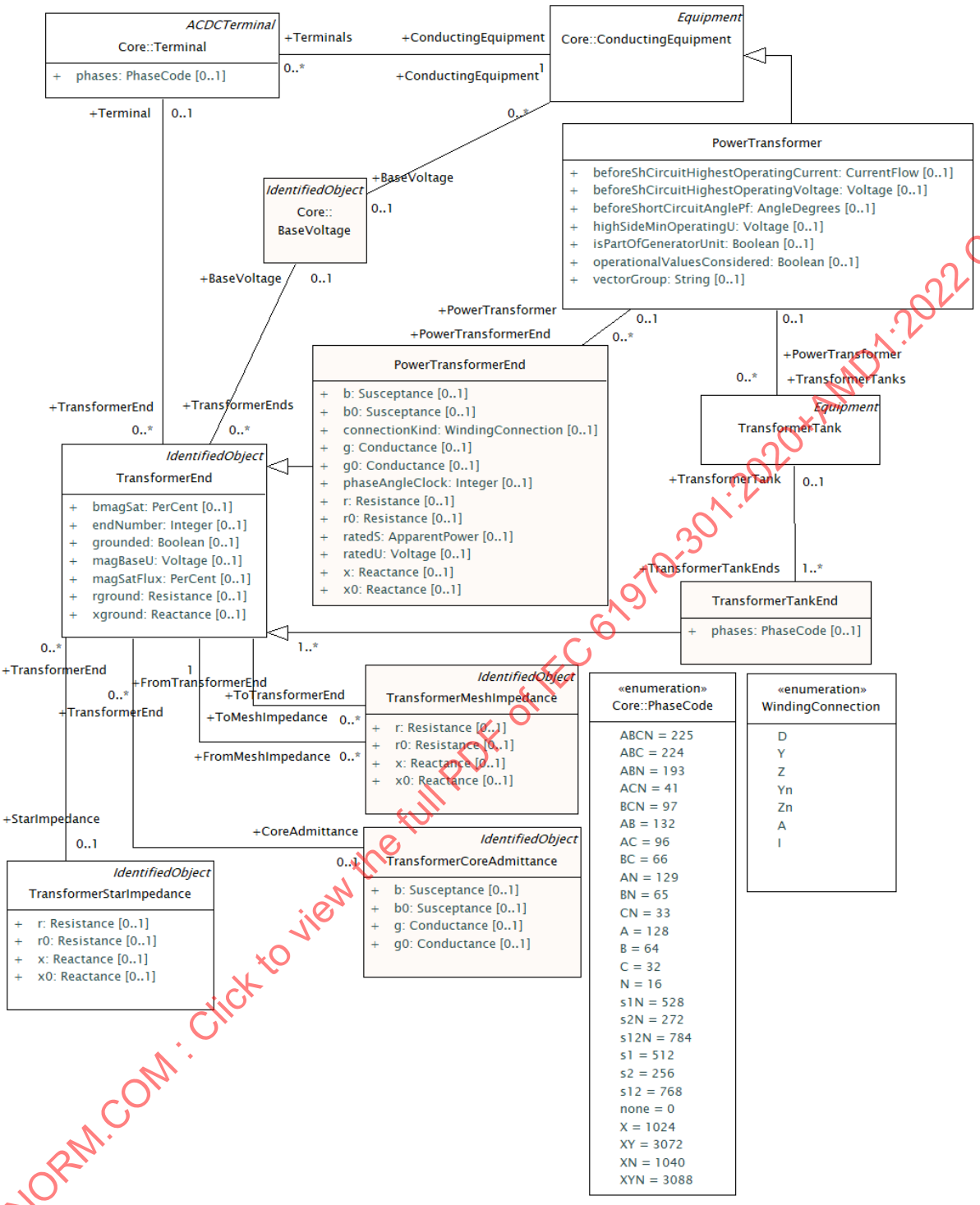
The PowerTransformerEnd specializes the TransformerEnd class which has other relationships as well:

- a generalization relationship with IdentifiedObject;
- two association relationships with the TransformerMeshImpedance class, such that a TransformerEnd object may be “From” 0, 1, or more TransformerMeshImpedance objects and “To” 0, 1, or more TransformerMeshImpedance objects;
- aggregation relationships with the PhaseTapChanger and RatioTapChanger classes, such that a TransformerWinding object may have 0 or 1 PhaseTapChanger objects and 0 or 1 RatioTapChanger objects associated with it.

For a transmission network PowerTransformer that has two or three ends, the equivalent pi-model impedances appear in the PowerTransformerEnd r, r0, x, x0, g, g0, b and b0 attributes. The PowerTransformerEnd and its connected Terminal both have sequence numbers TransformerEnd.endNumber and ACDCTerminal.sequenceNumber. Those numbers may or may not be in synch.

Figure 13 shows UML for the transformer model.

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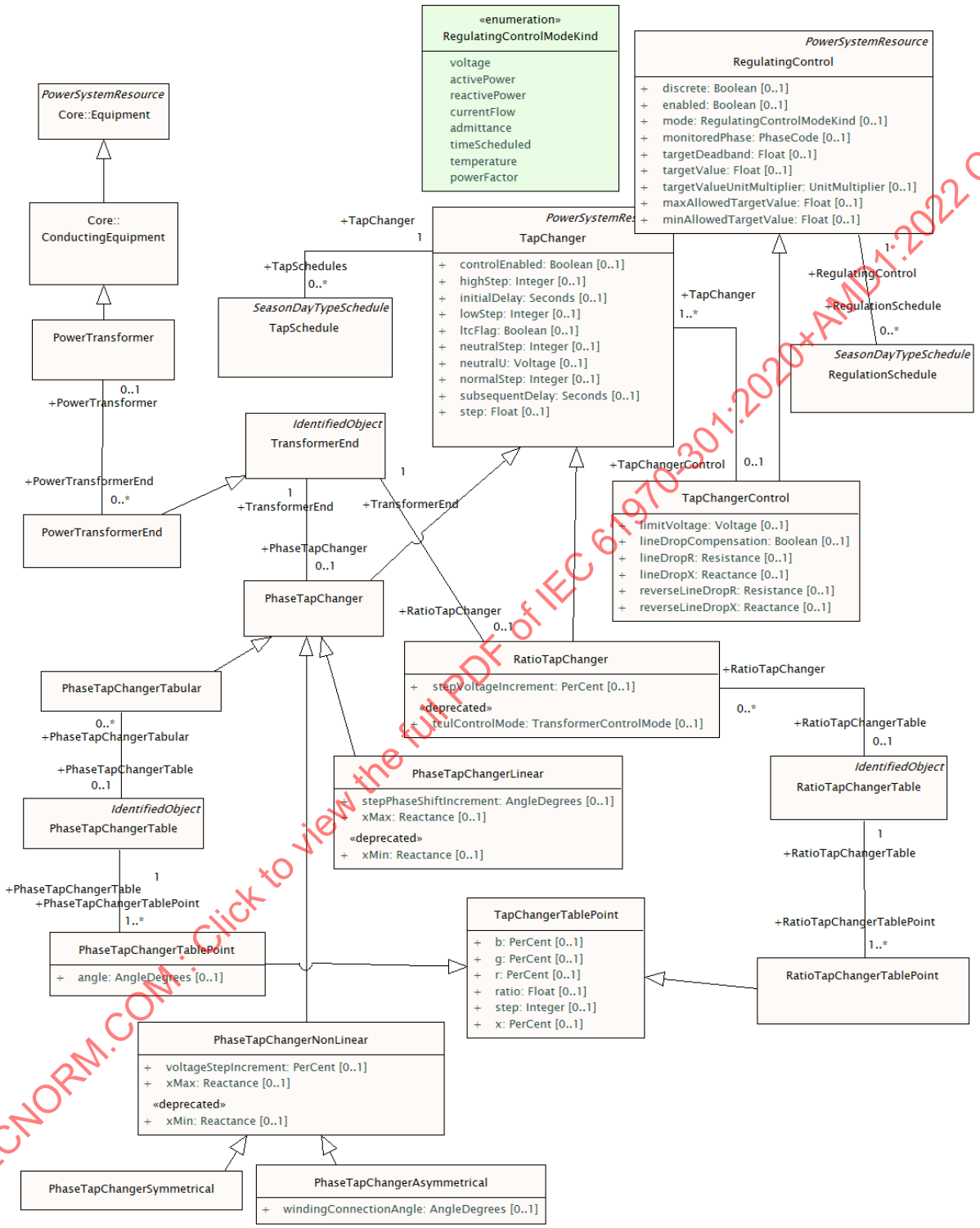
Figure 13 – Transformer model

4.5.7 Transformer tap modelling

4.5.7.1 Generalized tap modelling

Multiple types of transformer tap models are supported by the CIM model. Depending on the physical construction, the effects of tap movement shall be defined using either the RatioTapChanger class or the PhaseTapChanger class and its various specializations. The PhaseTapChanger can be specialized into several different types representing the physical

construction and hence behaviour. The attributes of TapChanger are applicable for all the RatioTapChanger specializations. Figure 14 shows the UML model for the transformer taps.



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Figure 14 – Transformer tap model

Multiple tap changers can be combined within one power transformer, but to avoid interpretation issues only one phase shifting and one ratio changing tap changer shall be modelled on any given terminal. The ratio or phase shift change is documented relative to the other terminal(s) assuming those terminals are at the nominal (1 PU) ratio and nominal (zero) phase angle shift. Tabular representation is required in cases where it is necessary to combine both phase shifting and ratio tap changer on one terminal, as it conveys the explicit values of the resulting phases and angles.

Tabular representations for both ratio and phase shifting transformers can be used where the available CIM models do not appropriately reflect the physical behaviour. The tabular models are optional to the other CIM tap models. Tabular models may be used to describe the change in impedance through the tap range.

In 4.5.7.2 to 4.5.7.7 the various tap changer models are described in more detail.

4.5.7.2 Voltage ratio transformer modelling

The RatioTapChanger class is used to define a transformer tap that changes the voltage magnitude ratio without changing the phase angle across the transformer. A RatioTapChanger may be used in cases where the transformer inherently introduces a fixed phase shift, such as from a wye-delta winding connection.

4.5.7.3 Voltage ratio transformer tabular modelling

A RatioTapChangerTabular may be optionally associated to any RatioTapChanger and may represent a non-linear relationship between tap number, tap ratio, and impedances. If associated, the tabular ratio model takes precedence.

4.5.7.4 Linear phase shifter transformer modelling

A phase shifting transformer is linear if the phase shift increment per tap step is uniform and the voltage magnitude is constant over the full range of the tap changer. A linear phase shifter is modelled using the PhaseTapChangerLinear class.

4.5.7.5 Symmetrical and asymmetrical phase shifter modelling

4.5.7.5.1 Common information

Subclause 4.5.7.5 describes Phase-Shifting Transformer (PST) modelling according to the type and technology of the equipment; and more specifically, equivalent series reactance of phase shifters in the positive sequence as a function of the phase shift angle. In these specific models, the resistances and the magnetizing currents are always neglected.

The phase shift transformers within 4.5.7.5 are mapped to CIM classes as described in Table 1.

Table 1 – Mapping of phase shift transformers to CIM classes

Phase shifter type	CIM class
General Case	cim:PhaseTapChangerTabular
Symmetrical phase shifters	cim:PhaseTapChangerSymmetrical or cim:PhaseTapChangerLinear
Asymmetrical phase shifter	cim:PhaseTapChangerAsymmetrical
In-phase transformer and symmetrical phase shifter	cim:PhaseTapChangerSymmetrical and cim:RatioTapChanger
In-phase transformer and asymmetrical phase shifter	cim:PhaseTapChangerAsymmetrical and cim:RatioTapChanger

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It is highly recommended to use tabular data to exchange PST parameters (cim:PhaseTapChangerTabular) instead of having to recalculate the parameters per tap according to each model type.

The symbols used in formulas within 4.5.7.5 are mapped to CIM classes as described in Table 2.

Table 2 – Mapping of symbols used in formulas to CIM attributes

Power Shifter Transformer attribute	CIM attribute
n	cim:PhaseTapChangerTablePoint.step
n_0	cim:TapChanger.neutralStep
δu	cim:PhaseTapChangerNonLinear.voltageStepIncrement
r	cim:TapChangerTablePoint.ratio
α	cim:PhaseTapChangerTablePoint.angle
$\delta\alpha$	cim:PhaseTapChangerLinear.stepPhaseShiftIncrement
$X(\alpha)$	cim:TapChangerTablePoint.x
$X(0)$	cim:PhaseTapChangerLinear.xMin or cim:PhaseTapChangerNonLinear.xMin or PowerTransformerEnd.x as .xMin is a deprecated attribute
$X(\alpha_{max})$	cim:PhaseTapChangerLinear.xMax or cim:PhaseTapChangerNonLinear.xMax or PowerTransformerEnd.x as .xMin is a deprecated attribute
θ	cim:PhaseTapChangerAsymmetrical.windingConnectionAngle

The impedance variation depending on tap position on a phase shift transformer is described in Table 3 and variables in Table 4.

Table 3 – Impedance variations in a phase shift transformer

Equipment type	Equivalent series reactance as a function of the phase shift angle
Symmetrical Phase shifters	$X(\alpha) = X(0) + \left(X(\alpha_{max}) - X(0)\right)\left(\frac{\sin(\alpha/2)}{\sin(\alpha_{max}/2)}\right)^2$
Asymmetrical Phase Shifter	$X(\alpha) = X(0) + \left(X(\alpha_{max}) - X(0)\right)\left(\frac{\tan\alpha}{\tan\alpha_{max}}\frac{\sin\theta - \tan\alpha_{max}\cos\theta}{\sin\theta - \tan\alpha\cos\theta}\right)^2$
In-phase transformer and symmetrical phase shifter	$X(r,\alpha) = X_r(r_{nom})\left(\frac{r}{r_{nom}}\right)^2 + X_\alpha(0) + \left(X_\alpha(\alpha_{max}) - X_\alpha(0)\right)\left(\frac{\sin(\alpha/2)}{\sin(\alpha_{max}/2)}\right)^2$
In-phase transformer and asymmetrical phase shifter	$X(r,\alpha) = X_r(r_{nom})\left(\frac{r}{r_{nom}}\right)^2 + X_\alpha(0)$ $+ \left(X_\alpha(\alpha^0_{max}) - X_\alpha(0)\right)\left(\frac{\tan\alpha}{\tan\alpha_{max}(r)}\frac{\sin\theta - \tan\alpha_{max}(r)\cos\theta}{\sin\theta - \tan\alpha\cos\theta}\right)^2$

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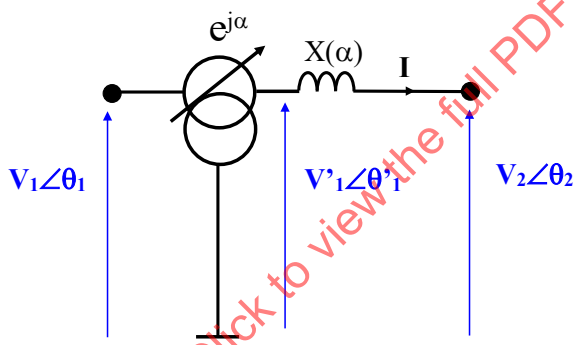
Equipment type	Equivalent series reactance as a function of the phase shift angle
	with $\alpha_{max}(r) = A\tan\left(\frac{\sin\theta}{\frac{r}{r_{nom}\tan\alpha^0_{max}}\left(\sin\theta - \tan\alpha^0_{max}\cos\theta\right)+\cos\theta}\right)$ and $\alpha^0_{max} = \alpha_{max}(r_{nom})$

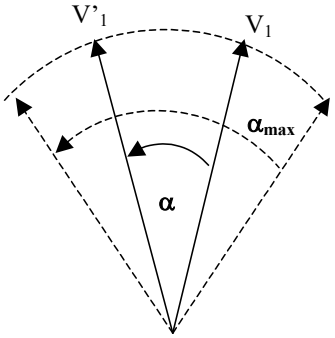
Table 4 – Description of variables

Variable	Meaning
α_{max}	Maximum phase shift: the maximum angle value of the phase shifter angles table
r_{nom}	Nominal ratio of the in-phase transformer
α^0_{max}	Maximum phase shift when the in-phase transformer ratio is nominal

4.5.7.5.2 Symmetrical Phase shifters

Phasor diagram and equations are shown in Figure 15.





$$V_2 = V_1 e^{j\alpha} - jX(\alpha)I \qquad V'_1 = V_1\left(1 + 2j\sin\frac{\alpha}{2}e^{j\frac{\alpha}{2}}\right) = e^{j\alpha}V_1$$

Figure 15 – Phasor diagram and equations

Expression of the angle and ratio per tap

Based on Figure 15:

$\alpha = (n - n_0)\cdot\delta\alpha$ or $\alpha = 2A\tan\left(\frac{(n - n_0)\cdot\delta u}{2}\right)$

$r = 1$

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Expression of the equivalent series reactance given the angle

Assuming the reactance of the regulating winding varies as the square of the number of turns, the equivalent reactance for non-delta-hexagonal technologies can be written as follows:

$$X(\alpha) = X(0) + \left(X(\alpha_{max}) - X(0)\right)\left(\frac{\sin(\alpha/2)}{\sin(\alpha_{max}/2)}\right)^2$$

Parameters:

α_{max} maximum phase shift

$X(0)$ equivalent series reactance at zero phase shift $\alpha = 0$

$X(\alpha_{max})$ equivalent series reactance at maximum phase shift $\alpha = \alpha_{max}$

Variable:

α current phase shift

The formula above is valid for single or double core symmetrical phase shifters except for the hexagonal technology.

For single core symmetrical phase shifters: $X(0) = 0$. An example of impedance variation is shown in Figure 16.

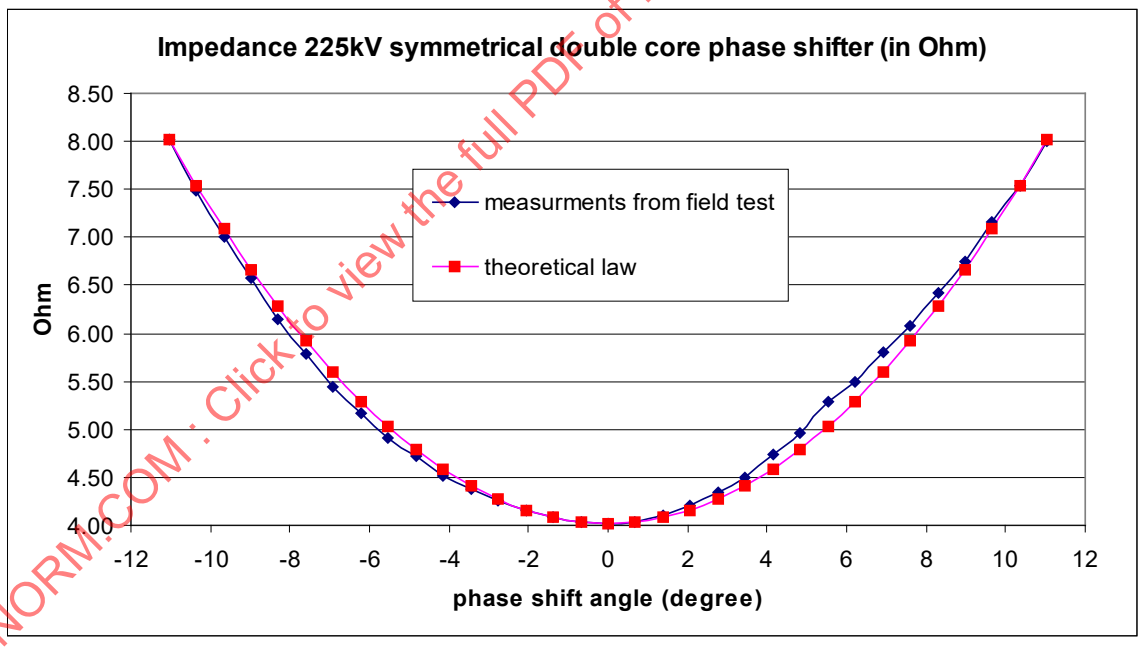


Figure 16 – Symmetrical phase shifter impedance variation

Three-phase core organization is shown in Figure 17.

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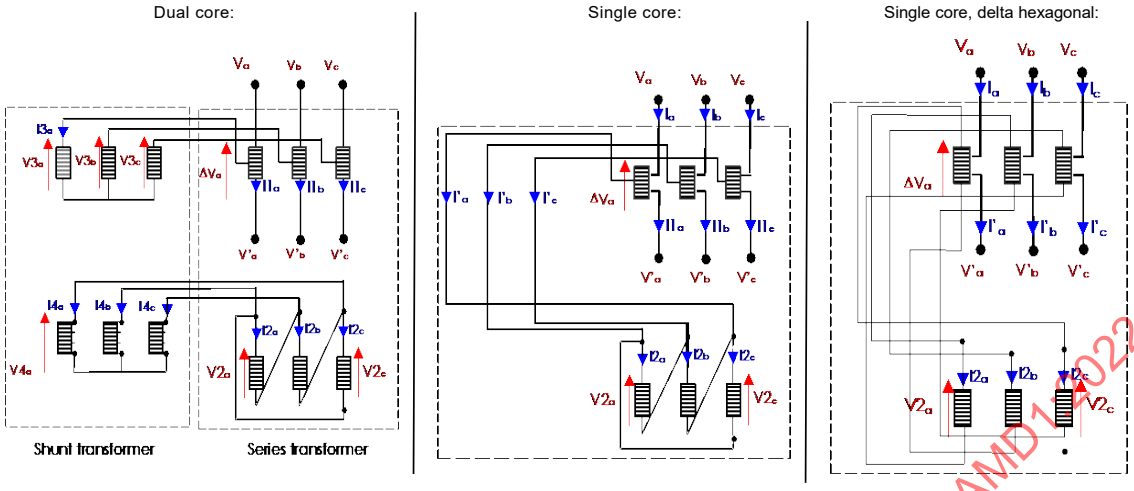
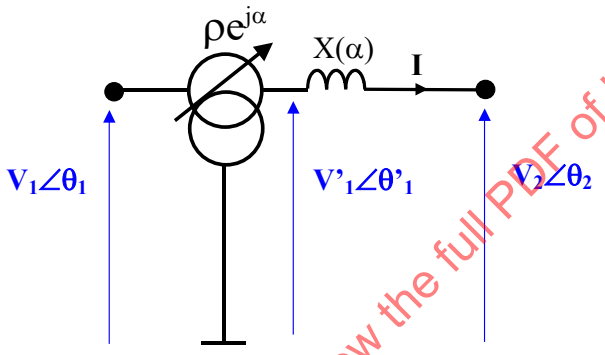
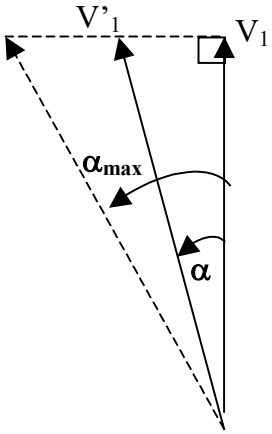


Figure 17 – Core organization

4.5.7.5.3 Quadrature booster

Phasor diagram and equations are shown in Figure 18.





$$V'_1 = V_1(1 + j\tan\alpha) = \rho e^{j\alpha} V_1$$

$$V_2 = V_1 \rho e^{j\alpha} - jX(\alpha)I$$

ρ and α vary with ρ.cos α = constant.

Figure 18 – Phasor diagram and equations

Expression of the angle and ratio per tap

Based on Figure 18:

$$\alpha = A\tan\left((n - n_0)\cdot \delta u\right)$$

$$r = \frac{1}{\sqrt{((n - n_0)\cdot \delta u)^2 + 1}}$$

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Expression of the equivalent series reactance given the angle

Assuming the reactance of the regulating winding varies as the square of the number of turns, the equivalent reactance of the quadrature booster can be written as follows.

$$X(\alpha) = X(0) + \left(X(\alpha_{max}) - X(0)\right)\left(\frac{\tan(\alpha)}{\tan(\alpha_{max})}\right)^2$$

Parameters:

α_{max} maximum phase shift

$X(0)$ equivalent series reactance at zero phase shift

$X(\alpha_{max})$ equivalent series reactance at maximum phase shift

Variable:

α current phase shift

For quadrature boosters with a single core: $X(0) = 0$

Three-phase core organization is shown in Figure 19.

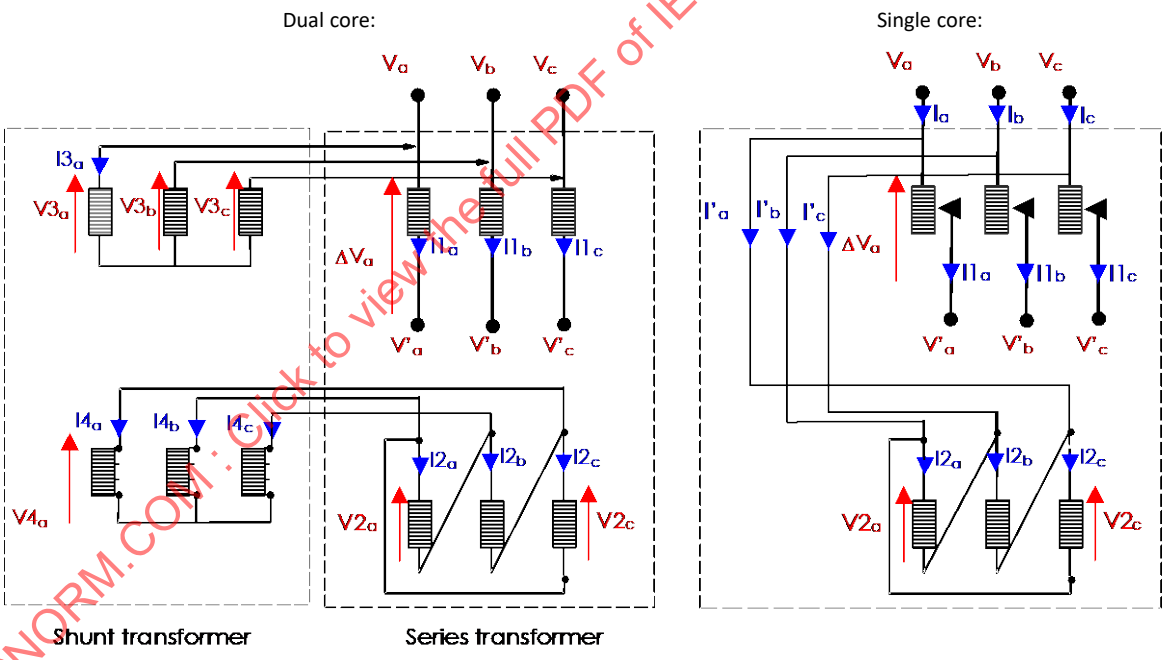
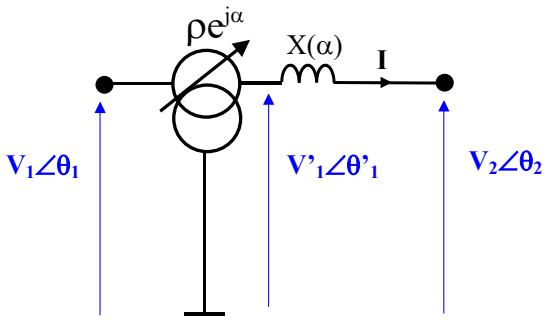


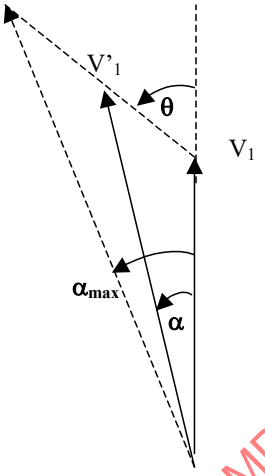
Figure 19 – Core organization

4.5.7.5.4 Asymmetrical phase shifter modelling

Phasor diagram and equations are shown in Figure 20.

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$$V'_1 = V_1\left(1 + e^{j\theta}.\frac{\tan\alpha}{\sin\theta - \tan\alpha\cos\theta}\right) = \rho e^{j\alpha}V_1$$

$$V_2 = V_1.\rho e^{j\alpha} - jX(\alpha)I$$

θ is fixed, only α and ρ vary.

Figure 20 – Phasor diagram and equations

Expression of the angle and ratio per tap

Based on Figure 20:

$$\alpha = A\tan\left(\frac{(n-n_0)\cdot\delta u\cdot\sin\theta}{1+(n-n_0)\cdot\delta u\cdot\cos\theta}\right)$$

$$r = \frac{1}{\sqrt{((n-n_0)\cdot\delta u\cdot\sin\theta)^2 + (1+(n-n_0)\cdot\delta u\cdot\sin\theta)^2}}$$

Expression of the equivalent series reactance given the angle

Assuming the reactance of the regulating winding varies as the square of the number of turns, the equivalent reactance can be written as follows

$$X(\alpha) = X(0) + (X(\alpha_{max}) - X(0))\left(\frac{\tan\alpha}{\tan\alpha_{max}}\frac{\sin\theta - \tan\alpha_{max}\cos\theta}{\sin\theta - \tan\alpha\cos\theta}\right)^2$$

Parameters:

α_{max}	maximum phase shift
$X(0)$	equivalent series reactance at zero phase shift
$X(\alpha_{max})$	equivalent series reactance at maximum phase shift
θ	boost voltage angle

Variable:

α	current phase shift

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Three-phase organizations are shown in Figure 21.

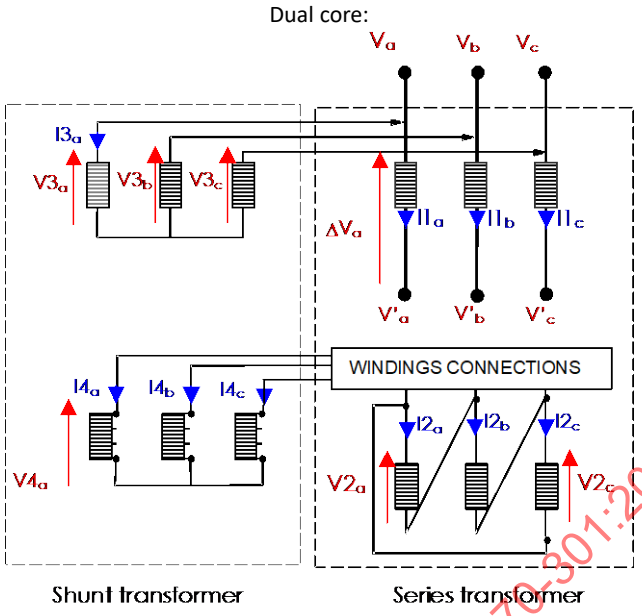
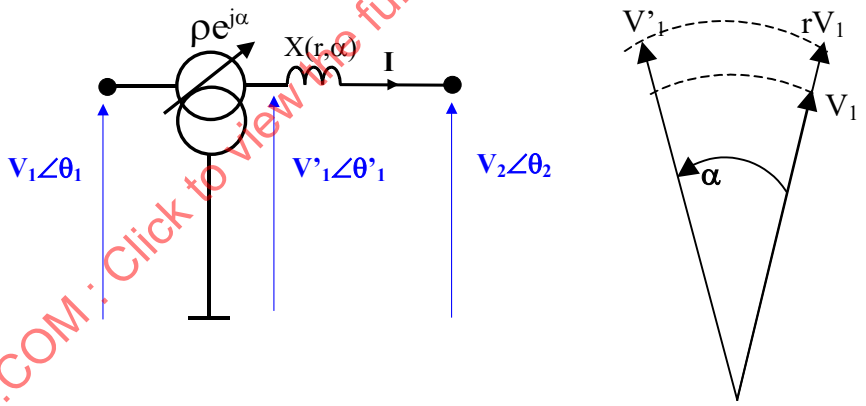


Figure 21 – Core organization

4.5.7.5.5 In-phase transformer and symmetrical phase shifter

Phasor diagram and equations are shown in Figure 22.



$$V_2 = \rho V_1 e^{j\alpha} - jX(\alpha)I. \qquad V'_1 = r.V_1\left(1 + 2j\sin\frac{\alpha}{2}e^{j\frac{\alpha}{2}}\right) = \rho e^{j\alpha}V_1$$

r and α vary, and ρ=r.

r and α vary, and ρ=r.

Figure 22 – Phasor diagram and equations

Expression of the angle and ratio per tap

Same as 4.5.7.5.2 with the addition of the in-phase transformer ratio r.

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Equivalent series reactance given the angle and the in-phase transformer ratio;

Assumptions:

- the reactance of the regulating winding varies as the square of the number of turns,
- the equivalent reactance is the sum of the reactance of the in-phase transformer X_r and the reactance of the phase shifter part X_α,
- the phase shifting angle α does not depend on the in-phase ratio r.

The equivalent reactance can be written as follows:

$$X(r,\alpha) = X_r(r_{nom})\left(\frac{r}{r_{nom}}\right)^2 + X_\alpha(0) + \left(X_\alpha(\alpha_{max}) - X_\alpha(0)\right)\left(\frac{\sin(\alpha/2)}{\sin(\alpha_{max}/2)}\right)^2$$

Parameters:

r_{nom} nominal ratio of the in-phase transformer

$X_r(r_{nom})$ equivalent series reactance of the in-phase transformer at nominal in-phase ratio

α_{max} maximum phase shift

$X_\alpha(0)$ equivalent series reactance of the phase shifter part at zero phase shift

$X_\alpha(\alpha_{max})$ equivalent series reactance of the phase shifter part at maximum phase shift at nominal in-phase ratio (r_{nom})

Variables:

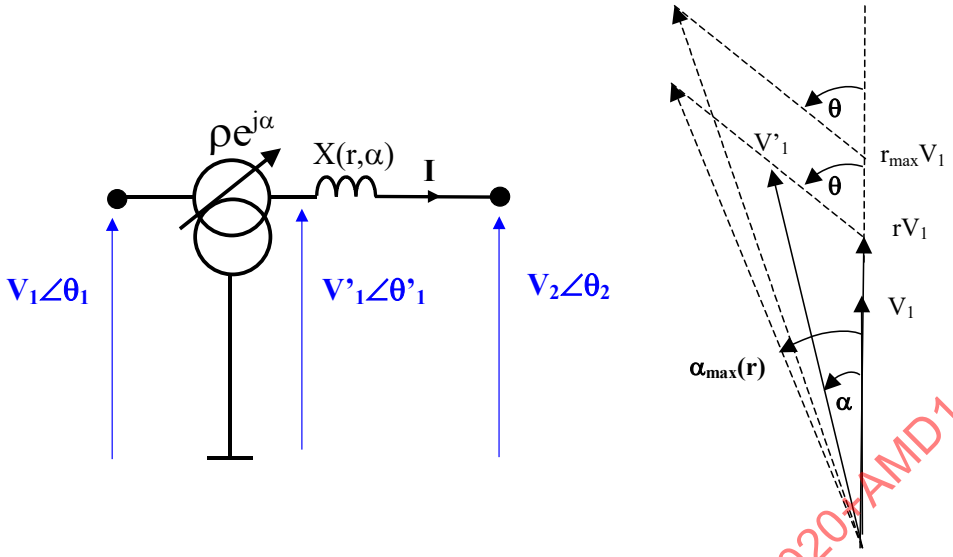
r current ratio of the in-phase transformer

α current phase shift

4.5.7.5.6 In-phase transformer and asymmetrical phase shifter

Phasor diagram and equations are shown in Figure 23.

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$$V'_1 = rV_1\left(1 + e^{j\theta}.\frac{\tan\alpha}{\sin\theta - \tan\alpha\cos\theta}\right) = \rho e^{j\alpha}V_1 \qquad V_2 = (V1 - jX(\alpha)I).\rho e^{j\alpha}$$

θ is fixed, only r and α are variables, ρ varies as a consequence.

θ is fixed, only r and α are variables, ρ varies as a consequence.

Figure 23 – Phasor diagrams and equations

Equivalent series reactance given the angle and the in-phase transformer ratio

Assumptions:

- the reactance of the regulating winding varies as the square of the number of turns.
- the equivalent reactance is the sum of the reactance of the in-phase transformer X_r and the reactance of the phase shifter part X_α.

The equivalent series reactance can be written as follows:

$$X(r,\alpha) = X_r(r_{nom})\left(\frac{r}{r_{nom}}\right)^2 + X_\alpha(0) + \left(X_\alpha(\alpha^0_{\max}) - X_\alpha(0)\right)\left(\frac{\tan\alpha}{\tan\alpha_{\max}(r)}\frac{\sin\theta - \tan\alpha_{\max}(r)\cos\theta}{\sin\theta - \tan\alpha\cos\theta}\right)^2$$

$$\text{with } \alpha_{\max}(r) = A\tan\left(\frac{\sin\theta}{\frac{r}{r_{nom}\tan\alpha^0_{\max}}\left(\sin\theta - \tan\alpha^0_{\max}\cos\theta\right) + \cos\theta}\right) \text{ with } \alpha^0_{\max} = \alpha_{\max}(r_{nom})$$

Parameters:

r_{nom} nominal ratio of the in-phase transformer

$X_r(r_{nom})$ equivalent series reactance of the in-phase transformer at nominal in-phase ratio r_{nom}

θ fixed boost voltage angle

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$\alpha^0_{\max} = \alpha_{\max}(r_{nom})$ maximum phase shift for nominal in-phase ratio (r_{nom})

X_α (0) equivalent series reactance of the phase shifter part at zero phase shift

X_α ($\alpha^0_{\max}$) equivalent series reactance of the phase shifter part at maximum phase shift at nominal in-phase ratio (r_{nom})

Variables:

r current ratio of the in-phase transformer

α current phase shift

For $\theta = \pi/2$ (quadrature booster): $\alpha_{\max}(r) = A\tan\left(\frac{r_{nom}}{r}\tan\alpha^0_{\max}\right)$

Three-phase organizations shown in Figure 24.

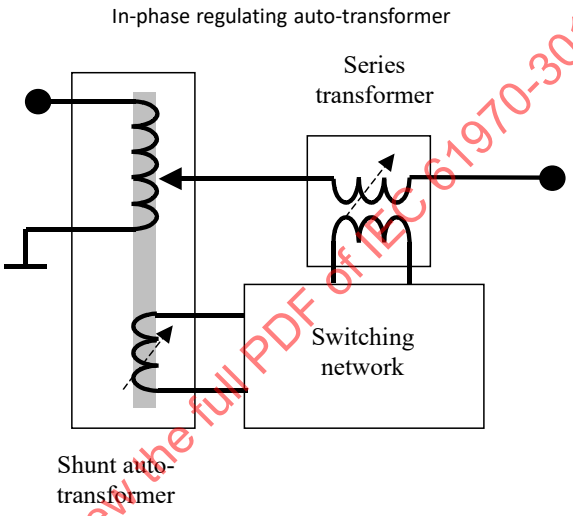


Figure 24 – Core organization

The phase shift regulation may be on the shunt or on the series transformer.

4.5.7.6 Phase shifter transformer tabular modelling

A PhaseTapChangerTabular is an explicit tabular representation of the phase shift, ratio and impedance change over the range of the tap changer. The PhaseTapChangerTabular may be associated with PhaseTapChangerTable representing a non-linear relationship between tap number, phase shift, ratios and impedances.

4.5.7.7 Tap changer control

Control of tap changers in a power flow type of application is made using the TapChangerControl class and the TapChanger.ltcFlag. If a TapChanger has a TapChangerControl (referenced TapChanger.TapChangerControl), power flow application may control the tap changer. The TapChanger.ltcFlag provides information that the TapChanger has physical capability to move the tap under load. The attribute is also used in the IEC 60909 calculations.

The meaning of the combinations for TapChanger.TapChangerControl and TapChanger.ltcFlag are described in Table 5.

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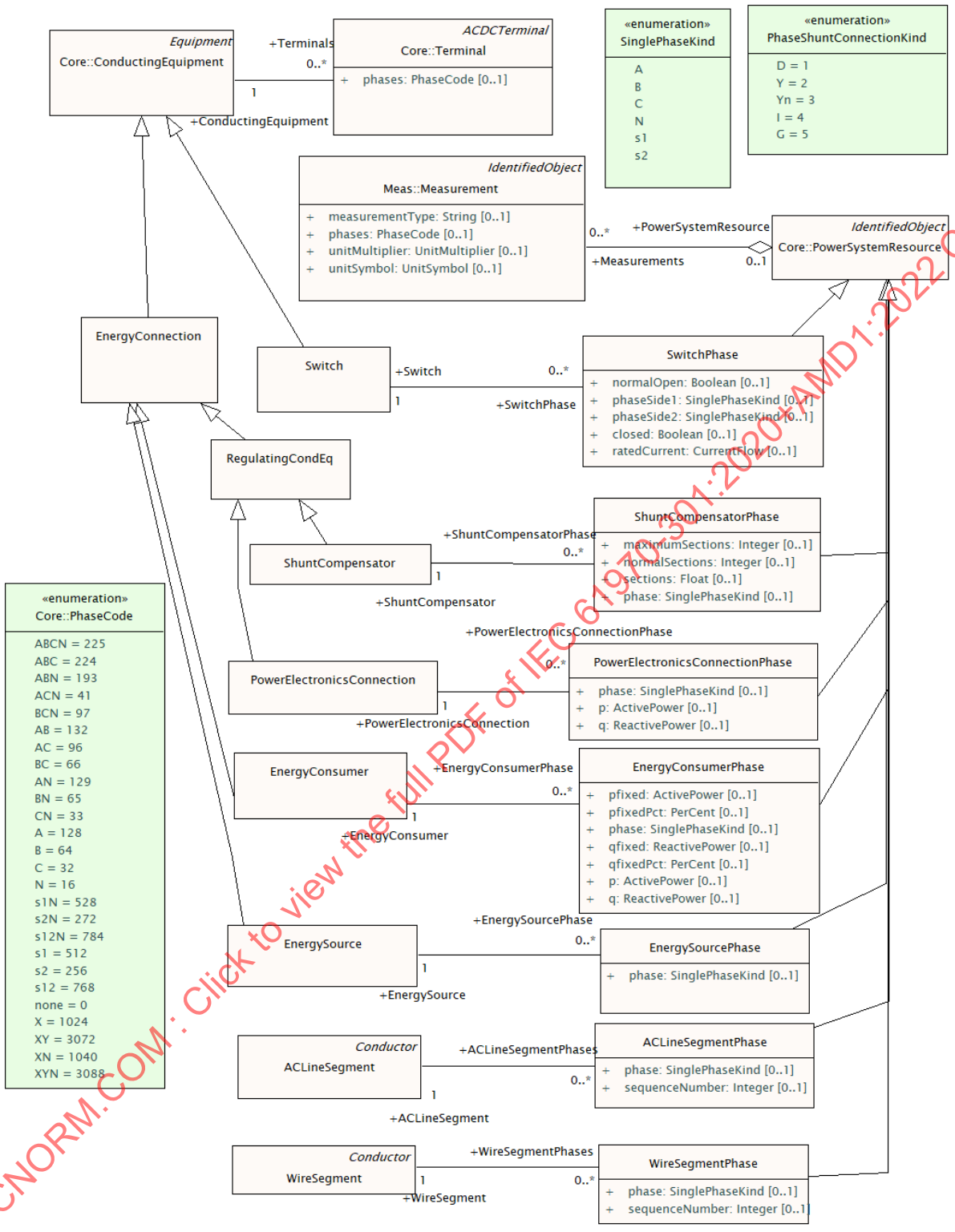
Table 5 – Tap changer control options

TapChanger. ItcFlag	TapChanger. TapChangerControl	Description
False	Not present	A real and fixed tap that is not controlled and cannot be moved on load (manual tap change). Power flow cannot be set to change the tap for voltage control during the calculation.
True	Not present	A real and fixed tap that is not controlled but can be moved under load, e.g. manually. Power flow cannot be set to change the tap for voltage control during the calculation. Optimal power flow might have access to these taps and change in order to optimize. Also State Estimator may estimate the tap position to find a better solution for the system state.
True	Present	A real tap with a possibility to change taps automatically for voltage control/active power (load flow) enabled. Depending on the RegulatingControl.enabled and TapChanger.controlEnabled in SSH, the power flow shall or shall not participate in the regulation. In cases where the RegulatingControl is associated with more than one tap changer or other devices, the attribute TapChanger.controlEnabled can be set to false in order to set which of the taps are not enabled.
False	Present	An artificial tap changer can be used to simulate control behaviour in power flow.

4.5.8 Phase wire modelling

The CIM models provide a means to specify equivalent single-line representation of balanced three phase networks or to additionally and optionally specify individual phase detail. In single phase networks there is a direct correspondence between Terminal objects and physical wire connections. In the single-line representation of balanced three phase networks we use one Terminal to represent the group of coordinating phase connections. Thus one Terminal can be used to specify one or more coordinated phase connections using the Terminal.phases attribute which is of enumeration type PhaseCode. PhaseCode has the possible phase connection combinations of ABC, ABCN, AB, BC, CA, A, B, C and so forth. The specification of phases at each terminal allows for modelling jumpers or switches that connect the same or different phases. This phase connectivity specification is intended as a nominal or normal phase specification. The result of energization source is not reflected in this specification. This phase specification provides a means to locally connect the same phases. Figure 25 shows the phase wire data model.

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Figure 25 – Phase wire data model

Figure 26 provides an example for specifying phase connections. This example shows a ConnectivityNode instance on the left with A, B, and C phases implied. Note that ConnectivityNode does not specify its phase content but rather implicitly connects the same phases of terminals associated to the ConnectivityNode. The example shows a two phase jumper connecting on the left (Terminal.sequenceNumber=1) phases A and C and on the right (Terminal.sequenceNumber=2) phases A and B, with the internals of the jumper model SwitchPhase objects which specify in detail how the phase connections route. The

Terminal.phases attribute only specifies the external connection of a device. Continuing to the right, two line segments are connected. The upper line segment is a two phase line on phases A and B. The lower line segment is single phase on phase B. The dark lines indicate CIM associations while the lighter arrows indicate the represented electrical connections at the phase level.

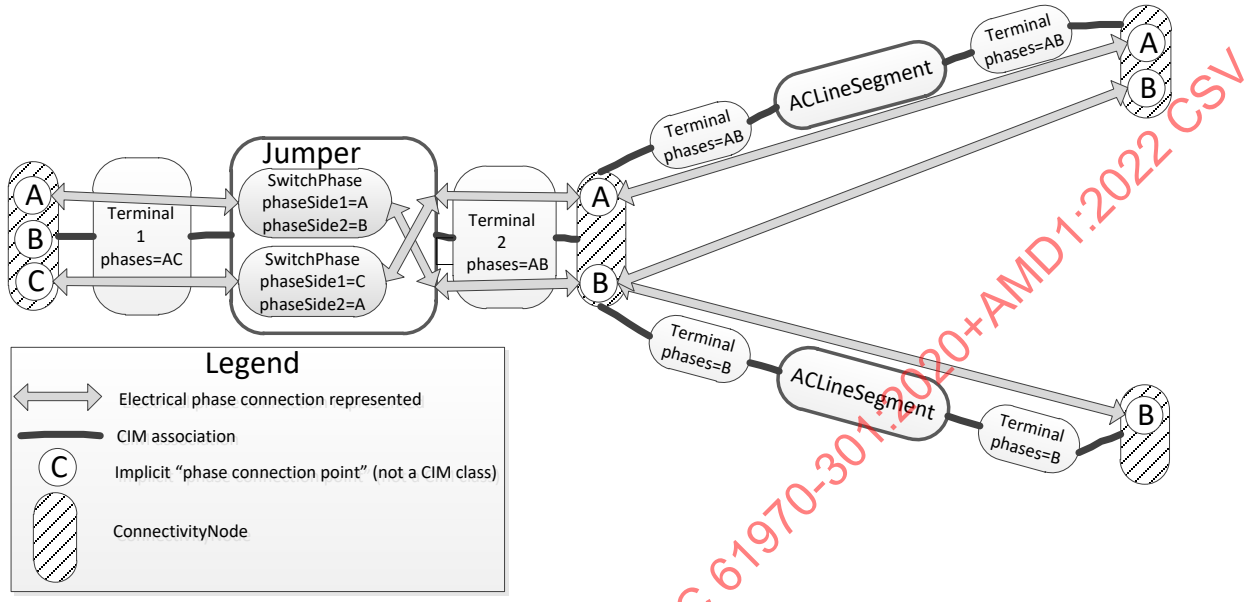


Figure 26 – Phase connectivity

As a clarification, the SwitchPhase attribute named phaseSide1 specifies any single phase (such as A, B, C, or N) and refers to the Terminal with sequenceNumber equal to 1. The SwitchPhase attribute named phaseSide2 refers to the Terminal with sequenceNumber equal to 2.

The switch model allows for cross phase connections to be modelled in general within the device. The transformer model also has explicit internal device modelling of phase connectivity. At this time all other ConductingEquipment branch specializations such as ACLineSegment assume the same phases connect at both terminals. The CIM model is open for future extensions to introduce internal device phase connectivity.

4.5.9 Grounding devices modelling

4.5.9.1 Use case for modelling grounding devices.

These devices have significant impact on short circuit currents for unbalanced faults. The devices are switched around in operation with switches when transformer to line switching is reconfigured. A Petersen Coil is a grounding reactor, used in alternating-current power transmission systems, designed to limit the current flowing to ground at the location of a fault by setting up a reactive current to ground that balances the capacitive current to ground flowing from the lines. Additionally Petersen coils are “tuned” to match the charging current expected from unbalanced faults. The impedance of Petersen coils can be “tuned” by adjusting a step position like a tap. This step position is telemetered sometimes. Sometimes a linear model is sufficient for relating step position to impedance value and sometimes a table is needed to reflect the non-linear relationship between step position and impedance.

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4.5.9.2 Model

The EarthFaultCompensator is a type of abstract conducting equipment intended to model grounding equipment. The EarthFaultCompensator is a specialization of ConductingEquipment because a short circuit requires proper connections and various switches may open or close to change the topology configuration. This is not the same thing as a branch like ACLineSegment, ShuntCompensator, or PowerTransformer; it does not regulate voltage and is never connected to Y or delta. A zig-zag grounding transformer is still a PowerTransformer, because of all the other complexities of the transformer. Two specializations handle fixed impedance devices (GroundingImpedance) and adjustable (variable) Petersen coil devices (PetersenCoil).

The GroundingImpedance and PetersenCoil connect the same way as other devices using Terminal. The phases attribute on Terminal indicates the connection is at the neutral phase. The EarthFaultCompensator can have either one or two terminals modelled. If the second terminal of an EarthFaultCompensator is omitted, it is assumed the terminal solidly connects to ground. If there is some kind of topology or local earth resistivity that is important to model on the ground side of the device, then a second terminal is added.

If a PowerTransformer has a Y connection on one Terminal (secondary) and a PetersenCoil is connected to that Terminal, then the PowerTransformer's secondary Terminal should be specified with phases attribute equal to ABCN and the PetersenCoil's Terminal should be specified with phase N. This allows the ACLineSegment to connect with phases ABC (the default) and the PetersenCoil to connect to the same TransformerTerminal but only on the N phase. It is expected all PetersenCoil terminals to have only phase N.

If a normal modelling of a non-neutral network is done, then the Petersen coil model is added, which includes:

1) Adding the phasing of ABCN to the transformer secondary terminal so you have a place to connect neutral.
2) Adding the PetersenCoil object with its associated Terminal which is phase N, since only one Terminal is modelled the PetersenCoil is assumed solidly grounded.
3) Associating the PetersenCoil's single Terminal to the ConnectivityNode at transformer secondary.

A separate class for ground disconnector (GroundDisconnector) is included since these are typically physically very different from most other switches and often excluded from normal power flow analysis. Similar to PetersenCoils, it is expected that all GroundDisconnector terminals will have only phase N. For the data model refer to Figure 27.

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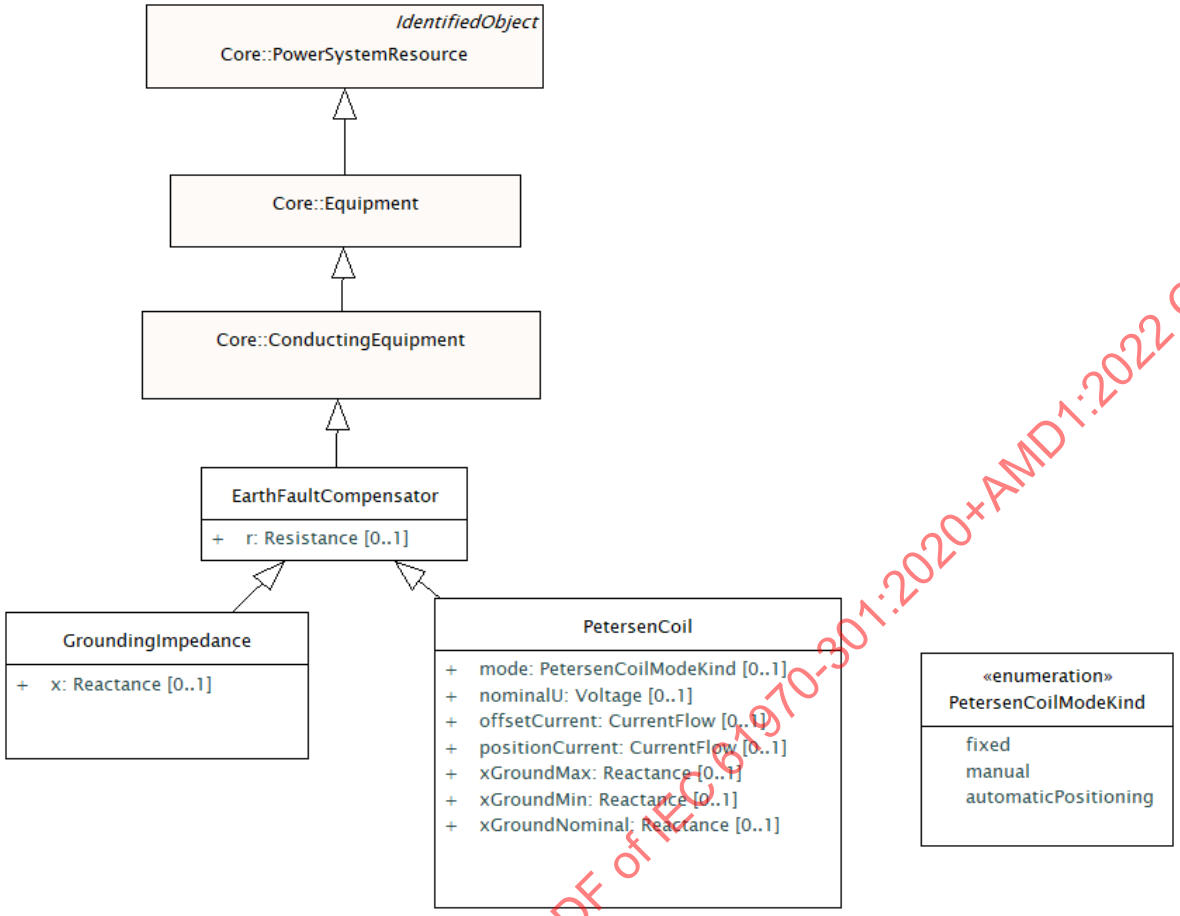


Figure 27 – Grounding device data model

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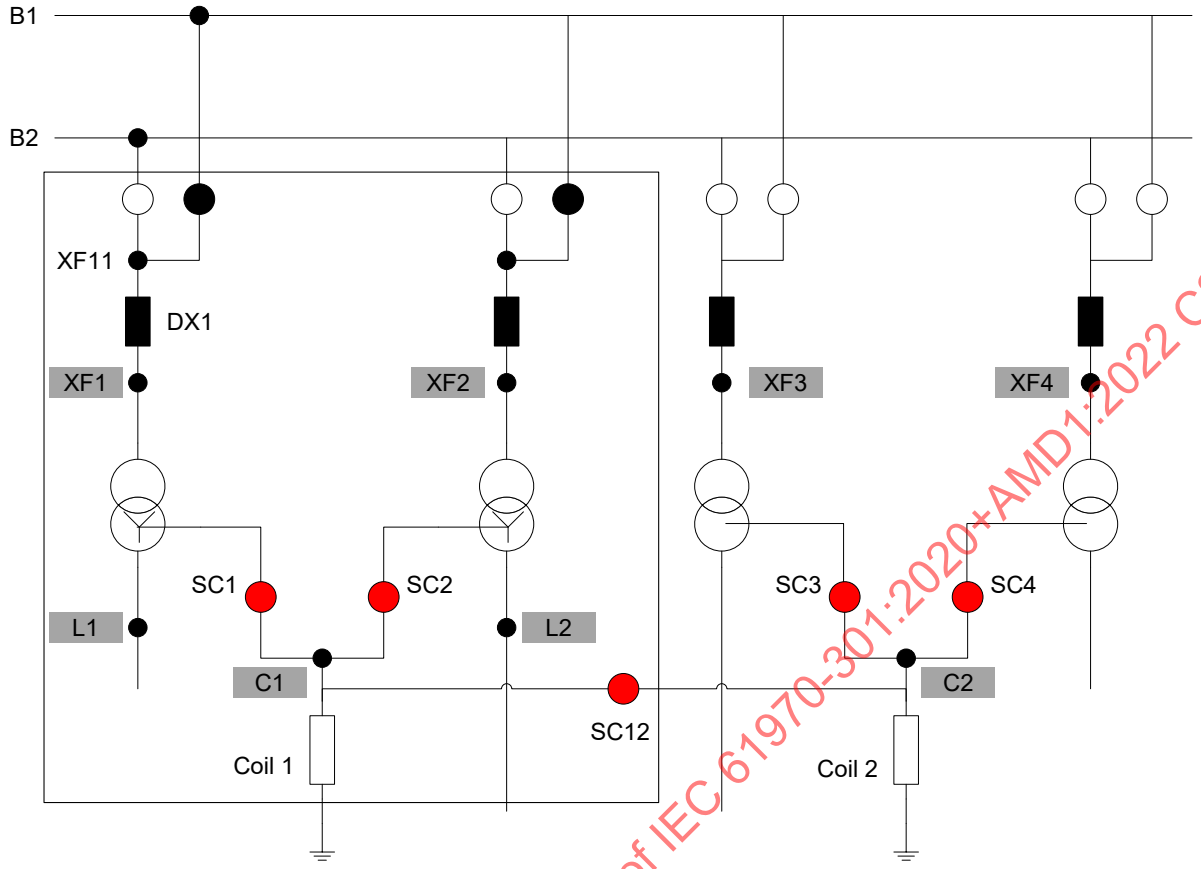


Figure 28 – Station including Petersen coils drawing example

In the example above, SC1, SC2, SC3, SC4 and SC12 are the ground circuit disconnectors. B1 and B2 are bus bar sections. XF1, XF2, XF3, XF4, C1, C2, L1 and L2 are connectivity nodes.

The grounding point in a transformer is the midpoint of the Y-connected windings and the ground circuit disconnectors are connected to these midpoints. In CIM the midpoint is described by the phasing attribute of the Terminal at the Y-connected windings. This means that ground circuit switches are connected to the connectivity node at the Terminal with the Y-connected windings. In Figure 28 this means SC1 is connected to L1 and SC2 is connected to L2 and that L1/L2 has the phases ABC as well as the N phase for the midpoint.

4.5.9.3 CIM instance model example

The PetersenCoil that was depicted previously in Figure 28 is shown in Figure 29 modelled with only one terminal and implicit grounding.

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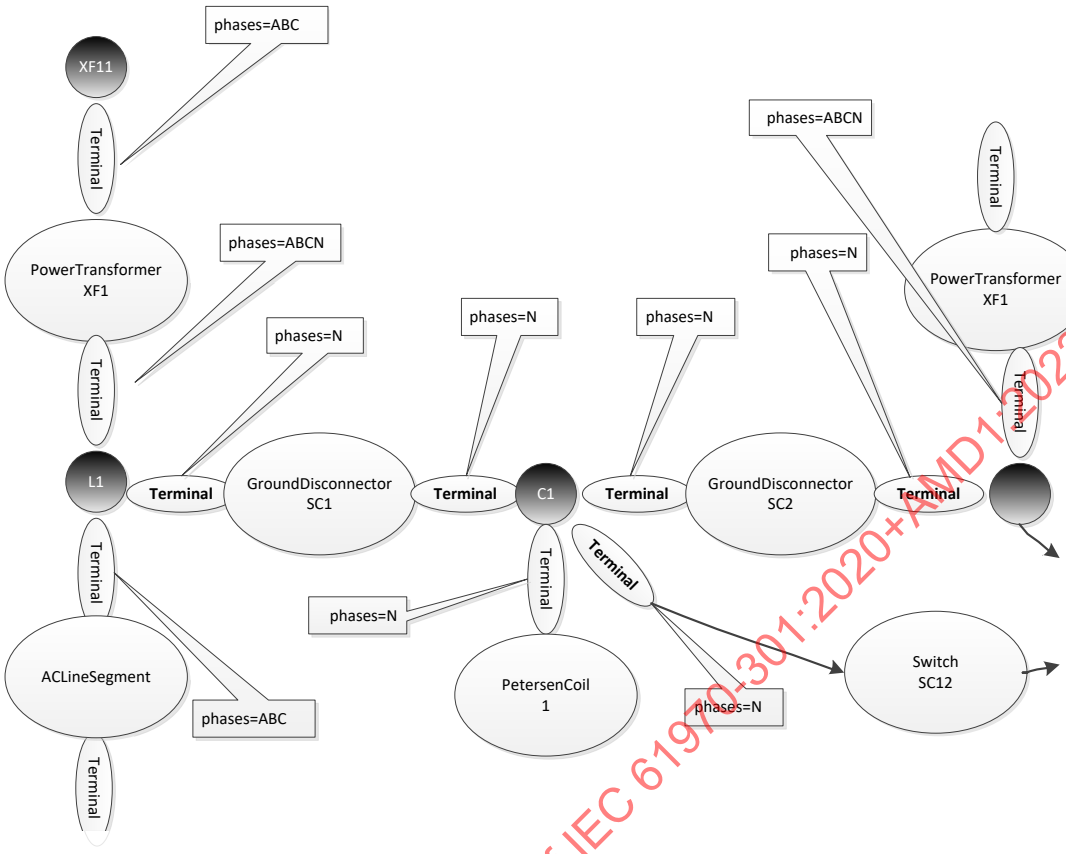


Figure 29 – Instance diagram objects with one terminal coil

Figure 29 shows how the ground disconnector SC1 has a Terminal with N phase and the transformer Terminal connected to L1 has the phases ABCN.

4.5.10 Cuts, clamps and jumpers model

The UML model for cuts and jumpers on a line segment and the additional connections are described in Figure 30. The Jumper class is a specialization of the more general Switch class and provides for phase crossings and phase connectivity as was illustrated in Figure 26. The jumpers therefore can connect terminals in the normal manner. The CIM classes Cut and Clamp provide a means to effectively add Terminals to an ACLineSegment at a specified distance down the line by associating new CIM objects to an ACLineSegment object, without other modification of ACLineSegment as-built model. Each Clamp instance introduces one new terminal connected at the specified distance down the line and without interruption of the line. Each Cut instance introduces two new terminals which are effectively the ends of the cut. By convention, each terminal of a cut is oriented toward the ACLineSegment terminal with the same sequenceNumber. If the cut is open, no flow passes through the ACLineSegment across the point of the cut, but flow can pass through either side of the ACLineSegment and through the appropriate cut terminal. Commonly, jumpers are connected to the ends of cuts, but they can also be connected to any type of conducting equipment in the normal manner using ConnectivityNode or TopologicalNode.

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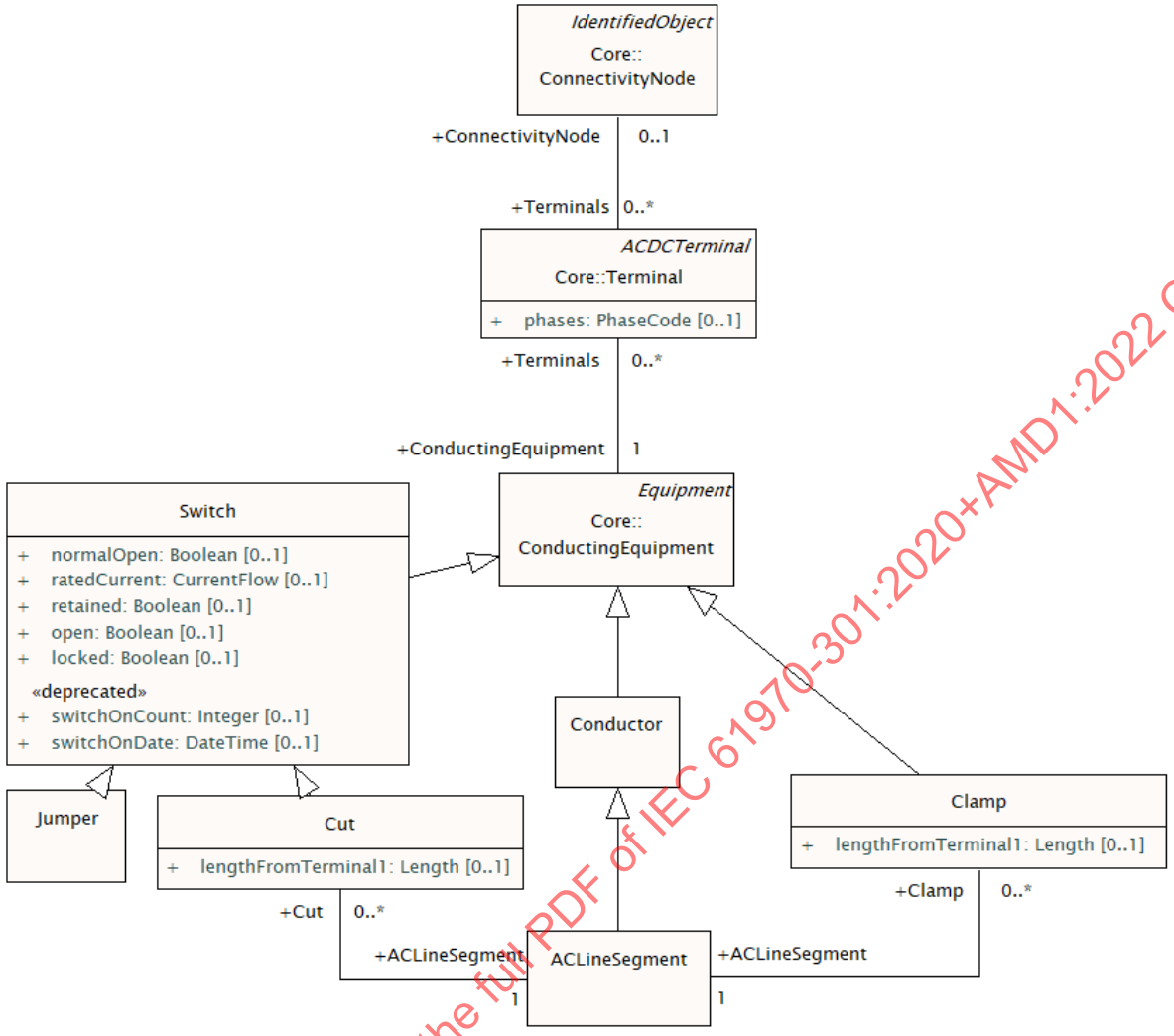


Figure 30 – Cuts, clamps, and jumpers UML model

An example of the addition of cuts and clamps to an existing CIM model is illustrated in Figure 31 and Figure 32. Figure 31 shows two physically parallel line segments named “FRED” and “LEROY”. In this example the system is energized from the right, the switch on the left is closed, and the loads named “ONE” and “TWO” are being supplied. Then the three faults are applied at the specified distances from Terminal 1 of the respective line segments. In this example the phase detail is not specified for simplicity, but phase detail can follow the same approach outlined in 4.5.8.

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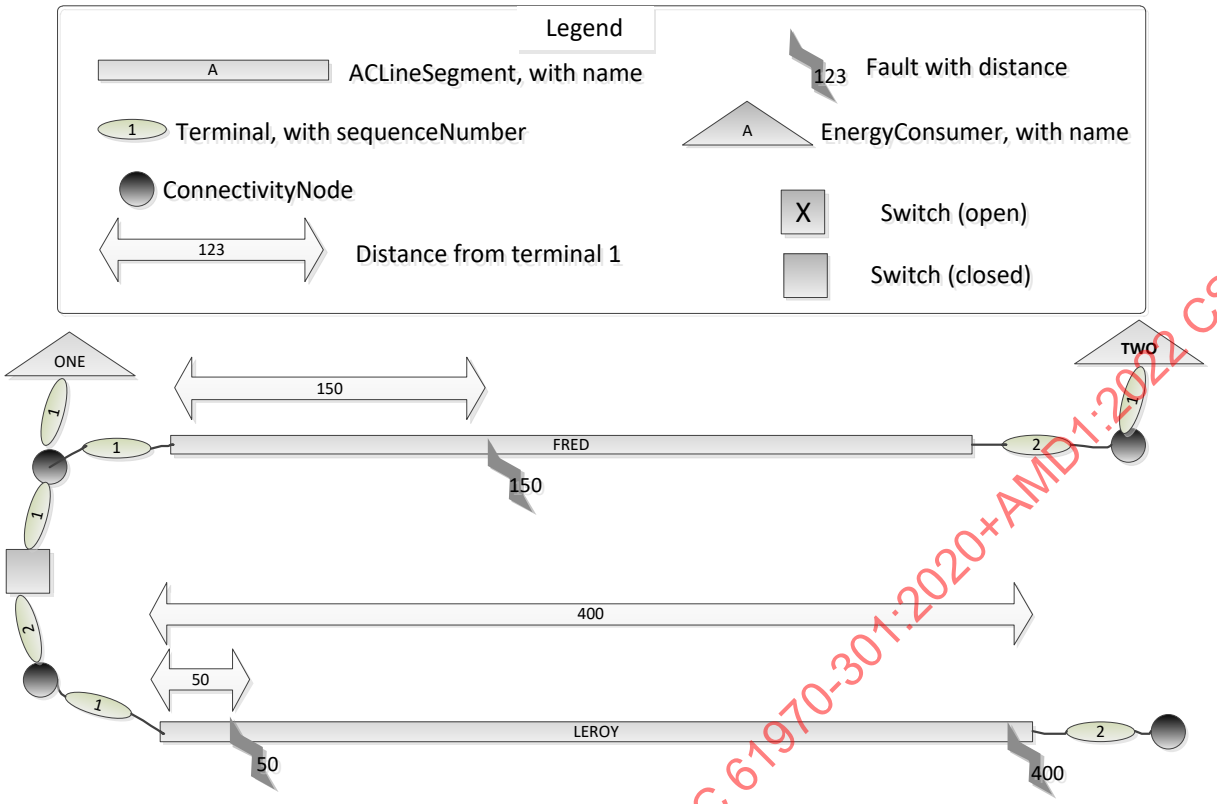


Figure 31 – Example before cuts and jumpers are applied

Figure 32 shows how the pure addition of Cut, ConnectivityNode, Jumper, Clamp and potentially other Conducting Equipment can represent model changes reflecting typical temporary work. These same models can also be used for permanent model changes. The example shows how cuts applied at the specified distances can isolate the faults, leaving the faulted ends of cuts dangling, while the remaining network is connected to supply the loads. This example also demonstrates how multiple cuts can be applied to one line segment. This example shows open cuts, but if a cut were closed, flow could continue through the ACLineSegment with part of the flow potentially redirected to the terminals of the cut, much like the case for a clamp.

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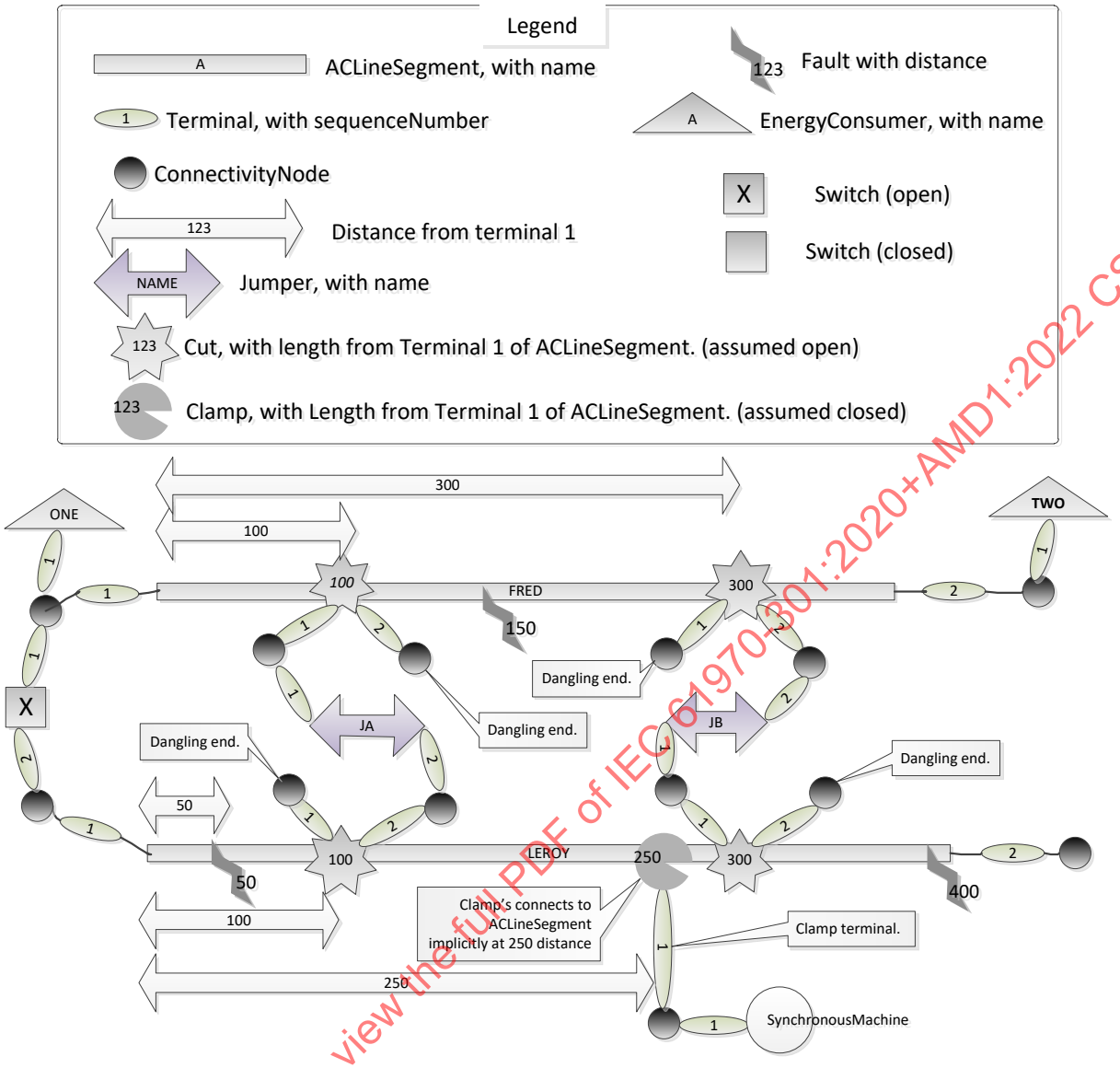


Figure 32 – Example after cuts and jumpers are applied

A cut provides two terminals, and although not shown in the example above, connections could be made to either or both terminals of the cut. An example case might involve introducing a cut and connecting both cut terminals with a jumper that crosses phases.

A jumper may be used without clamps or cuts in a situation where existing terminals are to be connected. Figure 33 shows an example of using a jumper without a cut or clamp. In this case a temporary jumper might be used to bypass a switch under maintenance.

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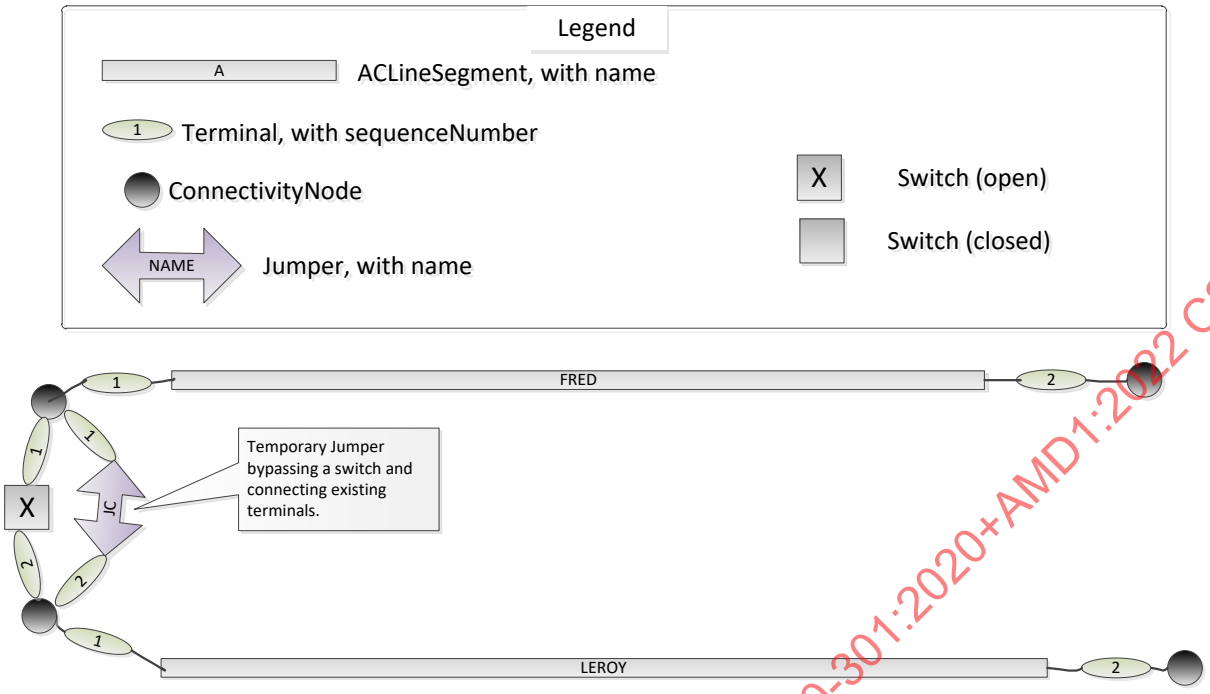


Figure 33 – Example of jumper without cut or clamp

4.5.11 Measurements and controls

4.5.11.1 Measurement overview

Measurements are used to represent the state variables that can be found in industrial processes. Each industrial process has its specific types of measurements. A power system typically has power flows, voltages, positions (e.g. breakers, isolators), fault indications (air pressure, oil pressure over temperature, etc.), counters (e.g. energy), etc.

The name "Measurement" would seem to indicate that all the state variables are measured. This is not always strictly the case as many measurements are calculated by SCADA or EMS/DMS functions, such as state estimator or power flow calculations. As a consequence, a measurement may have several alternate values (e.g. manually supplied, telemetered, state estimated, optimized etc.). This is supported by the Measurement and MeasurementValue models in the Meas package. The classes in the StateVariables package have been added to the CIM model specifically for the purpose of supporting exchange of values calculated by functions such as state estimator and power flow.

The measurement model now allows for optionally specifying the specific phases of a measurement.

4.5.11.2 Control overview

Controls are used to represent control variables. Power system control variables typically are set points, raise/lower commands, select before execute commands and on/off commands. The Meas package supports control variables with the Control model.

4.5.11.3 Use of measurement-related classes

A PowerSystemResource (PSR) may have zero to many measurements associated with it by containing one or more measurements. Each measurement may have one or more measurement values. Observing the following guidelines will enable applications to navigate and find the required measurement values in a consistent way (see Figure 34):

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a) Measurements of a PowerSystemResource are classified by the attribute measurementType. The values to be used for Measurement.measurementType are specified in Table 6.

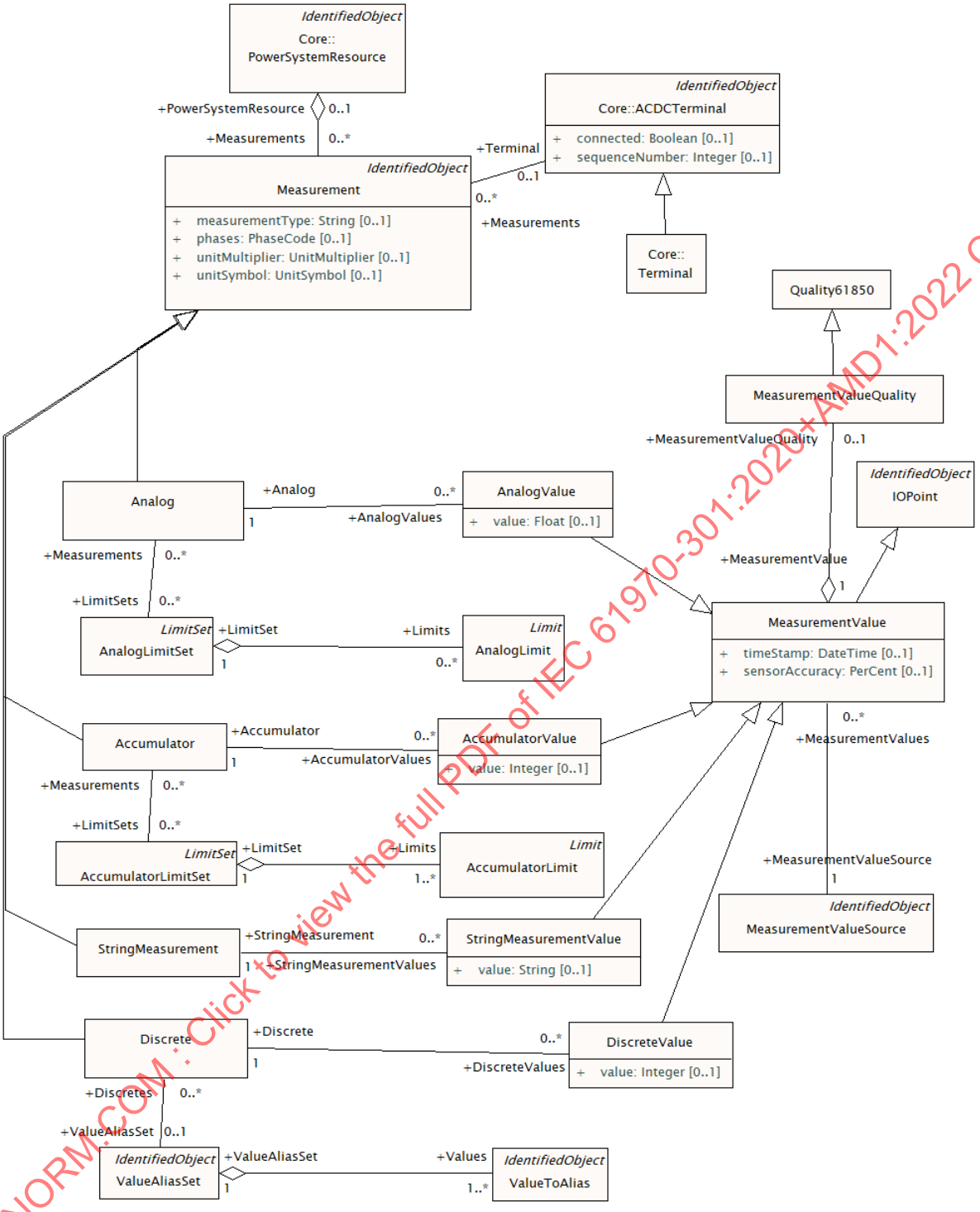
b) MeasurementValues of a Measurement are classified by MeasurementValueSource.

c) MeasurementValueSource inherits from IdentifiedObject. The values to be used for MeasurementValueSource.name are given in Table 7. This table provides several source names to be used where possible. However, the exact names to be used for specific applications are defined in related IEC 61970 Component Interface Specifications (CIS).

d) The tables may be extended for proprietary needs. The names added shall start with a unique name (e.g. the company name) and an underscore. Example: xyz_AverageTemperature.

e) The ValueAliasSet is used for discrete measurements and describes mappings from values to symbolic names, such as enumeration literals having specific integer values. Different communication protocols (e.g. for RTUs and for control centres such as ICCP or ELCOM) use different data encodings. A system may have a system wide mapping for all Discrete values or group the Discrete values and make a mapping per group. Creation of a single system wide mapping that covers existing communication protocols is outside the scope of this document.

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Figure 34 – Navigating from PSR to MeasurementValue

Table 6 – measurementType naming conventions

measurementType	61850 Name	description
Current	Amp	Current (rms) of a non-three phase circuit
ThreePhaseCurrent	AvAmps	Total current (rms) in a three phase circuit
PhaseCurrent	A	Measured phase current.
Frequency	Hz	Frequency
PowerFactor	PwrFact	Power factor not allocated to a phase
ThreePhasePowerFactor	TotPF	Average power factor in a three phase circuit
ThreePhaseApparentPower	TotVA	Total apparent power in a three phase circuit
ThreePhaseReactivePower	TotVAr	Total reactive power in a three phase circuit
ThreePhaseActivePower	TotW	Total real power in a three phase circuit.
ApparentPower	VolAmp	Apparent power in a non-three phase circuit
ReactivePower	VolAmpr	Reactive power in a non-three phase circuit
Voltage	Vol	Voltage (rms) not allocated to a phase
ActivePower	Watt	Real power in a non-three phase circuit
Pressure	Pres	Pressure
Temperature	Tmp	Temperature
Angle	Ang	Angle between voltage and current
ApparentEnergy	TotVAh	Apparent energy
ReactiveEnergy	TotVArh	Reactive energy
ActiveEnergy	TotWh	Real energy
Automatic	Auto	Automatic operation (not manual)
LocalOperation	Loc	Local operation (not remote)
SwitchPosition	Pos	Switch position [2bits= intermediate,open,closed,ignore]
TapPosition	TapPos	Tap position of power transformer or phaseshifter
Operation Count	OperCnt	Operation count – typically for switches
LineToNeutralVoltage		Line to neutral voltage.
LineToGroundVoltage		Line to ground voltage.
Specialization		Used when a specialization of the Analog class defines the type of measurement rather than the Measurement.measurementType attribute.

Table 6 describes various types of measurements also defined in IEC 61850. The meanings of the columns in Table 6 are as follows:

- measurementType (Measurement.measurementType) is the IEC 61970 measurement type name.
- 61850 Name is the name assigned to the data object in IEC 61850. IEC 61850-7-4:2010, data object name semantics).
- description is the description of the data.

It shall be noted that Table 6 is not an exhaustive list and that the mapping between measurements as defined in a control centre and a substation is non-trivial.

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Table 7 – MeasurementValueSource naming conventions

Name	description
SCADA	Telemetered values received from a local SCADA system
CCLink	Value received from a remote control centre via TASE.2 or other control centre protocol
Operator	Operator entered value (always manually maintained, PSR is not connected to an RTU)
Estimated	Value updated by a state estimator
PowerFlow	Value updated as result of a Powerflow
Forecasted	Value that is planned or forecasted.
Calculated	Calculated from other measurement values (e.g. a sum)
Allocated	Calculated by a load allocator

Following these conventions:

- each Measurement instance represents a technological quantity of a PowerSystemResource;
- each MeasurementValue of a Measurement represents a value for the technological quantity, as supplied from a single source;
- the source attribute in MeasurementValueQuality then indicates whether the source actually provided the current value, or whether it had been substituted or defaulted.

Note that a new MeasurementValue identity is not normally created for each exchange of a measured value. It is expected that the same MeasurementValue instance could exchange new values in subsequent messages. Therefore the identity of a MeasurementValue instance can be established apriori to exchange of measured values. The modelling of a time series of values is not explicitly expressed in the CIM model, though the model allows for systems to internally build such time series models through a series of measurement value exchanges.

4.5.11.4 Attachment of measurements

As mentioned in 4.5.11.3 and as shown in Figure 34, Measurements are contained by a PowerSystemResource. This is sufficient for Measurements that are not related to connectivity, e.g. temperature, weight, size.

To specify the location of a Measurement in the network, an association to Terminal is used. Examples include power flows, voltages, and currents. Voltages have no direction and can be attached wherever appropriate in relation to the sensor placement. Flows have direction and shall be attached such that the flow direction is evident from the placement.

Figure 35 shows two examples of the placement of Measurements.

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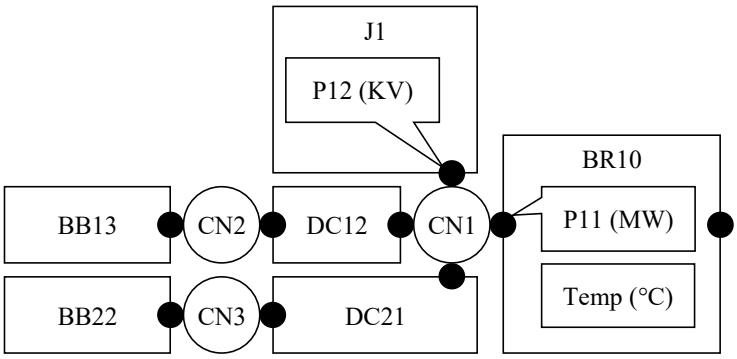


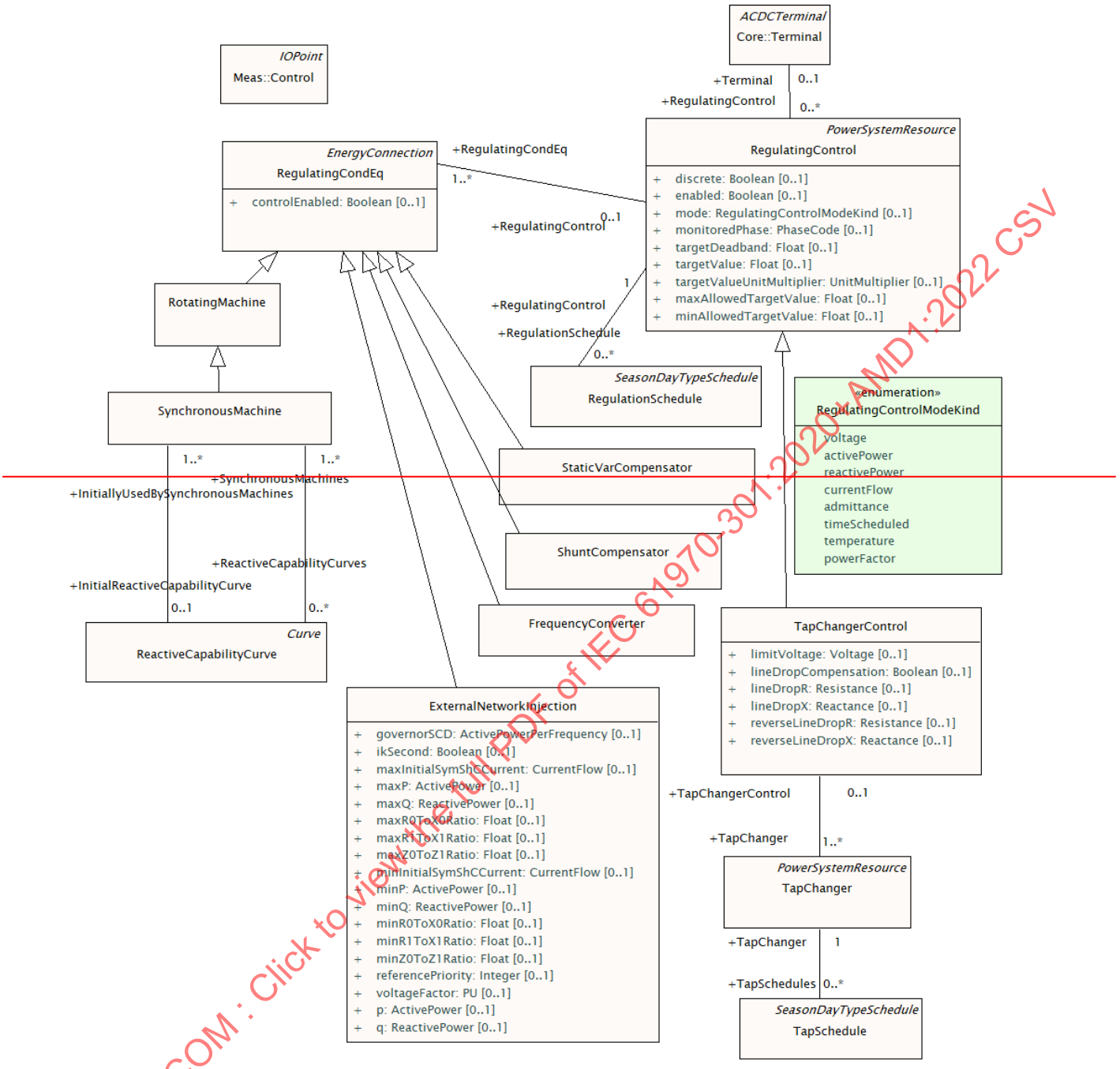
Figure 35 – Measurement placement

P12 is a voltage Measurement that measures the voltage at the Junction J1. P12 is topologically related to the ConnectivityNode CN1 via the Terminal in Junction J1. P11 is a Measurement that measures the flow through Breaker BR10 at the side connected to the ConnectivityNode CN1. P11 is topologically related to the ConnectivityNode CN1 via the left Terminal in Breaker BR10. Temp is a Measurement that measures the Breaker temperature. As a temperature is not related to connectivity, it has no relation to a Terminal – it just belongs to the Breaker BR10.

4.5.12 Regulating control models

Regulation control, such as automatic voltage control at generators or voltage tap control at transformers is modelled using the RegulatingControl class which provides the capability to model multiple instances of equipment participating in a regulation scheme. These regulation schemes may be physical or manually implemented in actual power system operation but are reflected in the models used for power system analysis purposes. Figure 36 shows how RegulatingCondEq and TapChanger classes can participate in regulation.

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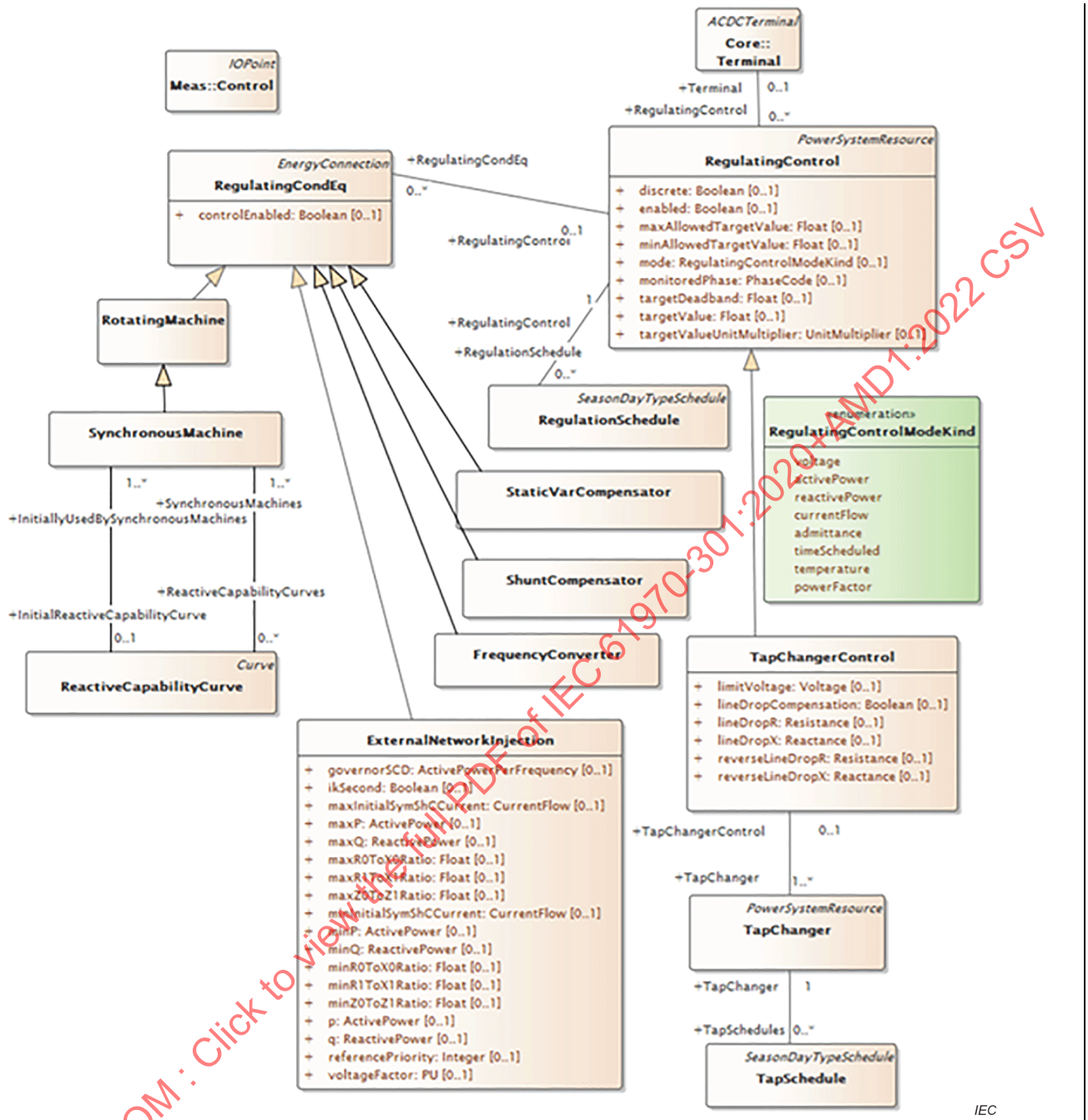


Figure 36 – Regulating control models

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4.5.13 DC model for CIM

4.5.13.1 Introduction

4.5.13.1.1 General

Control systems modelling HVDC interconnection typically have three levels of detail in terms of modelling:

- Simplified injection model not using the CIM DC package.
- Detailed HVDC model using the CIM DC package and fictitious HVDC substations.
- Detailed HVDC model using the CIM DC package and no fictitious HVDC substations.

The purpose of this document is to outline the most minimal HVDC model possible for use in SCADA/EMS/planning power flow, short circuit calculations and dynamic studies. Transient studies are not covered.

The following general rules are defined:

- The flow through a DC pole relate to the Point of Common Coupling (PCC) at the ends of a pole. This means that PCC is always on the AC side.
- Detailed HVDC model using the CIM DC package and no fictitious HVDC substations is the preferred modelling as it corresponds to how substations are built, and equipment named
- Rules for switching of AC filters for LCCs are not supported by the standard.
- The converter transformer typically connects to switches located in a VoltageLevel where the AC network connects.
- The filters are typically located in the VoltageLevel where converter transformer connects.
- No TapChangerControl is used for the converter transformer, the control function is described in the ACDCConverter-s.
- The terminal at the HV side of the converter transformer, closest to the AC network, shall be associated with the Boundary Point/Connection point with the other MAS.
- The converter transformer and every ACDCConverter instance, belonging to the same substation pole, as well as all converter control equipment, essential protective and switching devices and auxiliaries, if any, used for conversion, shall be contained in the same cim:DCConverterUnit container instance. This also applies to shunts and series compensators at the LV side of the converter transformer and the DC smoothing reactors.
- In case of back-to-back installations two separate DCConverterUnit instances are used, each associated with one converter transformer.
- All HVDC overhead lines and cables, connecting two or more substations, shall be contained in the same DCLine container for every HVDC system pole.

4.5.13.1.2 Simplified Injection Model

The simplified injection model illustrated in Figure 37 connects the real substations at each ends of the DC pole with a Line that has two boundary ConnectivityNodes (CNs) or TopologicalNodes in case of bus-branch model representation, one for each DC pole end. The CNs are also the Point of Common Coupling (PCC) for each side. The real substations connect to the boundary CN/PCC with a ACLineSegment (ACLS) and an EquivalentInjection (EI).

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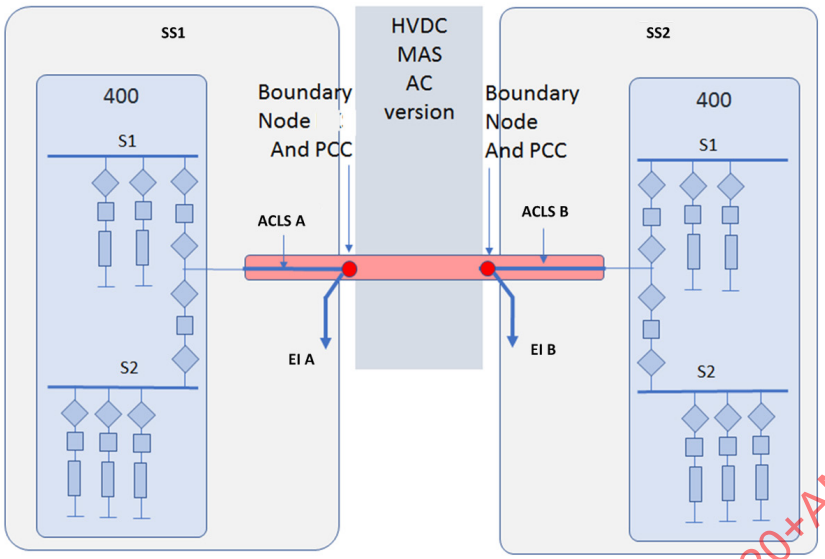


Figure 37 – Simplified example of HVDC model representation

Blue colours in Figure 37 represent objects in a regular MAS and red objects in a boundary MAS.

The ACLS "A", EI "A", ACLS "B" and EI "B" are at the PCCs at each side of the DC pole. The PCCs are the boundary nodes or connection points agreed between the parties responsible for the MAS of SS1 and SS2.

For a current source converter the reactive power is set to zero assuming that the AC filters keep the reactive consumption around zero. If the AC substation models the AC filters, then the reactive power consumption of the LCC shall be considered. The reactive consumption can normally be approximated by a reactive power demand equal to approx. 0.45-0.55 of the absolute value of the active power transfer. When substituting the HVDC poles by an internal representation featuring two "simplified HVDC injection models", and the power transfer is changed the reactive power may stay at the same value. This will ease power flow solution and not requiring switching of AC filters.

For voltage source converters reactive power control capabilities can be described by setting the attributes EquivalentInjection.regulationCapability and regulatingStatus to true. The limits minQ and maxQ or associated ReactiveCapabilityCurve shall reflect the reactive capability range if regulatingStatus is true.

4.5.13.1.3 Detailed HVDC model using the CIM DC package and fictitious HVDC substations

A detailed model contains the following parts:

- The real substations at each side of the connection.
- The same boundary as in the simplified model as in all cases the HVDC links have two boundary/connection points, see 4.5.13.1.2.
- For each real substation a fictitious substation that represents the HVDC part and connects to the boundary PCCs at each DC pole end.

Figure 38 shows a HVDC connection as a detailed model.

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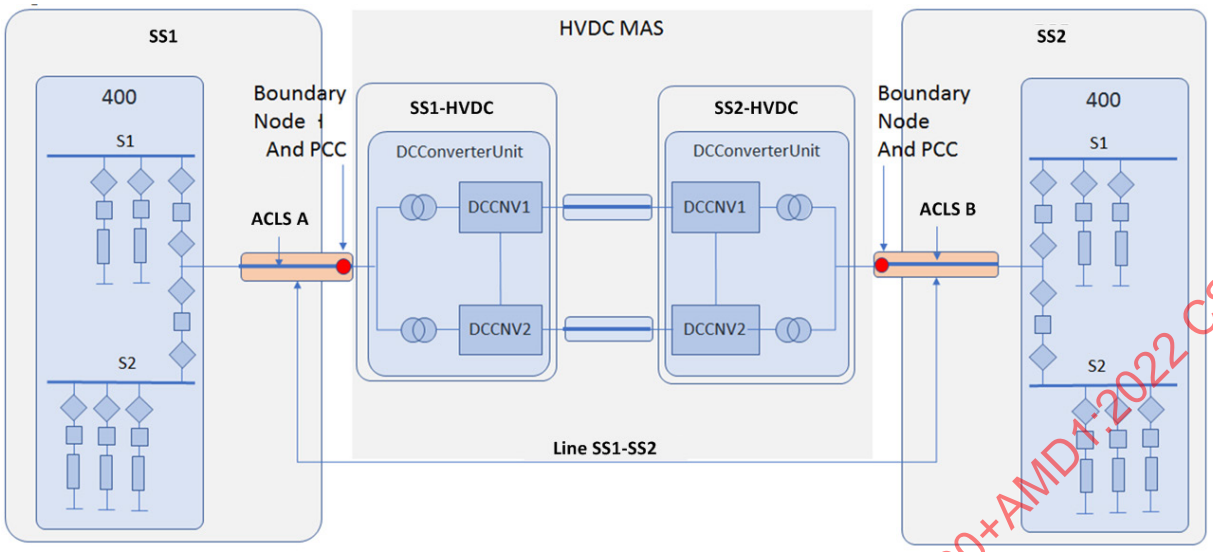


Figure 38 – Detailed example of HVDC model representation with fictitious HVDC substations

Blue colours in Figure 38 represent objects in a regular MAS and red objects in the boundary.

The SS1 and SS2 substations are the real ones, SS1-HVDC and SS2-HVDC are the fictitious with the HVDC equipment. “SS1-SS2” is the boundary Line with the two boundary CNs/PCCs that connect with the DC poles.

To convert a detailed model to simplified model the fictitious HVDC substations are removed and the EIs at the PCCs are inserted.

4.5.13.1.4 Detailed HVDC model using the CIM DC package and no fictitious HVDC substations

The preferred HVDC model is with all components in the real substation without fictitious substations or boundary Lines as shown in Figure 39.

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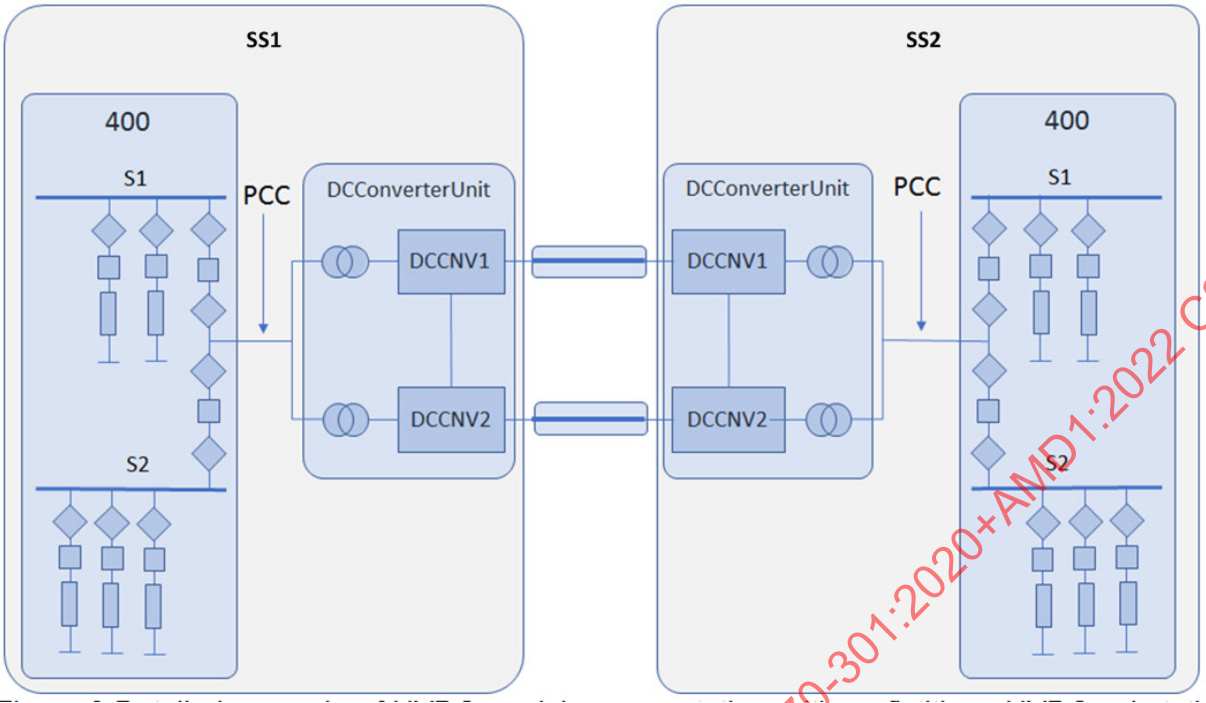


Figure 39 – Detailed example of HVDC model representation with no fictitious HVDC substations

A boundary point within a substation is defined at the PCC arrows in Figure 39.

A detailed HVDC model using the CIM DC package and no fictitious HVDC substations cannot easily be converted to a simplified model and must first be changed to a detailed HVDC model using the CIM DC package and fictitious HVDC substations model before it can be converted.

4.5.13.2 HVDC basic design

4.5.13.2.1 General

The proposed model is based on the following documents:

- IEC 60633:1998+AMD1:2009, *Terminology for high-voltage direct current (HVDC) transmission.*
- ”VSC Transmission”, CIGRÉ B4-37 April 2005
- IEC 62747, *Terminology for voltage-sourced converters (VSC) for high-voltage direct current (HVDC) systems*
- HVDC Transmission by Dennis A. Woodford, Manitoba HVDC Research Centre.
- “ABB technical description of HVDC light technology”
- Flexible Power Transmission. Jos Arrillaga, Y. H. Liu, Neville R. Watson, 2007
- ”Power System Stability Benefits with VSC DC-Transmission Systems”, CIGRÉ B4-204, 2004

4.5.13.2.2 CSC Topology

A current source HVDC link is modelled as shown in Figure 40.

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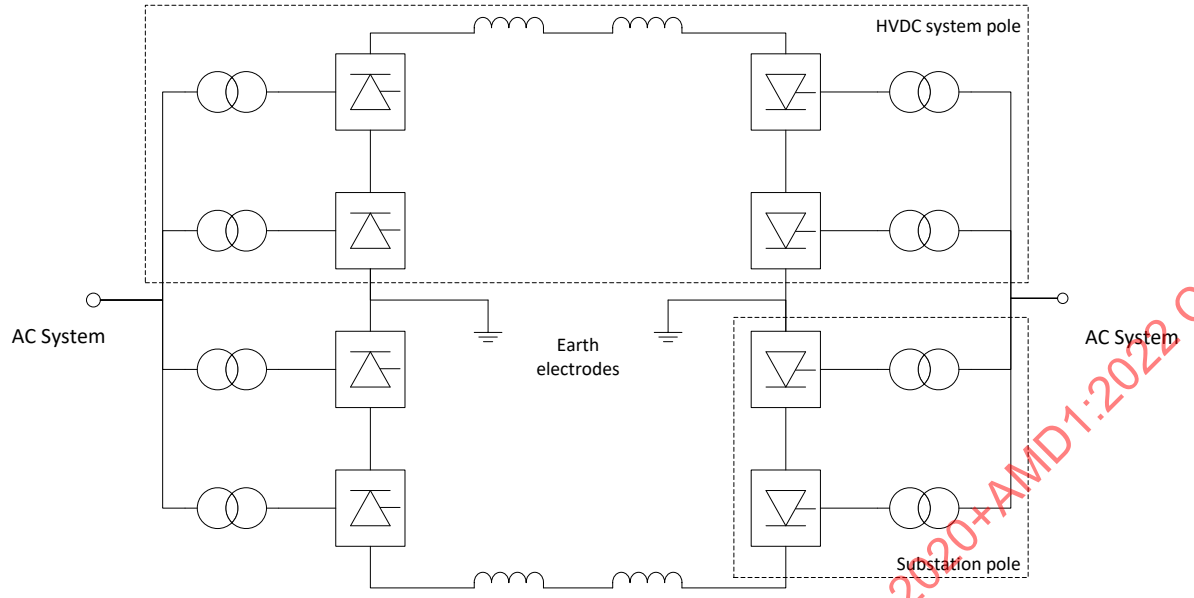


Figure 40 – HVDC bi-polar link from IEC 60633

HVDC Bipolar link consists of two poles, one with positive polarity and another with negative polarity having both their natural points grounded. No current flows in the ground return because the current flowing in the poles is the same. For a CSC HVDC, the transformer shall be modelled explicitly.

4.5.13.2.3 VSC Topology

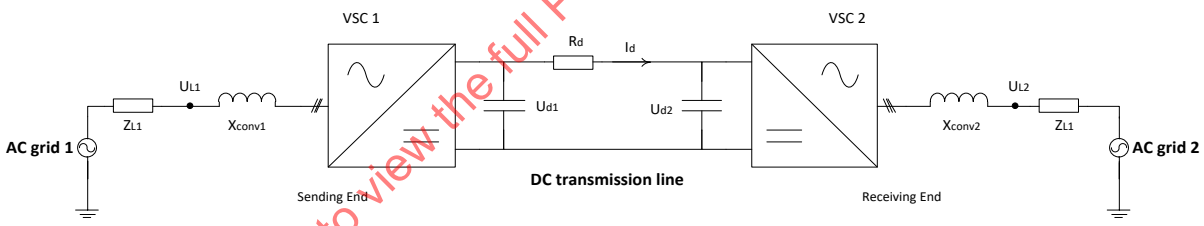


Figure 41 – A point-to-point VSC transmission scheme

The point-to-point VSC transmission scheme shown in Figure 41 consists of two VSCs interconnected on the DC side via a DC transmission line and connected to two different AC systems on the AC side. One of VSC characteristics is that the DC voltage polarity is always the same. Therefore, the direction of the power flow on the DC line is determined by the direction of the DC current.

The direction of a DC current is always from a higher DC voltage level to a lower DC voltage level. The DC voltage at the sending end of the DC line shall therefore be higher than DC voltage at the receiving end.

In line-commutated converter (LCC) HVDC, the DC line power flow can be controlled by holding the DC voltage at the receiving end converter (the inverter) at a constant value, and by letting the sending end converter (the rectifier) control the DC current. The same approach can be used in VSC transmission. However, one main difference is that in LCC HVDC the current direction is always the same; therefore, the power direction is changed by changing the DC voltage polarity.

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4.5.13.3 HVDC power flow modelling

4.5.13.3.1 General

A power flow model derived from Figure 41 is shown in Figure 42.

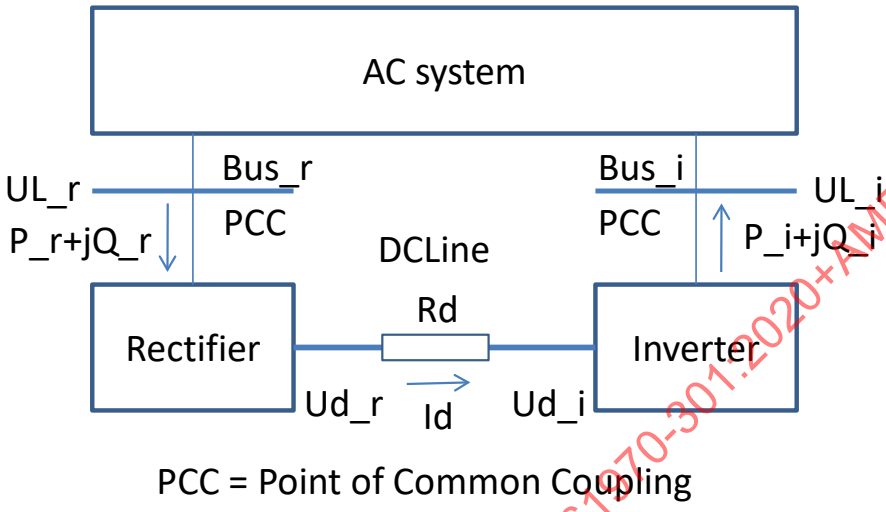


Figure 42 – HVDC power flow model

The AC side variables are as follows:

- P is the AC side active power injection at the rectifier (index r) and inverter (index i).
- Q is the AC side reactive power injection at the rectifier (index r) and inverter (index i).
- U_{L} is the AC side voltage at the rectifier (index r) and inverter (index i).

The DC side variables are as follows:

- U_{d} is the DC voltage at the rectifier (index r) and inverter (index i).
- U_{dN} is the rated DC voltage
- I_{d} is the DC line current
- I_{dN} is rated DC line current
- R_{d} is the DC line resistance

The interface between the HVDC system and the AC system are the two busses Bus_r and Bus_i. The voltage at Bus_r is $U_{\mathrm{L_r}}$ and the voltage at Bus_i is $U_{\mathrm{L_i}}$. Power injected into the Rectifier from the AC system is $P_{\mathrm{r}} + jQ_{\mathrm{r}}$ and power injected into the Inverter is $P_i + jQ_{\mathrm{i}}$. The busses Bus_r and Bus_i are from the AC system seen as PQ nodes for current source HVDC and PV nodes for voltage source HVDC. For PQ nodes the injections $P_{\mathrm{r}} + jQ_{\mathrm{r}}$ and $P_{\mathrm{i}} + jQ_{\mathrm{i}}$ and for PV nodes the active power injection and voltage $P_{\mathrm{r}}, UL_{\mathrm{r}}$ and $P_{\mathrm{i}}, UL_{\mathrm{i}}$ are computed from the HVDC link. Initial conditions for the HVDC link are given in two ways:

- P_{r} or P_{i}
- $U_{\mathrm{d_r}}$ or $U_{\mathrm{d_i}}$

The relation between the variables are $I_{\mathrm{d}} = P_{\mathrm{r}}/U_{\mathrm{d_r}} = P_{\mathrm{i}}/U_{\mathrm{d}_i}$.

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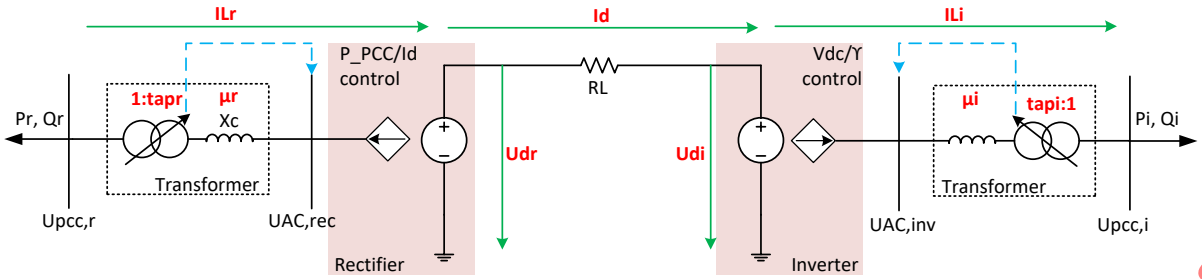


Figure 43 – Detailed HVDC power flow model

The active power and the reactive power at PCCs are derived, for lossless converters, via the following equations:

- $P_{\mathrm{r}} = U_{\mathrm{dr}} * I_{\mathrm{d}}$
- $Q_{\mathrm{r}} = U_{\mathrm{d0r}} * I_{\mathrm{d}} * \frac{\sin 2\alpha - \sin 2(\alpha - \mu_r) + 2\mu_r}{4 * (\cos\alpha - \cos(\alpha + \mu_r))}$
- $P_i = -U_{\mathrm{di}} * I_{\mathrm{d}}$
- $Q_i = U_{\mathrm{d0}i} * I_{\mathrm{d}} * \frac{\sin 2\gamma - \sin 2(\gamma - \mu_r) + 2\mu_r}{4 * (\cos\gamma - \cos(\gamma + \mu_r))}$

The power flow is illustrated in Figure 44 and Figure 45.

4.5.13.3.2 Current Source Converter (CSC)

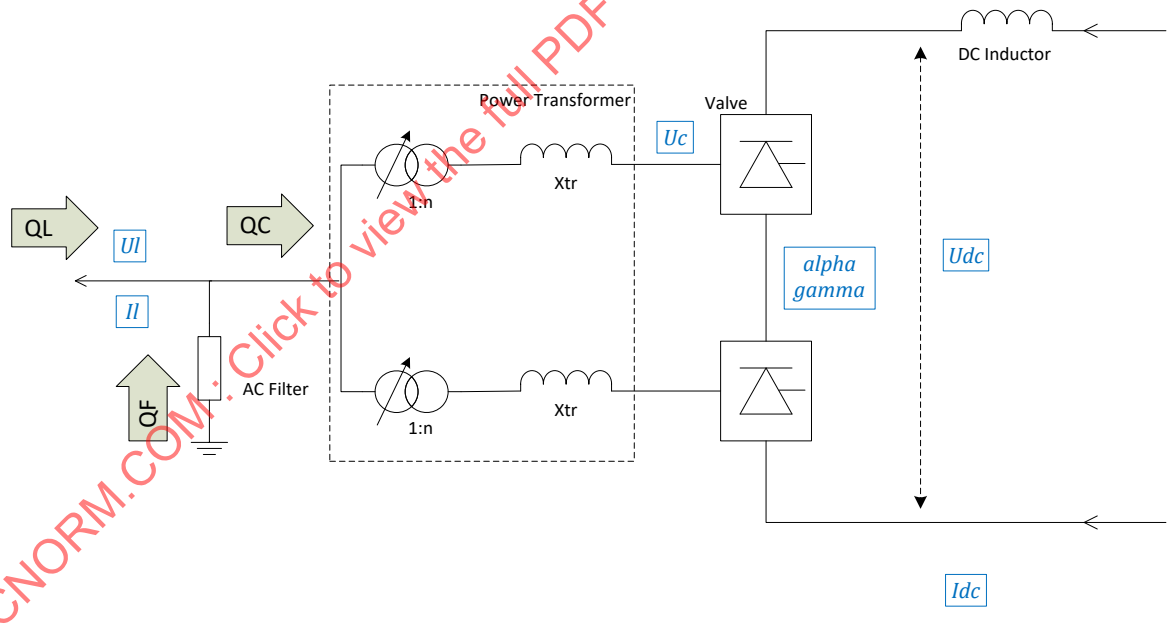


Figure 44 – Current Source Converter power flow

In a current source converter the reactive power is not controlled. Instead it is determined by the bridge firing angle that impacts the power factor. CSC equations require commutation reactance, tap changer and firing angle cascaded control. The commutation reactance for the CsConverters is based on the PowerTransformer which belongs to the DcConverterUnit, i.e. the impedance from converter transformer is used as Xc. The tap changer control for firing angle adjustment used also the tap changer data from the converter transformer. In case of shared tap changer in 2x6-pulse bridge configurations (3-winding converter transformer) the 6-pulse bridges shall be controlled in master/slave.

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The following equations shall be considered:

- $U_{\mathrm{d}} = U_{\mathrm{d0}} * \cos\alpha - \left(\frac{3}{\pi}\right) * X_{\mathrm{tr}} * I_{\mathrm{d}} * B$ or $U_{\mathrm{d}} = U_{\mathrm{d0}} * \cos\gamma - \left(\frac{3}{\pi}\right) * X_{\mathrm{tr}} * I_{\mathrm{d}} * B$
- $\varphi \approx cos^{-1}\left(\frac{V_d}{V_{d0}}\right)$
- $P = V_{\mathrm{d}} * I_{\mathrm{d}} = P_{\mathrm{ac}}$
- $Q = P * tan\varphi$
- the rated direct voltage: $U_{\mathrm{d0}} = ((3 * \sqrt{2})/\pi) * U_{\mathrm{C}} * B * T$
- $U_{\mathrm{t}} = U_{\mathrm{L}} * tapratio$

The approximation of reactive power injection could be presented in the following way:

- $Q_{\mathrm{L}} = Q_{\mathrm{C}} - Q_{\mathrm{F}} = \left(\frac{P}{2}\right) - Q_{\mathrm{F}} \approx \frac{P}{2}$

where:

- α – firing angle
- B – number of bridges in series
- T – transformer turns ratio
- I_{d}, V_{d} – direct current and voltage per pole

4.5.13.3.3 Voltage Source Converter

The electrical components and their interconnections within a converter are shown in Figure 45. Figure 45 is the reference for the formulas in 4.5.13.3.

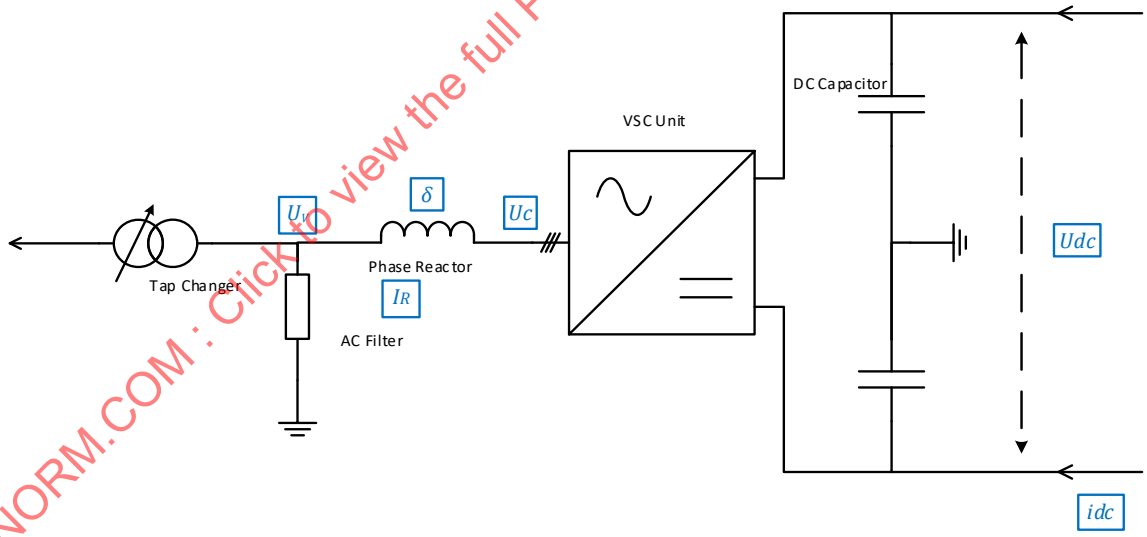


Figure 45 – Voltage Source Converter power flow

Additional parameters to those previously listed are as follows:

- U_{dc} is the voltage at the DC side of the VSC Unit.
- I_{dc} is the current at the DC side of the VSC Unit.
- U_{C} is the voltage at the AC side of the VSC Unit, also called converter voltage
- U_{V} is the voltage at the filter bus.
- modulation index is the ratio between U_{dc} and U_{C}, this is a VSC parameter and has typical values between 0 and 1.

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- I_R is the current through the phase reactor.
- X_C is the phase reactor reactance.
- δ is the angle between the U_V and U_C voltages.

The diagrams in Figure 46 show the voltage vectors and the resulting power flow cases.

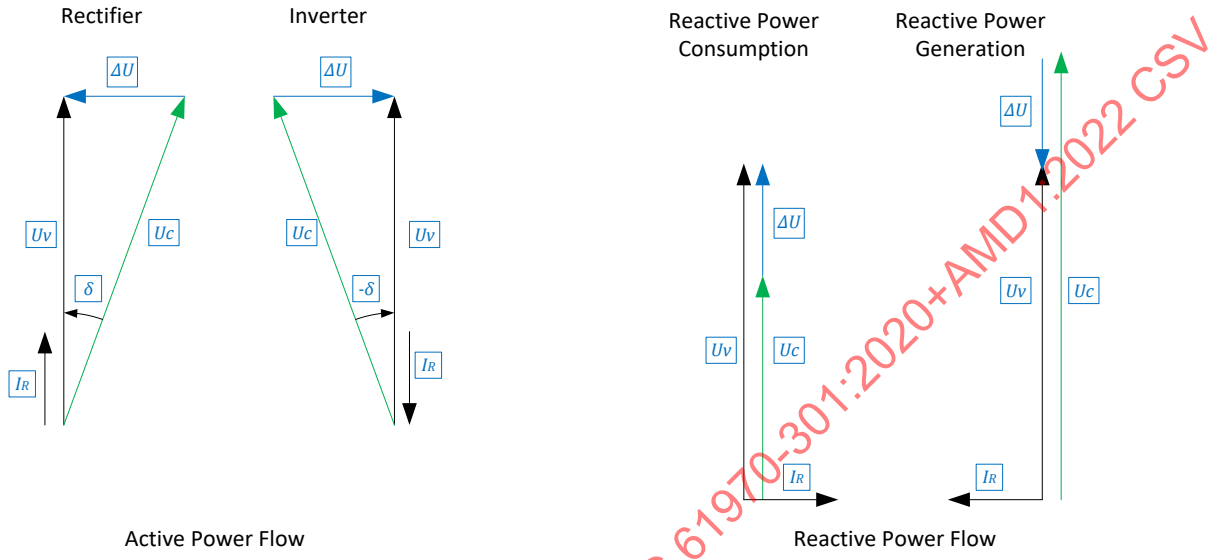


Figure 46 – Power flow cases

The behaviour of the Rectifier and Inverter can be described by a set of formulas having the following parameters, some of which are shown in Figure 42 and Figure 45.

- U_{rated} is the converter rated AC voltage (one each for rectifier and inverter).
- S_{rated} is the converter rated AC power.
- R_C is the phase reactor resistance
- number of converter bridges (one each for rectifier and inverter)
- I_{dmax} and I_{dmin} are the DC flow upper and lower limits.
- R_d is the DC line resistance.
- The active and reactive components (refer to Figure 46) are computed as $P = U_V * U_C * (\sin(\delta)/X_C)$
- $Q = U_V * (U_V - U_C) * (\cos(\delta)/X_C)$

The losses at a pole are described by the equation:

- $P(poleLoss) = idleLossFactor + switchLossFactor * I_{dc} + resistiveLossFactor * I_{dc} + resistiveLossFactor * I_{dc}^2$

Where:

- $P_{dc} = P_{ac}$ for lossless operation
- $P_{dc} = P_{ac} - P_{loss}$ for rectifier operation with losses
- $P_{dc} = P_{ac} + P_{loss}$ for inverter operation with losses

Figure 47 shows a diagram for a symmetric monopole Voltage Source Converter.

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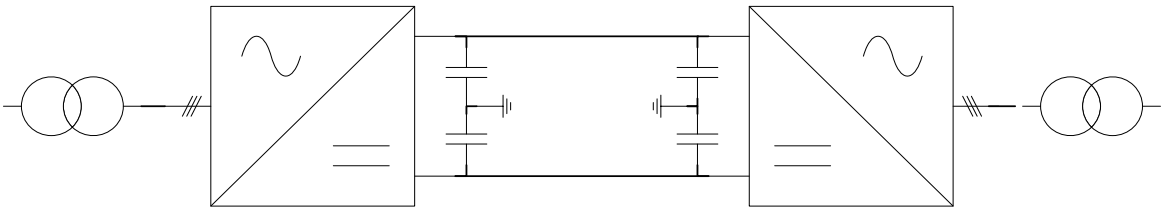


Figure 47 – VSC transmission with a symmetrical monopole illustrated with capacitive earthing on the DC side (IEC 62747)

By controlling the angle δ between the voltages U_V/U_C and voltage difference $U_V - U_C$ independent active and reactive power control is achieved.

Limitations of the VSC results in a P-Q curve. An example P-Q curve is shown in Figure 48.

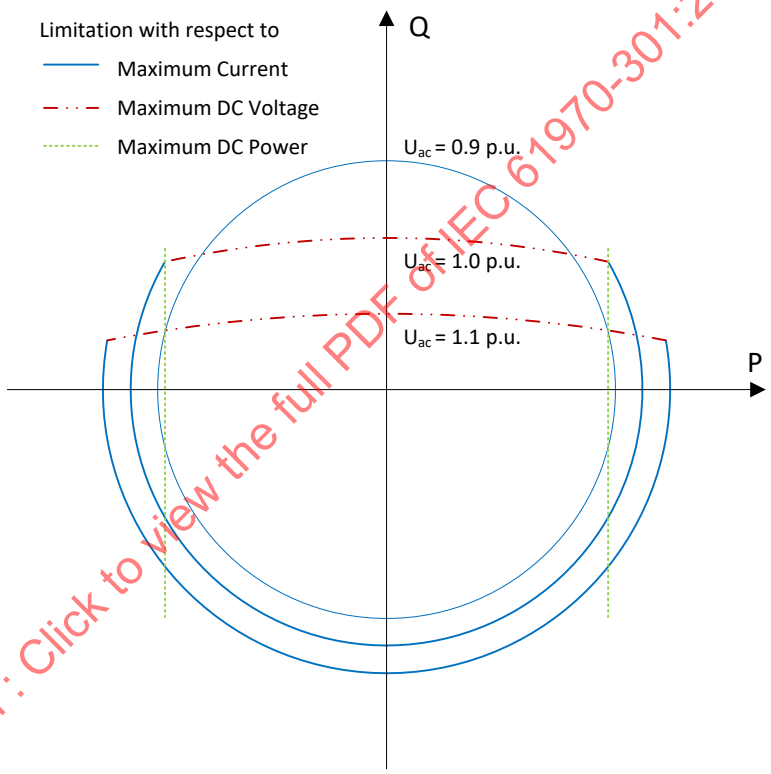


Figure 48 – VSC P-Q capability curve

It is also possible to use VSC in bipolar configurations as shown in Figure 49.

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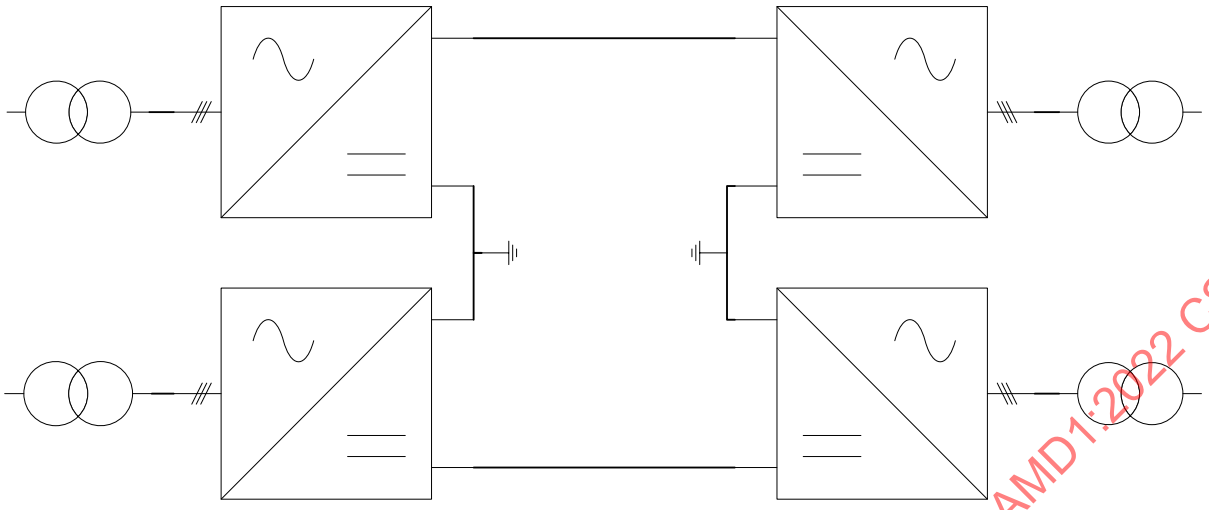


Figure 49 – Bipolar VSC transmission with earth return (IEC 62747)

In this configuration two high voltage DC cables are used for the positive (+DC) and negative (-DC) voltages. A medium voltage cable is used for the neutral.

4.5.13.4 Data model

4.5.13.4.1 General

A data model is created using the following assumptions

- The DCConverterUnit in CIM is identical with IEC 60633 Substation Pole that is a container.
- The IEC 60633 System Pole is not modelled in CIM. The reason is that the IEC 60633 System Pole is not relevant in DC grids. The bridges, filters and bridge units are not modelled explicitly in CIM and are considered part of the Converter.
- Using ConnectivityNode and Terminal for the connectivity also in DC grids enables DC and AC components to be connected together, which is an error. Attributes will also have different meanings in AC and DC grids, e.g. DCNode does not have phase angle or reactive power injection. Hence different artefacts are used to describe AC and DC grids.

Figure 50 shows an example with the modelled objects of a bi-polar current source HVDC line.

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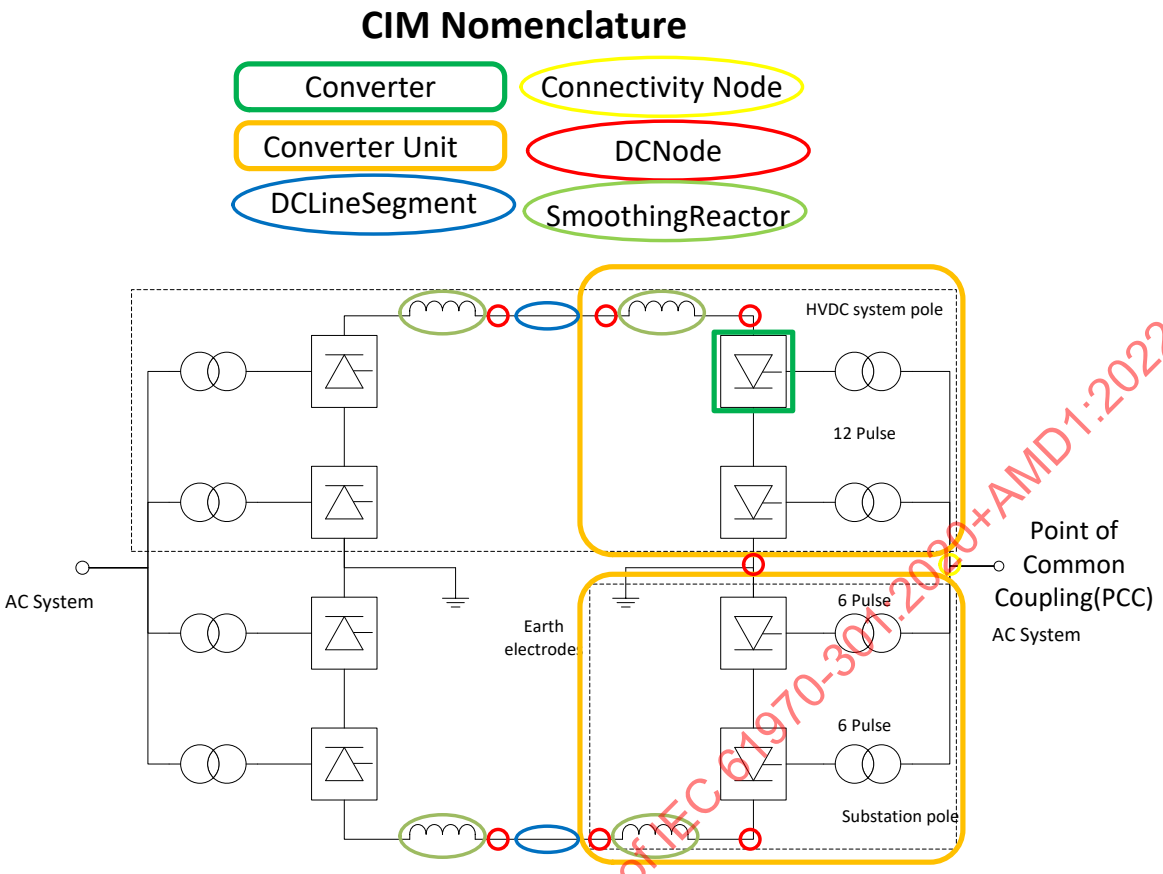


Figure 50 – Object instances for a bi-polar current source HVDC line

The Converter Unit is the object bridging the AC and DC networks.

The corresponding diagram for VSC is shown in Figure 51.

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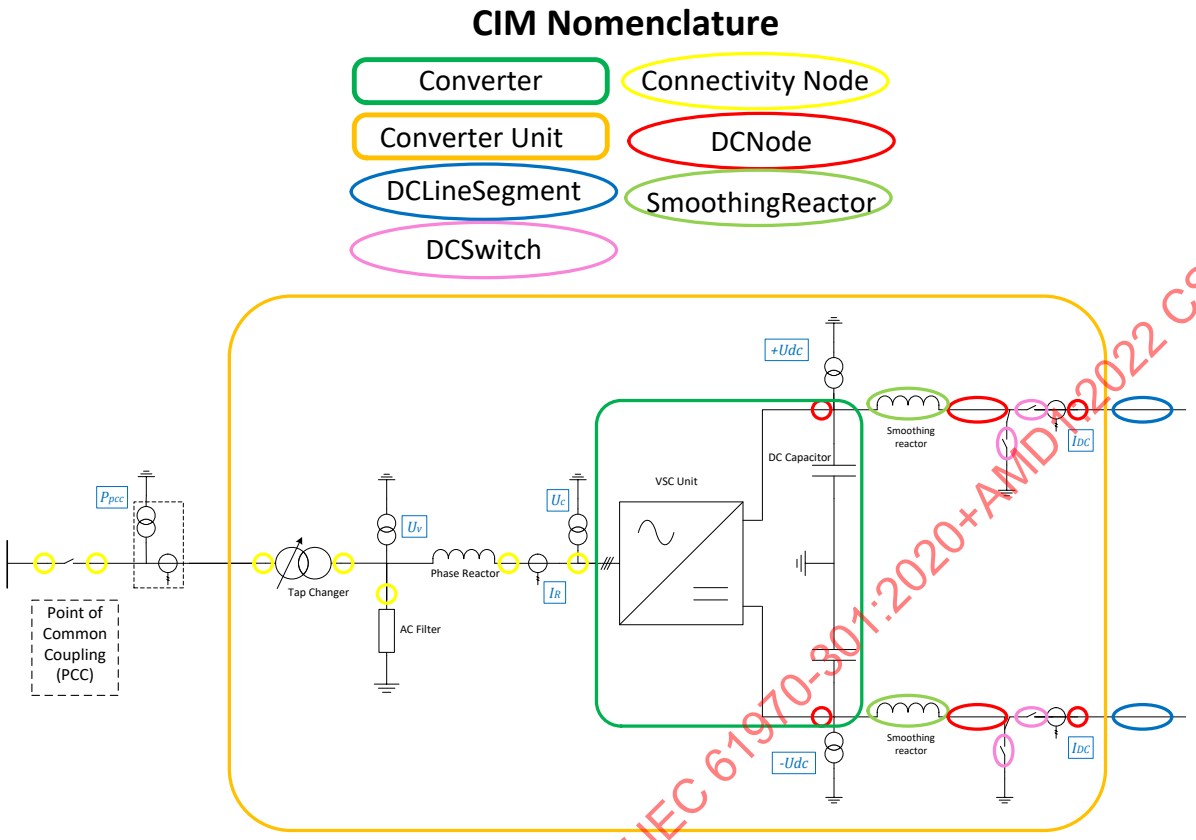


Figure 51 – Object instances for symmetric monopole VSC HVDC data model

As indicated in Figure 50 and Figure 51 an HVDC substation consists of

- one or more Converters;
- SmoothingReactors;
- DC switches for reconfiguration of the DC-lines;
- a Point of Common Coupling (PCC) that is the interface with the AC system.

A Converter consists of one or more sets of

- bridges;
- a PowerTransformer;
- an AC filter;
- a converter or phase reactor for VSC, in multi-level HVDC several Bridges exists in the converter arms. The Converter reactor is then part of the arms rather than a single reactor as shown in Figure 51;
- breakers and disconnectors.

HVDC link can be operated in several ways:

- Bipolar, refer to Figure 49;
- Symmetrical monopole with capacitive earthing on the DC side – refer to Figure 47;
- Asymmetrical monopole with ground return – this lower active power capacity and sustained operation is not allowed;
- Asymmetrical monopole with metallic return – this lower active power capacity and sustained operation is allowed.

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A Converter with several Bridges may have the capability to reconfigure how Bridges are connected. A reconfiguration normally results in down rating of limits.

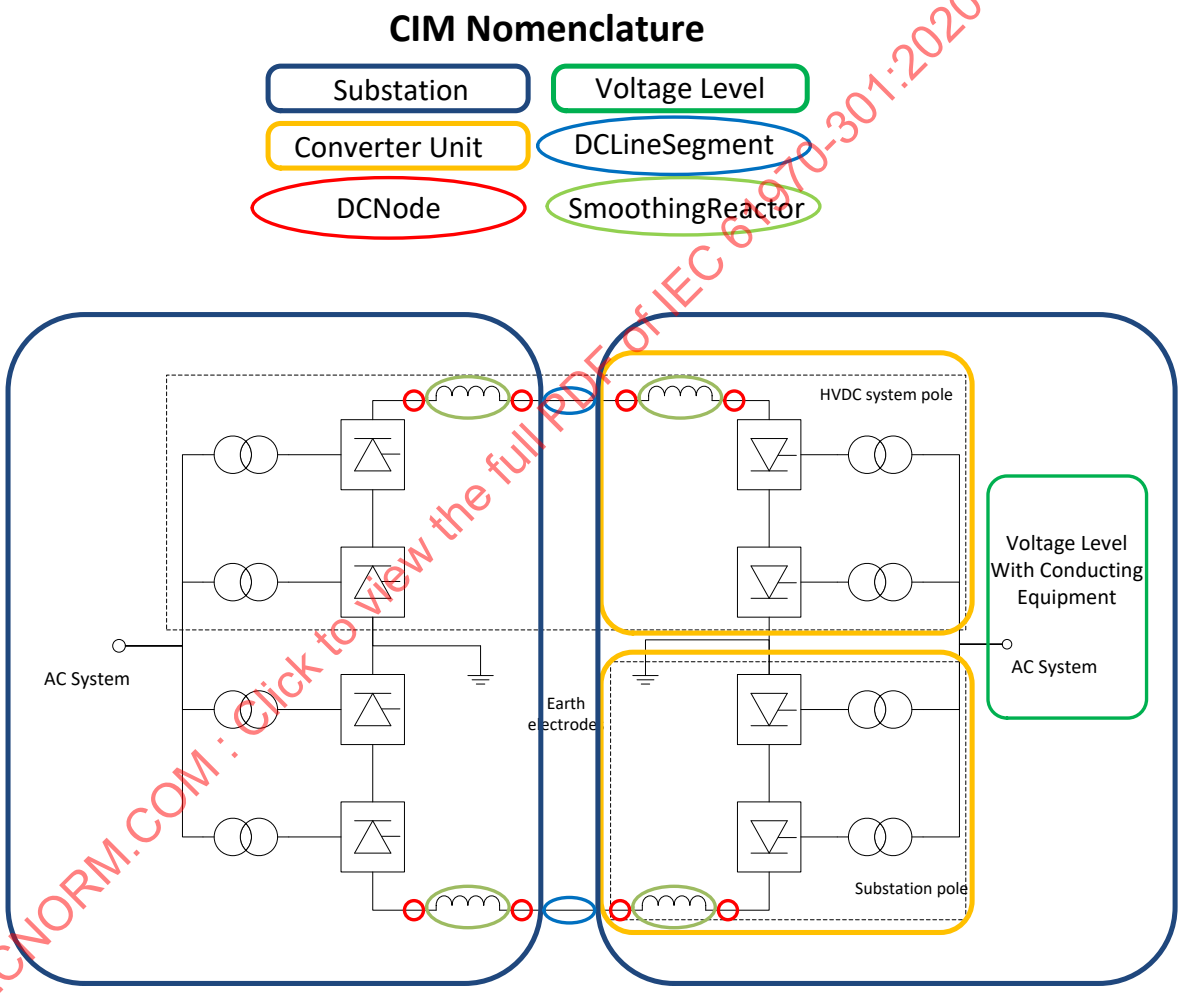
An HVDC substation sends operational status as SCADA signals to a superior SCADA. In bi-polar operation mode down rated Converter limits are typically sent to the superior SCADA.

The containment structures for two cases are shown in Figure 52 and Figure 53.

For the transformers note that

- they are not in a Substation but a DCConverterUnit;
- no VoltageLevels exist at the low and high voltage sides of a transformer.

Hence the containment rules for transformers in the AC network are replaced by rules specific to the DCConverterUnit.



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Figure 52 – Containment structure for a bipolar HVDC line

The two DCLineSegments are part of a Line. The reason is that the DCLineSegments typically are at the same tower or in the same cable channel.

The two substations are regular Substations mixing DC and AC equipment. The DCConverterUnit and Converters are at Substation level and connect to AC equipment in a VoltageLevel.

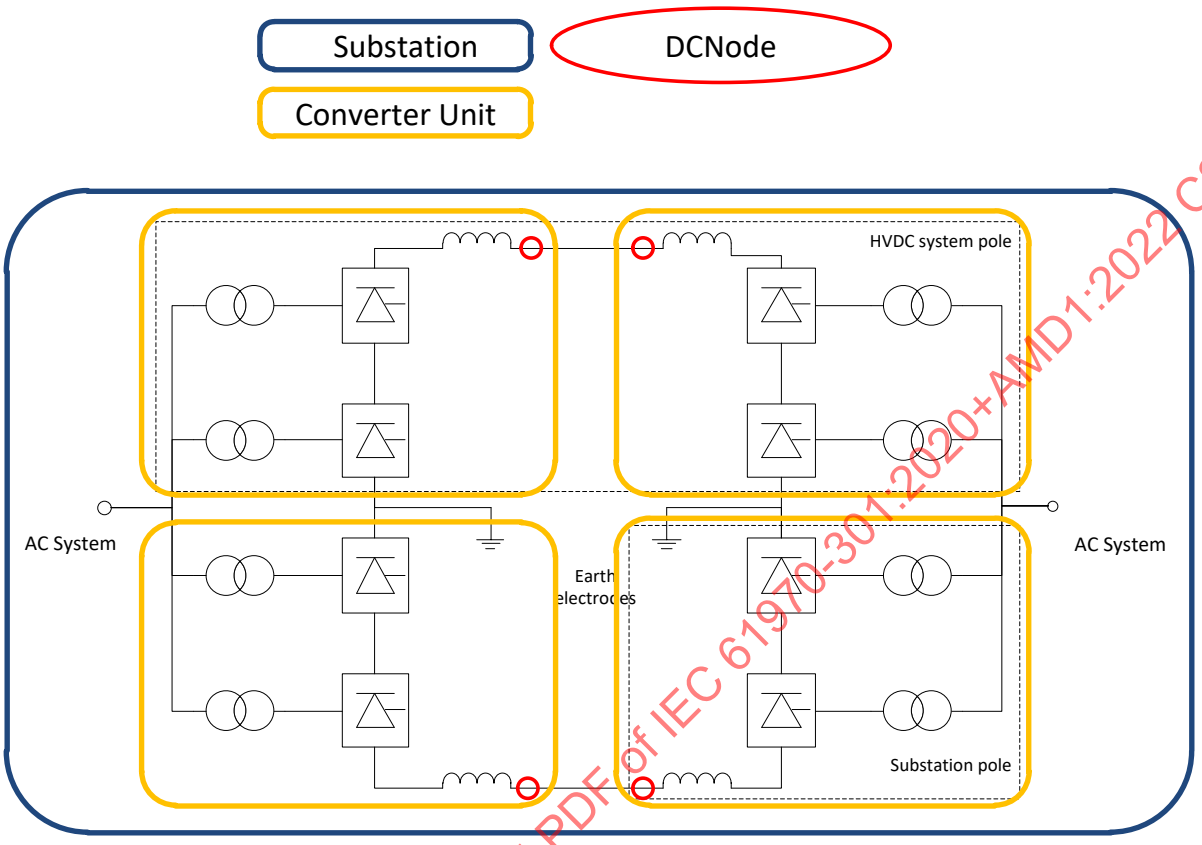


Figure 53 – Containment structure for a bipolar back-to-back HVDC station

4.5.13.4.2 DC Grids

DC grids will have switches that are used to reconfigure the DCLine-s in the grid. To do this it is important that the switches are included in the model and are placed at the appropriate locations in the grid. Figure 51 shows a DCLine connected at a Converter with a simple switch arrangement. As the smoothing reactor belongs to the Substation rather than the DCLine it cannot be included in the DCLine inductance. For DC grid the incoming DCLine connections with the Converters will have more switches and the information model needs to support this. DC grid topology processing will be required in the same way as AC grid topology processing is currently done.

4.5.13.4.3 Topology

The basic AC system connectivity is shown in Figure 54.

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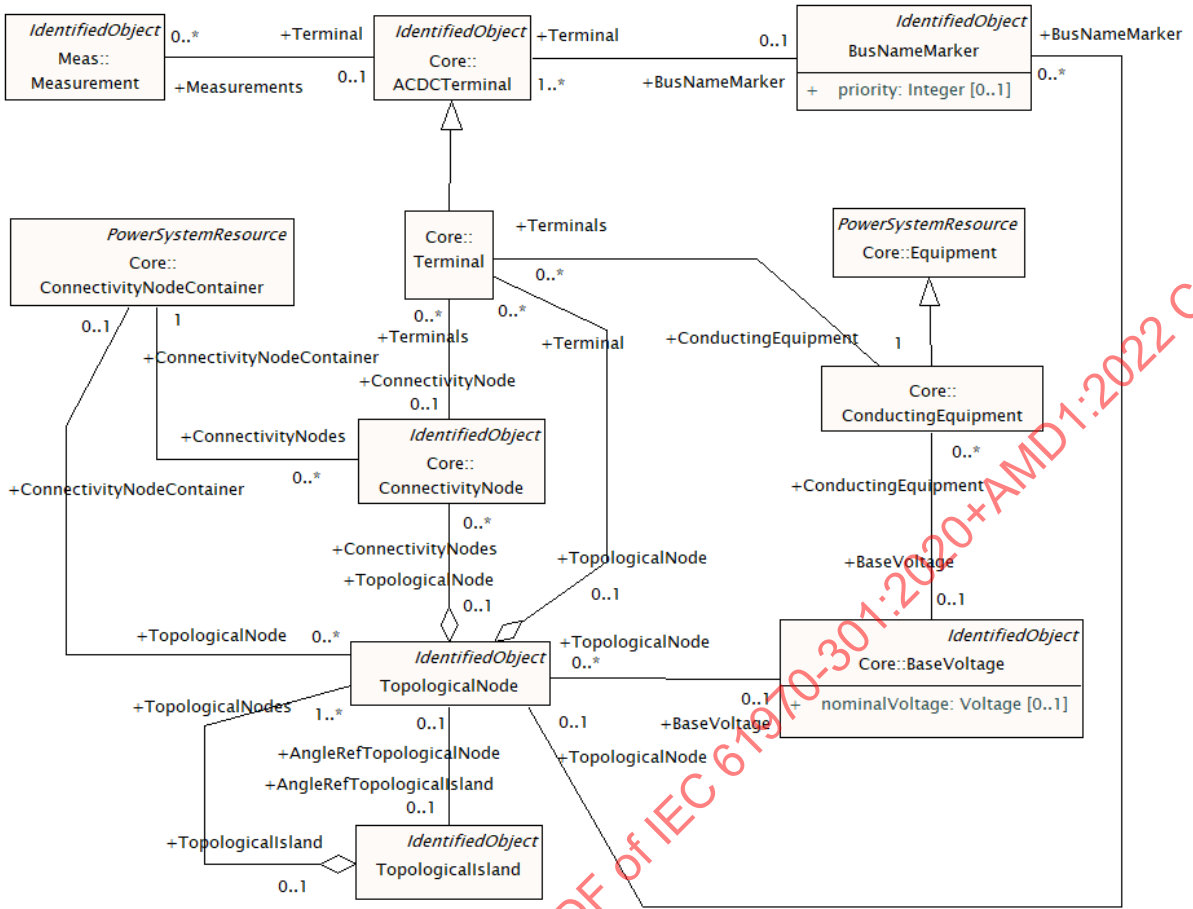


Figure 54 – The Basic topology in package Core

As shown in Figure 54, Terminal is used only for AC ConductingEquipment. A new class ACDCTerminal has been introduced to hold characteristics common between AC and DC.

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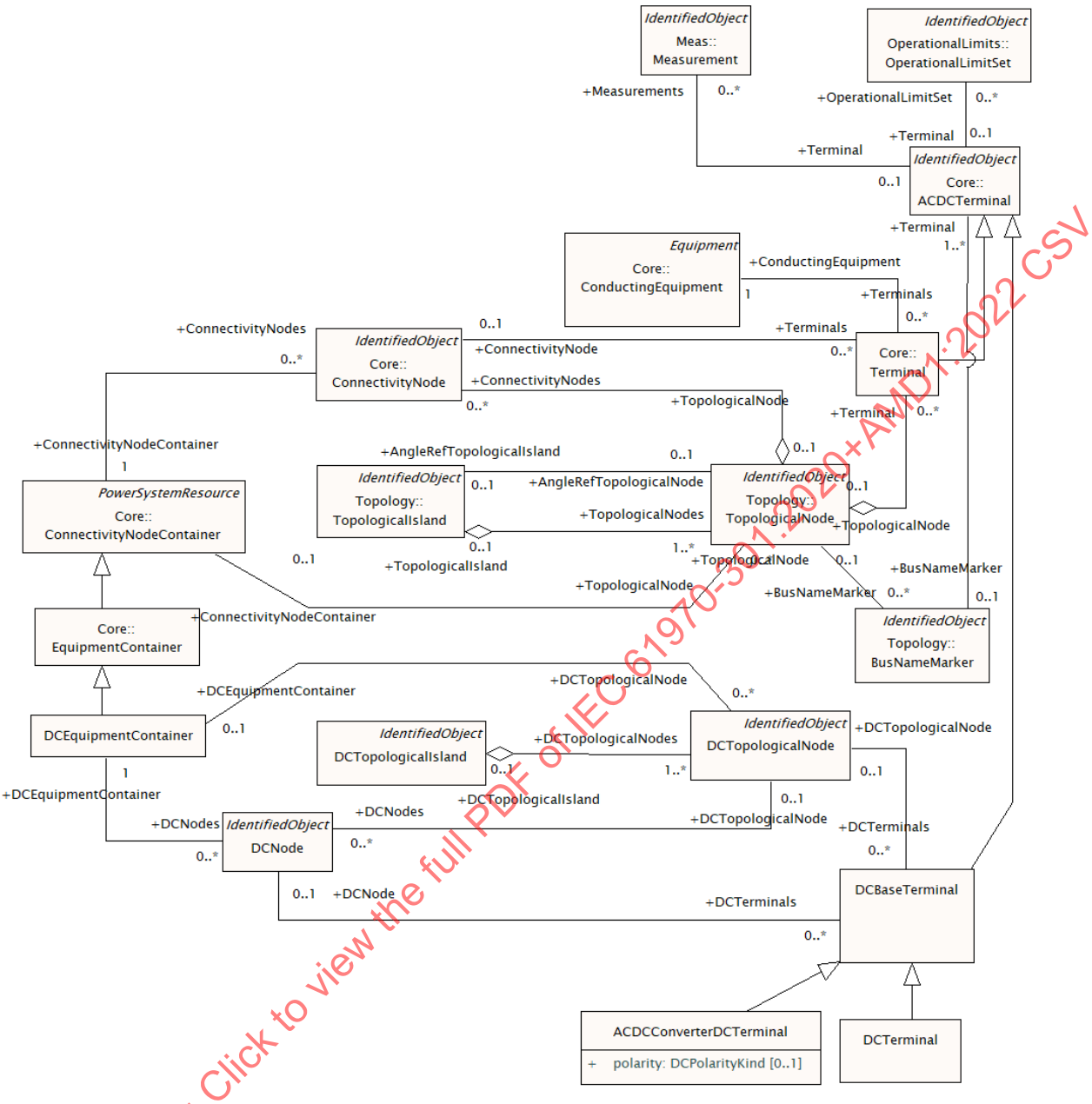


Figure 55 – DC and AC topology

As shown in Figure 55, the ConductingEquipment-Terminal-ConnectivityNode pattern from the AC network is repeated for the DC network with the classes DCConductingEquipment-DCTerminal-DCNode.

4.5.13.4.4 Equipment

The DC equipment model is shown in Figure 56.

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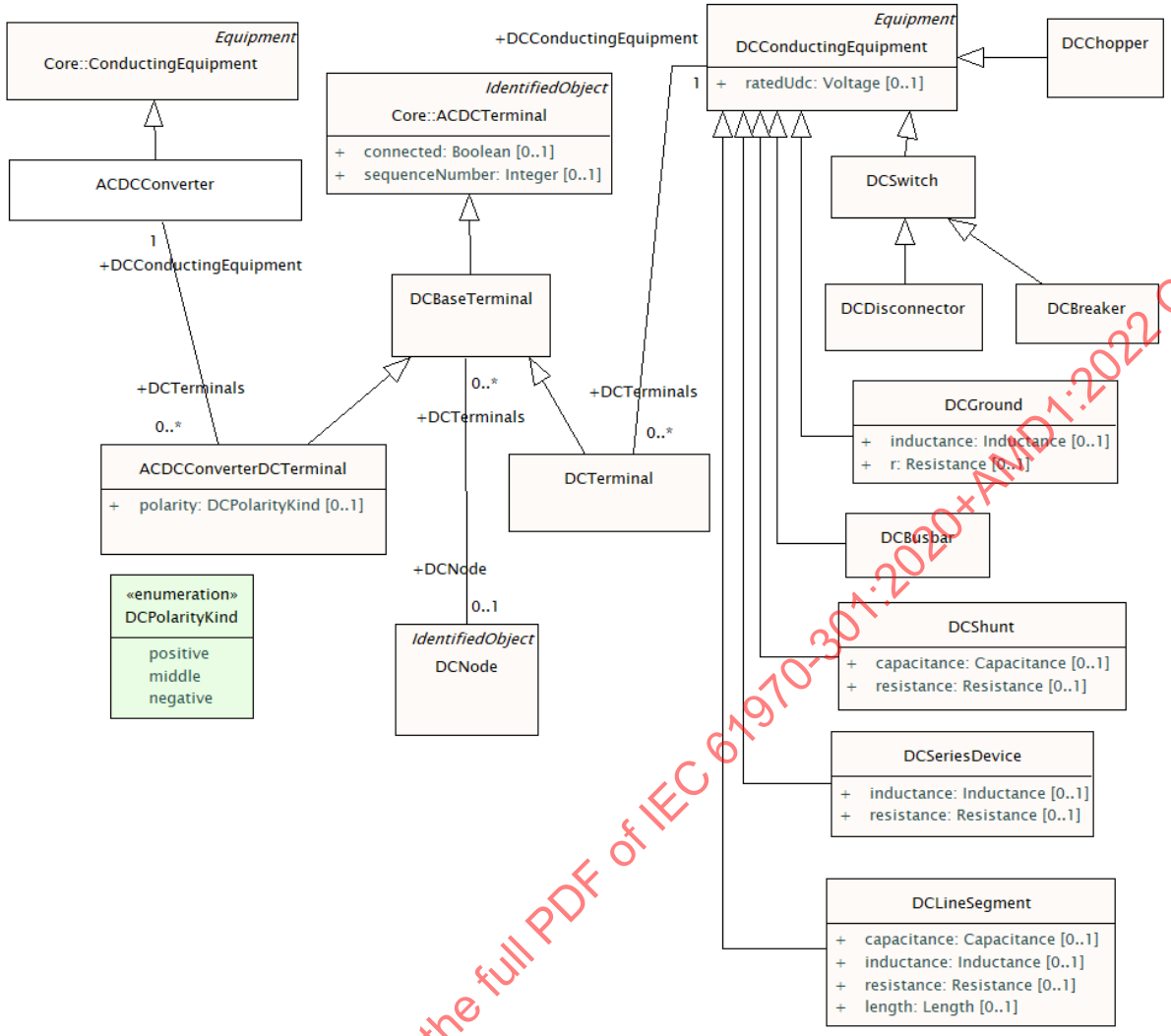


Figure 56 – Equipment model

In order for the ACDCTerminal to feature both ACDCConverter and DCConductingEquipment, two types of DC terminals have been implemented as shown in Figure 56: ACDCConverterDCTerminal and DCTerminal. ACDCConverterDCTerminal is associated with ACDCConverter. The DCTerminal is in association with DCConductingEquipment. In order to associate DCNode with DCTerminal and ACDCConverterDCTerminal, DCBaseTerminal is introduced which is inherited from ACDCTerminal.

As DCConductingEquipment in many cases will have different parameters compared with corresponding AC equipment, specific DC classes are needed anyway, e.g. the DCBreaker and DCBusbar.

The SvPowerFlow-s at the PCCTerminal-s hold the AC injections into the converter.

The DC line model is shown in Figure 57.

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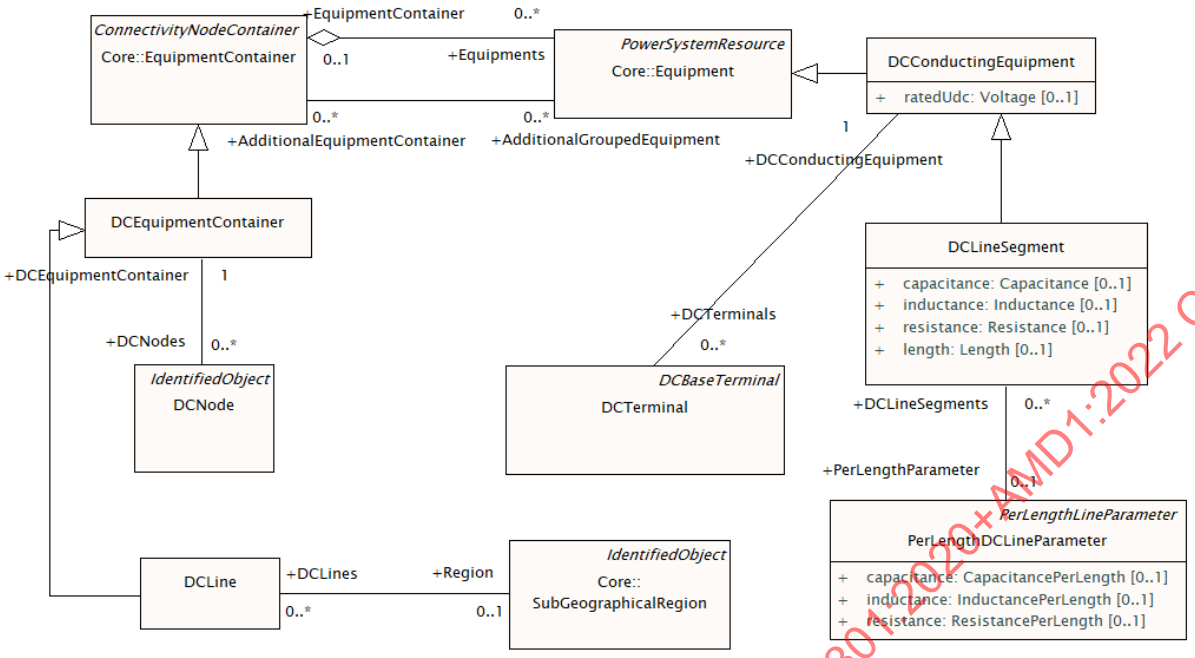


Figure 57 – HVDC line model

As shown in Figure 57 DCLineSegment is no longer a Conductor but DCConductingEquipment and does not connect to the AC network. It has its own attributes and per length class PerLengthDCLineParameter.

Every type of equipment in an HVDC grid will need its DC…class. Possible equipment types are

- DCSwitch
- DCGround

The method of specific DC… classes may result in duplication of attributes with the corresponding AC… classes.

4.5.13.5 Instance diagrams

Figure 58 is the legend for examples of DC equipment: a simple monopole, a simple bipolar and a detailed side of a monopole, shown in Figure 59, Figure 60 and Figure 61, respectively.

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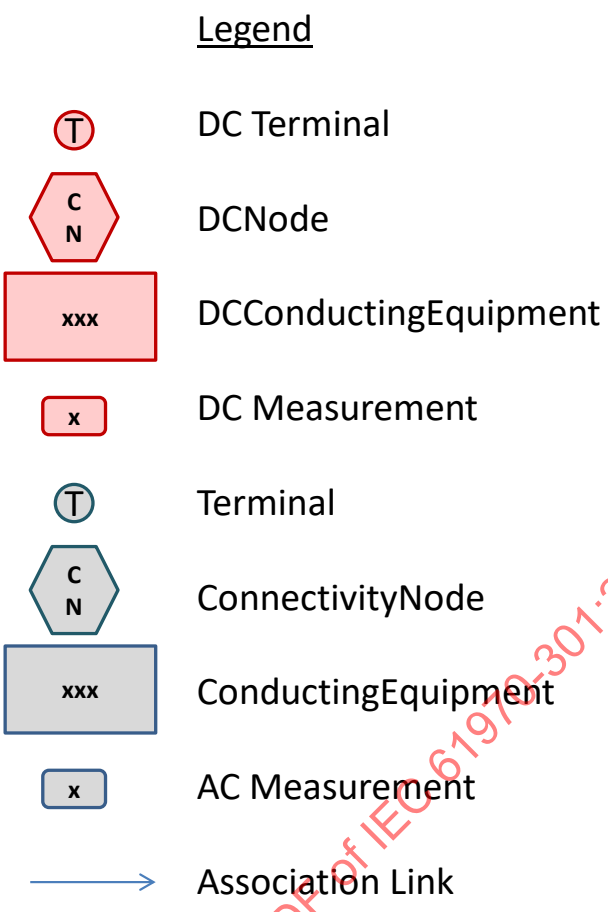


Figure 58 – Legend

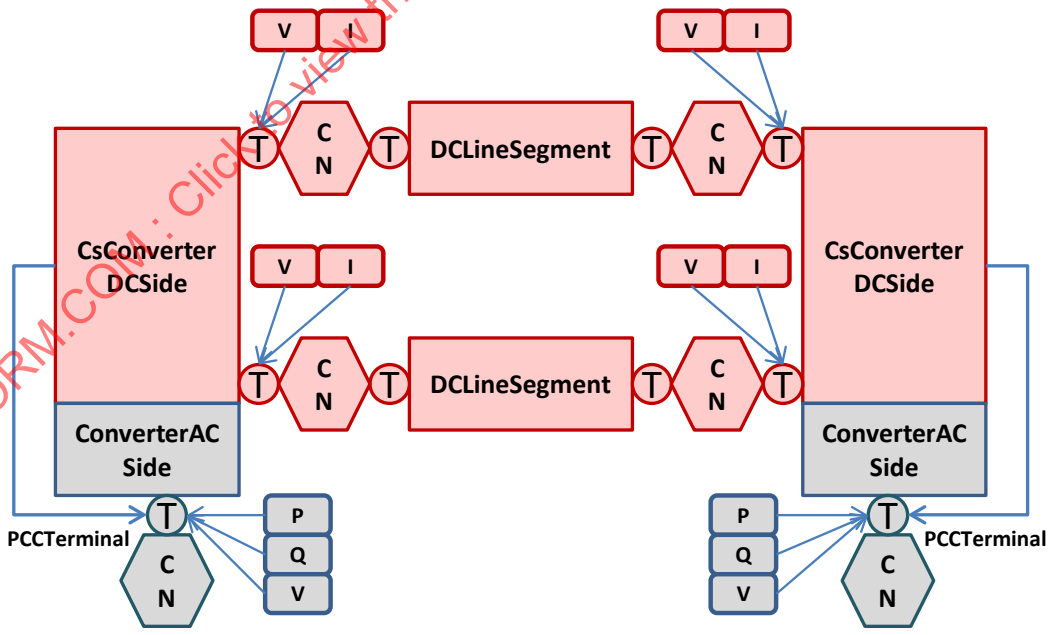


Figure 59 – Simple monopole with measurements

Refer to Figure 58 for an explanation of the symbols in Figure 59.

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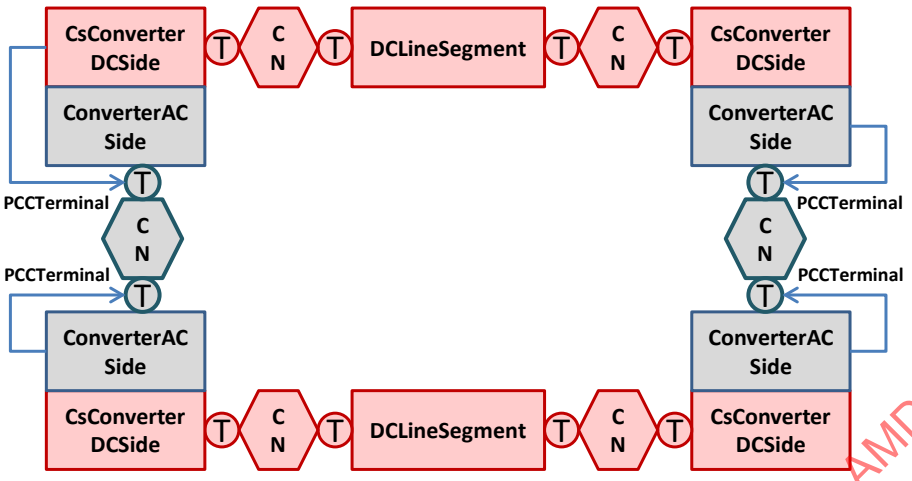


Figure 60 – Simple bipolar

Refer to Figure 58 for an explanation of the symbols in Figure 60.

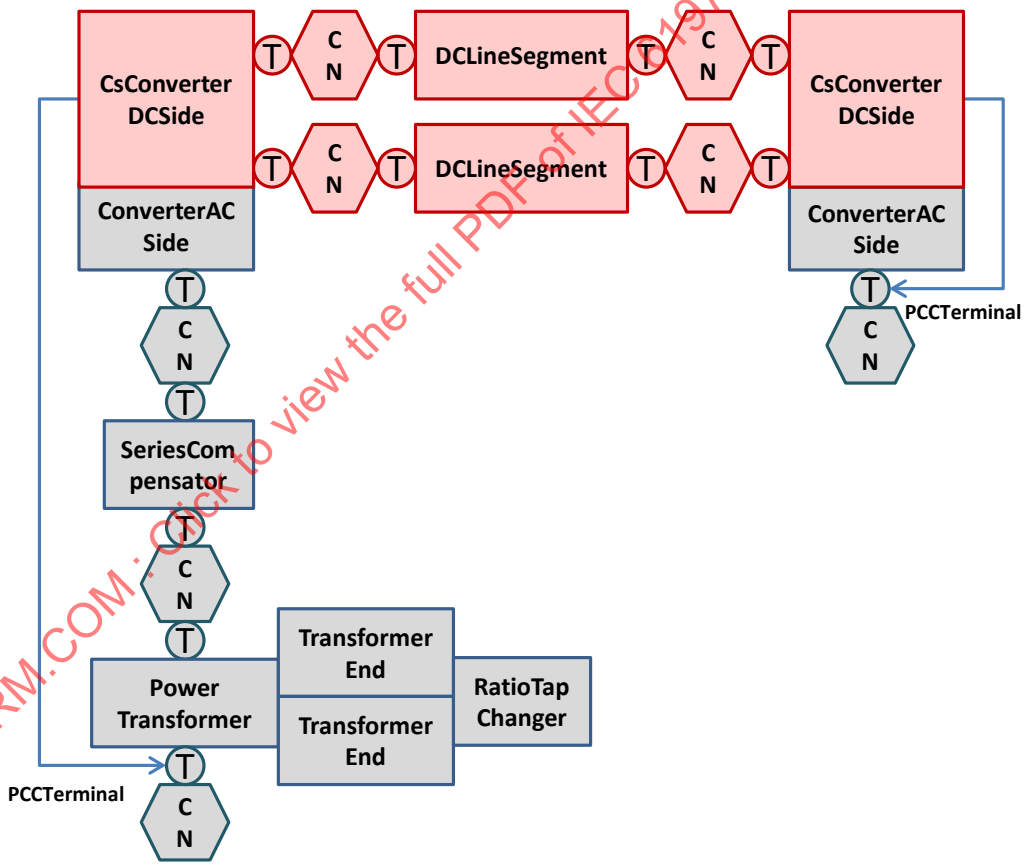


Figure 61 – Monopole one side with detailed model

Refer to Figure 58 for an explanation of the symbols in Figure 61.

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4.5.14 Static Var Compensator Voltage Regulation

4.5.14.1 Background

The Static VAR Compensator (SVC) is a shunt device of the Flexible AC Transmission Systems (FACTS) family using power electronics to control power flow and improve transient stability on power grids. The SVC can be operated in two different modes:

- Voltage regulation mode (the voltage is regulated within limits as explained below)
- Var control mode (the SVC susceptance is kept constant).

When the SVC is operated in voltage regulation mode, it implements the V-I characteristic shown in Figure 62.

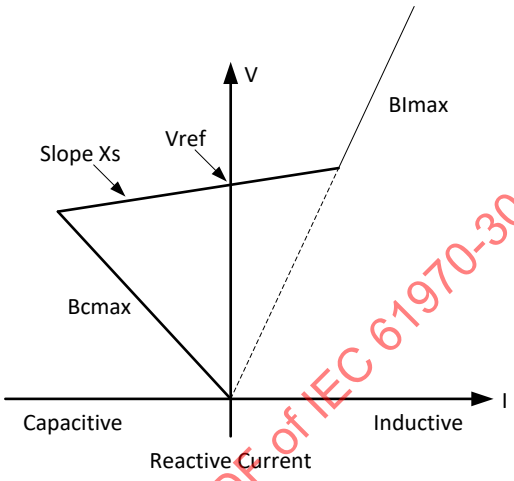


Figure 62 – V-I Characteristic of SVC

As long as the SVC susceptance B stays within the maximum and minimum susceptance values imposed by the total reactive power of capacitor banks (Bcmax) and reactor banks (BI_{max}), the voltage is regulated at the reference voltage V_{ref} (also referred to as voltage set point). The voltage at which the SVC neither absorbs nor generates reactive power is the reference voltage (V_{ref}).

A voltage droop is normally used (usually between 1 % and 4 % at maximum reactive power output), and the V-I characteristic has the slope indicated in the figure. The V-I characteristic is described by the following three equations:

$$V = \begin{cases} V_{ref} + X_S * I & if\ SVC\ is\ in\ regulation\ mode \quad (-Bc_{max} < B < BI_{max}) \\ -\dfrac{I}{Bc_{max}} & if\ SVC\ is\ fully\ capacitive \quad (B = Bc_{max}) \\ \dfrac{I}{BI_{max}} & if\ SVC\ is\ fully\ inductive \quad (B = BI_{max}) \end{cases}$$

Where:

V is the positive sequence voltage (pu) at regulated bus;

I is the reactive current ($I > 0$ indicates an inductive current);

X_S is the slope or droop reactance;

V_{ref} is the voltage reference (voltage set point);

Bc_{max} is the maximum capacitive susceptance;

BI_{max} is the maximum inductive susceptance.

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The voltage set point is typically chosen such that under normal operating conditions the SVC delivers close to zero reactive power so that the full control range of the SVC is available.

The voltage set point of an SVC is fundamentally different from a target voltage. The reactive output of an SVC is proportional to the square of the difference between the regulated bus voltage and the voltage set point. If the SVC is generating or absorbing reactive power, then there will by definition be a difference between the regulated bus voltage and the voltage set point.

4.5.14.2 CIM Model

StaticVarCompensator inherits the following attributes from RegulatingCondEq:

controlEnabled – Specifies the regulation status of the equipment. True is regulating, false is not regulating.

StaticVarCompensator gets its regulated Terminal through the association to RegulatingControl inherited from RegulatingCondEq.

4.5.15 ICCP Configuration Model

4.5.15.1 Configuration use case

An ICCP configuration can be created in two ways:

1) The IO points (measurement values and controls) that will be exchanged over ICCP are known from an exchange of the equipment profile IEC 61970-452/EQ and the ICCP configuration relate directly to these IO points.
2) The IO points that will be exchanged over ICCP are not known from an exchange of the equipment profile and the ICCP configuration instead use an intermediate and commonly agreed name, the ICCP provided point name for the IO points to be exchanged over ICCP. This corresponds to the traditional ICCP configuration case.

The following example is for use case 1 above.

Two utilities, Utility A and B, may have overlapping network models see Figure 63 and exchange CIMXML EQ files with the connectivity node as border. Both Utility A and B want measurement values from each other. The description of the IO points in the network model are included in the exchanged CIMXML IEC 61970-452/EQ files. Both Utility A and B have a subset of the measurements in the CIMXML IEC 61970-452/EQ files available for ICCP exchange.

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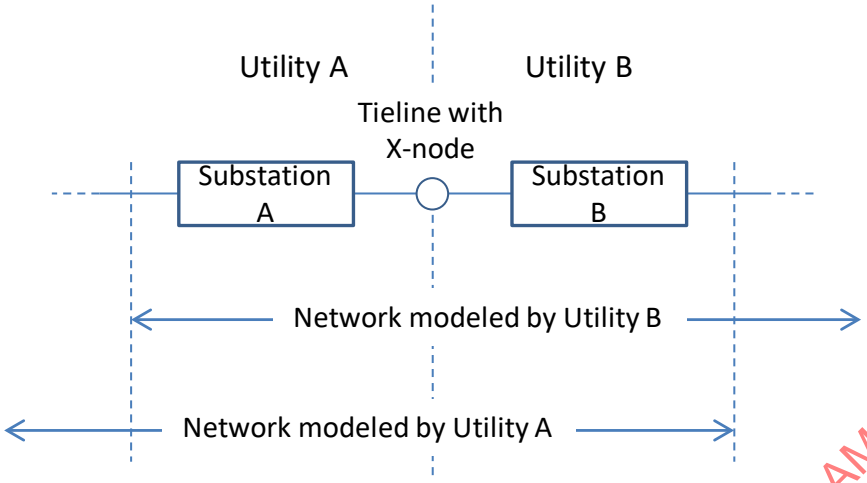


Figure 63 – ICCP measurements and network models

According to use case 2 above traditional way to configure ICCP is for the parties to agree on a common set of names for the exchanged measurements, the ICCP provided points. It is assumed that the two parties use different names for the same measurement and hence a third commonly agreed name is needed, the ICCP provided point names.

Based on this assumption Figure 64 shows a simplified sequence of configuring and starting ICCP.

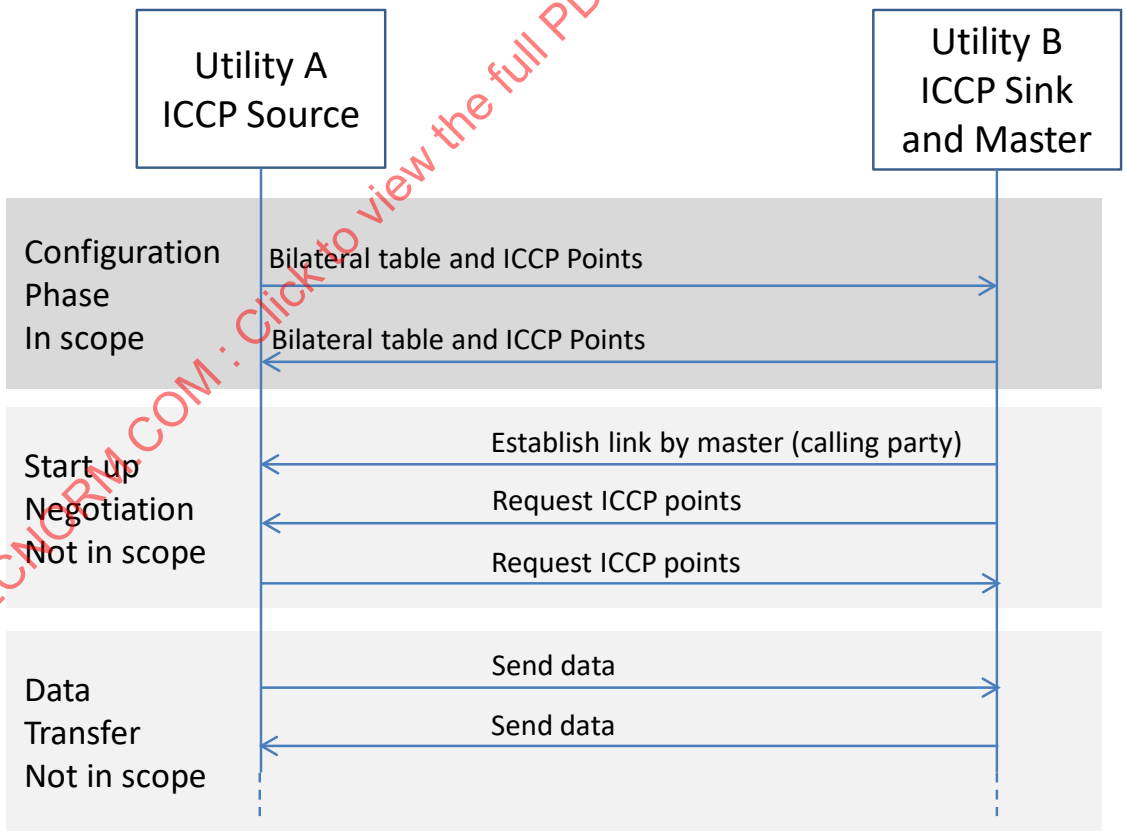


Figure 64 – ICCP configuration and start up

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In the configuration phase files describing the bilateral tables and ICCP point lists are exchanged, the dark grey shaded are in Figure 64. Configuring this exchange is in the scope of this document.

Setting up ICCP configuration means creating a cross reference for each measurement value between the parties. Creating the cross reference is tedious manual work.

When network models are exchanged as CIMXML data both the IEC 61970-452/EQ data and ICCP configuration data described in this document are exchanged. Given this the IO point identifiers and names are known by both parties. Hence the ICCP point mapping is already known and the manual cross referencing that is replaced by automatic linking.

Not all IO points defined in an IEC 61970-452/EQ file may be available over ICCP. Hence availability of a IO points over ICCP need to be described per IO point.

The ICCP protocol support providers of ICCP data to give different ICCP consumers different access rights, e.g. for the example in Figure 63 Utility A may want to allow access for the measurements in Substation A to Utility B but not to other utilities. Hence it must be possible for an ICCP provider to describe ICCP point availability per ICCP consumer. ICCP also support IO points that are globally available to all ICCP consumers.

Figure 65 shows an example ICCP configuration for one measurement value between different parties.

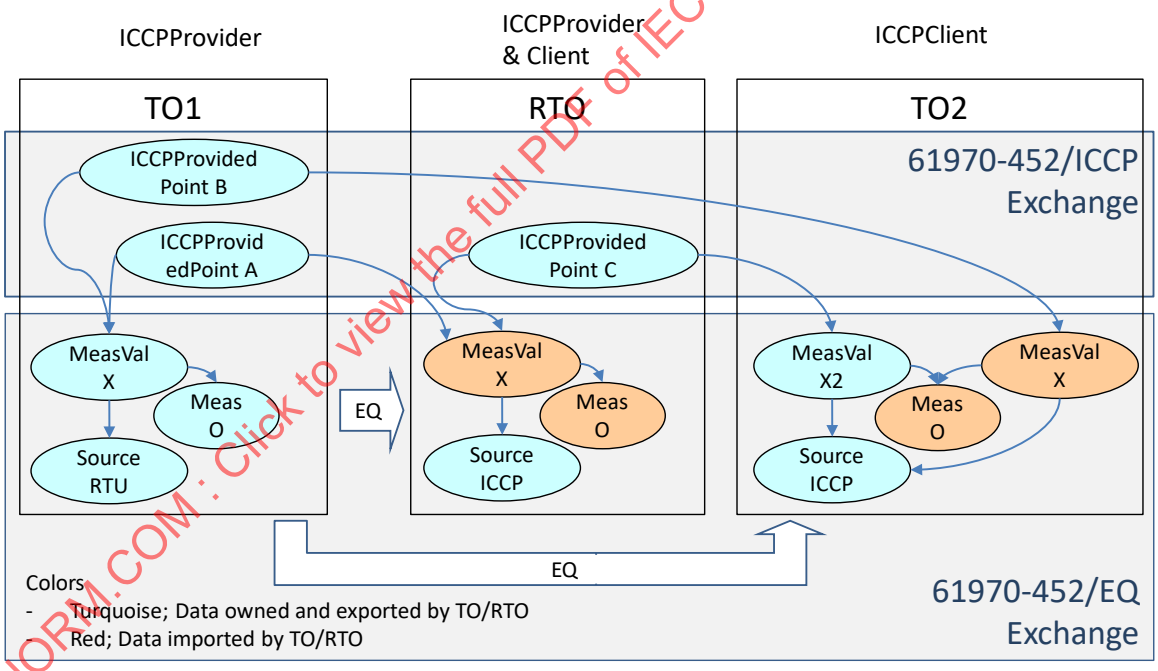


Figure 65 – Measurement value provider and consumer example

TO1 and RTO are control centres where TO1 provide the measurement value MeasVal X to an RTO and TO2. TO2 may get the measurement value MeasVal X directly from TO1 or indirectly from the RTO. Indirect exchange as between the RTO and TO2 may not be allowed even though it is technically possible.

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4.5.15.2 Information Model

ICCP (known officially as IEC 61870-6 TASE.2) data is exchanged using the Measurement classes (Analog, Discrete, and Accumulator), the MeasurementValue classes (AnalogValue, DiscreteValue, and AccumulatorValue), and the MeasurementValueSource class. The MeasurementValueSource class is used to define the control centre supplying the ICCP data. The MeasurementValueSource must be associated with an instance of Name where the attribute Name.name holds the name of the supplying control centre. The instance of NameType associated with the control centre Name must have the NameType.name attribute set to “ICCP Provider ID”.

The MeasurementValue classes are used to specify the ICCP ID. The MeasurementValue must be associated with an instance of Name where the attribute Name.name holds the ICCP ID. The instance of NameType associated with the ICCP ID Name must have the NameType.name attribute set to “ICCP ID”. The MeasurementValue.name attribute holds the SCADA point name. Each MeasurementValue will be associated with one Measurement.

Each MeasurementValue being supplied via ICCP must also have an association to a MeasurementValueSource.

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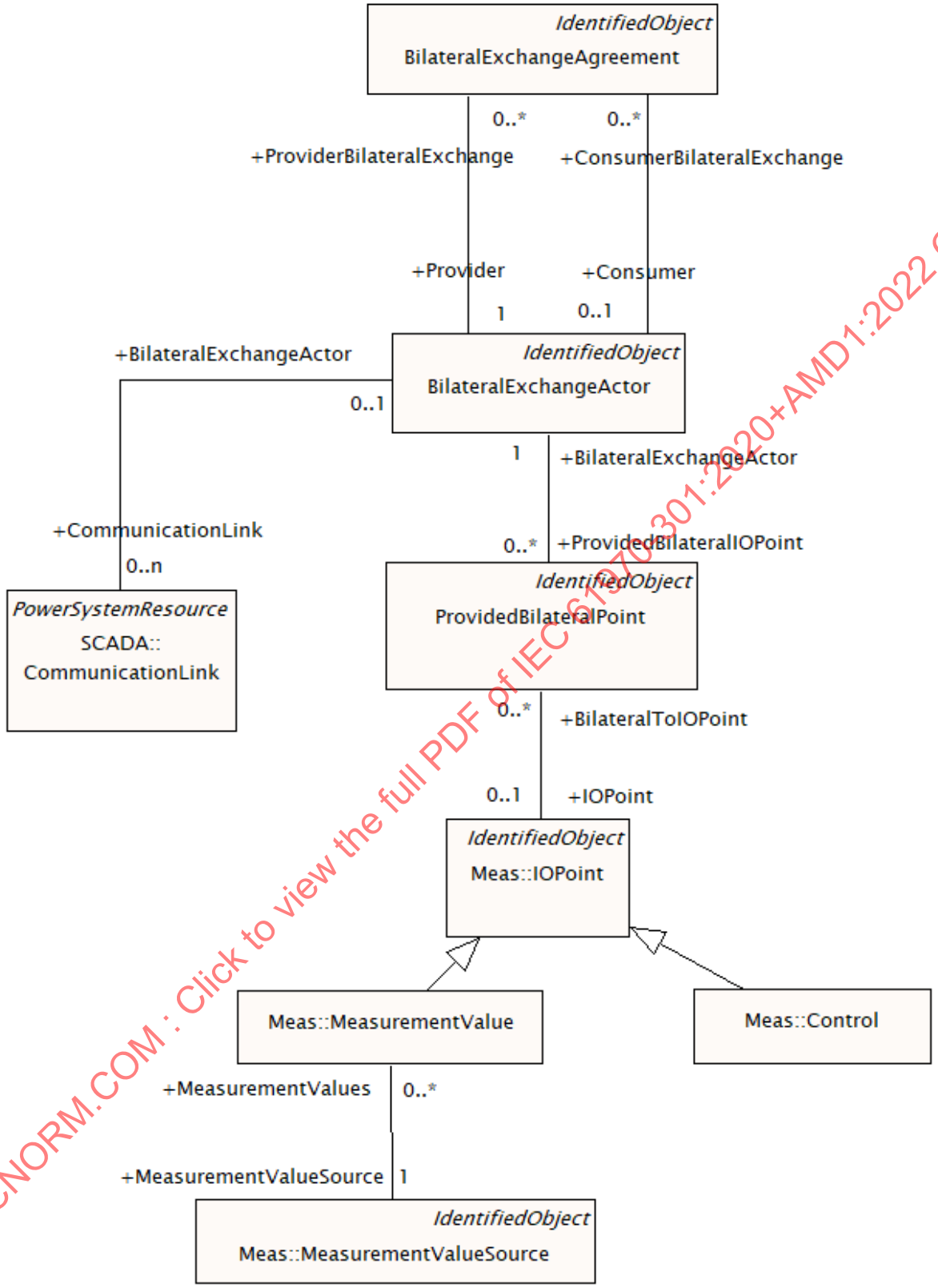


Figure 66 – Generalized bilateral exchange agreement data model

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The data model in Figure 66 is generalized to any bilateral exchange. It describes the actors in such an exchange with BilateralExchangeActor. Two types of actors exist:

- Providers that may also be consumers
- Consumers only

Providers offer IOPoint-s that are available for exchange, currently MeasurementValue-s and Controls. The availability of data is described by BilateralExchangeAgreement. A BilateralExchangeAgreement has two BilateralExchangeActor-s referenced by BilateralExchangeAgreement.Provider and BilateralExchangeAgreement.Consumer. The actor referenced by BilateralExchangeAgreement.Provider is always a provider but may also be a consumer. The actor referenced by BilateralExchangeAgreement.Consumer is always a consumer but may also be a provider. In the case that the actor referenced by BilateralExchangeAgreement.Consumer is also a provider means that the actor referenced by BilateralExchangeAgreement.Provider is also a consumer such that the data exchange is bidirectional for this BilateralExchangeAgreement. A bidirectional exchange between two actors can also be achieved with two one way BilateralExchangeAgreement-s where one of the BilateralExchangeAgreement-s have one actor as provider only and the other as consumer only, this is reversed in the other BilateralExchangeAgreement.

Data provided by a BilateralExchangeActor is described by ProvidedBilateralPoint that represents a many to many relation between the BilateralExchangeActor and IOPoint. IOPoint is a base class for MeasurementValue and Control and provides the association between measurements and ICCP points described by the class ProvidedBilateralPoint.

In the case where network models are exchanged as IEC 61970-452/EQ CIMXML files the ProvidedBilateralPoint.IOPont reference gives the IOPoint such that IOPoint identifiers (mRIDs) and names are known by a consumer. Based on this a consumer can select the whole or a subset of the provided IOPoint-s for exchange over ICCP. This is an internal decision on the consumer side and need not be exchanged as configuration data.

In the case where network models are not exchanged as IEC 61970-452/EQ CIMXML files the ProvidedBilateralPoint.IOPont reference is unspecified and the IOPoint identifiers (mRIDs) and names are unknown by a consumer. The ProvidedBilateralPoint name is then used as the commonly agreed ICCP name. The power industry has established rules for ICCP names that should be followed when used.

UML for ICCP bilateral exchange agreement is shown in Figure 67.

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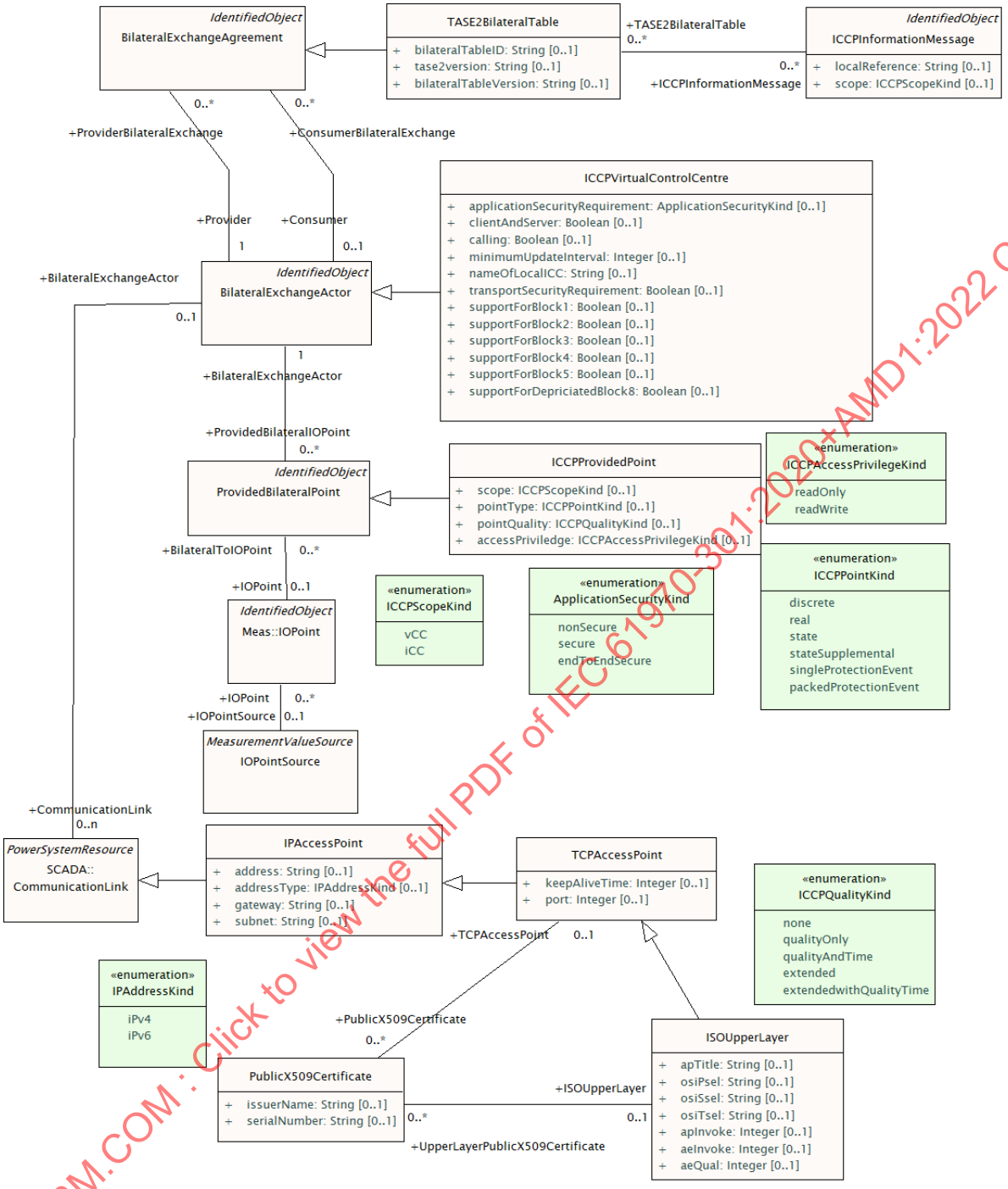


Figure 67 – ICCP bilateral exchange agreement data model

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The following subtypes from the generic data model are defined

- BilateralExchangeAgreement to TASE2BilateralTable.
- BilateralExchangeActor to ICCPVirtualControlCenter.
- ProvidedBilateralPoint to ICCPProvidedPoint.
- CommunicationLink to IPAccessPoint.

4.5.16 Feeder Model

The feeder model is used to represent “as built” feeders. Because Feeder is a type of ~~ConductingEquipment~~ ConnectivityNodeContainer, a Feeder can contain Equipment just as a Substation or VoltageLevel does. In addition to the containment association between EquipmentContainer and Equipment used for hierarchical naming purposes, there is a second association between these two classes to allow a piece of Equipment to be grouped with an additional EquipmentContainer. This modelling allows Equipment to be associated with more than one Feeder.

A Feeder can be contained by the Substation that nominally energized the feeder. One or more Terminals can also be associated with a Feeder to define the specific normal head feeding it. A Feeder can also contain a secondary distribution Substation. A secondary Substation can be associated with more than one Feeder to represent the Feeders that are normally energizing the Substation.

UML for the Feeder model is shown in Figure 68.

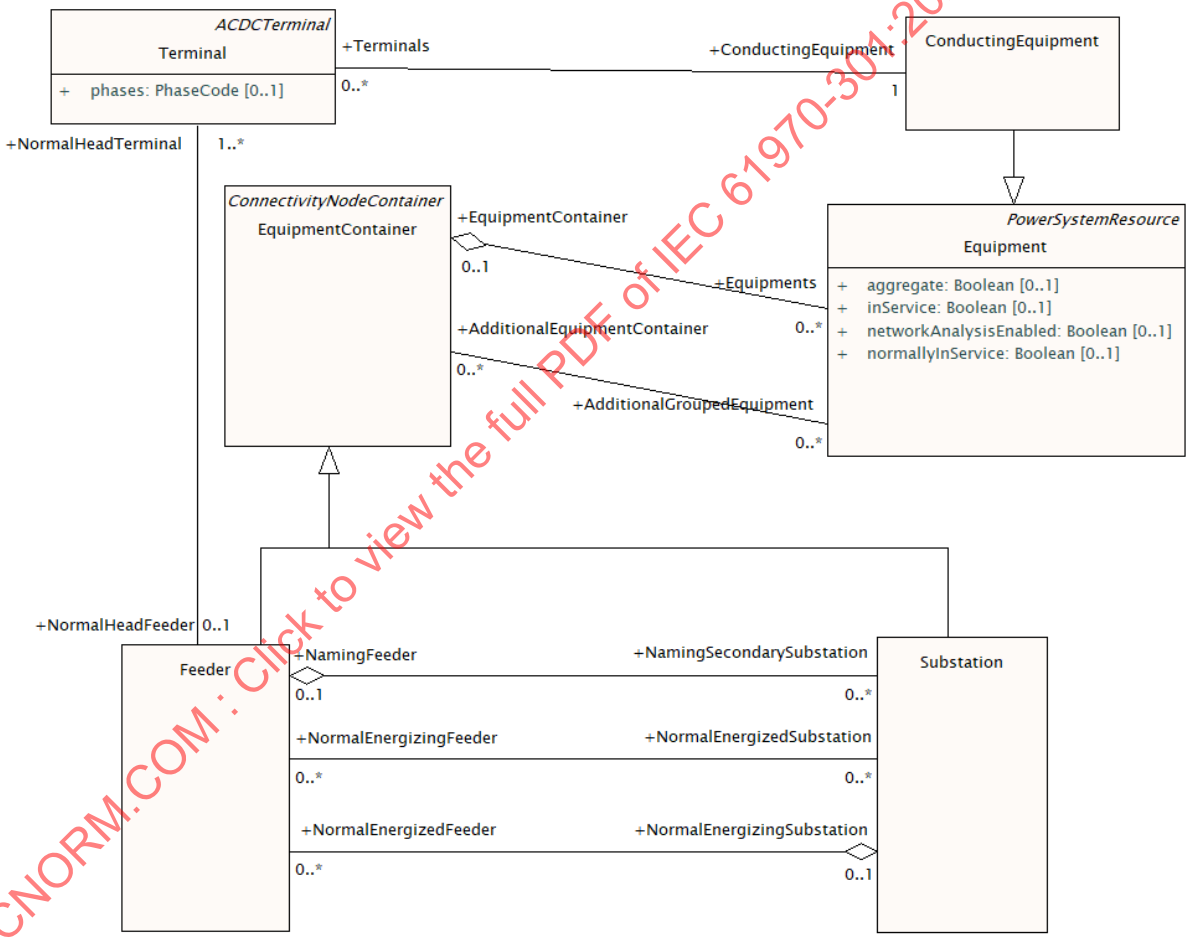


Figure 68 – Feeder data model

4.5.17 Control area modelling

Control area net interchange constraints are important for network analysis because when power flow cases are constructed, the situation to be studied almost always starts with a specification of the net load and net interchange for each control area. Control area constraints must be properly defined to correspond to the definitions for balancing authorities in the grid.Control area constraints in power flow are represented as a set of area control equality constraints of the form:

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Control Area Net Interchange = SUM (control area flow into the area on each tie)

Ties define control areas and ties must be defined such that every conducting element of the network is inside exactly one control area – in other words, control areas cover the network and do not overlap. This is also what happens in the real network, so it is natural and tie locations are usually well known. The control area net interchange is determined by summing flows in Terminals. The Terminals are identified by creating a set of TieFlow objects associated with a ControlArea object. Each TieFlow object is associated with one Terminal. An attribute of the ControlArea object specifies the net interchange (ControlArea.netInterchange).The control area orientation for net interchange is positive for an import, negative for an export. A tie between two control areas will appear in both control area specifications. It must be modelled in each such that the two representations of the tie flow sum to zero. The normal orientation of Terminal flow is positive for flow into the conducting equipment of the Terminal. (i.e. Flow from a bus into a device is positive.) However, the orientation of each flow in the control area specification must align with the control area convention, i.e. import is positive. If the orientation of the Terminal flow referenced by a TieFlow is positive into the control area, then this is confirmed by setting TieFlow.positiveFlowIn flag TRUE; if not, the orientation must be reversed by setting the TieFlow.positiveFlowIn flag FALSE.Figure 69 illustrates a simple tie, where the green arrows indicate the orientation of the Terminal flow (not the actual flow, but the direction of flow that will carry a plus sign):

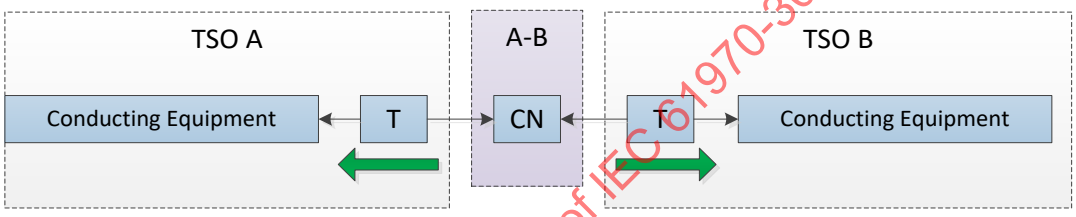


Figure 69 – Orientation of the Terminal flow

Figure 70 illustrates several ways that one can correctly describe the corresponding control area ties. The first two examples below agree on one single Terminal where both parties will measure flow. The third example chooses Terminals that are in the TSO network model so that the area control is always referencing its own network model.

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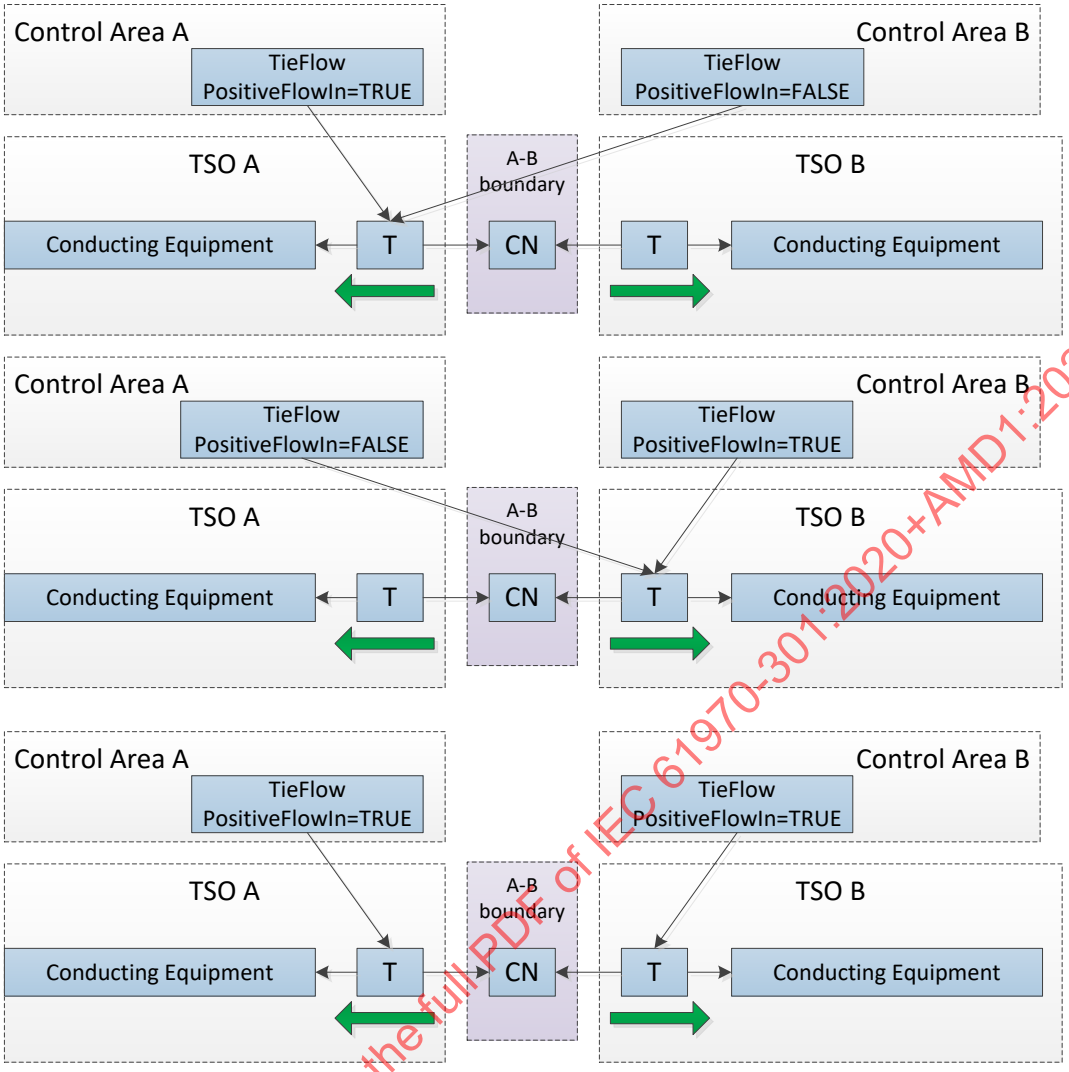


Figure 70 – Several ways to describe control area ties

4.6 Modelling guidelines

4.6.1 Modelling for change

Subclauses 4.6.2 to 4.6.5 provide guidelines on how to maintain and extend the CIM.

The CIM is meant to contain classes and attributes that will be exchanged over public interfaces between major applications. The goal is to keep, as much as possible, only the generic features from which a detailed implementation may be derived. In general, it is easier to change the value or domain of an attribute than to change a class definition. This makes the model more robust because it is able to support a broader class of requirements, and more stable because new requirements may be able to be handled without requiring changes to the model.

4.6.2 Process for amendments to the CIM

It may be desirable to amend the CIM to either revise the existing model or to extend the CIM to model additional elements of an electric utility power system. The recommended process for such amendments is as follows.

1) Prepare use case(s) and a request for change to describe the desired changes. This should include proposed changes to the appropriate class diagrams showing new/revised classes, attributes, and associations.

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2) The use case(s) and request for change are then reviewed by the appropriate IEC Working Group to decide if the requested changes should be treated as revisions to the current CIM standard, or if they should be treated as private amendments, not requiring a change to the standard itself.

3) Proposed amendments accepted by the working group will be added to a list of outstanding issues, and at the appropriate time, a new version of the CIM model will be prepared and an update made to the appropriate IEC CIM specification.

4.6.3 Changes to the CIM UML model

From a modelling perspective, when the CIM is extended, the approach is to start with the existing CIM UML model. The extensions may be added in any of several ways that are available in UML, but in all cases the approach is to inspect the current model and determine the best way to start from the existing class diagrams. The extensions may take the form of any of the following, starting from the simplest to the most complex:

- adding additional attributes to existing classes;
- adding new classes that are specializations of existing classes;
- adding new classes via associations with existing classes.

For the purpose of extending this standard, the main objective is to reuse the existing CIM to the maximum extent possible. From a packaging point of view, extensions should be made to existing packages where possible. If the extensions comprise a new domain of application, then consideration should be given to creating a new package for the additions, but still creating the necessary associations to the existing package, keeping in mind that even though a new package is being created, the CIM is still a single model.

For the purpose of creating non-standard changes to the information model, the standard CIM should be extended without modifying the standard CIM. Preferably, such extensions should be placed in new packages to both identify the changes as non-standard and to facilitate transferring changes to an updated version of the standard.

4.6.4 Changes to the CIM standards documents

From a documentation perspective, when the CIM is extended, a decision shall be made whether the changes constitute updates to existing CIM standards documents, or new IEC 61970-3x is required. In either case, the extensions will then become part of the IEC standard CIM.

4.6.5 Deprecations

The CIM model may at times contain packages, classes, attributes, or associations that have been identified as deprecated. These items will be noted in the documentation or with a UML stereotype of “deprecated”. A deprecated item is retained in the present version of the model but is expected to be removed from future versions. An item that has not been deprecated is not guaranteed to be retained in future versions, but using an item marked as deprecated should be avoided if possible.

4.6.6 CIM profiles

An implementation of the CIM need not include all classes, attributes, or associations in the standard CIM specification to be compliant with the CIM standard. Profiles may be defined to specify which elements shall be included (i.e. mandatory elements) in a particular use of the CIM, as well as which are optional. These profiles are defined in the profile documents of IEC 61970 series, as well as in other IEC series of standards that use and extend the base CIM specified in this document.

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An example is IEC 61970-452, CIM static transmission network model profiles. This profile specifies how the CIM is to be used for exchanging power system models in XML, and also specifies the mandatory and optional classes, attributes, and associations to be supported for this use of the CIM. Profiles can be maintained using a variety of tools such as the open source CIMTool[1].

4.7 Modelling tools

This CIM release was constructed using Enterprise Architect[2]. The entire CIM UML model exists as an Enterprise Architect project file and is viewable with that tool, including the class diagrams and descriptions of classes, attributes, types, and relationships. Viewing the CIM in this fashion provides a graphical navigation interface that permits all CIM specification data to be viewed via point-and-click from the class diagram in each package. A free viewer is available through Sparx Systems.

Ideally, the CIM information model is independent of any specific UML tool, though experience has shown that exchanges between different tools are often less than perfect. Until tool interoperability is proven effective, future changes to the CIM specification, resulting in new versions of this standard, will be incorporated first into the Enterprise Architect project description to ensure a single source for the CIM model data.

Clause 6 of this document was auto-generated using the open source tool jCleanCim[3], which uses the automation interfaces of Microsoft® Word[4] and Enterprise Architect and the standard IEC format and styles.

4.8 User implementation conventions

4.8.1 Conventions beyond UML

Subclause 4.8 provides recommended user conventions when using the CIM in actual system implementations.

4.8.2 Number of terminals for ConductingEquipment objects

The following ConductingEquipment classes have two terminals: ACLineSegment, DCLineSegment, DCSeriesDevice, DCSwitch (and its specializations), DCChopper, Switch and all its specializations (including Jumper, Fuse, Breaker, Disconnector, LoadBreakSwitch, and Cut), SeriesCompensator, and EquivalentBranch. The PowerTransformer class typically has two terminals but may also have one or more terminals. For example, a zig-zag connected grounding transformer may have one terminal. Three terminal transformers are commonly used in transmission systems and in special cases transformers may have four, five, or more terminals. All other ConductingEquipment leaf classes (notably also including Clamp and BusbarSection) and DCConductingEquipment have a single terminal.

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[1] Available at <~~http://www.CIMTool.org~~ https://cimug-org.github.io/CIMTool/>. CIMTool is the trade name of a product supplied by the Free Software Foundation. This information is given for the convenience of users of this document and does not constitute an endorsement by IEC of the product named. Equivalent products may be used if they can be shown to lead to the same results.

[2] Enterprise Architect is the trade name of a product supplied by Sparx Systems. This information is given for the convenience of users of this document and does not constitute an endorsement by IEC of the product named. Equivalent products may be used if they can be shown to lead to the same results.

[3] Available at <http://tanjakostic.org/jcleancim>. JCleanCim is the trade name of a product supplied by the Free Software Foundation. This information is given for the convenience of users of this document and does not constitute an endorsement by IEC of the product named. Equivalent products may be used if they can be shown to lead to the same results.

[4] Word is the trade name of a product supplied by Microsoft. This information is given for the convenience of users of this document and does not constitute an endorsement by IEC of the product named. Equivalent products may be used if they can be shown to lead to the same results.

4.8.3 Nominal quantities

Many network model equipment attributes express nominal quantities. The following principles apply to those attributes.

- Nominal quantities are not related to the equipment but to the system nominal voltage in the grid.
- Rated quantities such as ratedU are related to the nameplate data.

4.8.4 Datatypes

W3C XML Schema Definition Language (XSD) 1.1 Part 2: Datatypes allows use of the following special values: INF, NaN to express quantities such as positive infinity, negative infinity, and not a number. CIM data types in general and the primitive Float are restricted not to use INF and NaN, if not explicitly allowed in a description of an attribute.

4.9 CIM modelling examples

Power system models have been created from the CIM UML model in various ways. The first example is an RDF (Resource Description Framework) Schema version of the CIM, which uses XML (eXtensible Markup Language) to describe a power system network model. IEC 61970-501 and other profile standards in development are used to specify the model exchange format. RDF Schema versions of the CIM have been used to create XML model files of actual networks for purposes of interoperability testing. An RDF Schema version of the CIM is generated from the CIM UML model file using software tools based on the RDF Schema specification of the CIM.

It should be noted that an RDF schema version of the CIM is still metadata rather than an instantiation of an actual network. However, complete network model files with descriptions of all network elements and their electrical connectivity can be generated by system suppliers using proprietary export tools, and then imported by other systems via a similar import tool, which is used to populate a local network engineering tool database.

5 Detailed model

5.1 Overview

The part of the common information model (CIM) covered by IEC 61970-301 represents a comprehensive logical view of information exchanged between various systems in electrical utilities. This definition includes the public classes and attributes, as well as the relationships between them.

5.2 Context

The CIM is partitioned into subpackages. Classes within the packages are listed in the order they are defined in the UML model. Native class attributes are listed first, followed by inherited attributes in order of depth of inheritance. Native associations are listed first for each class, followed by inherited associations in order of depth of inheritance, then alphabetically by association end name. The associations are described according to the role of each class participating in the association. The association ends are listed under the class at each end of an association.

Figure 71 shows the top level packages included in this document.

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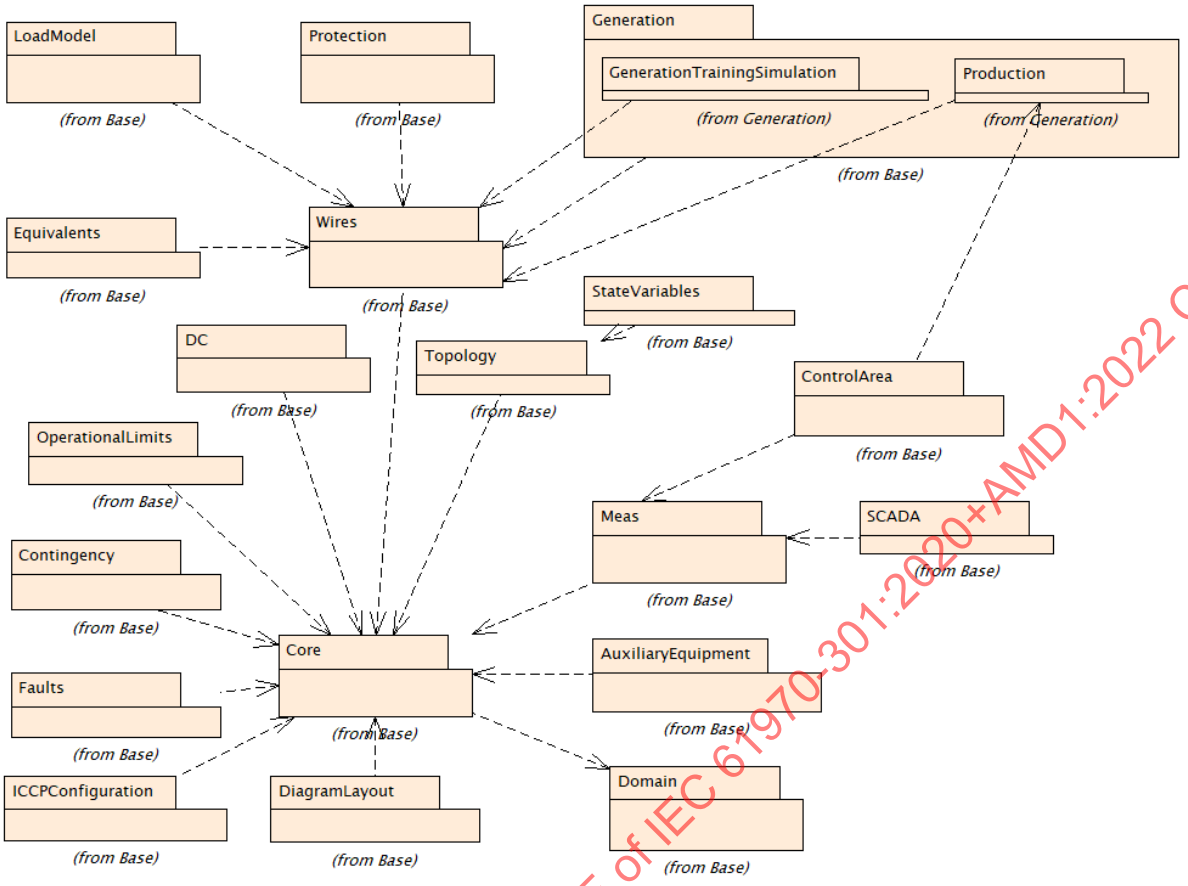


Figure 71 – CIM top level packages

For each package, the model information for each class is fully described. Attribute and association end information for native and inherited attributes is listed as in Table 8 and Table 9 for an example class named “Class1” in example package “Package1”. For any inherited attributes or association ends the “description” column will contain text indicating the attributes is inherited from a specific class. In this example we assume Class1 inherits from class IdentifiedObject. The description column for native attributes and association ends contains the actual description. For inherited attributes, the base class is noted in the description and the full attribute documentation is available in that base class as a native attribute.

Table 8 – Attributes of Package1::Class1

name	type	description
native1	Float	A floating point native attribute of the class is described here.
native2	ActivePower	Documentation for another native attribute of type ActivePower.
name	String	Inherited from: IdentifiedObject

For cases where an attribute is a constant, Table 8 will add the phrase “(const)” to the name column. In such cases, the attribute normally has an initial value also which is preceded by an equal sign and appended to the attribute name.

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Table 9 – Association ends of Package1::Class1 with other classes

[mult from]	[mult to] name	type	description
[0..*]	[0..1] Class2	Class2	The description of the association end to another class named “Class1”. Note it is typical, but not required, that the association end is the same as the referenced type. This association end may reference zero or one objects. The other end of the association may reference any number of Class1 instances.
[0..1]	[0..*] SecondClass2	Class2	The description of references to class named “Class2”. In this case any number of references may be made. The reverse reference may reference zero or one Class1 instances.
[1..1]	[0..*] Class3	Class3	References any number of Class3 instances. The reverse reference shall reference only one instance of Class1.
[0..*]	[0..*] Class4	Class4	A many to many association.
[0..1]	[0..*] DiagramObjects	DiagramObject	inherited from: IdentifiedObject
[1..1]	[0..*] Names	Name	inherited from: IdentifiedObject

In Table 9, the first column describes the multiplicity at this end of the association (i.e. how this class participates in association). Second column describes the other association end. Its multiplicity is included in brackets. The association end name is listed in plain text. The class at the other end of the association is in the third column. A multiplicity of zero indicates an optional association. A multiplicity of “*” indicates any number is allowed. For example, a multiplicity of [1..*] indicates a range from 1 to any larger number is allowed.

In the case that a class is an enumeration named “Enumeration1”, the attributes table is replaced by the literals documentation as shown in Table 10 since enumeration literals have no type. There are no inherited enumeration literals for an enumeration class.

Table 10 – Literals of Package1::Enumeration1

literal	description
native1	This is the first native enumeration value.
native2	This is the second native enumeration value.
native3	There are typically no inherited attributes for enumerations.

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6 Package Base

6.1 General

[nsuri = http://iec.ch/TC57/CIM100#, nsprefix = cim]

Content of the base CIM published as IEC 61970-301.

6.2 Package Domain

6.2.1 General

The domain package defines primitive datatypes that are used by classes in other packages. Stereotypes are used to describe the datatypes. The following stereotypes are defined:

- <<enumeration>> A list of permissible constant values.
- <<Primitive>> The most basic data types used to compose all other data types.
- <<CIMDatatype>> A datatype that contains a value attribute, an optional unit of measure and a unit multiplier. The unit and multiplier may be specified as a static variable initialized to the allowed value.
- <<Compound>> A composite of Primitive, enumeration, CIMDatatype or other Compound classes, as long as the Compound classes do not recurse.

For all datatypes both positive and negative values are allowed unless stated otherwise for a particular datatype.

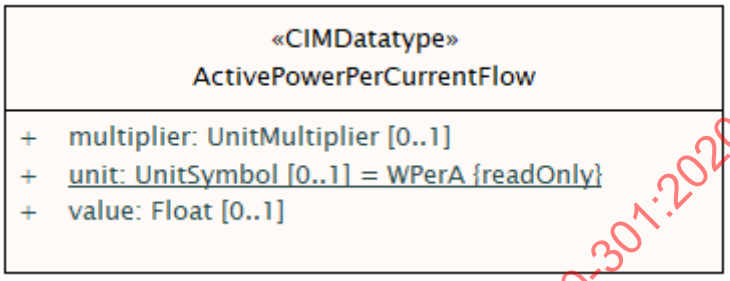


Figure 72 – Class diagram Domain::CombinedElectricalDatatypes

Figure 72: This diagram shows electrical datatypes that are combinations of other electrical datatypes.

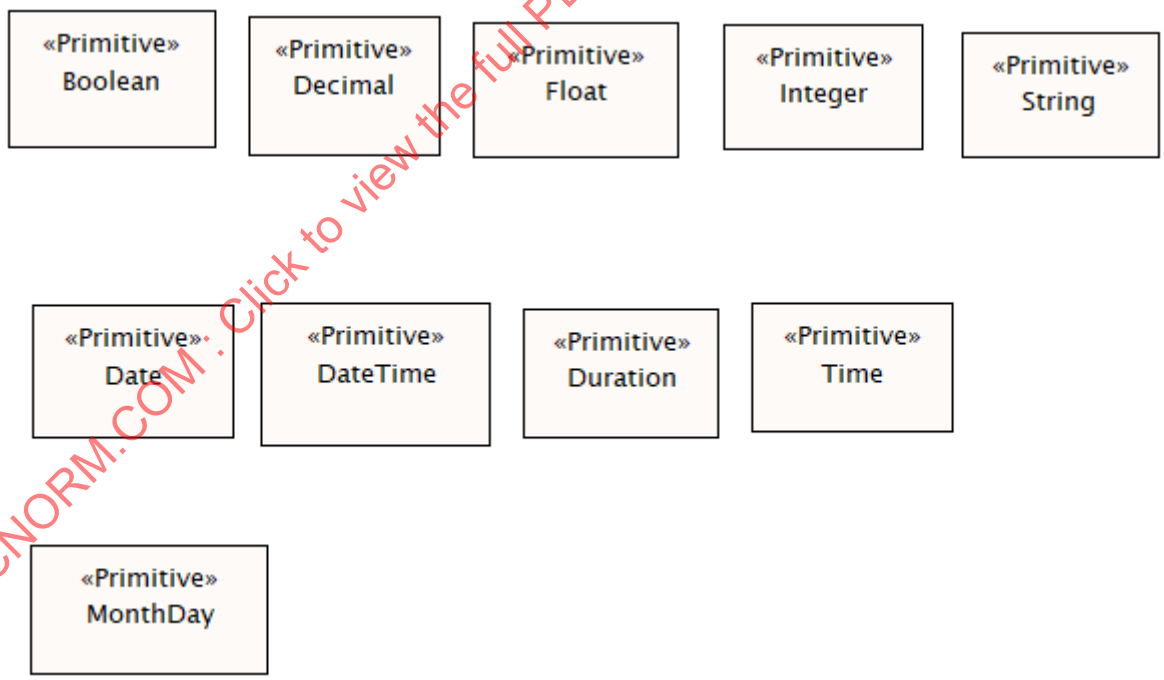
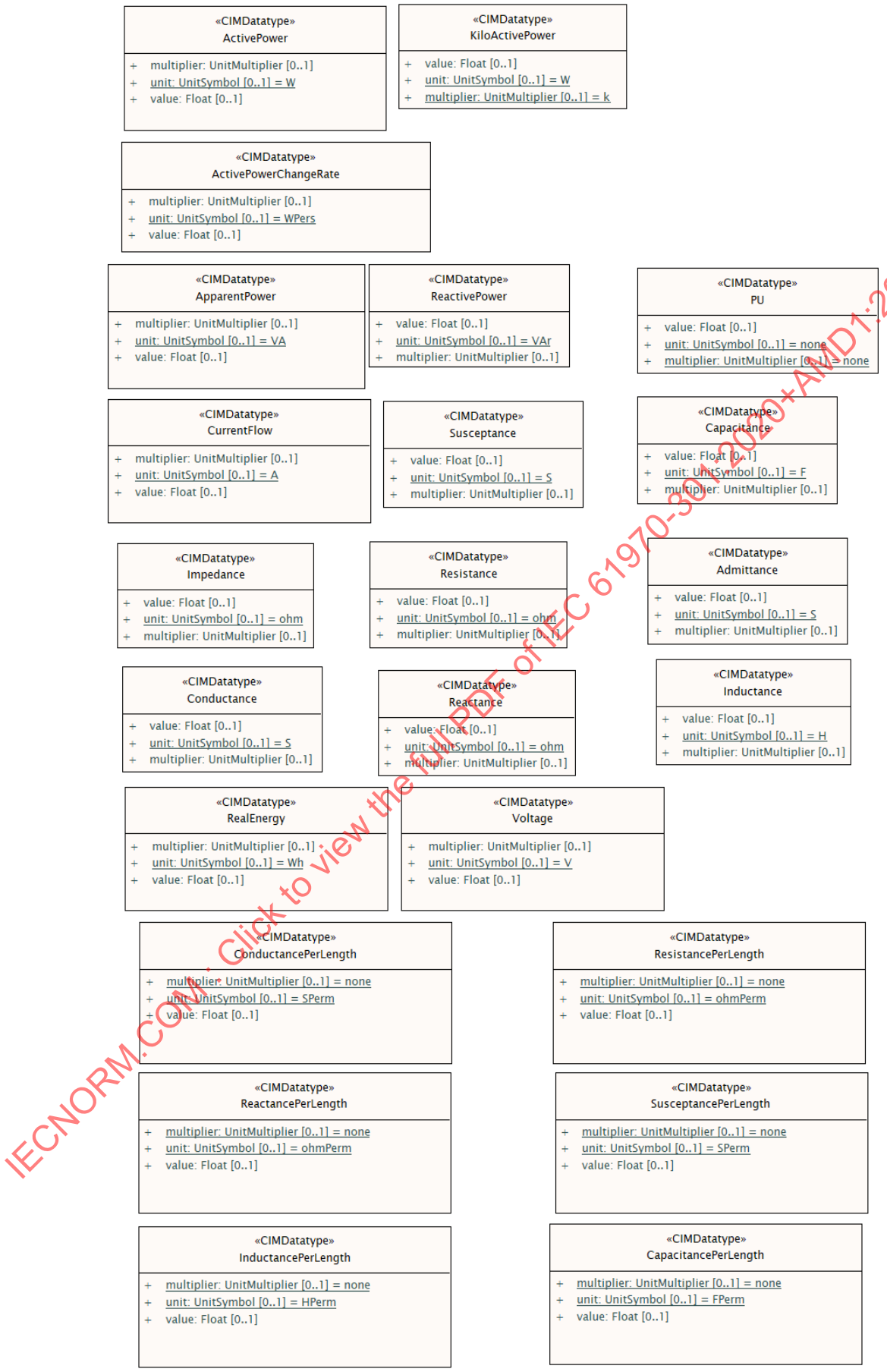


Figure 73 – Class diagram Domain::BasicDatatypes

Figure 73: This diagram shows basic datatypes that are the basis for all other datatypes.

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Figure 74 – Class diagram Domain::ElectricityDatatypes

Figure 74: This diagram shows electricity related data types.

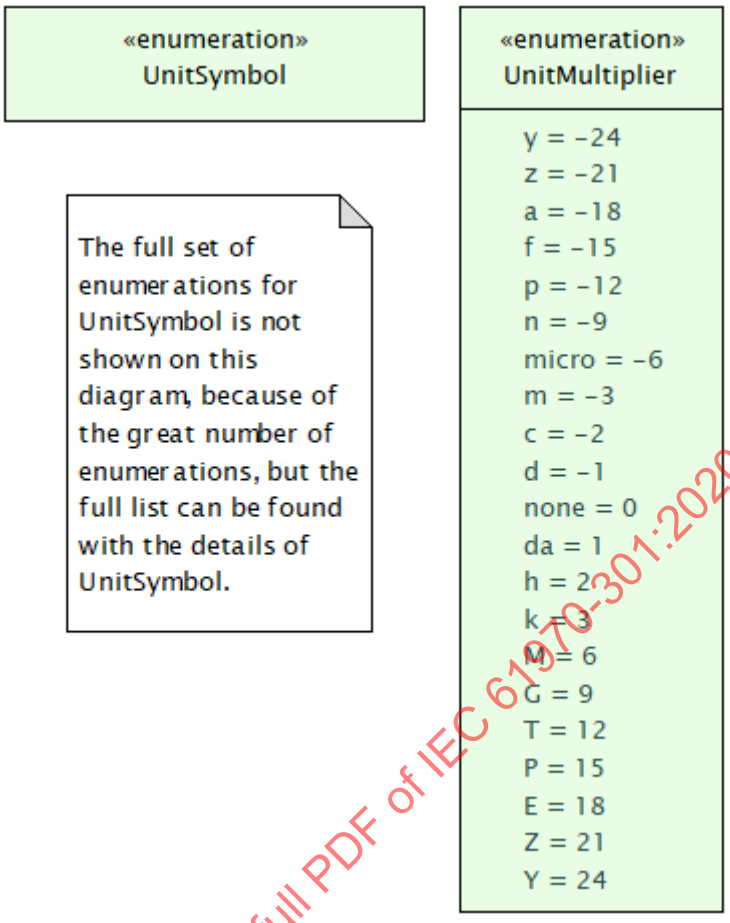
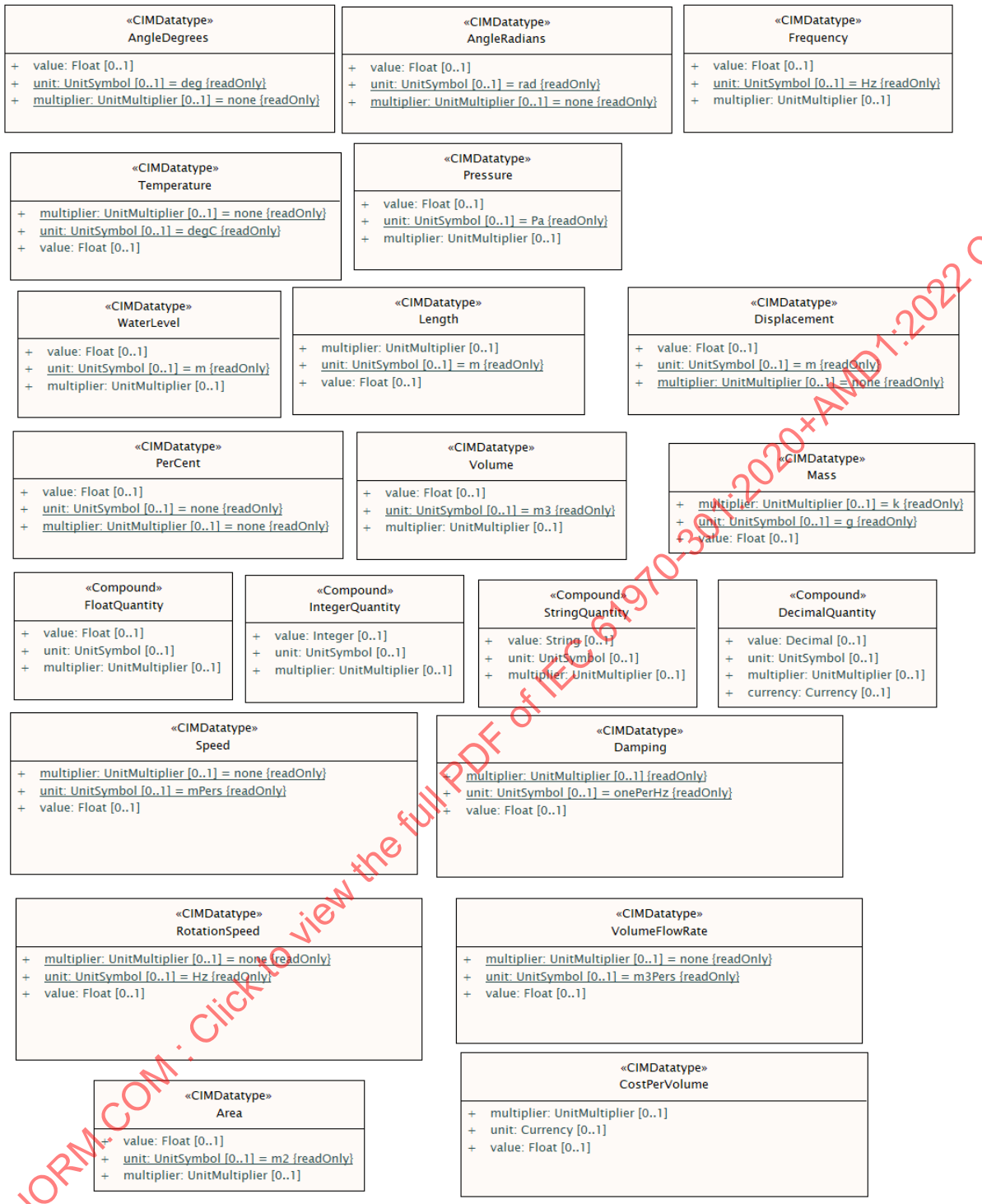


Figure 75 – Class diagram Domain::EnumeratedUnitDatatypes

Figure 75: This diagram shows enumerated data types related to the SI unit system.

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Figure 76 – Class diagram Domain::GeneralDatatypes

Figure 76: This diagram shows general data types.

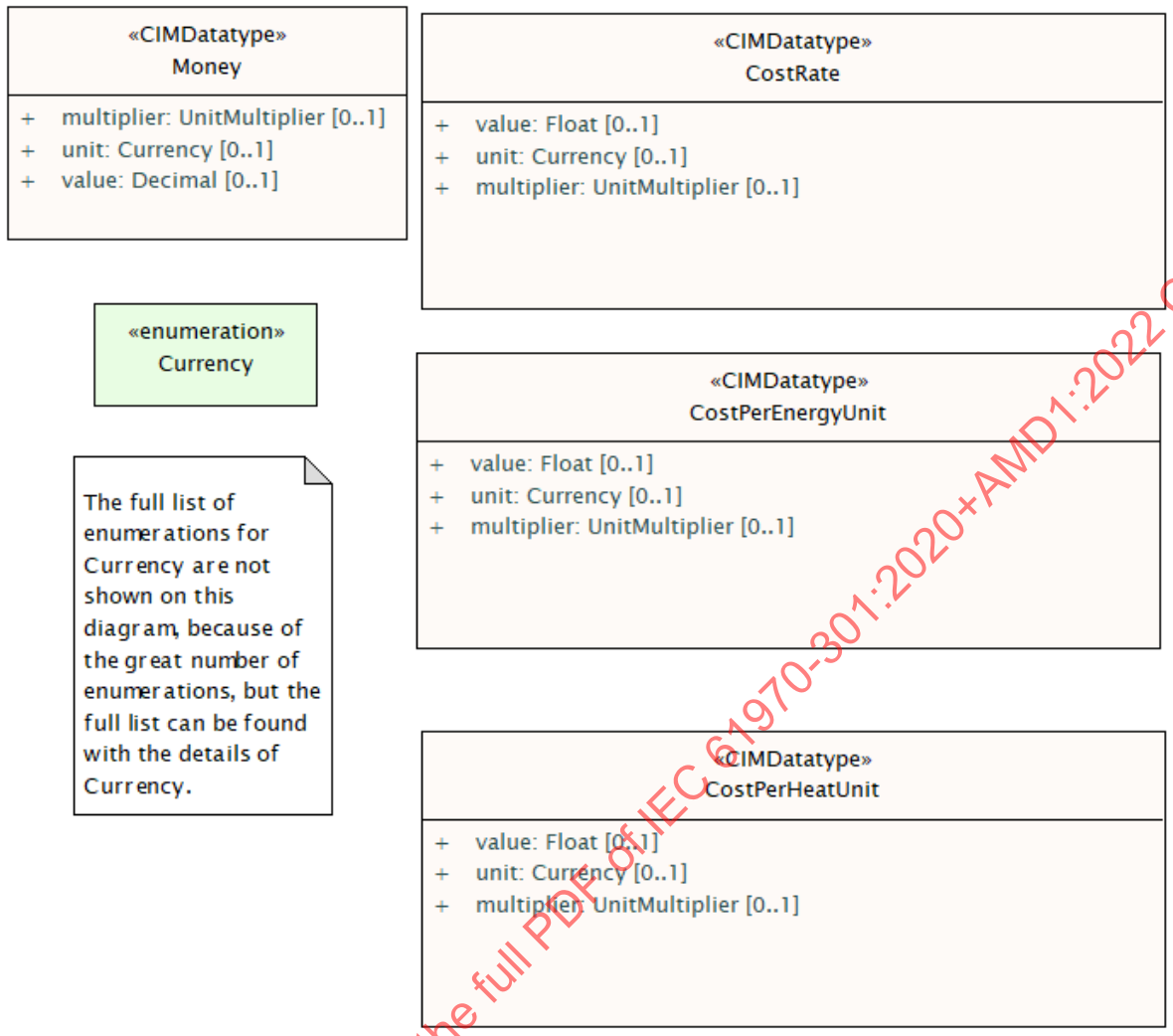


Figure 77 – Class diagram Domain::MonetaryDatatypes

Figure 77: This diagram shows monetary related data types.

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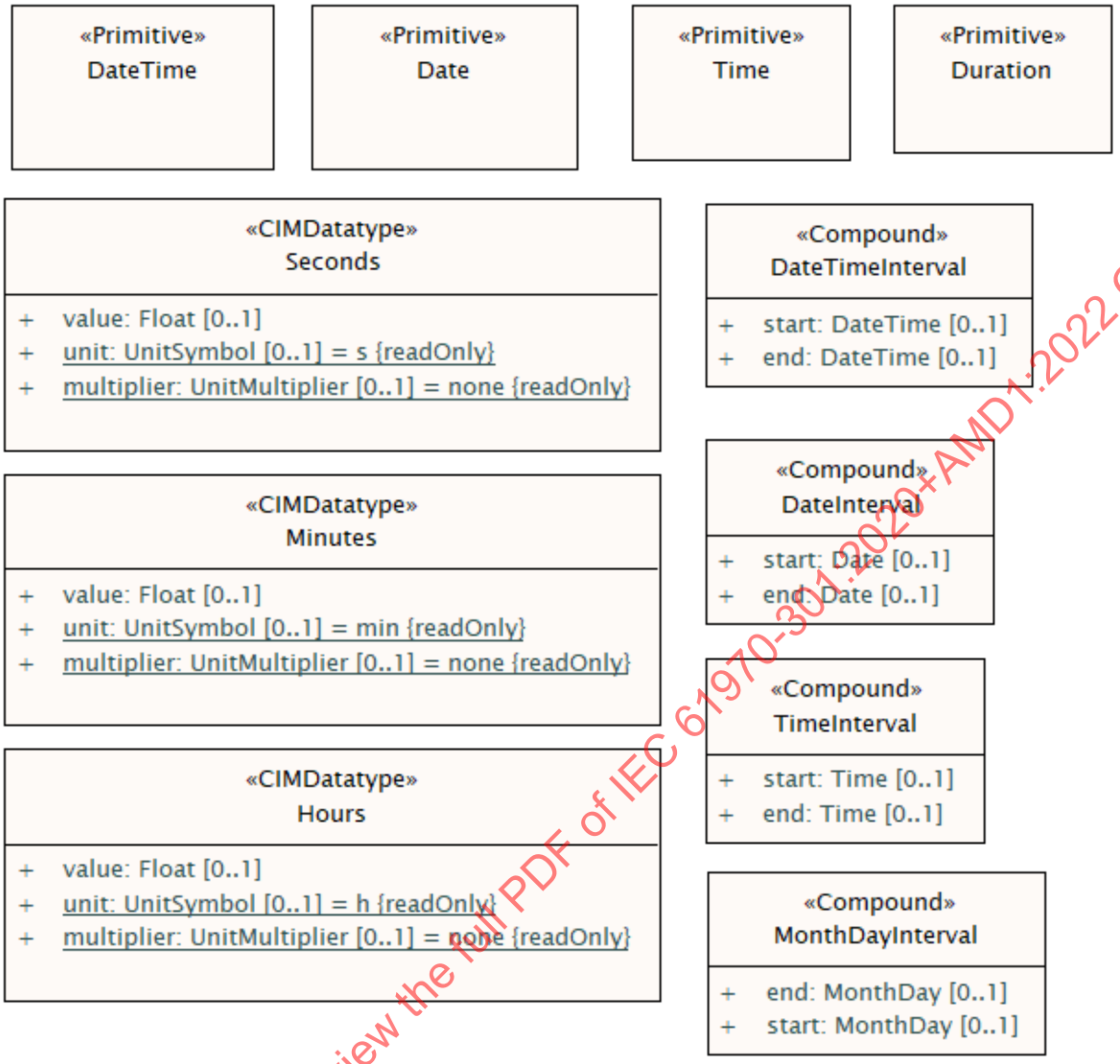


Figure 78 – Class diagram Domain::TimeDatatypes

Figure 78: This diagram shows time related data types.

6.2.2 ActivePower datatype

Product of RMS value of the voltage and the RMS value of the in-phase component of the current.

Table 11 shows all attributes of ActivePower.

Table 11 – Attributes of Domain::ActivePower

name	mult	type	description
multiplier	0..1	UnitMultiplier	
unit	0..1	UnitSymbol	(const=W)
value	0..1	Float	

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6.2.3 ActivePowerChangeRate datatype

Rate of change of active power per time.

Table 12 shows all attributes of ActivePowerChangeRate.

Table 12 – Attributes of Domain::ActivePowerChangeRate

name	mult	type	description
multiplier	0..1	UnitMultiplier	
unit	0..1	UnitSymbol	(const=WPers)
value	0..1	Float	

6.2.4 ActivePowerPerCurrentFlow datatype

Active power variation with current flow.

Table 13 shows all attributes of ActivePowerPerCurrentFlow.

Table 13 – Attributes of Domain::ActivePowerPerCurrentFlow

name	mult	type	description
multiplier	0..1	UnitMultiplier	
unit	0..1	UnitSymbol	(const=WPerA)
value	0..1	Float	

6.2.5 ActivePowerPerFrequency datatype

Active power variation with frequency.

Table 14 shows all attributes of ActivePowerPerFrequency.

Table 14 – Attributes of Domain::ActivePowerPerFrequency

name	mult	type	description
multiplier	0..1	UnitMultiplier	
unit	0..1	UnitSymbol	(const=WPers)
value	0..1	Float	

6.2.6 Admittance datatype

Ratio of current to voltage.

Table 15 shows all attributes of Admittance.

Table 15 – Attributes of Domain::Admittance

name	mult	type	description
value	0..1	Float	
unit	0..1	UnitSymbol	(const=S)
multiplier	0..1	UnitMultiplier	

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6.2.7 AngleDegrees datatype

Measurement of angle in degrees.

Table 16 shows all attributes of AngleDegrees.

Table 16 – Attributes of Domain::AngleDegrees

name	mult	type	description
value	0..1	Float	
unit	0..1	UnitSymbol	(const=deg)
multiplier	0..1	UnitMultiplier	(const=none)

6.2.8 AngleRadians datatype

Phase angle in radians.

Table 17 shows all attributes of AngleRadians.

Table 17 – Attributes of Domain::AngleRadians

name	mult	type	description
value	0..1	Float	
unit	0..1	UnitSymbol	(const=rad)
multiplier	0..1	UnitMultiplier	(const=none)

6.2.9 ApparentPower datatype

Product of the RMS value of the voltage and the RMS value of the current.

Table 18 shows all attributes of ApparentPower.

Table 18 – Attributes of Domain::ApparentPower

name	mult	type	description
multiplier	0..1	UnitMultiplier	
unit	0..1	UnitSymbol	(const=VA)
value	0..1	Float	

6.2.10 Area datatype

Area.

Table 19 shows all attributes of Area.

Table 19 – Attributes of Domain::Area

name	mult	type	description
value	0..1	Float	
unit	0..1	UnitSymbol	(const=m2)
multiplier	0..1	UnitMultiplier	

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6.2.11 Boolean primitive

A type with the value space "true" and "false".

6.2.12 Capacitance datatype

Capacitive part of reactance (imaginary part of impedance), at rated frequency.

Table 20 shows all attributes of Capacitance.

Table 20 – Attributes of Domain::Capacitance

name	mult	type	description
value	0..1	Float	
unit	0..1	UnitSymbol	(const=F)
multiplier	0..1	UnitMultiplier	

6.2.13 CapacitancePerLength datatype

Capacitance per unit of length.

Table 21 shows all attributes of CapacitancePerLength.

Table 21 – Attributes of Domain::CapacitancePerLength

name	mult	type	description
multiplier	0..1	UnitMultiplier	(const=none)
unit	0..1	UnitSymbol	(const=FPerm)
value	0..1	Float	

6.2.14 Classification datatype

Classification of level. Specify as 1..n, with 1 being the most detailed, highest priority, etc as described on the attribute using this data type.

Table 22 shows all attributes of Classification.

Table 22 – Attributes of Domain::Classification

name	mult	type	description
value	0..1	Integer	
unit	0..1	UnitSymbol	(const=none)
multiplier	0..1	UnitMultiplier	(const=none)

6.2.15 Conductance datatype

Factor by which voltage must be multiplied to give corresponding power lost from a circuit. Real part of admittance.

Table 23 shows all attributes of Conductance.

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Table 23 – Attributes of Domain::Conductance

name	mult	type	description
value	0..1	Float	
unit	0..1	UnitSymbol	(const=S)
multiplier	0..1	UnitMultiplier	

6.2.16 ConductancePerLength datatype

Real part of admittance per unit of length.

Table 24 shows all attributes of ConductancePerLength.

Table 24 – Attributes of Domain::ConductancePerLength

name	mult	type	description
multiplier	0..1	UnitMultiplier	(const=none)
unit	0..1	UnitSymbol	(const=SPerm)
value	0..1	Float	

6.2.17 CostPerEnergyUnit datatype

Cost, in units of currency, per quantity of electrical energy generated.

Table 25 shows all attributes of CostPerEnergyUnit.

Table 25 – Attributes of Domain::CostPerEnergyUnit

name	mult	type	description
value	0..1	Float	
unit	0..1	Currency	
multiplier	0..1	UnitMultiplier	

6.2.18 CostPerHeatUnit datatype

Cost, in units of currency, per quantity of heat generated.

Table 26 shows all attributes of CostPerHeatUnit.

Table 26 – Attributes of Domain::CostPerHeatUnit

name	mult	type	description
value	0..1	Float	
unit	0..1	Currency	
multiplier	0..1	UnitMultiplier	

6.2.19 CostPerVolume datatype

Cost per unit volume.

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Table 27 shows all attributes of CostPerVolume.

Table 27 – Attributes of Domain::CostPerVolume

name	mult	type	description
multiplier	0..1	UnitMultiplier	
unit	0..1	Currency	
value	0..1	Float	

6.2.20 CostRate datatype

Cost, in units of currency, per elapsed time.

Table 28 shows all attributes of CostRate.

Table 28 – Attributes of Domain::CostRate

name	mult	type	description
value	0..1	Float	
unit	0..1	Currency	
multiplier	0..1	UnitMultiplier	

6.2.21 Currency enumeration

Monetary currencies. ISO 4217 standard including 3-character currency code.

Table 29 shows all literals of Currency.

Table 29 – Literals of Domain::Currency

literal	value	description
AED	784	United Arab Emirates dirham.
AFN	971	Afghan afghani.
ALL	008	Albanian lek.
AMD	051	Armenian dram.
ANG	532	Netherlands Antillean guilder.
AOA	973	Angolan kwanza.
ARS	032	Argentine peso.
AUD	036	Australian dollar.
AWG	533	Aruban florin.
AZN	944	Azerbaijani manat.
BAM	977	Bosnia and Herzegovina convertible mark.
BBD	052	Barbados dollar.
BDT	050	Bangladeshi taka.
BGN	975	Bulgarian lev.
BHD	048	Bahraini dinar.
BIF	108	Burundian franc.
BMD	060	Bermudian dollar (customarily known as Bermuda dollar).

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literal	value	description
BND	096	Brunei dollar.
BOB	068	Boliviano.
BOV	984	Bolivian Mvdol (funds code).
BRL	986	Brazilian real.
BSD	044	Bahamian dollar.
BTN	064	Bhutanese ngultrum.
BWP	072	Botswana pula.
BYR	974	Belarusian ruble.
BZD	084	Belize dollar.
CAD	124	Canadian dollar.
CDF	976	Congolese franc.
CHF	756	Swiss franc.
CLF	990	Unidad de Fomento (funds code), Chile.
CLP	152	Chilean peso.
CNY	156	Chinese yuan.
COP	170	Colombian peso.
COU	970	Unidad de Valor Real.
CRC	188	Costa Rican colon.
CUC	931	Cuban convertible peso.
CUP	192	Cuban peso.
CVE	132	Cape Verde escudo.
CZK	203	Czech koruna.
DJF	262	Djiboutian franc.
DKK	208	Danish krone.
DOP	214	Dominican peso.
DZD	012	Algerian dinar.
EEK	233	Estonian kroon.
EGP	818	Egyptian pound.
ERN	232	Eritrean nakfa.
ETB	230	Ethiopian birr.
EUR	978	Euro.
FJD	242	Fiji dollar.
FKP	238	Falkland Islands pound.
GBP	826	Pound sterling.
GEL	981	Georgian lari.
GHS	936	Ghanaian cedi.
GIP	929	Gibraltar pound.
GMD	270	Gambian dalasi.
GNF	324	Guinean franc.
GTQ	320	Guatemalan quetzal.
GYD	328	Guyanese dollar.
HKD	344	Hong Kong dollar.
HNL	340	Honduran lempira.
HRK	191	Croatian kuna.

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literal	value	description
HTG	332	Haitian gourde.
HUF	348	Hungarian forint.
IDR	360	Indonesian rupiah.
ILS	376	Israeli new sheqel.
INR	356	Indian rupee.
IQD	368	Iraqi dinar.
IRR	364	Iranian rial.
ISK	352	Icelandic króna.
JMD	388	Jamaican dollar.
JOD	400	Jordanian dinar.
JPY	392	Japanese yen.
KES	404	Kenyan shilling.
KGS	417	Kyrgyzstani som.
KHR	116	Cambodian riel.
KMF	174	Comoro franc.
KPW	408	North Korean won.
KRW	410	South Korean won.
KWD	414	Kuwaiti dinar.
KYD	136	Cayman Islands dollar.
KZT	398	Kazakhstani tenge.
LAK	418	Lao kip.
LBP	422	Lebanese pound.
LKR	144	Sri Lanka rupee.
LRD	430	Liberian dollar.
LSL	426	Lesotho loti.
LTL	440	Lithuanian litas.
LVL	428	Latvian lats.
LYD	434	Libyan dinar.
MAD	504	Moroccan dirham.
MDL	498	Moldovan leu.
MGA	969	Malagasy ariary.
MKD	807	Macedonian denar.
MMK	104	Myanma kyat.
MNT	496	Mongolian tugrik.
MOP	446	Macanese pataca.
MRO	478	Mauritanian ouguiya.
MUR	480	Mauritian rupee.
MVR	462	Maldivian rufiyaa.
MWK	454	Malawian kwacha.
MXN	484	Mexican peso.
MYR	458	Malaysian ringgit.
MZN	943	Mozambican metical.
NAD	516	Namibian dollar.
NGN	566	Nigerian naira.

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literal	value	description
NIO	558	Cordoba oro.
NOK	578	Norwegian krone.
NPR	524	Nepalese rupee.
NZD	554	New Zealand dollar.
OMR	512	Omani rial.
PAB	590	Panamanian balboa.
PEN	604	Peruvian nuevo sol.
PGK	598	Papua New Guinean kina.
PHP	608	Philippine peso.
PKR	586	Pakistani rupee.
PLN	985	Polish zloty.
PYG	600	Paraguayan guaraní.
QAR	634	Qatari rial.
RON	946	Romanian new leu.
RSD	941	Serbian dinar.
RUB	643	Russian rouble.
RWF	646	Rwandan franc.
SAR	682	Saudi riyal.
SBD	090	Solomon Islands dollar.
SCR	690	Seychelles rupee.
SDG	938	Sudanese pound.
SEK	752	Swedish krona/kronor.
SGD	702	Singapore dollar.
SHP	654	Saint Helena pound.
SLL	694	Sierra Leonean leone.
SOS	706	Somali shilling.
SRD	968	Surinamese dollar.
STD	678	São Tomé and Príncipe dobra.
SYP	760	Syrian pound.
SZL	748	Lilangeni.
THB	764	Thai baht.
TJS	972	Tajikistani somoni.
TMT	934	Turkmenistani manat.
TND	788	Tunisian dinar.
TOP	776	Tongan pa'anga.
TRY	949	Turkish lira.
TTD	780	Trinidad and Tobago dollar.
TWD	901	New Taiwan dollar.
TZS	834	Tanzanian shilling.
UAH	980	Ukrainian hryvnia.
UGX	800	Ugandan shilling.
USD	840	United States dollar.
UYU	858	Uruguayan peso.
UZS	860	Uzbekistan som.

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literal	value	description
VEF	937	Venezuelan bolívar fuerte.
VND	704	Vietnamese Dong.
VUV	548	Vanuatu vatu.
WST	882	Samoan tala.
XAF	950	CFA franc BEAC.
XCD	951	East Caribbean dollar.
XOF	952	CFA Franc BCEAO.
XPF	953	CFP franc.
YER	886	Yemeni rial.
ZAR	710	South African rand.
ZMK	894	Zambian kwacha.
ZWL	932	Zimbabwe dollar.

6.2.22 CurrentFlow datatype

Electrical current with sign convention: positive flow is out of the conducting equipment into the connectivity node. Can be both AC and DC.

Table 30 shows all attributes of CurrentFlow.

Table 30 – Attributes of Domain::CurrentFlow

name	mult	type	description
multiplier	0..1	UnitMultiplier	
unit	0..1	UnitSymbol	(const=A)
value	0..1	Float	

6.2.23 Damping datatype

Per-unit active power variation with frequency referenced on the system apparent power base. Typical values are in the range 1,0 – 2,0.

Table 31 shows all attributes of Damping.

Table 31 – Attributes of Domain::Damping

name	mult	type	description
multiplier	0..1	UnitMultiplier	
unit	0..1	UnitSymbol	(const=onePerHz)
value	0..1	Float	

6.2.24 Date primitive

Date as "yyyy-mm-dd", which conforms with ISO 8601. UTC time zone is specified as "yyyy-mm-ddZ". A local timezone relative UTC is specified as "yyyy-mm-dd(+/-)hh:mm".

6.2.25 DateInterval compound

Interval between two dates.

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Table 32 shows all attributes of DateInterval.

Table 32 – Attributes of Domain::DateInterval

name	mult	type	description
start	0..1	Date	Start date of this interval.
end	0..1	Date	End date of this interval.

6.2.26 DateTime primitive

Date and time as "yyyy-mm-ddThh:mm:ss.sss", which conforms with ISO 8601. UTC time zone is specified as "yyyy-mm-ddThh:mm:ss.sssZ". A local timezone relative UTC is specified as "yyyy-mm-ddThh:mm:ss.sss-hh:mm". The second component (shown here as "ss.sss") could have any number of digits in its fractional part to allow any kind of precision beyond seconds.

6.2.27 DateTimeInterval compound

Interval between two date and time points, where the interval includes the start time but excludes end time.

Table 33 shows all attributes of DateTimeInterval.

Table 33 – Attributes of Domain::DateTimeInterval

name	mult	type	description
start	0..1	DateTime	Start date and time of this interval. The start date and time is included in the defined interval.
end	0..1	DateTime	End date and time of this interval. The end date and time where the interval is defined up to, but excluded.

6.2.28 Decimal primitive

Decimal is the base-10 notational system for representing real numbers.

6.2.29 DecimalQuantity compound

Quantity with decimal value and associated unit or currency information.

Table 34 shows all attributes of DecimalQuantity.

Table 34 – Attributes of Domain::DecimalQuantity

name	mult	type	description
value	0..1	Decimal	Value of this quantity.
unit	0..1	UnitSymbol	Unit of this quantity.
multiplier	0..1	UnitMultiplier	Unit multiplier of this quantity.
currency	0..1	Currency	Currency of this quantity.

6.2.30 Displacement datatype

Unit of displacement relative to a reference position, hence can be negative.

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Table 35 shows all attributes of Displacement.

Table 35 – Attributes of Domain::Displacement

name	mult	type	description
value	0..1	Float	
unit	0..1	UnitSymbol	(const=m)
multiplier	0..1	UnitMultiplier	(const=none)

6.2.31 Duration primitive

Duration as "PnYnMnDTnHnMnS" which conforms to ISO 8601, where nY expresses a number of years, nM a number of months, nD a number of days. The letter T separates the date expression from the time expression and, after it, nH identifies a number of hours, nM a number of minutes and nS a number of seconds. The number of seconds could be expressed as a decimal number, but all other numbers are integers.

6.2.32 Emission datatype

Quantity of emission per fuel heat content.

Table 36 shows all attributes of Emission.

Table 36 – Attributes of Domain::Emission

name	mult	type	description
multiplier	0..1	UnitMultiplier	(const=none)
unit	0..1	UnitSymbol	(const=kgPerJ)
value	0..1	Float	

6.2.33 Float primitive

A floating point number. The range is unspecified and not limited.

6.2.34 FloatQuantity compound

Quantity with float value and associated unit information.

Table 37 shows all attributes of FloatQuantity.

Table 37 – Attributes of Domain::FloatQuantity

name	mult	type	description
value	0..1	Float	Value of this quantity.
unit	0..1	UnitSymbol	Unit of this quantity.
multiplier	0..1	UnitMultiplier	Unit multiplier of this quantity.

6.2.35 Frequency datatype

Cycles per second.

Table 38 shows all attributes of Frequency.

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Table 38 – Attributes of Domain::Frequency

name	mult	type	description
value	0..1	Float	
unit	0..1	UnitSymbol	(const=Hz)
multiplier	0..1	UnitMultiplier	

6.2.36 HeatRate datatype

Heat generated, in energy per time unit of elapsed time.

Table 39 shows all attributes of HeatRate.

Table 39 – Attributes of Domain::HeatRate

name	mult	type	description
unit	0..1	UnitSymbol	(const=J)
value	0..1	Float	
multiplier	0..1	UnitMultiplier	

6.2.37 Hours datatype

Time specified in hours.

Table 40 shows all attributes of Hours.

Table 40 – Attributes of Domain::Hours

name	mult	type	description
value	0..1	Float	
unit	0..1	UnitSymbol	(const=h)
multiplier	0..1	UnitMultiplier	(const=none)

6.2.38 Impedance datatype

Ratio of voltage to current.

Table 41 shows all attributes of Impedance.

Table 41 – Attributes of Domain::Impedance

name	mult	type	description
value	0..1	Float	
unit	0..1	UnitSymbol	(const=ohm)
multiplier	0..1	UnitMultiplier	

6.2.39 Inductance datatype

Inductive part of reactance (imaginary part of impedance), at rated frequency.

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Table 42 shows all attributes of Inductance.

Table 42 – Attributes of Domain::Inductance

name	mult	type	description
value	0..1	Float	
unit	0..1	UnitSymbol	(const=H)
multiplier	0..1	UnitMultiplier	

6.2.40 InductancePerLength datatype

Inductance per unit of length.

Table 43 shows all attributes of InductancePerLength.

Table 43 – Attributes of Domain::InductancePerLength

name	mult	type	description
multiplier	0..1	UnitMultiplier	(const=none)
unit	0..1	UnitSymbol	(const=HPerm)
value	0..1	Float	

6.2.41 Integer primitive

An integer number. The range is unspecified and not limited.

6.2.42 IntegerQuantity compound

Quantity with integer value and associated unit information.

Table 44 shows all attributes of IntegerQuantity.

Table 44 – Attributes of Domain::IntegerQuantity

name	mult	type	description
value	0..1	Integer	Value of this quantity.
unit	0..1	UnitSymbol	Unit of this quantity.
multiplier	0..1	UnitMultiplier	Unit multiplier of this quantity.

6.2.43 KiloActivePower datatype

Active power in kilowatts.

Table 45 shows all attributes of KiloActivePower.

Table 45 – Attributes of Domain::KiloActivePower

name	mult	type	description
value	0..1	Float	
unit	0..1	UnitSymbol	(const=W)
multiplier	0..1	UnitMultiplier	(const=k)

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6.2.44 Length datatype

Unit of length. It shall be a positive value or zero.

Table 46 shows all attributes of Length.

Table 46 – Attributes of Domain::Length

name	mult	type	description
multiplier	0..1	UnitMultiplier	
unit	0..1	UnitSymbol	(const=m)
value	0..1	Float	

6.2.45 Mass datatype

Mass.

Table 47 shows all attributes of Mass.

Table 47 – Attributes of Domain::Mass

name	mult	type	description
multiplier	0..1	UnitMultiplier	(const=k)
unit	0..1	UnitSymbol	(const=g)
value	0..1	Float	

6.2.46 Minutes datatype

Time in minutes.

Table 48 shows all attributes of Minutes.

Table 48 – Attributes of Domain::Minutes

name	mult	type	description
value	0..1	Float	
unit	0..1	UnitSymbol	(const=min)
multiplier	0..1	UnitMultiplier	(const=none)

6.2.47 Money datatype

Amount of money.

Table 49 shows all attributes of Money.

Table 49 – Attributes of Domain::Money

name	mult	type	description
multiplier	0..1	UnitMultiplier	
unit	0..1	Currency	
value	0..1	Decimal	

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6.2.48 MonthDay primitive

MonthDay format as "--mm-dd", which conforms with XSD data type gMonthDay.

6.2.49 MonthDayInterval compound

Interval between two times specified as month and day.

Table 50 shows all attributes of MonthDayInterval.

Table 50 – Attributes of Domain::MonthDayInterval

name	mult	type	description
end	0..1	MonthDay	End time of this interval.
start	0..1	MonthDay	Start time of this interval.

6.2.50 PU datatype

Per Unit – a positive or negative value referred to a defined base. Values typically range from -10 to +10.

Table 51 shows all attributes of PU.

Table 51 – Attributes of Domain::PU

name	mult	type	description
value	0..1	Float	
unit	0..1	UnitSymbol	(const=none)
multiplier	0..1	UnitMultiplier	(const=none)

6.2.51 PerCent datatype

Percentage on a defined base. For example, specify as 100 to indicate at the defined base.

Table 52 shows all attributes of PerCent.

Table 52 – Attributes of Domain::PerCent

name	mult	type	description
value	0..1	Float	Normally 0 to 100 on a defined base.
unit	0..1	UnitSymbol	(const=none)
multiplier	0..1	UnitMultiplier	(const=none)

6.2.52 Pressure datatype

Pressure in pascals.

Table 53 shows all attributes of Pressure.

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Table 53 – Attributes of Domain::Pressure

name	mult	type	description
value	0..1	Float	
unit	0..1	UnitSymbol	(const=Pa)
multiplier	0..1	UnitMultiplier	

6.2.53 Reactance datatype

Reactance (imaginary part of impedance), at rated frequency.

Table 54 shows all attributes of Reactance.

Table 54 – Attributes of Domain::Reactance

name	mult	type	description
value	0..1	Float	
unit	0..1	UnitSymbol	(const=ohm)
multiplier	0..1	UnitMultiplier	

6.2.54 ReactancePerLength datatype

Reactance (imaginary part of impedance) per unit of length, at rated frequency.

Table 55 shows all attributes of ReactancePerLength.

Table 55 – Attributes of Domain::ReactancePerLength

name	mult	type	description
multiplier	0..1	UnitMultiplier	(const=none)
unit	0..1	UnitSymbol	(const=ohmPerm)
value	0..1	Float	

6.2.55 ReactivePower datatype

Product of RMS value of the voltage and the RMS value of the quadrature component of the current.

Table 56 shows all attributes of ReactivePower.

Table 56 – Attributes of Domain::ReactivePower

name	mult	type	description
value	0..1	Float	
unit	0..1	UnitSymbol	(const=VAr)
multiplier	0..1	UnitMultiplier	

6.2.56 RealEnergy datatype

Real electrical energy.

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Table 57 shows all attributes of RealEnergy.

Table 57 – Attributes of Domain::RealEnergy

name	mult	type	description
multiplier	0..1	UnitMultiplier	
unit	0..1	UnitSymbol	(const=Wh)
value	0..1	Float	

6.2.57 Resistance datatype

Resistance (real part of impedance).

Table 58 shows all attributes of Resistance.

Table 58 – Attributes of Domain::Resistance

name	mult	type	description
value	0..1	Float	
unit	0..1	UnitSymbol	(const=ohm)
multiplier	0..1	UnitMultiplier	

6.2.58 ResistancePerLength datatype

Resistance (real part of impedance) per unit of length.

Table 59 shows all attributes of ResistancePerLength.

Table 59 – Attributes of Domain::ResistancePerLength

name	mult	type	description
multiplier	0..1	UnitMultiplier	(const=none)
unit	0..1	UnitSymbol	(const=ohmPerm)
value	0..1	Float	

6.2.59 RotationSpeed datatype

Number of revolutions per second.

Table 60 shows all attributes of RotationSpeed.

Table 60 – Attributes of Domain::RotationSpeed

name	mult	type	description
multiplier	0..1	UnitMultiplier	(const=none)
unit	0..1	UnitSymbol	(const=Hz)
value	0..1	Float	

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6.2.60 Seconds datatype

Time, in seconds.

Table 61 shows all attributes of Seconds.

Table 61 – Attributes of Domain::Seconds

name	mult	type	description
value	0..1	Float	Time, in seconds
unit	0..1	UnitSymbol	(const=s)
multiplier	0..1	UnitMultiplier	(const=none)

6.2.61 Speed datatype

Distance per unit of time.

Table 62 shows all attributes of Speed.

Table 62 – Attributes of Domain::Speed

name	mult	type	description
multiplier	0..1	UnitMultiplier	(const=none)
unit	0..1	UnitSymbol	(const=mPers)
value	0..1	Float	

6.2.62 String primitive

A string consisting of a sequence of characters. The character encoding is UTF-8. The string length is unspecified and unlimited.

6.2.63 StringQuantity compound

Quantity with string value (when it is not important whether it is an integral or a floating point number) and associated unit information.

Table 63 shows all attributes of StringQuantity.

Table 63 – Attributes of Domain::StringQuantity

name	mult	type	description
value	0..1	String	Value of this quantity.
unit	0..1	UnitSymbol	Unit of this quantity.
multiplier	0..1	UnitMultiplier	Unit multiplier of this quantity.

6.2.64 Susceptance datatype

Imaginary part of admittance.

Table 64 shows all attributes of Susceptance.

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Table 64 – Attributes of Domain::Susceptance

name	mult	type	description
value	0..1	Float	
unit	0..1	UnitSymbol	(const=S)
multiplier	0..1	UnitMultiplier	

6.2.65 SusceptancePerLength datatype

Imaginary part of admittance per unit of length.

Table 65 shows all attributes of SusceptancePerLength.

Table 65 – Attributes of Domain::SusceptancePerLength

name	mult	type	description
multiplier	0..1	UnitMultiplier	(const=none)
unit	0..1	UnitSymbol	(const=SPerm)
value	0..1	Float	

6.2.66 Temperature datatype

Value of temperature in degrees Celsius.

Table 66 shows all attributes of Temperature.

Table 66 – Attributes of Domain::Temperature

name	mult	type	description
multiplier	0..1	UnitMultiplier	(const=none)
unit	0..1	UnitSymbol	(const=degC)
value	0..1	Float	

6.2.67 Time primitive

Time as "hh:mm:ss.sss", which conforms with ISO 8601. UTC time zone is specified as "hh:mm:ss.sssZ". A local timezone relative UTC is specified as "hh:mm:ss.sss±hh:mm". The second component (shown here as "ss.sss") could have any number of digits in its fractional part to allow any kind of precision beyond seconds.

6.2.68 TimeInterval compound

Interval between two times.

Table 67 shows all attributes of TimeInterval.

Table 67 – Attributes of Domain::TimeInterval

name	mult	type	description
start	0..1	Time	Start time of this interval.
end	0..1	Time	End time of this interval.

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6.2.69 UnitMultiplier enumeration

The unit multipliers defined for the CIM. When applied to unit symbols, the unit symbol is treated as a derived unit. Regardless of the contents of the unit symbol text, the unit symbol shall be treated as if it were a single-character unit symbol. Unit symbols should not contain multipliers, and it should be left to the multiplier to define the multiple for an entire data type.

For example, if a unit symbol is "m2Pers" and the multiplier is "k", then the value is k(m**2/s), and the multiplier applies to the entire final value, not to any individual part of the value. This can be conceptualized by substituting a derived unit symbol for the unit type. If one imagines that the symbol "Þ" represents the derived unit "m2Pers", then applying the multiplier "k" can be conceptualized simply as "kÞ".

For example, the SI unit for mass is "kg" and not "g". If the unit symbol is defined as "kg", then the multiplier is applied to "kg" as a whole and does not replace the "k" in front of the "g". In this case, the multiplier of "m" would be used with the unit symbol of "kg" to represent one gram. As a text string, this violates the instructions in IEC 80000-1. However, because the unit symbol in CIM is treated as a derived unit instead of as an SI unit, it makes more sense to conceptualize the "kg" as if it were replaced by one of the proposed replacements for the SI mass symbol. If one imagines that the "kg" were replaced by a symbol "Þ", then it is easier to conceptualize the multiplier "m" as creating the proper unit "mÞ", and not the forbidden unit "mkg".

Table 68 shows all literals of UnitMultiplier.

Table 68 – Literals of Domain::UnitMultiplier

literal	value	description
y	-24	Yocto 10**-24.
z	-21	Zepto 10**-21.
a	-18	Atto 10**-18.
f	-15	Femto 10**-15.
p	-12	Pico 10**-12.
n	-9	Nano 10**-9.
micro	-6	Micro 10**-6.
m	-3	Milli 10**-3.
c	-2	Centi 10**-2.
d	-1	Deci 10**-1.
none	0	No multiplier or equivalently multiply by 1.
da	1	Deca 10**1.
h	2	Hecto 10**2.
k	3	Kilo 10**3.
M	6	Mega 10**6.
G	9	Giga 10**9.
T	12	Tera 10**12.
P	15	Peta 10**15.
E	18	Exa 10**18.
Z	21	Zetta 10**21.
Y	24	Yotta 10**24.

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6.2.70 UnitSymbol enumeration

The derived units defined for usage in the CIM. In some cases, the derived unit is equal to an SI unit. Whenever possible, the standard derived symbol is used instead of the formula for the derived unit. For example, the unit symbol Farad is defined as "F" instead of "CPerV". In cases where a standard symbol does not exist for a derived unit, the formula for the unit is used as the unit symbol. For example, density does not have a standard symbol and so it is represented as "kgPerm3". With the exception of the "kg", which is an SI unit, the unit symbols do not contain multipliers and therefore represent the base derived unit to which a multiplier can be applied as a whole.

Every unit symbol is treated as an unparseable text as if it were a single-letter symbol. The meaning of each unit symbol is defined by the accompanying descriptive text and not by the text contents of the unit symbol.

To allow the widest possible range of serializations without requiring special character handling, several substitutions are made which deviate from the format described in IEC 80000-1. The division symbol "/" is replaced by the letters "Per". Exponents are written in plain text after the unit as "m3" instead of being formatted as "m" with a superscript of 3 or introducing a symbol as in "m^3". The degree symbol "°" is replaced with the letters "deg". Any clarification of the meaning for a substitution is included in the description for the unit symbol.

Non-SI units are included in list of unit symbols to allow sources of data to be correctly labelled with their non-SI units (for example, a GPS sensor that is reporting numbers that represent feet instead of meters). This allows software to use the unit symbol information correctly convert and scale the raw data of those sources into SI-based units.

The integer values are used for harmonization with IEC 61850.

Table 69 shows all literals of UnitSymbol.

Table 69 – Literals of Domain::UnitSymbol

literal	value	description
none	0	Dimension less quantity, e.g. count, per unit, etc.
m	2	Length in metres.
kg	3	Mass in kilograms. Note: multiplier “k” is included in this unit symbol for compatibility with IEC 61850-7-3.
s	4	Time in seconds.
A	5	Current in amperes.
K	6	Temperature in kelvins.
mol	7	Amount of substance in moles.
cd	8	Luminous intensity in candelas.
deg	9	Plane angle in degrees.
rad	10	Plane angle in radians (m/m).
sr	11	Solid angle in steradians (m^2/m^2).
Gy	21	Absorbed dose in grays (J/kg).
Bq	22	Radioactivity in becquerels (1/s).
degC	23	Relative temperature in degrees Celsius. In the SI unit system the symbol is °C. Electric charge is measured in coulomb that has the unit symbol C. To distinguish degree Celsius from coulomb the symbol used in the UML is degC. The reason for not using °C is that the special character ° is difficult to manage in software.

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literal	value	description
Sv	24	Dose equivalent in sieverts (J/kg).
F	25	Electric capacitance in farads (C/V).
C	26	Electric charge in coulombs (A·s).
S	27	Conductance in siemens.
H	28	Electric inductance in henrys (Wb/A).
V	29	Electric potential in volts (W/A).
ohm	30	Electric resistance in ohms (V/A).
J	31	Energy in joules (N·m = C·V = W·s).
N	32	Force in newtons (kg·m/s^2).
Hz	33	Frequency in hertz (1/s).
lx	34	Illuminance in lux (lm/m^2).
lm	35	Luminous flux in lumens (cd·sr).
Wb	36	Magnetic flux in webers (V·s).
T	37	Magnetic flux density in teslas (Wb/m^2).
W	38	Real power in watts (J/s). Electrical power may have real and reactive components. The real portion of electrical power (I^{2}R or VIcos(phi)), is expressed in Watts. See also apparent power and reactive power.
Pa	39	Pressure in pascals (N/m^2). Note: the absolute or relative measurement of pressure is implied with this entry. See below for more explicit forms.
m2	41	Area in square metres (m^2).
m3	42	Volume in cubic metres (m^3).
mPers	43	Velocity in metres per second (m/s).
mPers2	44	Acceleration in metres per second squared (m/s^2).
m3Pers	45	Volumetric flow rate in cubic metres per second (m^3/s).
mPerm3	46	Fuel efficiency in metres per cubic metres (m/m^3).
kgm	47	Moment of mass in kilogram metres (kg·m) (first moment of mass). Note: multiplier “k” is included in this unit symbol for compatibility with IEC 61850-7-3.
kgPerm3	48	Density in kilogram/cubic metres (kg/m^3). Note: multiplier “k” is included in this unit symbol for compatibility with IEC 61850-7-3.
m2Pers	49	Viscosity in square metres / second (m^2/s).
WPermK	50	Thermal conductivity in watt/metres kelvin.
JPerK	51	Heat capacity in joules/kelvin.
ppm	52	Concentration in parts per million.
rotPers	53	Rotations per second (1/s). See also Hz (1/s).
radPers	54	Angular velocity in radians per second (rad/s).
WPerm2	55	Heat flux density, irradiance, watts per square metre.
JPerm2	56	Insulation energy density, joules per square metre or watt second per square metre.
SPerm	57	Conductance per length (F/m).

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literal	value	description
KPers	58	Temperature change rate in kelvins per second.
PaPers	59	Pressure change rate in pascals per second.
JPerkgK	60	Specific heat capacity, specific entropy, joules per kilogram Kelvin.
VA	61	Apparent power in volt amperes. See also real power and reactive power.
VAr	63	Reactive power in volt amperes reactive. The “reactive” or “imaginary” component of electrical power (VIsin(phi)). (See also real power and apparent power). Note: Different meter designs use different methods to arrive at their results. Some meters may compute reactive power as an arithmetic value, while others compute the value vectorially. The data consumer should determine the method in use and the suitability of the measurement for the intended purpose.
cosPhi	65	Power factor, dimensionless. NOTE 1 This definition of power factor only holds for balanced systems. See the alternative definition under code 153. NOTE 2 Beware of differing sign conventions in use between the IEC and EEI. It is assumed that the data consumer understands the type of meter in use and the sign convention in use by the utility.
Vs	66	Volt seconds (Ws/A).
V2	67	Volt squared (W^2/A^2).
As	68	Ampere seconds (A·s).
A2	69	Amperes squared (A^2).
A2s	70	Ampere squared time in square amperes (A^2s).
VAh	71	Apparent energy in volt ampere hours.
Wh	72	Real energy in watt hours.
VArh	73	Reactive energy in volt ampere reactive hours.
VPerHz	74	Magnetic flux in volt per hertz.
HzPers	75	Rate of change of frequency in hertz per second.
character	76	Number of characters.
charPers	77	Data rate (baud) in characters per second.
kgm2	78	Moment of mass in kilogram square metres ($kg·m^2$) (Second moment of mass, commonly called the moment of inertia). Note: multiplier “k” is included in this unit symbol for compatibility with IEC 61850-7-3.
dB	79	Sound pressure level in decibels. Note: multiplier “d” is included in this unit symbol for compatibility with IEC 61850-7-3.
WPers	81	Ramp rate in watts per second.
lPers	82	Volumetric flow rate in litres per second.
dBm	83	Power level (logarithmic ratio of signal strength, Bel-mW), normalized to 1mW. Note: multiplier “d” is included in this unit symbol for compatibility with IEC 61850-7-3.
h	84	Time in hours, hour = 60 min = 3600 s.
min	85	Time in minutes, minute = 60 s.
Q	100	Quantity power, Q.

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literal	value	description
Qh	101	Quantity energy, Qh.
ohmm	102	Resistivity, ohm metres, (rho).
APerm	103	A/m, magnetic field strength, amperes per metre.
V2h	104	Volt-squared hour, volt-squared-hours.
A2h	105	Ampere-squared hour, ampere-squared hour.
Ah	106	Ampere-hours, ampere-hours.
count	111	Amount of substance, Counter value.
ft3	119	Volume, cubic feet.
m3Perh	125	Volumetric flow rate, cubic metres per hour.
gal	128	Volume in gallons, US gallon (1 gal = 231 in3 = 128 fl ounce).
Btu	132	Energy, British Thermal Units.
l	134	Volume in litres, litre = dm^3 = m^3/1 000.
lPerh	137	Volumetric flow rate, litres per hour.
lPerl	143	Concentration, The ratio of the volume of a solute divided by the volume of the solution. Note: Users may need use a prefix such a ‘µ’ to express a quantity such as ‘µL/L’.
gPerg	144	Concentration, The ratio of the mass of a solute divided by the mass of the solution. Note: Users may need use a prefix such a ‘µ’ to express a quantity such as ‘µg/g’.
molPerm3	145	Concentration, The amount of substance concentration, (c), the amount of solvent in moles divided by the volume of solution in m^3.
molPermol	146	Concentration, Molar fraction, the ratio of the molar amount of a solute divided by the molar amount of the solution.
molPerkg	147	Concentration, Molality, the amount of solute in moles and the amount of solvent in kilograms.
sPers	149	Time, Ratio of time. Note: Users may need to supply a prefix such as ‘µ’ to show rates such as ‘µs/s’.
HzPerHz	150	Frequency, rate of frequency change. Note: Users may need to supply a prefix such as ‘m’ to show rates such as ‘mHz/Hz’.
VPerV	151	Voltage, ratio of voltages. Note: Users may need to supply a prefix such as ‘m’ to show rates such as ‘mV/V’.
APerA	152	Current, ratio of amperages. Note: Users may need to supply a prefix such as ‘m’ to show rates such as ‘mA/A’.
VPerVA	153	Power factor, PF, the ratio of the active power to the apparent power. Note: The sign convention used for power factor will differ between IEC meters and EEI (ANSI) meters. It is assumed that the data consumers understand the type of meter being used and agree on the sign convention in use at any given utility.
rev	154	Amount of rotation, revolutions.
kat	158	Catalytic activity, katal = mol / s.
JPerkg	165	Specific energy, Joules / kg.
m3Uncompensated	166	Volume, cubic metres, with the value uncompensated for weather effects.

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literal	value	description
m3Compensated	167	Volume, cubic metres, with the value compensated for weather effects.
WPerW	168	Signal Strength, ratio of power. Note: Users may need to supply a prefix such as 'm' to show rates such as 'mW/W'.
therm	169	Energy, therms.
onePerm	173	Wavenumber, reciprocal metres, (1/m).
m3Perkg	174	Specific volume, cubic metres per kilogram, v.
Pas	175	Dynamic viscosity, pascal seconds.
Nm	176	Moment of force, newton metres.
NPerm	177	Surface tension, newton per metre.
radPers2	178	Angular acceleration, radians per second squared.
JPerm3	181	Energy density, joules per cubic metre.
VPerm	182	Electric field strength, volts per metre.
CPerm3	183	Electric charge density, coulombs per cubic metre.
CPerm2	184	Surface charge density, coulombs per square metre.
FPerm	185	Permittivity, farads per metre.
HPerm	186	Permeability, henrys per metre.
JPermol	187	Molar energy, joules per mole.
JPermolK	188	Molar entropy, molar heat capacity, joules per mole kelvin.
CPerkg	189	Exposure (x rays), coulombs per kilogram.
GyPers	190	Absorbed dose rate, grays per second.
WPersr	191	Radiant intensity, watts per steradian.
WPerm2sr	192	Radiance, watts per square metre steradian.
katPerm3	193	Catalytic activity concentration, katals per cubic metre.
d	195	Time in days, day = 24 h = 86 400 s.
anglemin	196	Plane angle, minutes.
anglesec	197	Plane angle, seconds.
ha	198	Area, hectares.
tonne	199	Mass in tons, "tonne" or "metric ton" (1000 kg = 1 Mg).
bar	214	Pressure in bars, (1 bar = 100 kPa).
mmHg	215	Pressure, millimetres of mercury (1 mmHg is approximately 133.3 Pa).
M	217	Length, nautical miles (1 M = 1 852 m).
kn	219	Speed, knots (1 kn = 1 852/3 600) m/s.
Mx	276	Magnetic flux, maxwells (1 Mx = 10-8 Wb).
G	277	Magnetic flux density, gausses (1 G = 10-4 T).
Oe	278	Magnetic field in oersteds, (1 Oe = (103/4p) A/m).
Vh	280	Volt-hour, Volt hours.
WPerA		Active power per current flow, watts per Ampere.
onePerHz		Reciprocal of frequency (1/Hz).

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literal	value	description
VPerVAr		Power factor, PF, the ratio of the active power to the apparent power. Note: The sign convention used for power factor will differ between IEC meters and EEI (ANSI) meters. It is assumed that the data consumers understand the type of meter being used and agree on the sign convention in use at any given utility.
ohmPerm	86	Electric resistance per length in ohms per metre ((V/A)/m).
kgPerJ		Weight per energy in kilograms per joule (kg/J). Note: multiplier “k” is included in this unit symbol for compatibility with IEC 61850-7-3.
JPers		Energy rate in joules per second (J/s).

6.2.71 Voltage datatype

Electrical voltage, can be both AC and DC.

Table 70 shows all attributes of Voltage.

Table 70 – Attributes of Domain::Voltage

name	mult	type	description
multiplier	0..1	UnitMultiplier	
unit	0..1	UnitSymbol	(const=V)
value	0..1	Float	

6.2.72 VoltagePerReactivePower datatype

Voltage variation with reactive power.

Table 71 shows all attributes of VoltagePerReactivePower.

Table 71 – Attributes of Domain::VoltagePerReactivePower

name	mult	type	description
multiplier	0..1	UnitMultiplier	
unit	0..1	UnitSymbol	(const=VPerVAr)
value	0..1	Float	

6.2.73 Volume datatype

Volume.

Table 72 shows all attributes of Volume.

Table 72 – Attributes of Domain::Volume

name	mult	type	description
value	0..1	Float	
unit	0..1	UnitSymbol	(const=m3)
multiplier	0..1	UnitMultiplier	

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6.2.74 VolumeFlowRate datatype

Volume per time.

Table 73 shows all attributes of VolumeFlowRate.

Table 73 – Attributes of Domain::VolumeFlowRate

name	mult	type	description
multiplier	0..1	UnitMultiplier	(const=none)
unit	0..1	UnitSymbol	(const=m3Pers)
value	0..1	Float	

6.2.75 WaterLevel datatype

Reservoir water level referred to a given datum such as mean sea level.

Table 74 shows all attributes of WaterLevel.

Table 74 – Attributes of Domain::WaterLevel

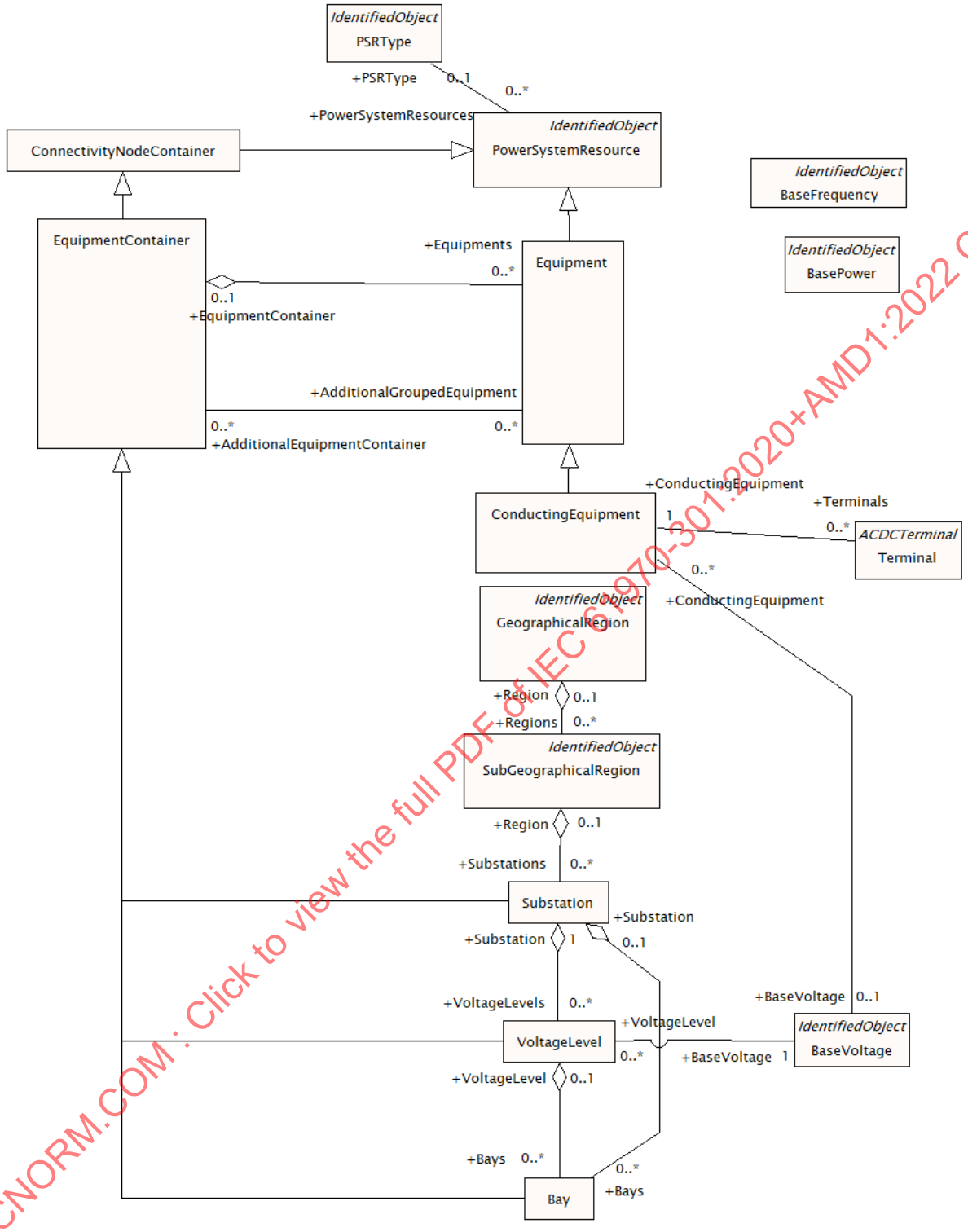
name	mult	type	description
value	0..1	Float	
unit	0..1	UnitSymbol	(const=m)
multiplier	0..1	UnitMultiplier	

6.3 Package Core

6.3.1 General

Contains the core PowerSystemResource and ConductingEquipment entities shared by all applications plus common collections of those entities. Not all applications require all the Core entities. This package does not depend on any other package except the Domain package, but most of the other packages have associations and generalizations that depend on it.

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Figure 79 – Class diagram Core::Main

Figure 79: This diagram shows the main classes needed for any application of the CIM for modelling transmission and generation systems.

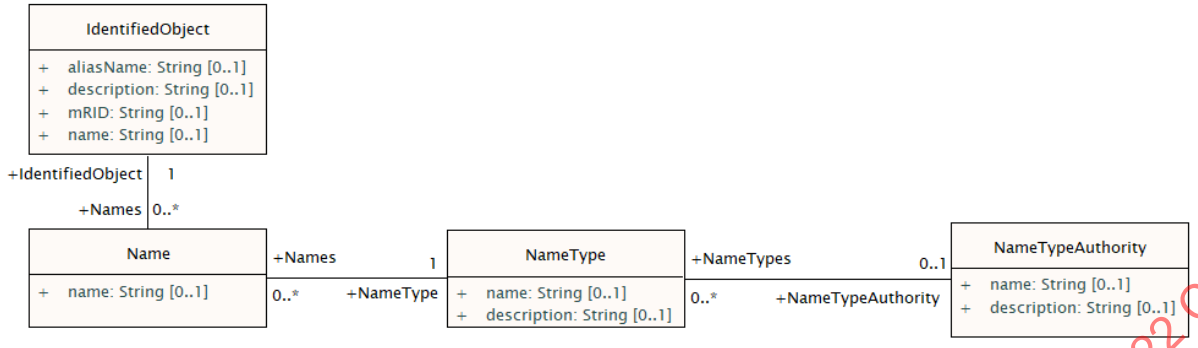


Figure 80 – Class diagram Core::Names

Figure 80: This diagram shows classes used to assign names to identified objects.

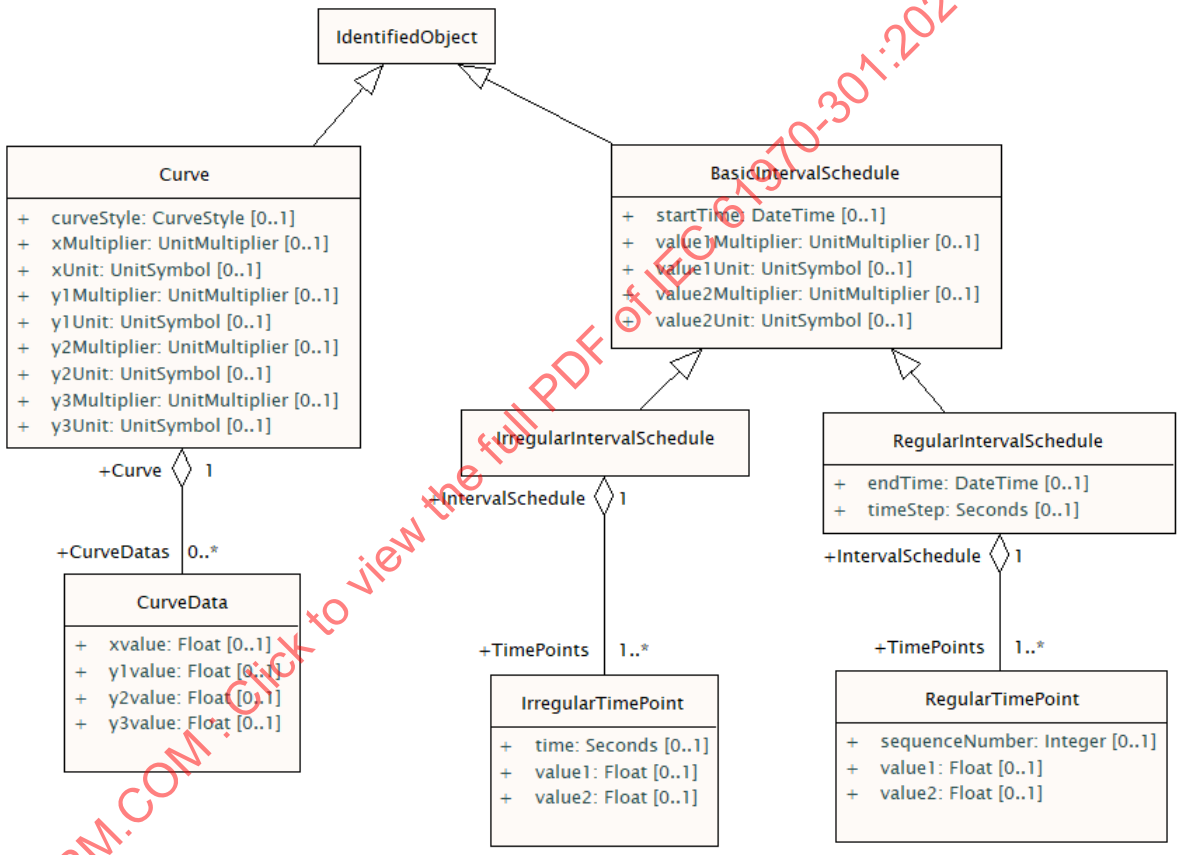


Figure 81 – Class diagram Core::CurveSchedule

Figure 81: This diagram shows the common model for curves and time dependent schedules.

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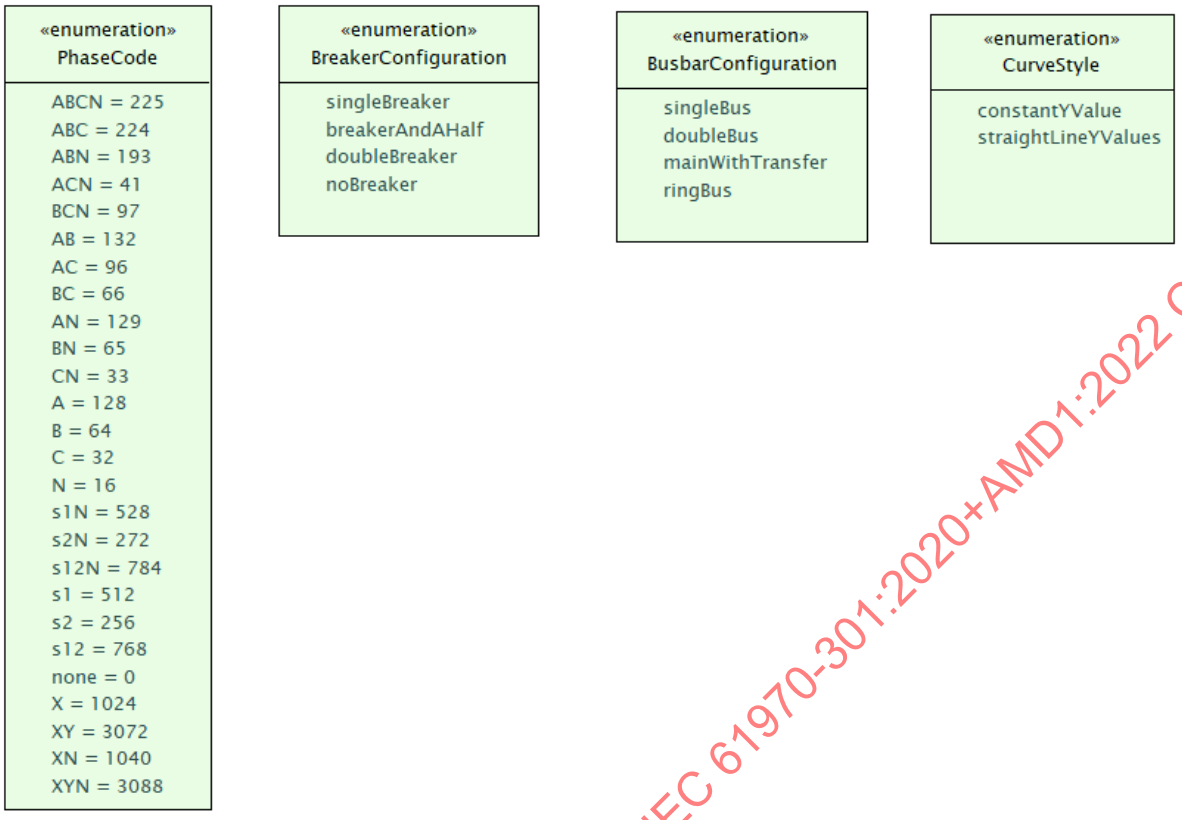


Figure 82 – Class diagram Core::Datatypes

Figure 82: This diagram shows the data types specific to the Core package.

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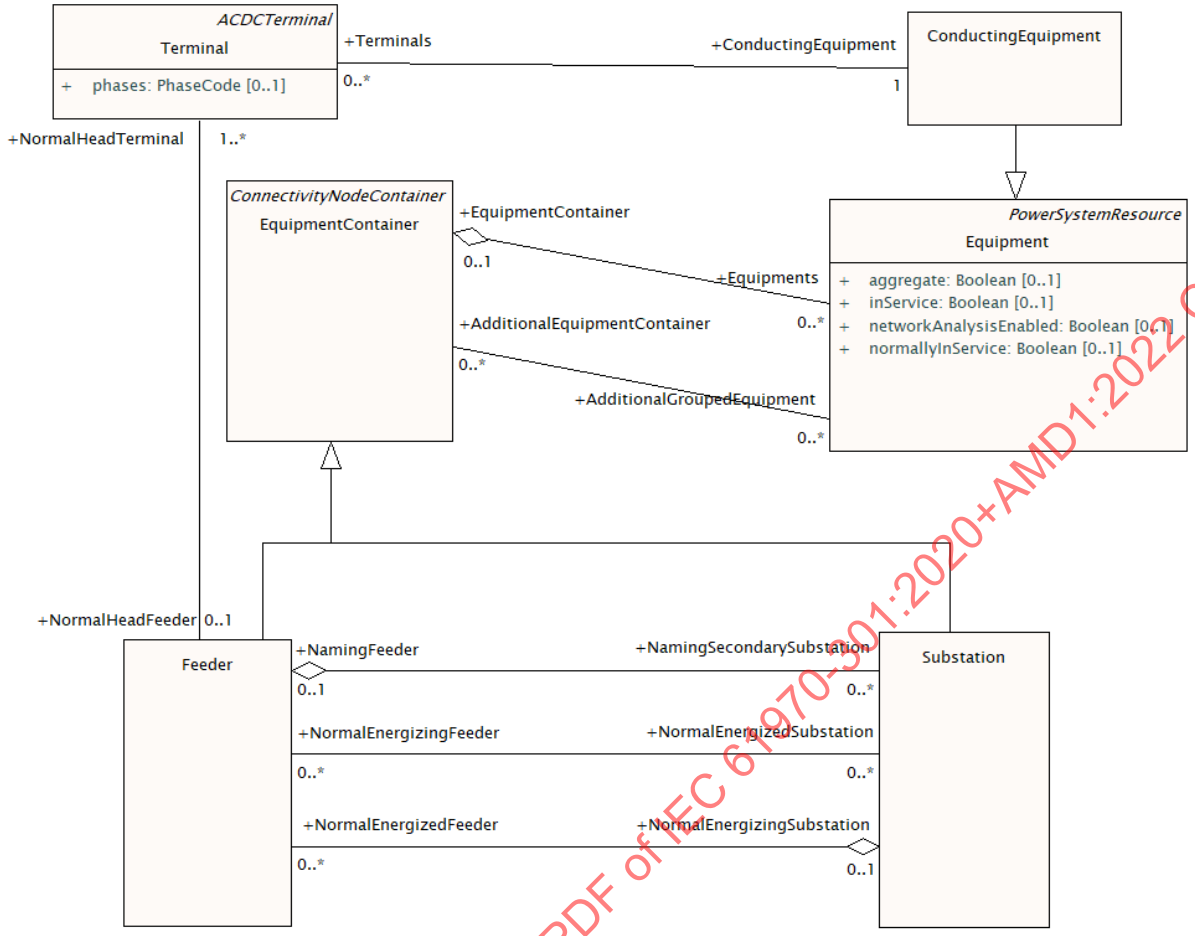


Figure 83 – Class diagram Core::FeederContainment

Figure 83: This diagram shows feeder containment.

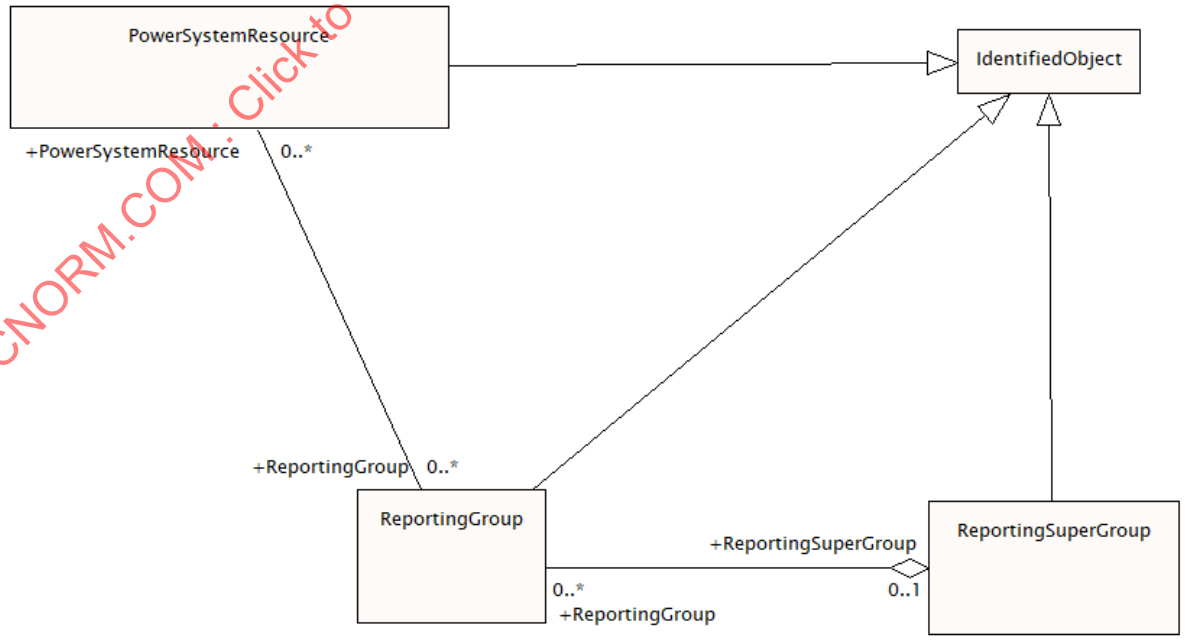


Figure 84 – Class diagram Core::Reporting

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Figure 84: This diagram shows the common model for ad-hoc reporting.

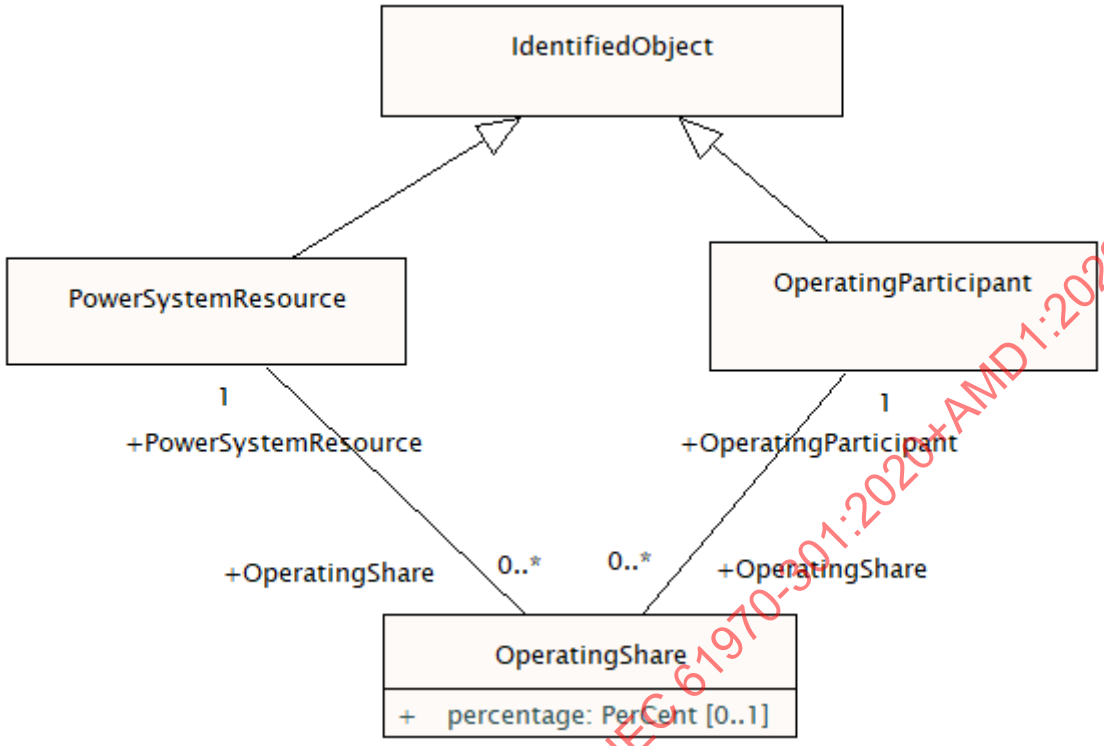


Figure 85 – Class diagram Core::OperatingShare

Figure 85: This diagram shows the common model for operating share.

6.3.2 ACDCTerminal

An electrical connection point (AC or DC) to a piece of conducting equipment. Terminals are connected at physical connection points called connectivity nodes.

Table 75 shows all attributes of ACDCTerminal.

Table 75 – Attributes of Core::ACDCTerminal

name	mult	type	description
connected	0..1	Boolean	The connected status is related to a bus-branch model and the topological node to terminal relation. True implies the terminal is connected to the related topological node and false implies it is not. In a bus-branch model, the connected status is used to tell if equipment is disconnected without having to change the connectivity described by the topological node to terminal relation. A valid case is that conducting equipment can be connected in one end and open in the other. In particular for an AC line segment, where the reactive line charging can be significant, this is a relevant case.
sequenceNumber	0..1	Integer	The orientation of the terminal connections for a multiple terminal conducting equipment. The sequence numbering starts with 1 and additional terminals should follow in increasing order. The

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name	mult	type	description
			first terminal is the "starting point" for a two terminal branch.
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 76 shows all association ends of ACDCTerminal with other classes.

Table 76 – Association ends of Core::ACDCTerminal with other classes

mult from	name	mult to	type	description
1..*	BusNameMarker	0..1	BusNameMarker	The bus name marker used to name the bus (topological node).
0..1	OperationalLimitSet	0..*	OperationalLimitSet	The operational limit sets at the terminal.
0..1	Measurements	0..*	Measurement	Measurements associated with this terminal defining where the measurement is placed in the network topology. It may be used, for instance, to capture the sensor position, such as a voltage transformer (PT) at a busbar or a current transformer (CT) at the bar between a breaker and an isolator.
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.3.3 BaseFrequency

The BaseFrequency class describes a base frequency for a power system network. In case of multiple power networks with different frequencies, e.g. 50 Hz or 60 Hz each network will have its own base frequency class. Hence it is assumed that power system objects having different base frequencies appear in separate documents where each document has a single base frequency instance.

Table 77 shows all attributes of BaseFrequency.

Table 77 – Attributes of Core::BaseFrequency

name	mult	type	description
frequency	0..1	Frequency	The base frequency.
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 78 shows all association ends of BaseFrequency with other classes.

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Table 78 – Association ends of Core::BaseFrequency with other classes

mult from	name	mult to	type	description
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.3.4 BasePower

The BasePower class defines the base power used in the per unit calculations.

Table 79 shows all attributes of BasePower.

Table 79 – Attributes of Core::BasePower

name	mult	type	description
basePower	0..1	ApparentPower	Value used as base power.
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 80 shows all association ends of BasePower with other classes.

Table 80 – Association ends of Core::BasePower with other classes

mult from	name	mult to	type	description
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.3.5 BaseVoltage

Defines a system base voltage which is referenced.

Table 81 shows all attributes of BaseVoltage.

Table 81 – Attributes of Core::BaseVoltage

name	mult	type	description
nominalVoltage	0..1	Voltage	The power system resource's base voltage. Shall be a positive value and not zero.
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 82 shows all association ends of BaseVoltage with other classes.

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Table 82 – Association ends of Core::BaseVoltage with other classes

mult from	name	mult to	type	description
0..1	ConductingEquipment	0..*	ConductingEquipment	All conducting equipment with this base voltage. Use only when there is no voltage level container used and only one base voltage applies. For example, not used for transformers.
1..1	VoltageLevel	0..*	VoltageLevel	The voltage levels having this base voltage.
0..1	TransformerEnds	0..*	TransformerEnd	Transformer ends at the base voltage. This is essential for PU calculation.
0..1	TopologicalNode	0..*	TopologicalNode	The topological nodes at the base voltage.
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.3.6 BasicIntervalSchedule

Schedule of values at points in time.

Table 83 shows all attributes of BasicIntervalSchedule.

Table 83 – Attributes of Core::BasicIntervalSchedule

name	mult	type	description
startTime	0..1	DateTime	The time for the first time point. The value can be a time of day, not a specific date.
value1Multiplier	0..1	UnitMultiplier	Multiplier for value1.
value1Unit	0..1	UnitSymbol	Value1 units of measure.
value2Multiplier	0..1	UnitMultiplier	Multiplier for value2.
value2Unit	0..1	UnitSymbol	Value2 units of measure.
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 84 shows all association ends of BasicIntervalSchedule with other classes.

Table 84 – Association ends of Core::BasicIntervalSchedule with other classes

mult from	name	mult to	type	description
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.3.7 Bay

A collection of power system resources (within a given substation) including conducting equipment, protection relays, measurements, and telemetry. A bay typically represents a physical grouping related to modularization of equipment.

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Table 85 shows all attributes of Bay.

Table 85 – Attributes of Core::Bay

name	mult	type	description
bayEnergyMeasFlag	0..1	Boolean	Indicates the presence/absence of energy measurements.
bayPowerMeasFlag	0..1	Boolean	Indicates the presence/absence of active/reactive power measurements.
breakerConfiguration	0..1	BreakerConfiguration	Breaker configuration.
busBarConfiguration	0..1	BusbarConfiguration	Busbar configuration.
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 86 shows all association ends of Bay with other classes.

Table 86 – Association ends of Core::Bay with other classes

mult from	name	mult to	type	description
0..*	Substation	0..1	Substation	Substation containing the bay.
0..*	VoltageLevel	0..1	VoltageLevel	The voltage level containing this bay.
0..1	Equipments	0..*	Equipment	inherited from: EquipmentContainer
0..*	AdditionalGroupedEquipment	0..*	Equipment	inherited from: EquipmentContainer
1..1	ConnectivityNodes	0..*	ConnectivityNode	inherited from: ConnectivityNodeContainer
0..1	TopologicalNode	0..*	TopologicalNode	inherited from: ConnectivityNodeContainer
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.3.8 BreakerConfiguration enumeration

Switching arrangement for bay.

Table 87 shows all literals of BreakerConfiguration.

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Table 87 – Literals of Core::BreakerConfiguration

literal	value	description
singleBreaker		Single breaker.
breakerAndAHalf		Breaker and a half.
doubleBreaker		Double breaker.
noBreaker		No breaker.

6.3.9 BusbarConfiguration enumeration

Busbar layout for bay.

Table 88 shows all literals of BusbarConfiguration.

Table 88 – Literals of Core::BusbarConfiguration

literal	value	description
singleBus		Single bus.
doubleBus		Double bus.
mainWithTransfer		Main bus with transfer bus.
ringBus		Ring bus.

6.3.10 ConductingEquipment

The parts of the AC power system that are designed to carry current or that are conductively connected through terminals.

Table 89 shows all attributes of ConductingEquipment.

Table 89 – Attributes of Core::ConductingEquipment

name	mult	type	description
aggregate	0..1	Boolean	inherited from: Equipment
inService	0..1	Boolean	inherited from: Equipment
networkAnalysisEnabled	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 90 shows all association ends of ConductingEquipment with other classes.

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Table 90 – Association ends of Core::ConductingEquipment with other classes

mult from	name	mult to	type	description
0..*	BaseVoltage	0..1	BaseVoltage	Base voltage of this conducting equipment. Use only when there is no voltage level container used and only one base voltage applies. For example, not used for transformers.
1..1	SvStatus	0..*	SvStatus	The status state variable associated with this conducting equipment.
0..*	ProtectionEquipments	0..*	ProtectionEquipment	Protection equipment used to protect specific conducting equipment.
1..1	Terminals	0..*	Terminal	Conducting equipment have terminals that may be connected to other conducting equipment terminals via connectivity nodes or topological nodes.
0..1	OperationalLimitSet	0..*	OperationalLimitSet	inherited from: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	inherited from: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment
0..1	Faults	0..*	Fault	inherited from: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	inherited from: Equipment
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.3.11 ConnectivityNode

Connectivity nodes are points where terminals of AC conducting equipment are connected together with zero impedance.

Table 91 shows all attributes of ConnectivityNode.

Table 91 – Attributes of Core::ConnectivityNode

name	mult	type	description
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 92 shows all association ends of ConnectivityNode with other classes.

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Table 92 – Association ends of Core::ConnectivityNode with other classes

mult from	name	mult to	type	description
0..*	TopologicalNode	0..1	TopologicalNode	The topological node to which this connectivity node is assigned. May depend on the current state of switches in the network.
0..*	ConnectivityNodeContainer	1..1	ConnectivityNodeContainer	Container of this connectivity node.
0..1	Terminals	0..*	Terminal	Terminals interconnected with zero impedance at this connectivity node.
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.3.12 ConnectivityNodeContainer

A base class for all objects that may contain connectivity nodes or topological nodes.

Table 93 shows all attributes of ConnectivityNodeContainer.

Table 93 – Attributes of Core::ConnectivityNodeContainer

name	mult	type	description
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 94 shows all association ends of ConnectivityNodeContainer with other classes.

Table 94 – Association ends of Core::ConnectivityNodeContainer with other classes

mult from	name	mult to	type	description
1..1	ConnectivityNodes	0..*	ConnectivityNode	Connectivity nodes which belong to this connectivity node container.
0..1	TopologicalNode	0..*	TopologicalNode	The topological nodes which belong to this connectivity node container.
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..*	Controls	0..*	Control	inherited from: PowerSystemResource
0..*	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.3.13 Curve

A multi-purpose curve or functional relationship between an independent variable (X-axis) and dependent (Y-axis) variables.

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Table 95 shows all attributes of Curve.

Table 95 – Attributes of Core::Curve

name	mult	type	description
curveStyle	0..1	CurveStyle	The style or shape of the curve.
xMultiplier	0..1	UnitMultiplier	Multiplier for X-axis.
xUnit	0..1	UnitSymbol	The X-axis units of measure.
y1Multiplier	0..1	UnitMultiplier	Multiplier for Y1-axis.
y1Unit	0..1	UnitSymbol	The Y1-axis units of measure.
y2Multiplier	0..1	UnitMultiplier	Multiplier for Y2-axis.
y2Unit	0..1	UnitSymbol	The Y2-axis units of measure.
y3Multiplier	0..1	UnitMultiplier	Multiplier for Y3-axis.
y3Unit	0..1	UnitSymbol	The Y3-axis units of measure.
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 96 shows all association ends of Curve with other classes.

Table 96 – Association ends of Core::Curve with other classes

mult from	name	mult to	type	description
1..1	CurveDatas	0..*	CurveData	The point data values that define this curve.
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.3.14 CurveData root class

Multi-purpose data points for defining a curve. The use of this generic class is discouraged if a more specific class can be used to specify the X and Y axis values along with their specific data types.

Table 97 shows all attributes of CurveData.

Table 97 – Attributes of Core::CurveData

name	mult	type	description
xvalue	0..1	Float	The data value of the X-axis variable, depending on the X-axis units.
y1value	0..1	Float	The data value of the first Y-axis variable, depending on the Y-axis units.
y2value	0..1	Float	The data value of the second Y-axis variable (if present), depending on the Y-axis units.
y3value	0..1	Float	The data value of the third Y-axis variable (if present), depending on the Y-axis units.

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Table 98 shows all association ends of CurveData with other classes.

Table 98 – Association ends of Core::CurveData with other classes

mult from	name	mult to	type	description
0..*	Curve	1..1	Curve	The curve of this curve data point.

6.3.15 CurveStyle enumeration

Style or shape of curve.

Table 99 shows all literals of CurveStyle.

Table 99 – Literals of Core::CurveStyle

literal	value	description
constantYValue		The Y-axis values are assumed constant until the next curve point and prior to the first curve point.
straightLineYValues		The Y-axis values are assumed to be a straight line between values. Also known as linear interpolation.

6.3.16 Equipment

The parts of a power system that are physical devices, electronic or mechanical.

Table 100 shows all attributes of Equipment.

Table 100 – Attributes of Core::Equipment

name	mult	type	description
aggregate	0..1	Boolean	The aggregate flag provides an alternative way of representing an aggregated (equivalent) element. It is applicable in cases when the dedicated classes for equivalent equipment do not have all of the attributes necessary to represent the required level of detail. In case the flag is set to “true” the single instance of equipment represents multiple pieces of equipment that have been modelled together as an aggregate equivalent obtained by a network reduction procedure. Examples would be power transformers or synchronous machines operating in parallel modelled as a single aggregate power transformer or aggregate synchronous machine. The attribute is not used for EquivalentBranch, EquivalentShunt and EquivalentInjection.
inService	0..1	Boolean	Specifies the availability of the equipment. True means the equipment is available for topology processing, which determines if the equipment is energized or not. False means that the equipment is treated by network applications as if it is not in the model.
networkAnalysisEnabled	0..1	Boolean	The equipment is enabled to participate in network analysis. If unspecified, the value is assumed to be true.

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name	mult	type	description
normallyInService	0..1	Boolean	Specifies the availability of the equipment under normal operating conditions. True means the equipment is available for topology processing, which determines if the equipment is energized or not. False means that the equipment is treated by network applications as if it is not in the model.
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 101 shows all association ends of Equipment with other classes.

Table 101 – Association ends of Core::Equipment with other classes

mult from	name	mult to	type	description
0..1	OperationalLimitSet	0..*	OperationalLimitSet	The operational limit sets associated with this equipment.
1..1	ContingencyEquipment	0..*	ContingencyEquipment	The contingency equipments in which this equipment participates.
0..*	EquipmentContainer	0..1	EquipmentContainer	Container of this equipment.
0..1	Faults	0..*	Fault	All faults on this equipment.
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	Additional equipment container beyond the primary equipment container. The equipment is contained in another equipment container, but also grouped with this equipment container.
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.3.17 EquipmentContainer

A modelling construct to provide a root class for containing equipment.

Table 102 shows all attributes of EquipmentContainer.

Table 102 – Attributes of Core::EquipmentContainer

name	mult	type	description
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

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Table 103 shows all association ends of EquipmentContainer with other classes.

Table 103 – Association ends of Core::EquipmentContainer with other classes

mult from	name	mult to	type	description
0..1	Equipments	0..*	Equipment	Contained equipment.
0..*	AdditionalGroupedEquipment	0..*	Equipment	The additonal contained equipment. The equipment belong to the equipment container. The equipment is contained in another equipment container, but also grouped with this equipment container. Examples include when a switch contained in a substation is also desired to be grouped with a line container or when a switch is included in a secondary substation and also grouped in a feeder.
1..1	ConnectivityNodes	0..*	ConnectivityNode	inherited from: ConnectivityNodeContainer
0..1	TopologicalNode	0..*	TopologicalNode	inherited from: ConnectivityNodeContainer
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.3.18 Feeder

A collection of equipment for organizational purposes, used for grouping distribution resources.

The organization a feeder does not necessarily reflect connectivity or current operation state.

Table 104 shows all attributes of Feeder.

Table 104 – Attributes of Core::Feeder

name	mult	type	description
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 105 shows all association ends of Feeder with other classes.

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Table 105 – Association ends of Core::Feeder with other classes

mult from	name	mult to	type	description
0..*	NormalEnergizingSubstation	0..1	Substation	The substation that nominally energizes the feeder. Also used for naming purposes.
0..1	NamingSecondarySubstation	0..*	Substation	The secondary substations that are normally energized from the feeder. Used for naming purposes. Should be consistent with the other associations for energizing terminal specification and the feeder energization specification.
0..1	NormalHeadTerminal	1..*	Terminal	The normal head terminal or terminals of the feeder.
0..*	NormalEnergizedSubstation	0..*	Substation	The substations that are normally energized by the feeder.
0..1	Equipments	0..*	Equipment	inherited from: EquipmentContainer
0..*	AdditionalGroupedEquipment	0..*	Equipment	inherited from: EquipmentContainer
1..1	ConnectivityNodes	0..*	ConnectivityNode	inherited from: ConnectivityNodeContainer
0..1	TopologicalNode	0..*	TopologicalNode	inherited from: ConnectivityNodeContainer
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.3.19 GeographicalRegion

A geographical region of a power system network model.

Table 106 shows all attributes of GeographicalRegion.

Table 106 – Attributes of Core::GeographicalRegion

name	mult	type	description
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 107 shows all association ends of GeographicalRegion with other classes.

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Table 107 – Association ends of Core::GeographicalRegion with other classes

mult from	name	mult to	type	description
0..1	Regions	0..*	SubGeographicalRegion	All sub-geographical regions within this geographical region.
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.3.20 IdentifiedObject root class

This is a root class to provide common identification for all classes needing identification and naming attributes.

Table 108 shows all attributes of IdentifiedObject.

Table 108 – Attributes of Core::IdentifiedObject

name	mult	type	description
aliasName	0..1	String	The aliasName is free text human readable name of the object alternative to IdentifiedObject.name. It may be non unique and may not correlate to a naming hierarchy. The attribute aliasName is retained because of backwards compatibility between CIM relases. It is however recommended to replace aliasName with the Name class as aliasName is planned for retirement at a future time.
description	0..1	String	The description is a free human readable text describing or naming the object. It may be non unique and may not correlate to a naming hierarchy.
mRID	0..1	String	Master resource identifier issued by a model authority. The mRID is unique within an exchange context. Global uniqueness is easily achieved by using a UUID, as specified in RFC 4122, for the mRID. The use of UUID is strongly recommended. For CIMXML data files in RDF syntax conforming to IEC 61970-552, the mRID is mapped to rdf:ID or rdf:about attributes that identify CIM object elements.
name	0..1	String	The name is any free human readable and possibly non unique text naming the object.

Table 109 shows all association ends of IdentifiedObject with other classes.

Table 109 – Association ends of Core::IdentifiedObject with other classes

mult from	name	mult to	type	description
0..1	DiagramObjects	0..*	DiagramObject	The diagram objects that are associated with the domain object.
1..1	Names	0..*	Name	All names of this identified object.

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6.3.21 IrregularIntervalSchedule

The schedule has time points where the time between them varies.

Table 110 shows all attributes of IrregularIntervalSchedule.

Table 110 – Attributes of Core::IrregularIntervalSchedule

name	mult	type	description
startTime	0..1	DateTime	inherited from: BasicIntervalSchedule
value1Multiplier	0..1	UnitMultiplier	inherited from: BasicIntervalSchedule
value1Unit	0..1	UnitSymbol	inherited from: BasicIntervalSchedule
value2Multiplier	0..1	UnitMultiplier	inherited from: BasicIntervalSchedule
value2Unit	0..1	UnitSymbol	inherited from: BasicIntervalSchedule
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 111 shows all association ends of IrregularIntervalSchedule with other classes.

Table 111 – Association ends of Core::IrregularIntervalSchedule with other classes

mult from	name	mult to	type	description
1..1	TimePoints	1..*	IrregularTimePoint	The point data values that define a curve.
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.3.22 IrregularTimePoint root class

TimePoints for a schedule where the time between the points varies.

Table 112 shows all attributes of IrregularTimePoint.

Table 112 – Attributes of Core::IrregularTimePoint

name	mult	type	description
time	0..1	Seconds	The time is relative to the schedule starting time.
value1	0..1	Float	The first value at the time. The meaning of the value is defined by the derived type of the associated schedule.
value2	0..1	Float	The second value at the time. The meaning of the value is defined by the derived type of the associated schedule.

Table 113 shows all association ends of IrregularTimePoint with other classes.

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Table 113 – Association ends of Core::IrregularTimePoint with other classes

mult from	name	mult to	type	description
1..*	IntervalSchedule	1..1	IrregularIntervalSchedule	An IrregularTimePoint belongs to an IrregularIntervalSchedule.

6.3.23 Name root class

The Name class provides the means to define any number of human readable names for an object. A name is not to be used for defining inter-object relationships. For inter-object relationships instead use the object identification 'mRID'.

Table 114 shows all attributes of Name.

Table 114 – Attributes of Core::Name

name	mult	type	description
name	0..1	String	Any free text that name the object.

Table 115 shows all association ends of Name with other classes.

Table 115 – Association ends of Core::Name with other classes

mult from	name	mult to	type	description
0..*	IdentifiedObject	1..1	IdentifiedObject	Identified object that this name designates.
0..*	NameType	1..1	NameType	Type of this name.

6.3.24 NameType root class

Type of name. Possible values for attribute 'name' are implementation dependent but standard profiles may specify types. An enterprise may have multiple IT systems each having its own local name for the same object, e.g. a planning system may have different names from an EMS. An object may also have different names within the same IT system, e.g. localName as defined in CIM version 14. The definition from CIM14 is:

The localName is a human readable name of the object. It is a free text name local to a node in a naming hierarchy similar to a file directory structure. A power system related naming hierarchy may be: Substation, VoltageLevel, Equipment etc. Children of the same parent in such a hierarchy have names that typically are unique among them.

Table 116 shows all attributes of NameType.

Table 116 – Attributes of Core::NameType

name	mult	type	description
name	0..1	String	Name of the name type.
description	0..1	String	Description of the name type.

Table 117 shows all association ends of NameType with other classes.

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Table 117 – Association ends of Core::NameType with other classes

mult from	name	mult to	type	description
0..*	NameTypeAuthority	0..1	NameTypeAuthority	Authority responsible for managing names of this type.
1..1	Names	0..*	Name	All names of this type.

6.3.25 NameTypeAuthority root class

Authority responsible for creation and management of names of a given type; typically an organization or an enterprise system.

Table 118 shows all attributes of NameTypeAuthority.

Table 118 – Attributes of Core::NameTypeAuthority

name	mult	type	description
name	0..1	String	Name of the name type authority.
description	0..1	String	Description of the name type authority.

Table 119 shows all association ends of NameTypeAuthority with other classes.

Table 119 – Association ends of Core::NameTypeAuthority with other classes

mult from	name	mult to	type	description
0..1	NameTypes	0..*	NameType	All name types managed by this authority.

6.3.26 OperatingParticipant

An operator of multiple power system resource objects. Note multple operating participants may operate the same power system resource object. This can be used for modeling jointly owned units where each owner operates as a contractual share.

Table 120 shows all attributes of OperatingParticipant.

Table 120 – Attributes of Core::OperatingParticipant

name	mult	type	description
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 121 shows all association ends of OperatingParticipant with other classes.

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Table 121 – Association ends of Core::OperatingParticipant with other classes

mult from	name	mult to	type	description
1..1	OperatingShare	0..*	OperatingShare	The operating shares of this operating participant. An operating participant can be resused for any number of power system resources.
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.3.27 OperatingShare root class

Specifies the operations contract relationship between a power system resource and a contract participant.

Table 122 shows all attributes of OperatingShare.

Table 122 – Attributes of Core::OperatingShare

name	mult	type	description
percentage	0..1	PerCent	Percentage operational ownership between the pair (power system resource and operating participant) associated with this share. The total percentage ownership for a power system resource should add to 100%.

Table 123 shows all association ends of OperatingShare with other classes.

Table 123 – Association ends of Core::OperatingShare with other classes

mult from	name	mult to	type	description
0..*	OperatingParticipant	1..1	OperatingParticipant	The operating participant having this share with the associated power system resource.
0..*	PowerSystemResource	1..1	PowerSystemResource	The power system resource to which the share applies.

6.3.28 PSRType

Classifying instances of the same class, e.g. overhead and underground ACLineSegments. This classification mechanism is intended to provide flexibility outside the scope of this document, i.e. provide customisation that is non standard.

Table 124 shows all attributes of PSRType.

Table 124 – Attributes of Core::PSRType

name	mult	type	description
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 125 shows all association ends of PSRType with other classes.

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Table 125 – Association ends of Core::PSRType with other classes

mult from	name	mult to	type	description
0..1	PowerSystemResources	0..*	PowerSystemResource	Power system resources classified with this power system resource type.
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.3.29 PhaseCode enumeration

An unordered enumeration of phase identifiers. Allows designation of phases for both transmission and distribution equipment, circuits and loads. The enumeration, by itself, does not describe how the phases are connected together or connected to ground. Ground is not explicitly denoted as a phase.

Residential and small commercial loads are often served from single-phase, or split-phase, secondary circuits. For the example of s12N, phases 1 and 2 refer to hot wires that are 180 degrees out of phase, while N refers to the neutral wire. Through single-phase transformer connections, these secondary circuits may be served from one or two of the primary phases A, B, and C. For three-phase loads, use the A, B, C phase codes instead of s12N.

The integer values are from IEC 61968-9 to support revenue metering applications.

Table 126 shows all literals of PhaseCode.

Table 126 – Literals of Core::PhaseCode

literal	value	description
ABCN	225	Phases A, B, C, and N.
ABC	224	Phases A, B, and C.
ABN	193	Phases A, B, and neutral.
ACN	41	Phases A, C and neutral.
BCN	97	Phases B, C, and neutral.
AB	132	Phases A and B.
AC	96	Phases A and C.
BC	66	Phases B and C.
AN	129	Phases A and neutral.
BN	65	Phases B and neutral.
CN	33	Phases C and neutral.
A	128	Phase A.
B	64	Phase B.
C	32	Phase C.
N	16	Neutral phase.
s1N	528	Secondary phase 1 and neutral.
s2N	272	Secondary phase 2 and neutral.
s12N	784	Secondary phases 1, 2, and neutral.
s1	512	Secondary phase 1.
s2	256	Secondary phase 2.
s12	768	Secondary phase 1 and 2.

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literal	value	description
none	0	No phases specified.
X	1024	Unknown non-neutral phase.
XY	3072	Two unknown non-neutral phases.
XN	1040	Unknown non-neutral phase plus neutral.
XYN	3088	Two unknown non-neutral phases plus neutral.

6.3.30 PowerSystemResource

A power system resource (PSR) can be an item of equipment such as a switch, an equipment container containing many individual items of equipment such as a substation, or an organisational entity such as sub-control area. Power system resources can have measurements associated.

Table 127 shows all attributes of PowerSystemResource.

Table 127 – Attributes of Core::PowerSystemResource

name	mult	type	description
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 128 shows all association ends of PowerSystemResource with other classes.

Table 128 – Association ends of Core::PowerSystemResource with other classes

mult from	name	mult to	type	description
0..*	PSRType	0..1	PSRType	Custom classification for this power system resource.
0..1	Controls	0..*	Control	The controller outputs used to actually govern a regulating device, e.g. the magnetization of a synchronous machine or capacitor bank breaker actuator.
0..1	Measurements	0..*	Measurement	The measurements associated with this power system resource.
1..1	OperatingShare	0..*	OperatingShare	The operating shares of this power system resource.
0..*	ReportingGroup	0..*	ReportingGroup	Reporting groups to which this power system resource belongs.
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.3.31 RegularIntervalSchedule

The schedule has time points where the time between them is constant.

Table 129 shows all attributes of RegularIntervalSchedule.

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Table 129 – Attributes of Core::RegularIntervalSchedule

name	mult	type	description
endTime	0..1	DateTime	The time for the last time point. The value can be a time of day, not a specific date.
timeStep	0..1	Seconds	The time between each pair of subsequent regular time points in sequence order.
startTime	0..1	DateTime	inherited from: BasicIntervalSchedule
value1Multiplier	0..1	UnitMultiplier	inherited from: BasicIntervalSchedule
value1Unit	0..1	UnitSymbol	inherited from: BasicIntervalSchedule
value2Multiplier	0..1	UnitMultiplier	inherited from: BasicIntervalSchedule
value2Unit	0..1	UnitSymbol	inherited from: BasicIntervalSchedule
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 130 shows all association ends of RegularIntervalSchedule with other classes.

Table 130 – Association ends of Core::RegularIntervalSchedule with other classes

mult from	name	mult to	type	description
1..1	TimePoints	1..*	RegularTimePoint	The regular interval time point data values that define this schedule.
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.3.32 RegularTimePoint root class

Time point for a schedule where the time between the consecutive points is constant.

Table 131 shows all attributes of RegularTimePoint.

Table 131 – Attributes of Core::RegularTimePoint

name	mult	type	description
sequenceNumber	0..1	Integer	The position of the regular time point in the sequence. Note that time points don't have to be sequential, i.e. time points may be omitted. The actual time for a RegularTimePoint is computed by multiplying the associated regular interval schedule's time step with the regular time point sequence number and adding the associated schedules start time. To specify values for the start time, use sequence number 0. The sequence number cannot be negative.
value1	0..1	Float	The first value at the time. The meaning of the value is defined by the derived type of the associated schedule.
value2	0..1	Float	The second value at the time. The meaning of the value is defined by the derived type of the associated schedule.

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Table 132 shows all association ends of RegularTimePoint with other classes.

Table 132 – Association ends of Core::RegularTimePoint with other classes

mult from	name	mult to	type	description
1..*	IntervalSchedule	1..1	RegularIntervalSchedule	Regular interval schedule containing this time point.

6.3.33 ReportingGroup

A reporting group is used for various ad-hoc groupings used for reporting.

Table 133 shows all attributes of ReportingGroup.

Table 133 – Attributes of Core::ReportingGroup

name	mult	type	description
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 134 shows all association ends of ReportingGroup with other classes.

Table 134 – Association ends of Core::ReportingGroup with other classes

mult from	name	mult to	type	description
0..*	PowerSystemResource	0..*	PowerSystemResource	Power system resources which belong to this reporting group.
0..*	ReportingSuperGroup	0..1	ReportingSuperGroup	Reporting super group to which this reporting group belongs.
0..1	BusNameMarker	0..*	BusNameMarker	The bus name markers that belong to this reporting group.
0..1	TopologicalNode	0..*	TopologicalNode	The topological nodes that belong to the reporting group.
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.3.34 ReportingSuperGroup

A reporting super group, groups reporting groups for a higher level report.

Table 135 shows all attributes of ReportingSuperGroup.

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Table 135 – Attributes of Core::ReportingSuperGroup

name	mult	type	description
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 136 shows all association ends of ReportingSuperGroup with other classes.

Table 136 – Association ends of Core::ReportingSuperGroup with other classes

mult from	name	mult to	type	description
0..1	ReportingGroup	0..*	ReportingGroup	Reporting groups that are grouped under this super group.
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.3.35 SubGeographicalRegion

A subset of a geographical region of a power system network model.

Table 137 shows all attributes of SubGeographicalRegion.

Table 137 – Attributes of Core::SubGeographicalRegion

name	mult	type	description
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 138 shows all association ends of SubGeographicalRegion with other classes.

Table 138 – Association ends of Core::SubGeographicalRegion with other classes

mult from	name	mult to	type	description
0..1	Lines	0..*	Line	The lines within the sub-geographical region.
0..1	Substations	0..*	Substation	The substations in this sub-geographical region.
0..*	Region	0..1	GeographicalRegion	The geographical region which this sub-geographical region is within.
0..1	DCLines	0..*	DCLine	The DC lines in this sub-geographical region.
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

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6.3.36 Substation

A collection of equipment for purposes other than generation or utilization, through which electric energy in bulk is passed for the purposes of switching or modifying its characteristics.

Table 139 shows all attributes of Substation.

Table 139 – Attributes of Core::Substation

name	mult	type	description
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 140 shows all association ends of Substation with other classes.

Table 140 – Association ends of Core::Substation with other classes

mult from	name	mult to	type	description
1..1	VoltageLevels	0..*	VoltageLevel	The voltage levels within this substation.
0..1	Bays	0..*	Bay	Bays contained in the substation.
0..1	NormalEnergizedFeeder	0..*	Feeder	The normal energized feeders of the substation. Also used for naming purposes.
0..*	NamingFeeder	0..1	Feeder	The primary feeder that normally energizes the secondary substation. Used for naming purposes. Either this association or the substation to subgeographical region should be used for hierarchical containment specification.
0..*	NormalEnergizingFeeder	0..*	Feeder	The feeders that potentially energize the downstream substation. Should be consistent with the associations that describe the naming hierarchy.
0..*	Region	0..1	SubGeographicalRegion	The SubGeographicalRegion containing the substation.
0..1	DCConverterUnit	0..*	DCConverterUnit	The DC converter unit belonging of the substation.
0..1	Equipments	0..*	Equipment	inherited from: EquipmentContainer
0..*	AdditionalGroupedEquipment	0..*	Equipment	inherited from: EquipmentContainer
1..1	ConnectivityNodes	0..*	ConnectivityNode	inherited from: ConnectivityNodeContainer
0..1	TopologicalNode	0..*	TopologicalNode	inherited from: ConnectivityNodeContainer
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

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6.3.37 Terminal

An AC electrical connection point to a piece of conducting equipment. Terminals are connected at physical connection points called connectivity nodes.

Table 141 shows all attributes of Terminal.

Table 141 – Attributes of Core::Terminal

name	mult	type	description
phases	0..1	PhaseCode	Represents the normal network phasing condition. If the attribute is missing, three phases (ABC) shall be assumed, except for terminals of grounding classes (specializations of EarthFaultCompensator, GroundDisconnector~~,~~ ~~GroundSwitch,~~ and Ground) which will be assumed to be N. Therefore, phase code ABCN is explicitly declared when needed, e.g. for star point grounding equipment. The phase code on terminals connecting same ConnectivityNode or same TopologicalNode as well as for equipment between two terminals shall be consistent.
connected	0..1	Boolean	inherited from: ACDCTerminal
sequenceNumber	0..1	Integer	inherited from: ACDCTerminal
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 142 shows all association ends of Terminal with other classes.

Table 142 – Association ends of Core::Terminal with other classes

mult from	name	mult to	type	description
0..*	ConductingEquipment	1..1	ConductingEquipment	The conducting equipment of the terminal. Conducting equipment have terminals that may be connected to other conducting equipment terminals via connectivity nodes or topological nodes.
0..*	ConnectivityNode	0..1	ConnectivityNode	The connectivity node to which this terminal connects with zero impedance.
0..*	TopologicalNode	0..1	TopologicalNode	The topological node associated with the terminal. This can be used as an alternative to the connectivity node path to topological node, thus making it unnecessary to model connectivity nodes in some cases. Note that the if connectivity nodes are in the model, this association would probably not be used as an input specification.
0..1	RegulatingControl	0..*	RegulatingControl	The controls regulating this terminal.
1..*	NormalHeadFeeder	0..1	Feeder	The feeder that this terminal normally feeds. Only specified for the terminals at head of feeders.
1..1	HasFirstMutualCoupling	0..*	MutualCoupling	Mutual couplings associated with the branch as the first branch.
0..1	TransformerEnd	0..*	TransformerEnd	All transformer ends connected at this terminal.

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mult from	name	mult to	type	description
1..1	BranchGroupTerminal	0..*	BranchGroupTerminal	The directed branch group terminals for which this terminal is monitored.
1..1	SvPowerFlow	0..*	SvPowerFlow	The power flow state variable associated with the terminal.
1..1	AuxiliaryEquipment	0..*	AuxiliaryEquipment	The auxiliary equipment connected to the terminal.
1..1	HasSecondMutualCoupling	0..*	MutualCoupling	Mutual couplings with the branch associated as the first branch.
1..1	TieFlow	0..2	TieFlow	The control area tie flows to which this terminal associates.
0..1	EquipmentFaults	0..*	EquipmentFault	The equipment faults at this terminal.
0..1	ConverterDCSides	0..*	ACDCConverter	All converters' DC sides linked to this point of common coupling terminal.
1..1	RemoteInputSignal	0..*	RemoteInputSignal	Input signal coming from this terminal.
1..*	BusNameMarker	0..1	BusNameMarker	inherited from: ACDCTerminal
0..1	OperationalLimitSet	0..*	OperationalLimitSet	inherited from: ACDCTerminal
0..1	Measurements	0..*	Measurement	inherited from: ACDCTerminal
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.3.38 VoltageLevel

A collection of equipment at one common system voltage forming a switchgear. The equipment typically consists of breakers, busbars, instrumentation, control, regulation and protection devices as well as assemblies of all these.

Table 143 shows all attributes of VoltageLevel.

Table 143 – Attributes of Core::VoltageLevel

name	mult	type	description
highVoltageLimit	0..1	Voltage	The bus bar's high voltage limit. The limit applies to all equipment and nodes contained in a given VoltageLevel. It is not required that it is exchanged in pair with lowVoltageLimit. It is preferable to use operational VoltageLimit, which prevails, if present.
lowVoltageLimit	0..1	Voltage	The bus bar's low voltage limit. The limit applies to all equipment and nodes contained in a given VoltageLevel. It is not required that it is exchanged in pair with highVoltageLimit. It is preferable to use operational VoltageLimit, which prevails, if present.
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 144 shows all association ends of VoltageLevel with other classes.

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Table 144 – Association ends of Core::VoltageLevel with other classes

mult from	name	mult to	type	description
0..*	BaseVoltage	1..1	BaseVoltage	The base voltage used for all equipment within the voltage level.
0..1	Bays	0..*	Bay	The bays within this voltage level.
0..*	Substation	1..1	Substation	The substation of the voltage level.
0..1	Equipments	0..*	Equipment	inherited from: EquipmentContainer
0..*	AdditionalGroupedEquipment	0..*	Equipment	inherited from: EquipmentContainer
1..1	ConnectivityNodes	0..*	ConnectivityNode	inherited from: ConnectivityNodeContainer
0..1	TopologicalNode	0..*	TopologicalNode	inherited from: ConnectivityNodeContainer
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.4 Package Wires

6.4.1 General

An extension to the Core and Topology package that models information on the electrical characteristics of Transmission and Distribution networks. This package is used by network applications such as State Estimation, Load Flow and Optimal Power Flow.

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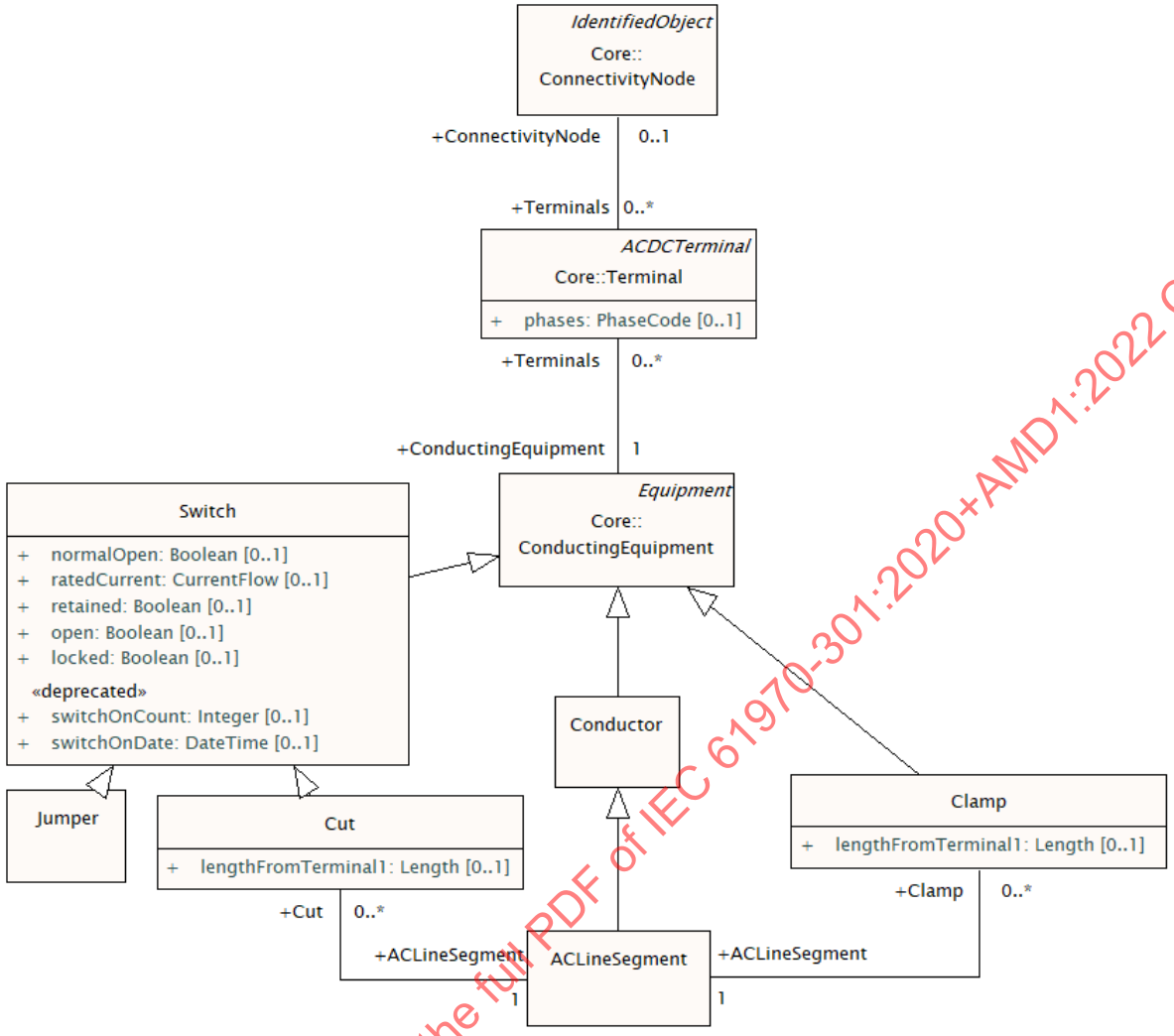


Figure 86 – Class diagram Wires::CutsAndJumpers

Figure 86: The diagram show the cuts and jumpers data model.

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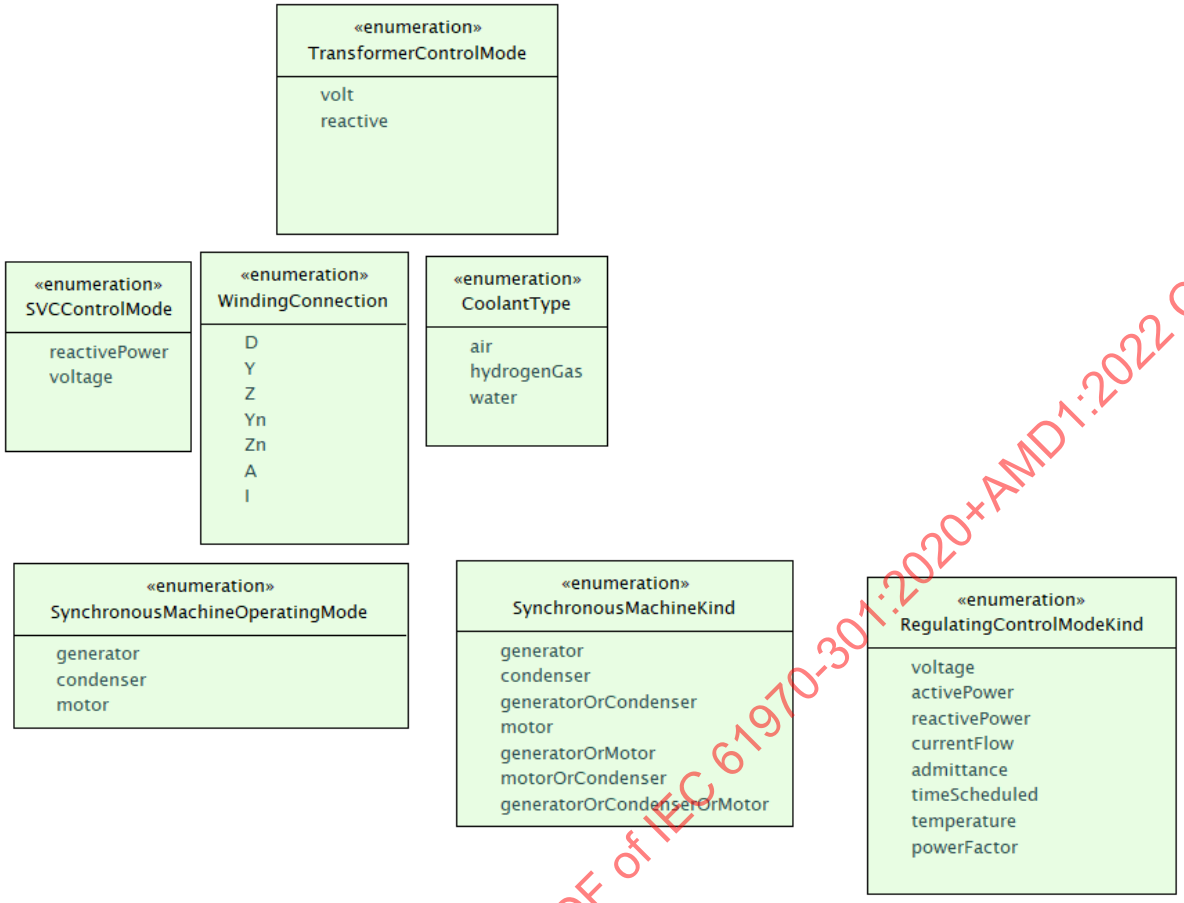


Figure 87 – Class diagram Wires::Datatypes

Figure 87: This diagram shows the data types specific to the Wires package.

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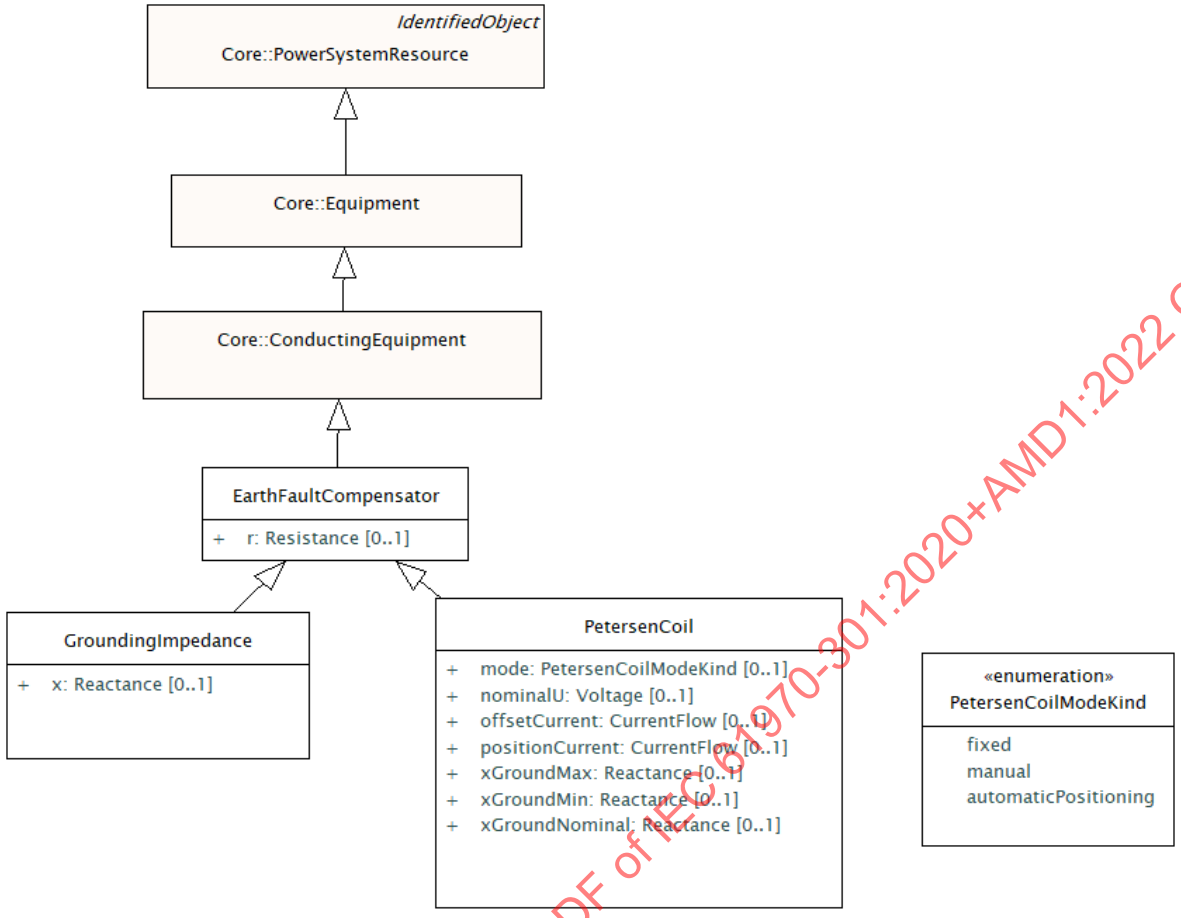
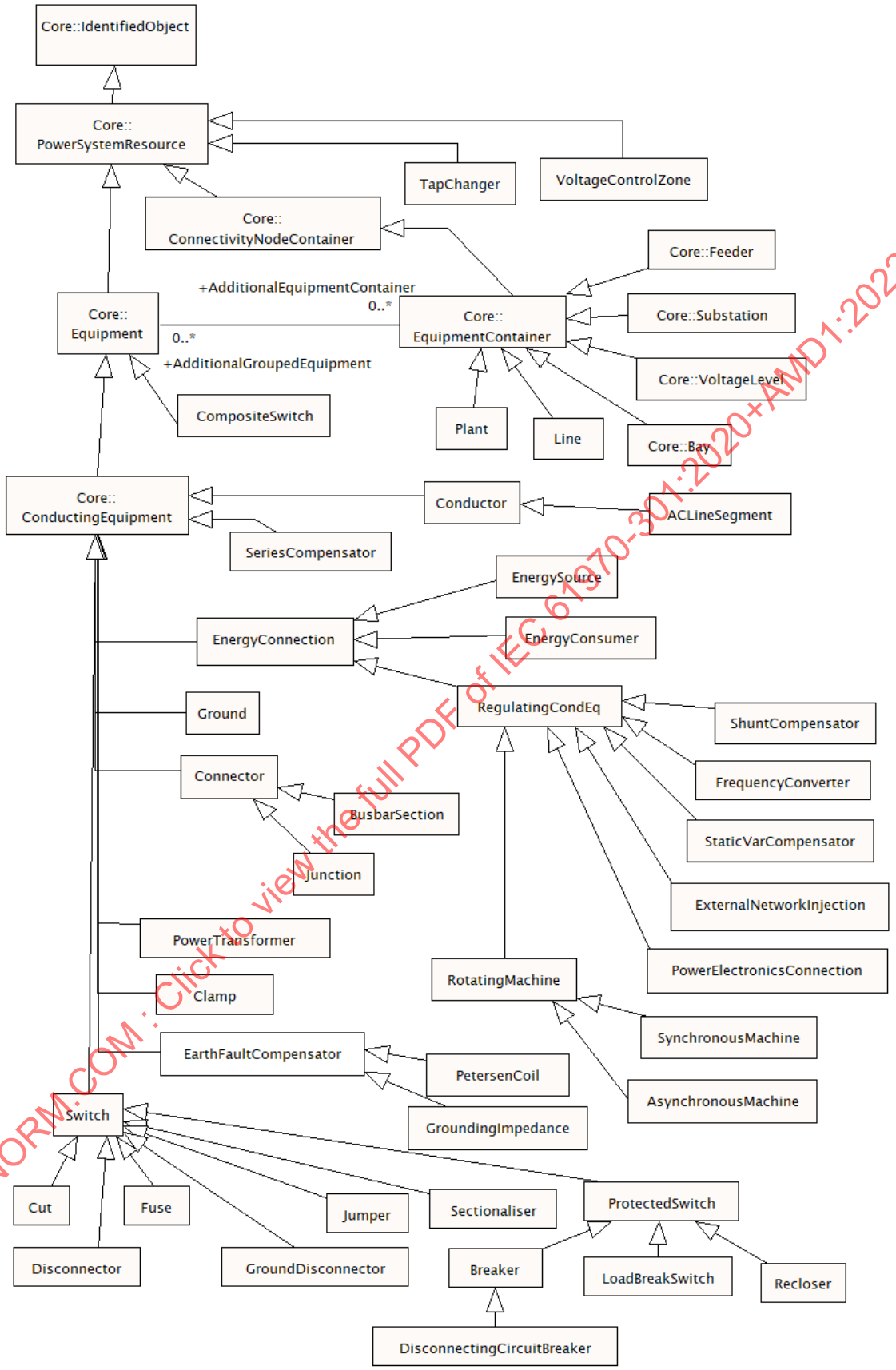


Figure 88 – Class diagram Wires::EarthFaultCompensator

Figure 88: Shows earth fault compensating devices.

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Figure 89 – Class diagram Wires::InheritanceHierarchy

Figure 89: This diagram describes inheritance between classes in and related to the Wires package.

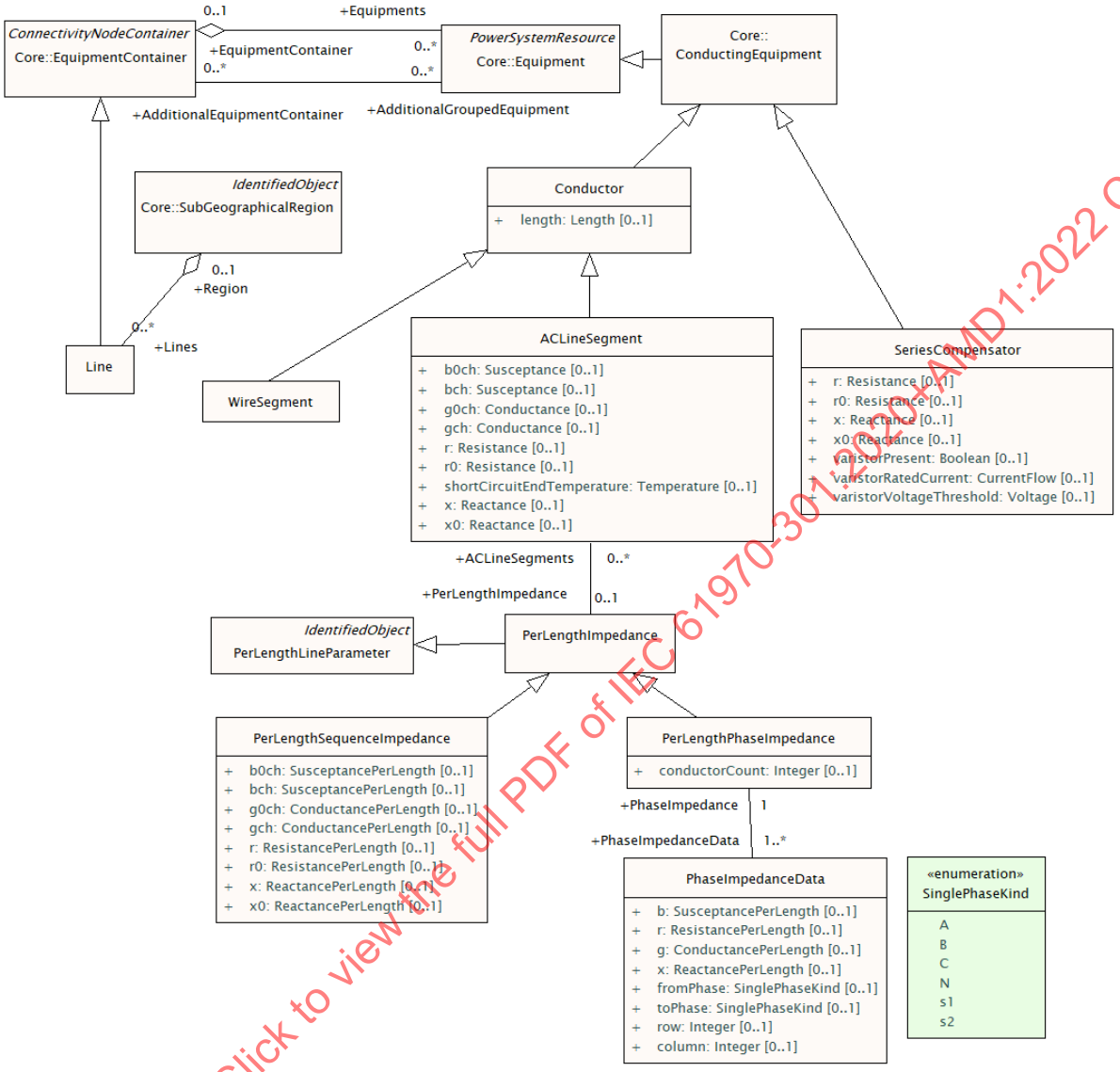


Figure 90 – Class diagram Wires::LineModel

Figure 90: This diagram shows all classes related to the transmission line model.

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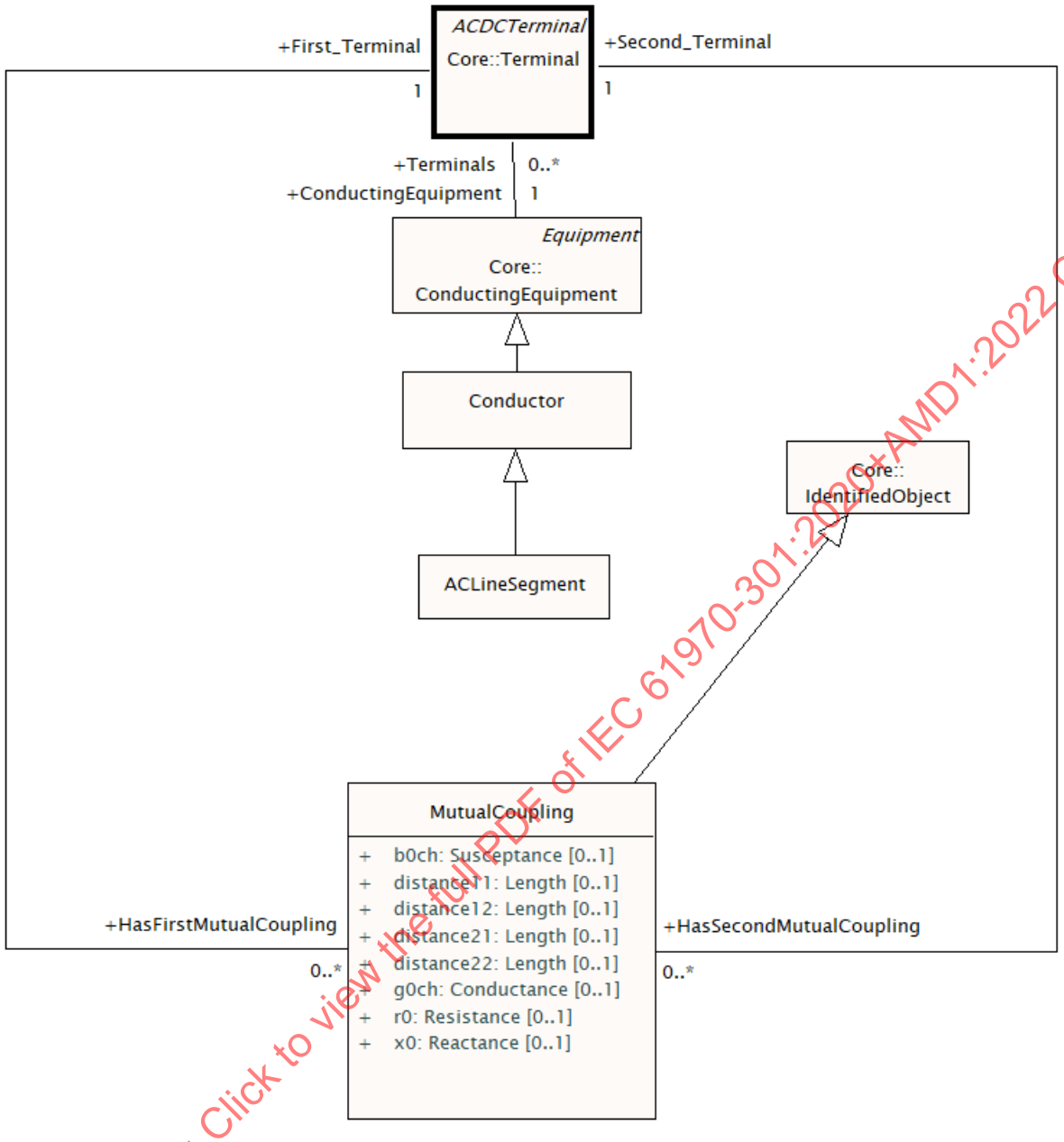
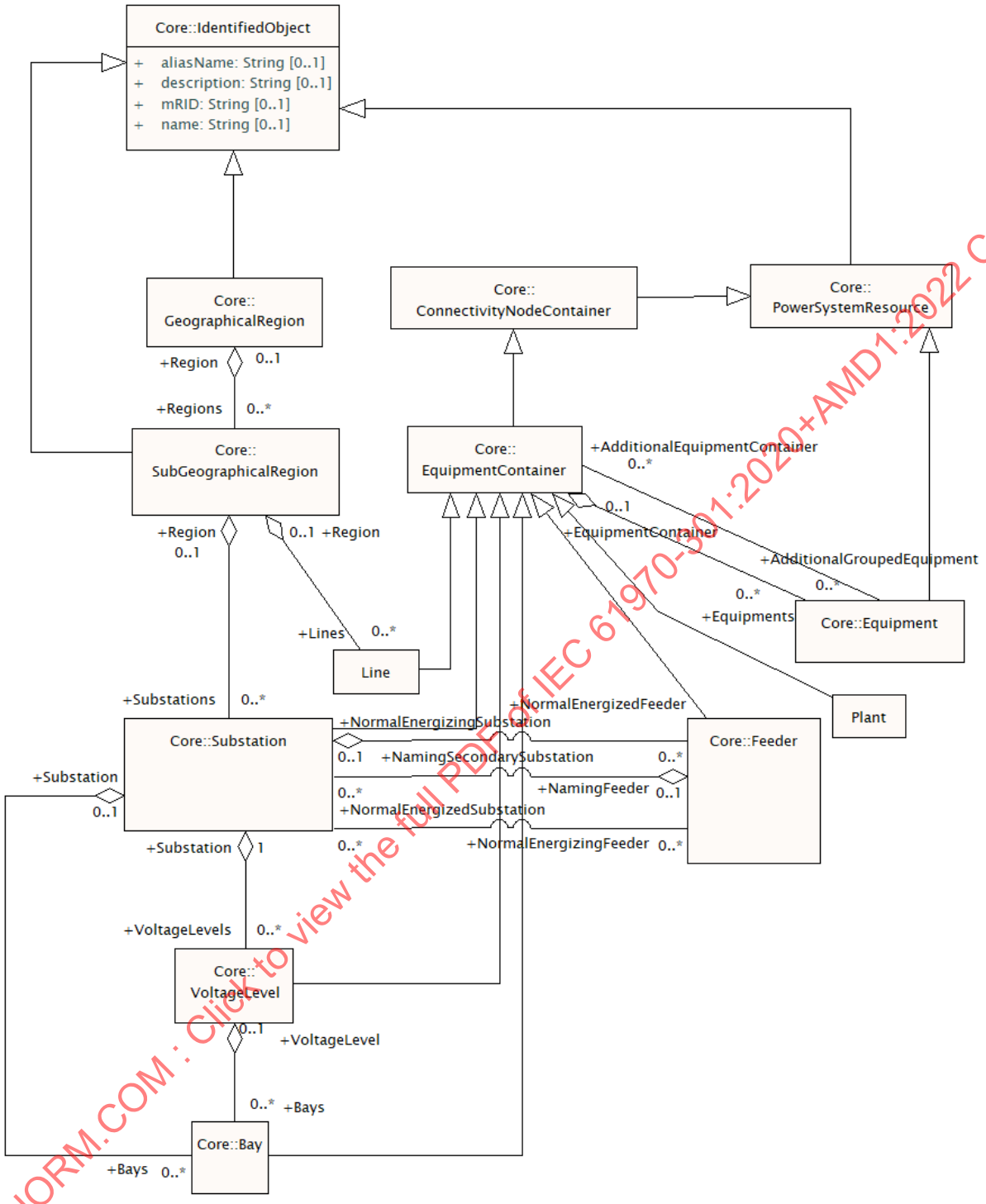


Figure 91 – Class diagram Wires::MutualCoupling

Figure 91: Shows mutual coupling models.

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Figure 92 – Class diagram Wires::NamingHierarchyPart1

Figure 92: The diagram shows the upper part of the naming hierarchy. The hierarchy is a way to organize and name equipment. Hence it is tightly related to the IdentifiedObject and its attributes. The Equipment class is further specialized into many subtypes that are all contained by subclasses of the EquipmentContainer.

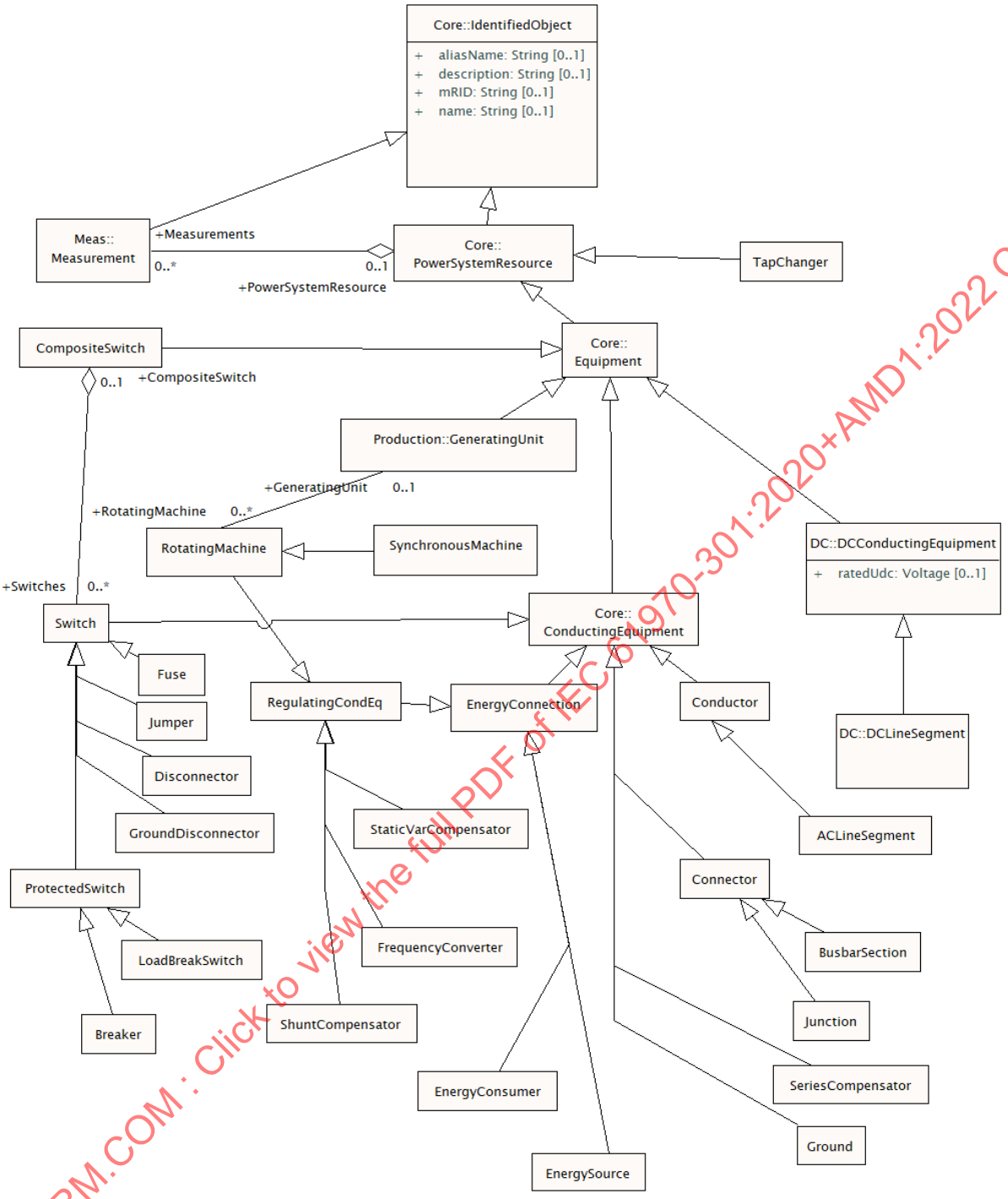


Figure 93 – Class diagram Wires::NamingHierarchyPart2

Figure 93: The diagram shows the lower part of the naming hierarchy. It shows how the Equipment class is further specialized into many subtypes that are all contained by subclasses of the EquipmentContainer. For the subclasses of equipment container refer to part 1 of the diagram.

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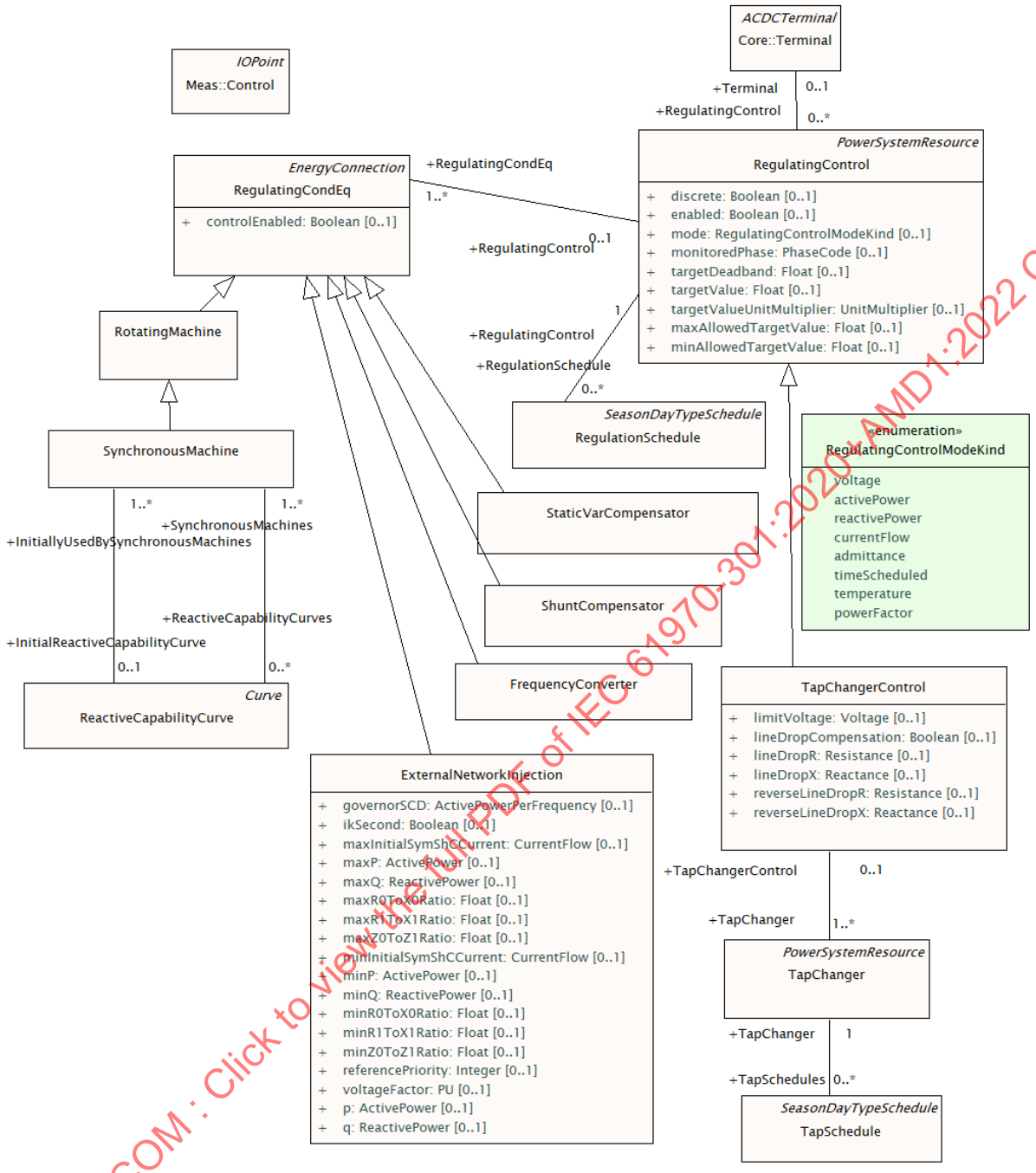


Figure 94 – Class diagram Wires::RegulatingEquipment

Figure 94: The diagram shows all classes related to equipment regulation and reactive power compensation.

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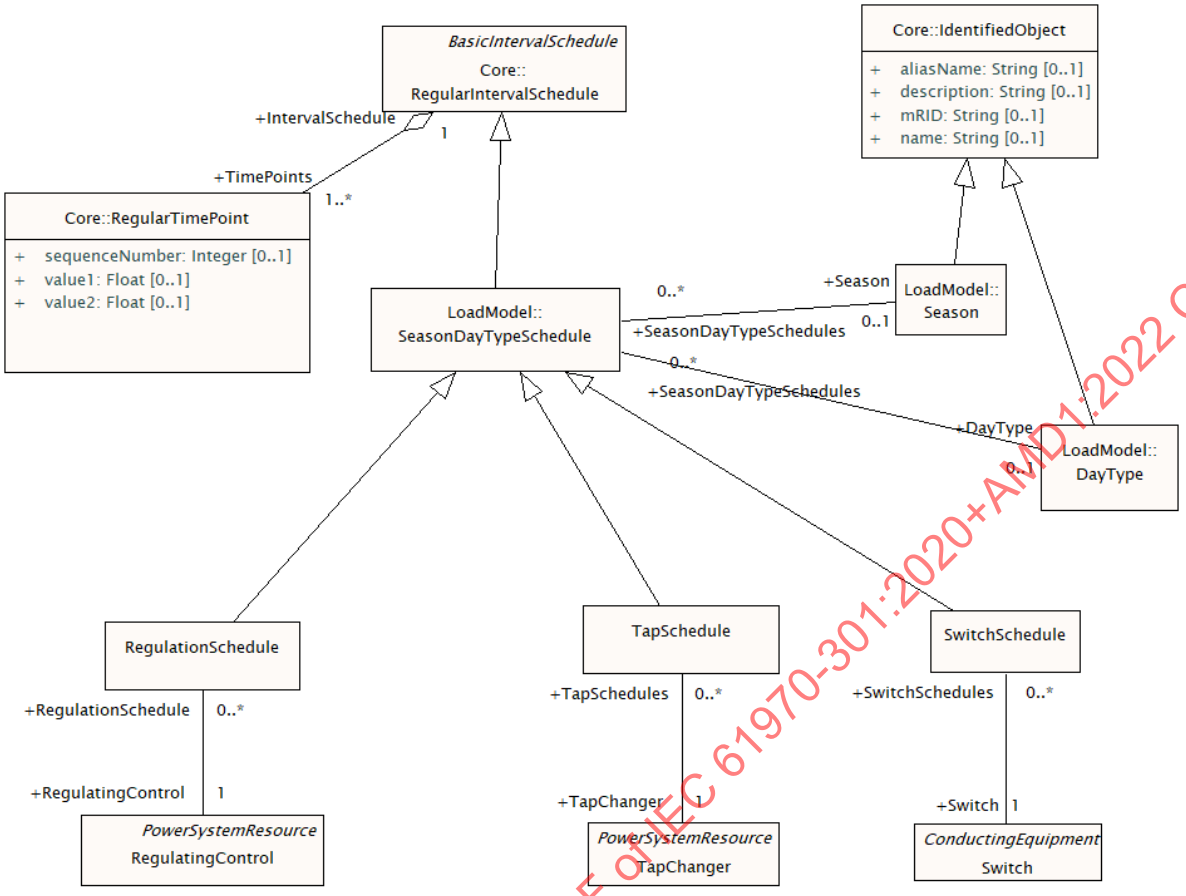


Figure 95 – Class diagram Wires::Schedules

Figure 95: Shows schedules of wires model.

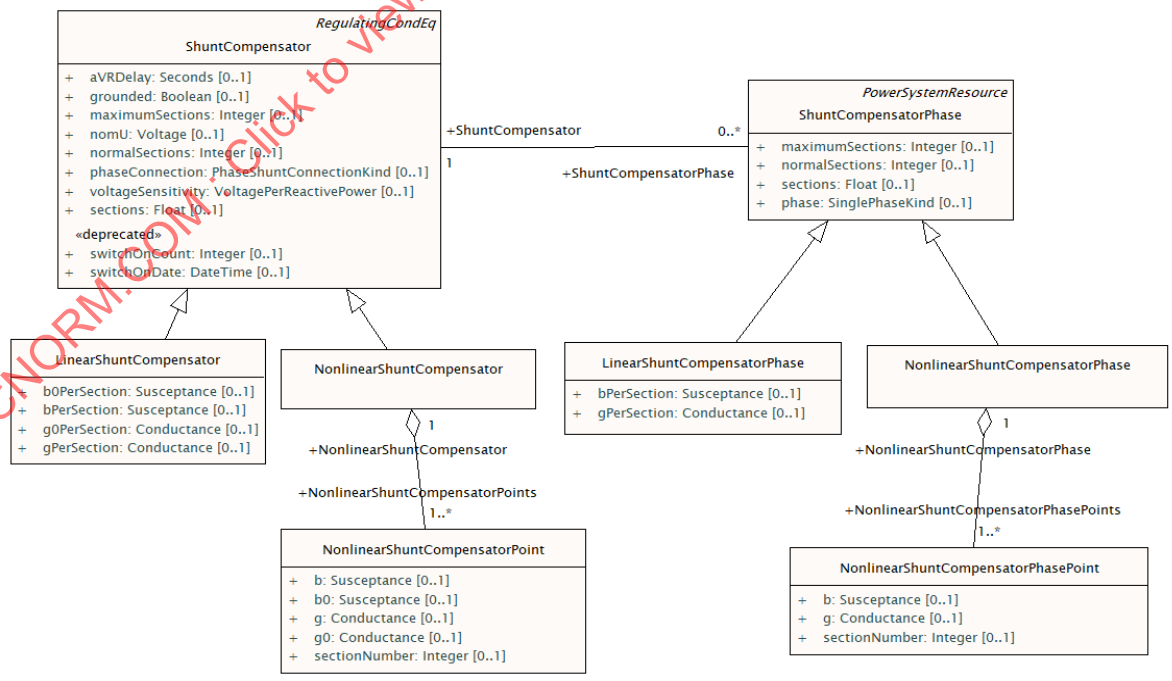


Figure 96 – Class diagram Wires::ShuntCompensator

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Figure 96: Shows shunt compensator inheritance structure.

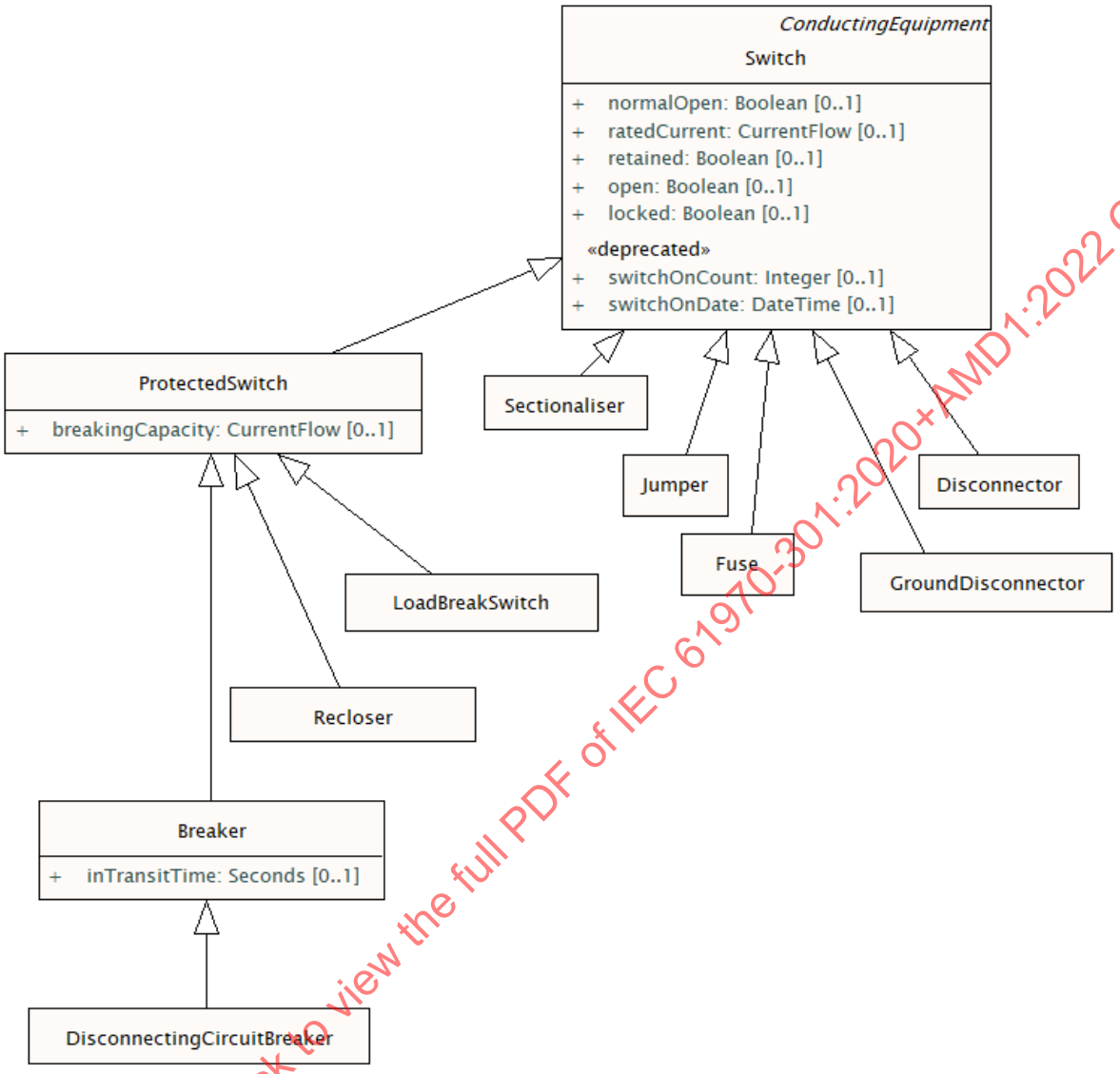
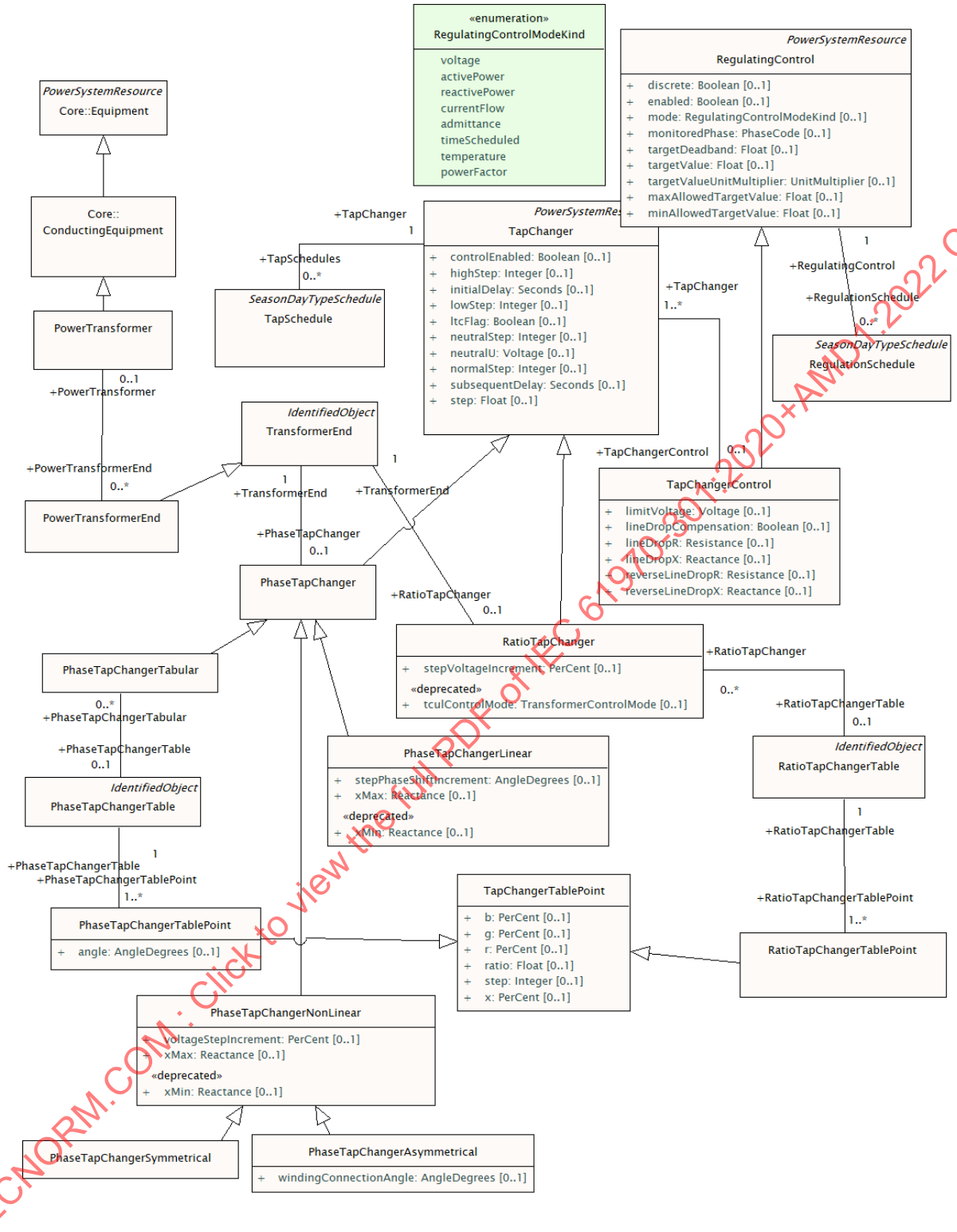


Figure 97 – Class diagram Wires::SwitchingEquipment

Figure 97: Shows switching equipment inheritance structure.

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Figure 98 – Class diagram Wires::TapChanger

Figure 98: This diagram shows all classes related to the transformer tap model.

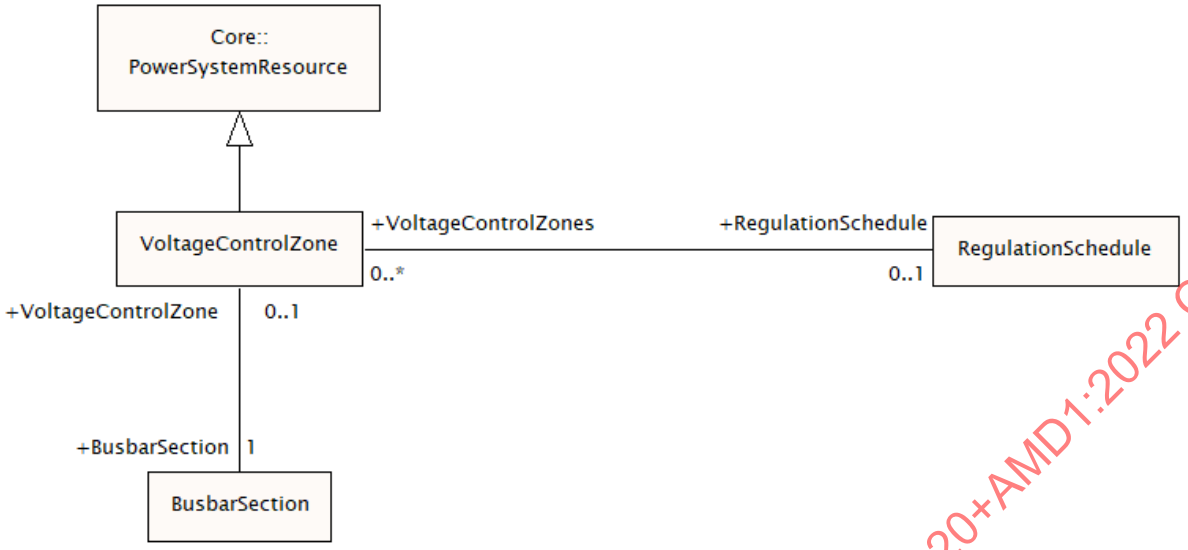
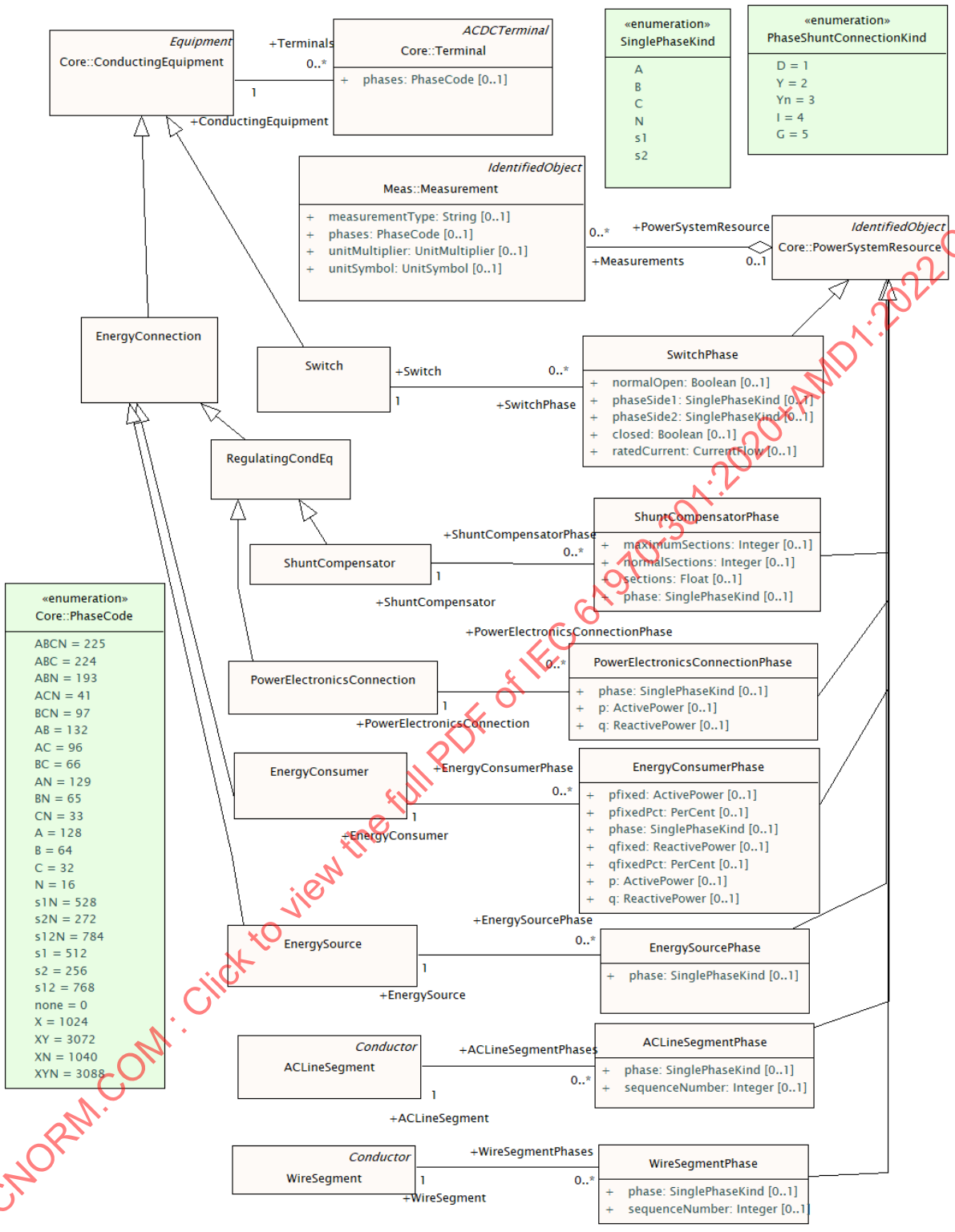


Figure 99 – Class diagram Wires::VoltageControl

Figure 99: This diagram shows all classes related to area voltage control.

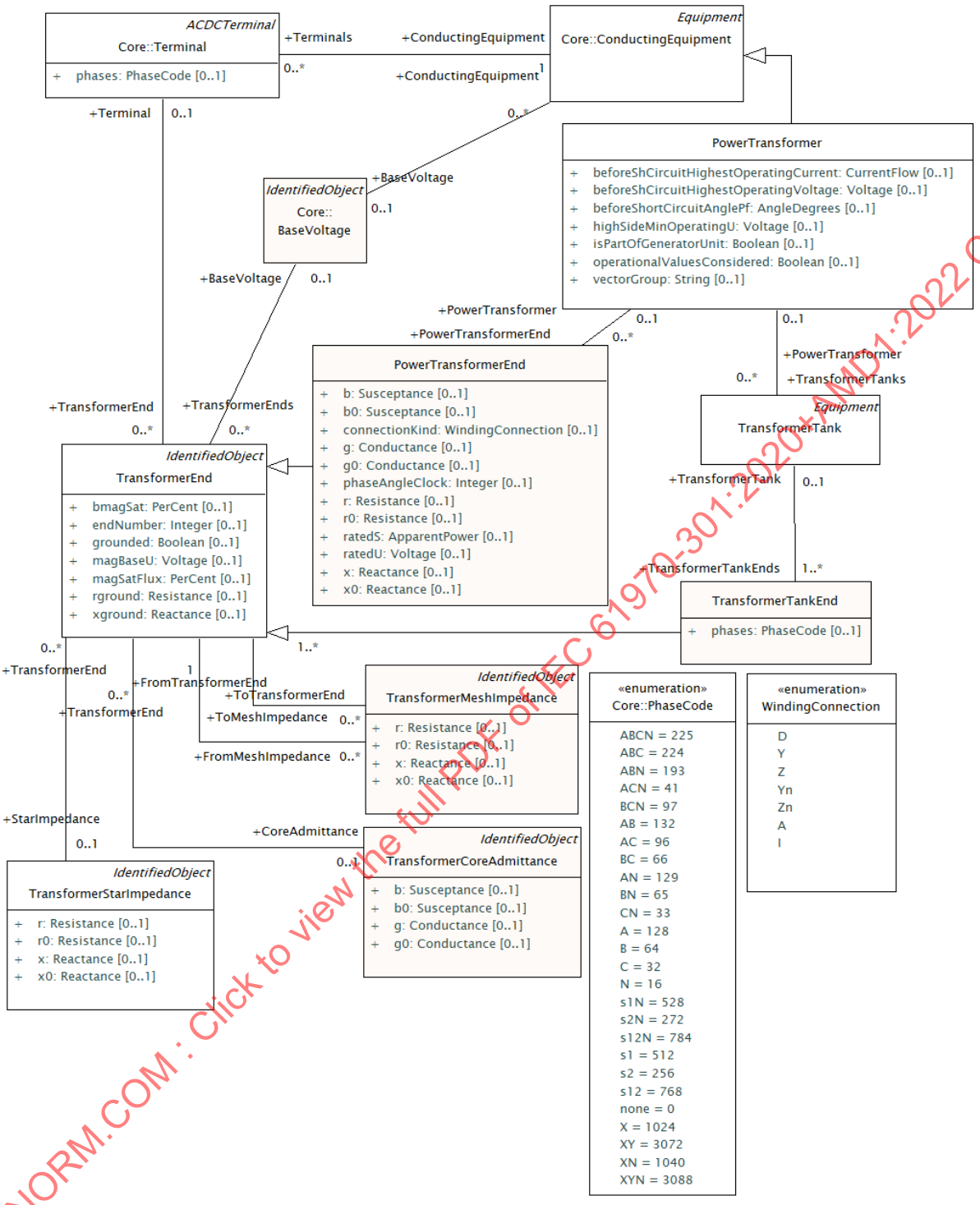
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Figure 100 – Class diagram Wires::WiresPhaseModel

Figure 100: Show the phase connection detail when modelling devices down to the phase components within a conducting equipment.



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Figure 101 – Class diagram Wires::Transformer

Figure 101: This diagram shows classes related to the core transformer model but does not show the tap changer details.

6.4.2 AsynchronousMachineKind enumeration

Kind of Asynchronous Machine.

Table 145 shows all literals of AsynchronousMachineKind.

Table 145 – Literals of Wires::AsynchronousMachineKind

literal	value	description
generator		The Asynchronous Machine is a generator.
motor		The Asynchronous Machine is a motor.

6.4.3 ACLineSegment

A wire or combination of wires, with consistent electrical characteristics, building a single electrical system, used to carry alternating current between points in the power system.

For symmetrical, transposed three phase lines, it is sufficient to use attributes of the line segment, which describe impedances and admittances for the entire length of the segment. Additionally, impedances can be computed by using length and associated per length impedances.

The BaseVoltage at the two ends of ACLineSegments in a Line shall have the same BaseVoltage.nominalVoltage. However, boundary lines may have slightly different BaseVoltage.nominalVoltages and variation is allowed. Larger voltage difference in general requires use of an equivalent branch.

Table 146 shows all attributes of ACLineSegment.

Table 146 – Attributes of Wires::ACLineSegment

name	mult	type	description
b0ch	0..1	Susceptance	Zero sequence shunt (charging) susceptance, uniformly distributed, of the entire line section.
bch	0..1	Susceptance	Positive sequence shunt (charging) susceptance, uniformly distributed, of the entire line section. This value represents the full charging over the full length of the line.
g0ch	0..1	Conductance	Zero sequence shunt (charging) conductance, uniformly distributed, of the entire line section.
gch	0..1	Conductance	Positive sequence shunt (charging) conductance, uniformly distributed, of the entire line section.
r	0..1	Resistance	Positive sequence series resistance of the entire line section.
r0	0..1	Resistance	Zero sequence series resistance of the entire line section.
shortCircuitEndTemperature	0..1	Temperature	Maximum permitted temperature at the end of SC for the calculation of minimum short-circuit currents. Used for short circuit data exchange according to IEC 60909.
x	0..1	Reactance	Positive sequence series reactance of the entire line section.
x0	0..1	Reactance	Zero sequence series reactance of the entire line section.
length	0..1	Length	inherited from: Conductor
aggregate	0..1	Boolean	inherited from: Equipment
inService	0..1	Boolean	inherited from: Equipment
networkAnalysisEnabled	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
aliasName	0..1	String	inherited from: IdentifiedObject

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name	mult	type	description
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 147 shows all association ends of ACLineSegment with other classes.

Table 147 – Association ends of Wires::ACLineSegment with other classes

mult from	name	mult to	type	description
1..1	Clamp	0..*	Clamp	The clamps connected to the line segment.
0..*	PerLengthImpedance	0..1	PerLengthImpedance	Per-length impedance of this line segment.
1..1	Cut	0..*	Cut	Cuts applied to the line segment.
0..1	LineFaults	0..*	LineFault	The line faults of the line segment.
1..1	ACLineSegmentPhases	0..*	ACLineSegmentPhase	The line segment phases which belong to the line segment.
0..*	BaseVoltage	0..1	BaseVoltage	inherited from: ConductingEquipment
1..1	SvStatus	0..*	SvStatus	inherited from: ConductingEquipment
0..*	ProtectionEquipments	0..*	ProtectionEquipment	inherited from: ConductingEquipment
1..1	Terminals	0..*	Terminal	inherited from: ConductingEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	inherited from: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	inherited from: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment
0..1	Faults	0..*	Fault	inherited from: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	inherited from: Equipment
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.4.4 ACLineSegmentPhase

Represents a single wire of an alternating current line segment.

Table 148 shows all attributes of ACLineSegmentPhase.

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Table 148 – Attributes of Wires::ACLineSegmentPhase

name	mult	type	description
phase	0..1	SinglePhaseKind	The phase connection of the wire at both ends.
sequenceNumber	0..1	Integer	Number designation for this line segment phase. Each line segment phase within a line segment should have a unique sequence number. This is useful for unbalanced modelling to bind the mathematical model (PhaseImpedanceData of PerLengthPhaseImpedance) with the connectivity model (this class) and the physical model (WirePosition) without tight coupling.
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 149 shows all association ends of ACLineSegmentPhase with other classes.

Table 149 – Association ends of Wires::ACLineSegmentPhase with other classes

mult from	name	mult to	type	description
0..*	ACLineSegment	1..1	ACLineSegment	The line segment to which the phase belongs.
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.4.5 AsynchronousMachine

A rotating machine whose shaft rotates asynchronously with the electrical field. Also known as an induction machine with no external connection to the rotor windings, e.g. squirrel-cage induction machine.

Table 150 shows all attributes of AsynchronousMachine.

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Table 150 – Attributes of Wires::AsynchronousMachine

name	mult	type	description
asynchronousMachineType	0..1	AsynchronousMachineKind	Indicates the type of Asynchronous Machine (motor or generator).
converterFedDrive	0..1	Boolean	Indicates whether the machine is a converter fed drive. Used for short circuit data exchange according to IEC 60909.
efficiency	0..1	PerCent	Efficiency of the asynchronous machine at nominal operation as a percentage. Indicator for converter drive motors. Used for short circuit data exchange according to IEC 60909.
iaIrRatio	0..1	Float	Ratio of locked-rotor current to the rated current of the motor (Ia/Ir). Used for short circuit data exchange according to IEC 60909.
nominalFrequency	0..1	Frequency	Nameplate data indicates if the machine is 50 Hz or 60 Hz.
nominalSpeed	0..1	RotationSpeed	Nameplate data. Depends on the slip and number of pole pairs.
polePairNumber	0..1	Integer	Number of pole pairs of stator. Used for short circuit data exchange according to IEC 60909.
ratedMechanicalPower	0..1	ActivePower	Rated mechanical power (Pr in IEC 60909-0). Used for short circuit data exchange according to IEC 60909.
reversible	0..1	Boolean	Indicates for converter drive motors if the power can be reversible. Used for short circuit data exchange according to IEC 60909.
rr1	0..1	Resistance	Damper 1 winding resistance.
rr2	0..1	Resistance	Damper 2 winding resistance.
rxLockedRotorRatio	0..1	Float	Locked rotor ratio (R/X). Used for short circuit data exchange according to IEC 60909.
tpo	0..1	Seconds	Transient rotor time constant (greater than tppo).
tppo	0..1	Seconds	Sub-transient rotor time constant (greater than 0).
xlr1	0..1	Reactance	Damper 1 winding leakage reactance.
xlr2	0..1	Reactance	Damper 2 winding leakage reactance.
xm	0..1	Reactance	Magnetizing reactance.
xp	0..1	Reactance	Transient reactance (unsaturated) (greater than or equal to xpp).
xpp	0..1	Reactance	Sub-transient reactance (unsaturated).
xs	0..1	Reactance	Synchronous reactance (greater than xp).
ratedPowerFactor	0..1	Float	inherited from: RotatingMachine
p	0..1	ActivePower	inherited from: RotatingMachine
ratedS	0..1	ApparentPower	inherited from: RotatingMachine
q	0..1	ReactivePower	inherited from: RotatingMachine
ratedU	0..1	Voltage	inherited from: RotatingMachine
controlEnabled	0..1	Boolean	inherited from: RegulatingCondEq
aggregate	0..1	Boolean	inherited from: Equipment
inService	0..1	Boolean	inherited from: Equipment
networkAnalysisEnabled	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment

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name	mult	type	description
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 151 shows all association ends of AsynchronousMachine with other classes.

Table 151 – Association ends of Wires::AsynchronousMachine with other classes

mult from	name	mult to	type	description
1..1	AsynchronousMachineDynamics	0..1	AsynchronousMachineDynamics	Asynchronous machine dynamics model used to describe dynamic behaviour of this asynchronous machine.
1..1	HydroPump	0..1	HydroPump	inherited from: RotatingMachine
0..*	GeneratingUnit	0..1	GeneratingUnit	inherited from: RotatingMachine
~~1~~0..*	RegulatingControl	0..1	RegulatingControl	inherited from: RegulatingCondEq
0..*	BaseVoltage	0..1	BaseVoltage	inherited from: ConductingEquipment
1..1	SvStatus	0..*	SvStatus	inherited from: ConductingEquipment
0..*	ProtectionEquipments	0..*	ProtectionEquipment	inherited from: ConductingEquipment
1..1	Terminals	0..*	Terminal	inherited from: ConductingEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	inherited from: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	inherited from: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment
0..1	Faults	0..*	Fault	inherited from: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	inherited from: Equipment
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.4.6 Breaker

A mechanical switching device capable of making, carrying, and breaking currents under normal circuit conditions and also making, carrying for a specified time, and breaking currents under specified abnormal circuit conditions e.g. those of short circuit.

Table 152 shows all attributes of Breaker.

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Table 152 – Attributes of Wires::Breaker

name	mult	type	description
inTransitTime	0..1	Seconds	The transition time from open to close.
breakingCapacity	0..1	CurrentFlow	inherited from: ProtectedSwitch
normalOpen	0..1	Boolean	inherited from: Switch
ratedCurrent	0..1	CurrentFlow	inherited from: Switch
switchOnCount	0..1	Integer	(deprecated) inherited from: Switch
switchOnDate	0..1	DateTime	(deprecated) inherited from: Switch
retained	0..1	Boolean	inherited from: Switch
open	0..1	Boolean	inherited from: Switch
locked	0..1	Boolean	inherited from: Switch
aggregate	0..1	Boolean	inherited from: Equipment
inService	0..1	Boolean	inherited from: Equipment
networkAnalysisEnabled	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 153 shows all association ends of Breaker with other classes.

Table 153 – Association ends of Wires::Breaker with other classes

mult from	name	mult to	type	description
0..*	OperatedByProtectionEquipment	0..*	ProtectionEquipment	inherited from: ProtectedSwitch
1..1	RecloseSequences	0..*	RecloseSequence	inherited from: ProtectedSwitch
1..1	SwitchPhase	0..*	SwitchPhase	inherited from: Switch
1..1	SwitchSchedules	0..*	SwitchSchedule	inherited from: Switch
0..*	CompositeSwitch	0..1	CompositeSwitch	inherited from: Switch
1..1	SvSwitch	0..*	SvSwitch	inherited from: Switch
0..*	BaseVoltage	0..1	BaseVoltage	inherited from: ConductingEquipment
1..1	SvStatus	0..*	SvStatus	inherited from: ConductingEquipment
0..*	ProtectionEquipments	0..*	ProtectionEquipment	inherited from: ConductingEquipment
1..1	Terminals	0..*	Terminal	inherited from: ConductingEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	inherited from: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	inherited from: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment
0..1	Faults	0..*	Fault	inherited from: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	inherited from: Equipment
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource

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mult from	name	mult to	type	description
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.4.7 BusbarSection

A conductor, or group of conductors, with negligible impedance, that serve to connect other conducting equipment within a single substation.

Voltage measurements are typically obtained from voltage transformers that are connected to busbar sections. A bus bar section may have many physical terminals but for analysis is modelled with exactly one logical terminal.

Table 154 shows all attributes of BusbarSection.

Table 154 – Attributes of Wires::BusbarSection

name	mult	type	description
ipMax	0..1	CurrentFlow	Maximum allowable peak short-circuit current of busbar (Ipmax in IEC 60909-0). Mechanical limit of the busbar in the substation itself. Used for short circuit data exchange according to IEC 60909.
aggregate	0..1	Boolean	inherited from: Equipment
inService	0..1	Boolean	inherited from: Equipment
networkAnalysisEnabled	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 155 shows all association ends of BusbarSection with other classes.

Table 155 – Association ends of Wires::BusbarSection with other classes

mult from	name	mult to	type	description
1..1	VoltageControlZone	0..1	VoltageControlZone	A VoltageControlZone is controlled by a designated BusbarSection.
0..*	BaseVoltage	0..1	BaseVoltage	inherited from: ConductingEquipment
1..1	SvStatus	0..*	SvStatus	inherited from: ConductingEquipment
0..*	ProtectionEquipments	0..*	ProtectionEquipment	inherited from: ConductingEquipment
1..1	Terminals	0..*	Terminal	inherited from: ConductingEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	inherited from: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	inherited from: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment

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mult from	name	mult to	type	description
0..1	Faults	0..*	Fault	inherited from: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	inherited from: Equipment
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.4.8 Clamp

A Clamp is a galvanic connection at a line segment where other equipment is connected. A Clamp does not cut the line segment.

A Clamp is ConductingEquipment and has one Terminal with an associated ConnectivityNode. Any other ConductingEquipment can be connected to the Clamp ConnectivityNode.

Table 156 shows all attributes of Clamp.

Table 156 – Attributes of Wires::Clamp

name	mult	type	description
lengthFromTerminal1	0..1	Length	The length to the place where the clamp is located starting from side one of the line segment, i.e. the line segment terminal with sequence number equal to 1.
aggregate	0..1	Boolean	inherited from: Equipment
inService	0..1	Boolean	inherited from: Equipment
networkAnalysisEnabled	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 157 shows all association ends of Clamp with other classes.

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Table 157 – Association ends of Wires::Clamp with other classes

mult from	name	mult to	type	description
0..*	ACLineSegment	1..1	ACLineSegment	The line segment to which the clamp is connected.
0..*	BaseVoltage	0..1	BaseVoltage	inherited from: ConductingEquipment
1..1	SvStatus	0..*	SvStatus	inherited from: ConductingEquipment
0..*	ProtectionEquipments	0..*	ProtectionEquipment	inherited from: ConductingEquipment
1..1	Terminals	0..*	Terminal	inherited from: ConductingEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	inherited from: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	inherited from: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment
0..1	Faults	0..*	Fault	inherited from: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	inherited from: Equipment
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.4.9 CompositeSwitch

A model of a set of individual Switches normally enclosed within the same cabinet and possibly with interlocks that restrict the combination of switch positions. These are typically found in medium voltage distribution networks.

A CompositeSwitch could represent a Ring-Main-Unit (RMU), or pad-mounted switchgear, with primitive internal devices such as an internal bus-bar plus 3 or 4 internal switches each of which may individually be open or closed. A CompositeSwitch and a set of contained Switches can also be used to represent a multi-position switch e.g. a switch that can connect a circuit to Ground, Open or Busbar.

Table 158 shows all attributes of CompositeSwitch.

Table 158 – Attributes of Wires::CompositeSwitch

name	mult	type	description
compositeSwitchType	0..1	String	An alphanumeric code that can be used as a reference to extra information such as the description of the interlocking scheme if any.
aggregate	0..1	Boolean	inherited from: Equipment
inService	0..1	Boolean	inherited from: Equipment
networkAnalysisEnabled	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject

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name	mult	type	description
name	0..1	String	inherited from: IdentifiedObject

Table 159 shows all association ends of CompositeSwitch with other classes.

Table 159 – Association ends of Wires::CompositeSwitch with other classes

mult from	name	mult to	type	description
0..1	Switches	0..*	Switch	Switches contained in this Composite switch.
0..1	OperationalLimitSet	0..*	OperationalLimitSet	inherited from: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	inherited from: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment
0..1	Faults	0..*	Fault	inherited from: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	inherited from: Equipment
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.4.10 Conductor

Combination of conducting material with consistent electrical characteristics, building a single electrical system, used to carry current between points in the power system.

Table 160 shows all attributes of Conductor.

Table 160 – Attributes of Wires::Conductor

name	mult	type	description
length	0..1	Length	Segment length for calculating line section capabilities.
aggregate	0..1	Boolean	inherited from: Equipment
inService	0..1	Boolean	inherited from: Equipment
networkAnalysisEnabled	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 161 shows all association ends of Conductor with other classes.

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Table 161 – Association ends of Wires::Conductor with other classes

mult from	name	mult to	type	description
0..*	BaseVoltage	0..1	BaseVoltage	inherited from: ConductingEquipment
1..1	SvStatus	0..*	SvStatus	inherited from: ConductingEquipment
0..*	ProtectionEquipments	0..*	ProtectionEquipment	inherited from: ConductingEquipment
1..1	Terminals	0..*	Terminal	inherited from: ConductingEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	inherited from: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	inherited from: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment
0..1	Faults	0..*	Fault	inherited from: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	inherited from: Equipment
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.4.11 Connector

A conductor, or group of conductors, with negligible impedance, that serve to connect other conducting equipment within a single substation and are modelled with a single logical terminal.

Table 162 shows all attributes of Connector.

Table 162 – Attributes of Wires::Connector

name	mult	type	description
aggregate	0..1	Boolean	inherited from: Equipment
inService	0..1	Boolean	inherited from: Equipment
networkAnalysisEnabled	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 163 shows all association ends of Connector with other classes.

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Table 163 – Association ends of Wires::Connector with other classes

mult from	name	mult to	type	description
0..*	BaseVoltage	0..1	BaseVoltage	inherited from: ConductingEquipment
1..1	SvStatus	0..*	SvStatus	inherited from: ConductingEquipment
0..*	ProtectionEquipments	0..*	ProtectionEquipment	inherited from: ConductingEquipment
1..1	Terminals	0..*	Terminal	inherited from: ConductingEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	inherited from: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	inherited from: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment
0..1	Faults	0..*	Fault	inherited from: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	inherited from: Equipment
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.4.12 CoolantType enumeration

Method of cooling a machine.

Table 164 shows all literals of CoolantType.

Table 164 – Literals of Wires::CoolantType

literal	value	description
air		Air.
hydrogenGas		Hydrogen gas.
water		Water.

6.4.13 Cut

A cut separates a line segment into two parts. The cut appears as a switch inserted between these two parts and connects them together. As the cut is normally open there is no galvanic connection between the two line segment parts. But it is possible to close the cut to get galvanic connection.

The cut terminals are oriented towards the line segment terminals with the same sequence number. Hence the cut terminal with sequence number equal to 1 is oriented to the line segment's terminal with sequence number equal to 1.

The cut terminals also act as connection points for jumpers and other equipment, e.g. a mobile generator. To enable this, connectivity nodes are placed at the cut terminals. Once the connectivity nodes are in place any conducting equipment can be connected at them.

Table 165 shows all attributes of Cut.

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Table 165 – Attributes of Wires::Cut

name	mult	type	description
lengthFromTerminal1	0..1	Length	The length to the place where the cut is located starting from side one of the cut line segment, i.e. the line segment Terminal with sequenceNumber equal to 1.
normalOpen	0..1	Boolean	inherited from: Switch
ratedCurrent	0..1	CurrentFlow	inherited from: Switch
switchOnCount	0..1	Integer	(deprecated) inherited from: Switch
switchOnDate	0..1	DateTime	(deprecated) inherited from: Switch
retained	0..1	Boolean	inherited from: Switch
open	0..1	Boolean	inherited from: Switch
locked	0..1	Boolean	inherited from: Switch
aggregate	0..1	Boolean	inherited from: Equipment
inService	0..1	Boolean	inherited from: Equipment
networkAnalysisEnabled	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 166 shows all association ends of Cut with other classes.

Table 166 – Association ends of Wires::Cut with other classes

mult from	name	mult to	type	description
0..*	ACLineSegment	1..1	ACLineSegment	The line segment to which the cut is applied.
1..1	SwitchPhase	0..*	SwitchPhase	inherited from: Switch
1..1	SwitchSchedules	0..*	SwitchSchedule	inherited from: Switch
0..*	CompositeSwitch	0..1	CompositeSwitch	inherited from: Switch
1..1	SvSwitch	0..*	SvSwitch	inherited from: Switch
0..*	BaseVoltage	0..1	BaseVoltage	inherited from: ConductingEquipment
1..1	SvStatus	0..*	SvStatus	inherited from: ConductingEquipment
0..*	ProtectionEquipments	0..*	ProtectionEquipment	inherited from: ConductingEquipment
1..1	Terminals	0..*	Terminal	inherited from: ConductingEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	inherited from: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	inherited from: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment
0..1	Faults	0..*	Fault	inherited from: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	inherited from: Equipment
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource

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mult from	name	mult to	type	description
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.4.14 Disconnector

A manually operated or motor operated mechanical switching device used for changing the connections in a circuit, or for isolating a circuit or equipment from a source of power. It is required to open or close circuits when negligible current is broken or made.

Table 167 shows all attributes of Disconnector.

Table 167 – Attributes of Wires::Disconnector

name	mult	type	description
normalOpen	0..1	Boolean	inherited from: Switch
ratedCurrent	0..1	CurrentFlow	inherited from: Switch
switchOnCount	0..1	Integer	(deprecated) inherited from: Switch
switchOnDate	0..1	DateTime	(deprecated) inherited from: Switch
retained	0..1	Boolean	inherited from: Switch
open	0..1	Boolean	inherited from: Switch
locked	0..1	Boolean	inherited from: Switch
aggregate	0..1	Boolean	inherited from: Equipment
inService	0..1	Boolean	inherited from: Equipment
networkAnalysisEnabled	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 168 shows all association ends of Disconnector with other classes.

Table 168 – Association ends of Wires::Disconnector with other classes

mult from	name	mult to	type	description
1..1	SwitchPhase	0..*	SwitchPhase	inherited from: Switch
1..1	SwitchSchedules	0..*	SwitchSchedule	inherited from: Switch
0..*	CompositeSwitch	0..1	CompositeSwitch	inherited from: Switch
1..1	SvSwitch	0..*	SvSwitch	inherited from: Switch
0..*	BaseVoltage	0..1	BaseVoltage	inherited from: ConductingEquipment
1..1	SvStatus	0..*	SvStatus	inherited from: ConductingEquipment
0..*	ProtectionEquipments	0..*	ProtectionEquipment	inherited from: ConductingEquipment
1..1	Terminals	0..*	Terminal	inherited from: ConductingEquipment

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mult from	name	mult to	type	description
0..1	OperationalLimitSet	0..*	OperationalLimitSet	inherited from: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	inherited from: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment
0..1	Faults	0..*	Fault	inherited from: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	inherited from: Equipment
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.4.15 DisconnectingCircuitBreaker

A circuit breaking device including disconnecting function, eliminating the need for separate disconnectors.

Table 169 shows all attributes of DisconnectingCircuitBreaker.

Table 169 – Attributes of Wires::DisconnectingCircuitBreaker

name	mult	type	description
inTransitTime	0..1	Seconds	inherited from: Breaker
breakingCapacity	0..1	CurrentFlow	inherited from: ProtectedSwitch
normalOpen	0..1	Boolean	inherited from: Switch
ratedCurrent	0..1	CurrentFlow	inherited from: Switch
switchOnCount	0..1	Integer	(deprecated) inherited from: Switch
switchOnDate	0..1	DateTime	(deprecated) inherited from: Switch
retained	0..1	Boolean	inherited from: Switch
open	0..1	Boolean	inherited from: Switch
locked	0..1	Boolean	inherited from: Switch
aggregate	0..1	Boolean	inherited from: Equipment
inService	0..1	Boolean	inherited from: Equipment
networkAnalysisEnabled	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 170 shows all association ends of DisconnectingCircuitBreaker with other classes.

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Table 170 – Association ends of Wires::DisconnectingCircuitBreaker with other classes

mult from	name	mult to	type	description
0..*	OperatedByProtectionEquipment	0..*	ProtectionEquipment	inherited from: ProtectedSwitch
1..1	RecloseSequences	0..*	RecloseSequence	inherited from: ProtectedSwitch
1..1	SwitchPhase	0..*	SwitchPhase	inherited from: Switch
1..1	SwitchSchedules	0..*	SwitchSchedule	inherited from: Switch
0..*	CompositeSwitch	0..1	CompositeSwitch	inherited from: Switch
1..1	SvSwitch	0..*	SvSwitch	inherited from: Switch
0..*	BaseVoltage	0..1	BaseVoltage	inherited from: ConductingEquipment
1..1	SvStatus	0..*	SvStatus	inherited from: ConductingEquipment
0..*	ProtectionEquipments	0..*	ProtectionEquipment	inherited from: ConductingEquipment
1..1	Terminals	0..*	Terminal	inherited from: ConductingEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	inherited from: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	inherited from: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment
0..1	Faults	0..*	Fault	inherited from: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	inherited from: Equipment
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.4.16 EarthFaultCompensator

A conducting equipment used to represent a connection to ground which is typically used to compensate earth faults. An earth fault compensator device modelled with a single terminal implies a second terminal solidly connected to ground. If two terminals are modelled, the ground is not assumed and normal connection rules apply.

Table 171 shows all attributes of EarthFaultCompensator.

Table 171 – Attributes of Wires::EarthFaultCompensator

name	mult	type	description
r	0..1	Resistance	Nominal resistance of device.
aggregate	0..1	Boolean	inherited from: Equipment
inService	0..1	Boolean	inherited from: Equipment
networkAnalysisEnabled	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject

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name	mult	type	description
name	0..1	String	inherited from: IdentifiedObject

Table 172 shows all association ends of EarthFaultCompensator with other classes.

Table 172 – Association ends of Wires::EarthFaultCompensator with other classes

mult from	name	mult to	type	description
0..*	BaseVoltage	0..1	BaseVoltage	inherited from: ConductingEquipment
1..1	SvStatus	0..*	SvStatus	inherited from: ConductingEquipment
0..*	ProtectionEquipments	0..*	ProtectionEquipment	inherited from: ConductingEquipment
1..1	Terminals	0..*	Terminal	inherited from: ConductingEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	inherited from: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	inherited from: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment
0..1	Faults	0..*	Fault	inherited from: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	inherited from: Equipment
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.4.17 EnergyConnection

A connection of energy generation or consumption on the power system model.

Table 173 shows all attributes of EnergyConnection.

Table 173 – Attributes of Wires::EnergyConnection

name	mult	type	description
aggregate	0..1	Boolean	inherited from: Equipment
inService	0..1	Boolean	inherited from: Equipment
networkAnalysisEnabled	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 174 shows all association ends of EnergyConnection with other classes.

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Table 174 – Association ends of Wires::EnergyConnection with other classes

mult from	name	mult to	type	description
0..*	BaseVoltage	0..1	BaseVoltage	inherited from: ConductingEquipment
1..1	SvStatus	0..*	SvStatus	inherited from: ConductingEquipment
0..*	ProtectionEquipments	0..*	ProtectionEquipment	inherited from: ConductingEquipment
1..1	Terminals	0..*	Terminal	inherited from: ConductingEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	inherited from: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	inherited from: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment
0..1	Faults	0..*	Fault	inherited from: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	inherited from: Equipment
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.4.18 EnergyConsumer

Generic user of energy – a point of consumption on the power system model.

EnergyConsumer.pfixed, .qfixed, .pfixedPct and .qfixedPct have meaning only if there is no LoadResponseCharacteristic associated with EnergyConsumer or if LoadResponseCharacteristic.exponentModel is set to False.

Table 175 shows all attributes of EnergyConsumer.

Table 175 – Attributes of Wires::EnergyConsumer

name	mult	type	description
customerCount	0..1	Integer	Number of individual customers represented by this demand.
grounded	0..1	Boolean	Used for Yn and Zn connections. True if the neutral is solidly grounded.
pfixed	0..1	ActivePower	Active power of the load that is a fixed quantity and does not vary as load group value varies. Load sign convention is used, i.e. positive sign means flow out from a node.
pfixedPct	0..1	PerCent	Fixed active power as a percentage of load group fixed active power. Used to represent the time-varying components. Load sign convention is used, i.e. positive sign means flow out from a node.
phaseConnection	0..1	PhaseShuntConnectionKind	The type of phase connection, such as wye or delta.
qfixed	0..1	ReactivePower	Reactive power of the load that is a fixed quantity and does not vary as load group value varies. Load sign convention is used, i.e. positive sign means flow out from a node.

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name	mult	type	description
qfixedPct	0..1	PerCent	Fixed reactive power as a percentage of load group fixed reactive power. Used to represent the time-varying components. Load sign convention is used, i.e. positive sign means flow out from a node.
p	0..1	ActivePower	Active power of the load. Load sign convention is used, i.e. positive sign means flow out from a node. For voltage dependent loads the value is at rated voltage. Starting value for a steady state solution.
q	0..1	ReactivePower	Reactive power of the load. Load sign convention is used, i.e. positive sign means flow out from a node. For voltage dependent loads the value is at rated voltage. Starting value for a steady state solution.
aggregate	0..1	Boolean	inherited from: EquipmentContent
inService	0..1	Boolean	inherited from: Equipment
networkAnalysisEnabled	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 176 shows all association ends of EnergyConsumer with other classes.

Table 176 – Association ends of Wires::EnergyConsumer with other classes

mult from	name	mult to	type	description
0..*	LoadResponse	0..1	LoadResponseCharacteristic	The load response characteristic of this load. If missing, this load is assumed to be constant power.
1..1	EnergyConsumerPhase	0..*	EnergyConsumerPhase	The individual phase models for this energy consumer.
1..*	PowerCutZone	0..1	PowerCutZone	The energy consumer is assigned to this power cut zone.
0..*	LoadDynamics	0..1	LoadDynamics	Load dynamics model used to describe dynamic behaviour of this energy consumer.
0..*	BaseVoltage	0..1	BaseVoltage	inherited from: ConductingEquipment
1..1	SvStatus	0..*	SvStatus	inherited from: ConductingEquipment
0..*	ProtectionEquipments	0..*	ProtectionEquipment	inherited from: ConductingEquipment
1..1	Terminals	0..*	Terminal	inherited from: ConductingEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	inherited from: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	inherited from: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment
0..1	Faults	0..*	Fault	inherited from: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	inherited from: Equipment

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mult from	name	mult to	type	description
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.4.19 EnergyConsumerPhase

A single phase of an energy consumer.

Table 177 shows all attributes of EnergyConsumerPhase.

Table 177 – Attributes of Wires::EnergyConsumerPhase

name	mult	type	description
pfixed	0..1	ActivePower	Active power of the load that is a fixed quantity. Load sign convention is used, i.e. positive sign means flow out from a node.
pfixedPct	0..1	PerCent	Fixed active power as per cent of load group fixed active power. Load sign convention is used, i.e. positive sign means flow out from a node.
phase	0..1	SinglePhaseKind	Phase of this energy consumer component. If the energy consumer is wye connected, the connection is from the indicated phase to the central ground or neutral point. If the energy consumer is delta connected, the phase indicates an energy consumer connected from the indicated phase to the next logical non-neutral phase.
qfixed	0..1	ReactivePower	Reactive power of the load that is a fixed quantity. Load sign convention is used, i.e. positive sign means flow out from a node.
qfixedPct	0..1	PerCent	Fixed reactive power as per cent of load group fixed reactive power. Load sign convention is used, i.e. positive sign means flow out from a node.
p	0..1	ActivePower	Active power of the load. Load sign convention is used, i.e. positive sign means flow out from a node. For voltage dependent loads the value is at rated voltage. Starting value for a steady state solution.
q	0..1	ReactivePower	Reactive power of the load. Load sign convention is used, i.e. positive sign means flow out from a node. For voltage dependent loads the value is at rated voltage. Starting value for a steady state solution.
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject

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name	mult	type	description
name	0..1	String	inherited from: IdentifiedObject

Table 178 shows all association ends of EnergyConsumerPhase with other classes.

Table 178 – Association ends of Wires::EnergyConsumerPhase with other classes

mult from	name	mult to	type	description
0..*	EnergyConsumer	1..1	EnergyConsumer	The energy consumer to which this phase belongs.
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.4.20 EnergySchedulingType

Used to define the type of generation for scheduling purposes.

Table 179 shows all attributes of EnergySchedulingType.

Table 179 – Attributes of Wires::EnergySchedulingType

name	mult	type	description
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 180 shows all association ends of EnergySchedulingType with other classes.

Table 180 – Association ends of Wires::EnergySchedulingType with other classes

mult from	name	mult to	type	description
0..1	EnergySource	0..*	EnergySource	Energy Source of a particular Energy Scheduling Type.
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.4.21 EnergySource

A generic equivalent for an energy supplier on a transmission or distribution voltage level.

Table 181 shows all attributes of EnergySource.

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Table 181 – Attributes of Wires::EnergySource

name	mult	type	description
activePower	0..1	ActivePower	High voltage source active injection. Load sign convention is used, i.e. positive sign means flow out from a node. Starting value for steady state solutions.
reactivePower	0..1	ReactivePower	High voltage source reactive injection. Load sign convention is used, i.e. positive sign means flow out from a node. Starting value for steady state solutions.
nominalVoltage	0..1	Voltage	Phase-to-phase nominal voltage.
r	0..1	Resistance	Positive sequence Thevenin resistance.
r0	0..1	Resistance	Zero sequence Thevenin resistance.
rn	0..1	Resistance	Negative sequence Thevenin resistance.
voltageAngle	0..1	AngleRadians	Phase angle of a-phase open circuit used when voltage characteristics need to be imposed at the node associated with the terminal of the energy source, such as when voltages and angles from the transmission level are used as input to the distribution network. The attribute shall be a positive value or zero.
voltageMagnitude	0..1	Voltage	Phase-to-phase open circuit voltage magnitude used when voltage characteristics need to be imposed at the node associated with the terminal of the energy source, such as when voltages and angles from the transmission level are used as input to the distribution network. The attribute shall be a positive value or zero.
x	0..1	Reactance	Positive sequence Thevenin reactance.
x0	0..1	Reactance	Zero sequence Thevenin reactance.
xn	0..1	Reactance	Negative sequence Thevenin reactance.
pMin	0..1	ActivePower	This is the minimum active power that can be produced by the source. Load sign convention is used, i.e. positive sign means flow out from a TopologicalNode (bus) into the conducting equipment.
pMax	0..1	ActivePower	This is the maximum active power that can be produced by the source. Load sign convention is used, i.e. positive sign means flow out from a TopologicalNode (bus) into the conducting equipment.
aggregate	0..1	Boolean	inherited from: Equipment
inService	0..1	Boolean	inherited from: Equipment
networkAnalysisEnabled	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 182 shows all association ends of EnergySource with other classes.

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Table 182 – Association ends of Wires::EnergySource with other classes

mult from	name	mult to	type	description
0..*	EnergySchedulingType	0..1	EnergySchedulingType	Energy Scheduling Type of an Energy Source.
1..1	EnergySourcePhase	0..*	EnergySourcePhase	The individual phase information of the energy source.
0..*	BaseVoltage	0..1	BaseVoltage	inherited from: ConductingEquipment
1..1	SvStatus	0..*	SvStatus	inherited from: ConductingEquipment
0..*	ProtectionEquipments	0..*	ProtectionEquipment	inherited from: ConductingEquipment
1..1	Terminals	0..*	Terminal	inherited from: ConductingEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	inherited from: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	inherited from: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment
0..1	Faults	0..*	Fault	inherited from: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	inherited from: Equipment
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.4.22 EnergySourcePhase

Represents the single phase information of an unbalanced energy source.

Table 183 shows all attributes of EnergySourcePhase.

Table 183 – Attributes of Wires::EnergySourcePhase

name	mult	type	description
phase	0..1	SinglePhaseKind	Phase of this energy source component. If the energy source wye connected, the connection is from the indicated phase to the central ground or neutral point. If the energy source is delta connected, the phase indicates an energy source connected from the indicated phase to the next logical non-neutral phase.
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 184 shows all association ends of EnergySourcePhase with other classes.

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Table 184 – Association ends of Wires::EnergySourcePhase with other classes

mult from	name	mult to	type	description
0..*	EnergySource	1..1	EnergySource	The energy sourceto which the phase belongs.
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.4.23 ExternalNetworkInjection

This class represents the external network and it is used for IEC 60909 calculations.

Table 185 shows all attributes of ExternalNetworkInjection.

Table 185 – Attributes of Wires::ExternalNetworkInjection

name	mult	type	description
governorSCD	0..1	ActivePowerPerFrequency	Power Frequency Bias. This is the change in power injection divided by the change in frequency and negated. A positive value of the power frequency bias provides additional power injection upon a drop in frequency.
ikSecond	0..1	Boolean	Indicates whether initial symmetrical short-circuit current and power have been calculated according to IEC (Ik"). Used only if short circuit calculations are done according to superposition method.
maxInitialSymShCCurrent	0..1	CurrentFlow	Maximum initial symmetrical short-circuit currents (Ik" max) in A (Ik" = Sk"/(SQRT(3) Un)). Used for short circuit data exchange according to IEC 60909.
maxP	0..1	ActivePower	Maximum active power of the injection.
maxQ	0..1	ReactivePower	Maximum reactive power limit. It is used for modelling of infeed for load flow exchange and not for short circuit modelling.
maxR0ToX0Ratio	0..1	Float	Maximum ratio of zero sequence resistance of Network Feeder to its zero sequence reactance (R(0)/X(0) max). Used for short circuit data exchange according to IEC 60909.
maxR1ToX1Ratio	0..1	Float	Maximum ratio of positive sequence resistance of Network Feeder to its positive sequence reactance (R(1)/X(1) max). Used for short circuit data exchange according to IEC 60909.
maxZ0ToZ1Ratio	0..1	Float	Maximum ratio of zero sequence impedance to its positive sequence impedance (Z(0)/Z(1) max). Used for short circuit data exchange according to IEC 60909.
minInitialSymShCCurrent	0..1	CurrentFlow	Minimum initial symmetrical short-circuit currents (Ik" min) in A (Ik" = Sk"/(SQRT(3) Un)). Used for short circuit data exchange according to IEC 60909.
minP	0..1	ActivePower	Minimum active power of the injection.

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name	mult	type	description
minQ	0..1	ReactivePower	Minimum reactive power limit. It is used for modelling of infeed for load flow exchange and not for short circuit modelling.
minR0ToX0Ratio	0..1	Float	Indicates whether initial symmetrical short-circuit current and power have been calculated according to IEC (Ik"). Used for short circuit data exchange according to IEC 6090.
minR1ToX1Ratio	0..1	Float	Minimum ratio of positive sequence resistance of Network Feeder to its positive sequence reactance (R(1)/X(1) min). Used for short circuit data exchange according to IEC 60909.
minZ0ToZ1Ratio	0..1	Float	Minimum ratio of zero sequence impedance to its positive sequence impedance (Z(0)/Z(1) min). Used for short circuit data exchange according to IEC 60909.
referencePriority	0..1	Integer	Priority of unit for use as powerflow voltage phase angle reference bus selection. 0 = don t care (default) 1 = highest priority. 2 is less than 1 and so on.
voltageFactor	0..1	PU	Voltage factor in pu, which was used to calculate short-circuit current Ik" and power Sk". Used only if short circuit calculations are done according to superposition method.
p	0..1	ActivePower	Active power injection. Load sign convention is used, i.e. positive sign means flow out from a node. Starting value for steady state solutions.
q	0..1	ReactivePower	Reactive power injection. Load sign convention is used, i.e. positive sign means flow out from a node. Starting value for steady state solutions.
controlEnabled	0..1	Boolean	inherited from: RegulatingCondEq
aggregate	0..1	Boolean	inherited from: Equipment
inService	0..1	Boolean	inherited from: Equipment
networkAnalysisEnabled	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 186 shows all association ends of ExternalNetworkInjection with other classes.

Table 186 – Association ends of Wires::ExternalNetworkInjection with other classes

mult from	name	mult to	type	description
~~1~~0..*	RegulatingControl	0..1	RegulatingControl	inherited from: RegulatingCondEq
0..*	BaseVoltage	0..1	BaseVoltage	inherited from: ConductingEquipment
1..1	SvStatus	0..*	SvStatus	inherited from: ConductingEquipment
0..*	ProtectionEquipments	0..*	ProtectionEquipment	inherited from: ConductingEquipment
1..1	Terminals	0..*	Terminal	inherited from: ConductingEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	inherited from: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	inherited from: Equipment

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mult from	name	mult to	type	description
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment
0..1	Faults	0..*	Fault	inherited from: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	inherited from: Equipment
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.4.24 FrequencyConverter

A device to convert from one frequency to another (e.g., frequency F1 to F2) comprises a pair of FrequencyConverter instances. One converts from F1 to DC, the other converts the DC to F2.

Table 187 shows all attributes of FrequencyConverter.

Table 187 – Attributes of Wires::FrequencyConverter

name	mult	type	description
frequency	0..1	Frequency	Frequency on the AC side.
maxP	0..1	ActivePower	The maximum active power on the DC side at which the frequency converter should operate.
maxU	0..1	Voltage	The maximum voltage on the DC side at which the frequency converter should operate.
minP	0..1	ActivePower	The minimum active power on the DC side at which the frequency converter should operate.
minU	0..1	Voltage	The minimum voltage on the DC side at which the frequency converter should operate.
controlEnabled	0..1	Boolean	inherited from: RegulatingCondEq
aggregate	0..1	Boolean	inherited from: Equipment
inService	0..1	Boolean	inherited from: Equipment
networkAnalysisEnabled	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 188 shows all association ends of FrequencyConverter with other classes.

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Table 188 – Association ends of Wires::FrequencyConverter with other classes

mult from	name	mult to	type	description
~~1~~0..*	RegulatingControl	0..1	RegulatingControl	inherited from: RegulatingCondEq
0..*	BaseVoltage	0..1	BaseVoltage	inherited from: ConductingEquipment
1..1	SvStatus	0..*	SvStatus	inherited from: ConductingEquipment
0..*	ProtectionEquipments	0..*	ProtectionEquipment	inherited from: ConductingEquipment
1..1	Terminals	0..*	Terminal	inherited from: ConductingEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	inherited from: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	inherited from: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment
0..1	Faults	0..*	Fault	inherited from: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	inherited from: Equipment
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.4.25 Fuse

An overcurrent protective device with a circuit opening fusible part that is heated and severed by the passage of overcurrent through it. A fuse is considered a switching device because it breaks current.

Table 189 shows all attributes of Fuse.

Table 189 – Attributes of Wires::Fuse

name	mult	type	description
normalOpen	0..1	Boolean	inherited from: Switch
ratedCurrent	0..1	CurrentFlow	inherited from: Switch
switchOnCount	0..1	Integer	(deprecated) inherited from: Switch
switchOnDate	0..1	DateTime	(deprecated) inherited from: Switch
retained	0..1	Boolean	inherited from: Switch
open	0..1	Boolean	inherited from: Switch
locked	0..1	Boolean	inherited from: Switch
aggregate	0..1	Boolean	inherited from: Equipment
inService	0..1	Boolean	inherited from: Equipment
networkAnalysisEnabled	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject

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name	mult	type	description
name	0..1	String	inherited from: IdentifiedObject

Table 190 shows all association ends of Fuse with other classes.

Table 190 – Association ends of Wires::Fuse with other classes

mult from	name	mult to	type	description
1..1	SwitchPhase	0..*	SwitchPhase	inherited from: Switch
1..1	SwitchSchedules	0..*	SwitchSchedule	inherited from: Switch
0..*	CompositeSwitch	0..1	CompositeSwitch	inherited from: Switch
1..1	SvSwitch	0..*	SvSwitch	inherited from: Switch
0..*	BaseVoltage	0..1	BaseVoltage	inherited from: ConductingEquipment
1..1	SvStatus	0..*	SvStatus	inherited from: ConductingEquipment
0..*	ProtectionEquipments	0..*	ProtectionEquipment	inherited from: ConductingEquipment
1..1	Terminals	0..*	Terminal	inherited from: ConductingEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	inherited from: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	inherited from: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment
0..1	Faults	0..*	Fault	inherited from: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	inherited from: Equipment
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.4.26 Ground

A point where the system is grounded used for connecting conducting equipment to ground. The power system model can have any number of grounds.

Table 191 shows all attributes of Ground.

Table 191 – Attributes of Wires::Ground

name	mult	type	description
aggregate	0..1	Boolean	inherited from: Equipment
inService	0..1	Boolean	inherited from: Equipment
networkAnalysisEnabled	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject

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name	mult	type	description
name	0..1	String	inherited from: IdentifiedObject

Table 192 shows all association ends of Ground with other classes.

Table 192 – Association ends of Wires::Ground with other classes

mult from	name	mult to	type	description
0..*	BaseVoltage	0..1	BaseVoltage	inherited from: ConductingEquipment
1..1	SvStatus	0..*	SvStatus	inherited from: ConductingEquipment
0..*	ProtectionEquipments	0..*	ProtectionEquipment	inherited from: ConductingEquipment
1..1	Terminals	0..*	Terminal	inherited from: ConductingEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	inherited from: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	inherited from: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment
0..1	Faults	0..*	Fault	inherited from: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	inherited from: Equipment
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.4.27 GroundingImpedance

A fixed impedance device used for grounding.

Table 193 shows all attributes of GroundingImpedance.

Table 193 – Attributes of Wires::GroundingImpedance

name	mult	type	description
x	0..1	Reactance	Reactance of device.
r	0..1	Resistance	inherited from: EarthFaultCompensator
aggregate	0..1	Boolean	inherited from: Equipment
inService	0..1	Boolean	inherited from: Equipment
networkAnalysisEnabled	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

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Table 194 shows all association ends of GroundingImpedance with other classes.

Table 194 – Association ends of Wires::GroundingImpedance with other classes

mult from	name	mult to	type	description
0..*	BaseVoltage	0..1	BaseVoltage	inherited from: ConductingEquipment
1..1	SvStatus	0..*	SvStatus	inherited from: ConductingEquipment
0..*	ProtectionEquipments	0..*	ProtectionEquipment	inherited from: ConductingEquipment
1..1	Terminals	0..*	Terminal	inherited from: ConductingEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	inherited from: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	inherited from: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment
0..1	Faults	0..*	Fault	inherited from: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	inherited from: Equipment
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.4.28 GroundDisconnector

A manually operated or motor operated mechanical switching device used for isolating a circuit or equipment from ground.

Table 195 shows all attributes of GroundDisconnector.

Table 195 – Attributes of Wires::GroundDisconnector

name	mult	type	description
normalOpen	0..1	Boolean	inherited from: Switch
ratedCurrent	0..1	CurrentFlow	inherited from: Switch
switchOnCount	0..1	Integer	(deprecated) inherited from: Switch
switchOnDate	0..1	DateTime	(deprecated) inherited from: Switch
retained	0..1	Boolean	inherited from: Switch
open	0..1	Boolean	inherited from: Switch
locked	0..1	Boolean	inherited from: Switch
aggregate	0..1	Boolean	inherited from: Equipment
inService	0..1	Boolean	inherited from: Equipment
networkAnalysisEnabled	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject

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name	mult	type	description
name	0..1	String	inherited from: IdentifiedObject

Table 196 shows all association ends of GroundDisconnector with other classes.

Table 196 – Association ends of Wires::GroundDisconnector with other classes

mult from	name	mult to	type	description
1..1	SwitchPhase	0..*	SwitchPhase	inherited from: Switch
1..1	SwitchSchedules	0..*	SwitchSchedule	inherited from: Switch
0..*	CompositeSwitch	0..1	CompositeSwitch	inherited from: Switch
1..1	SvSwitch	0..*	SvSwitch	inherited from: Switch
0..*	BaseVoltage	0..1	BaseVoltage	inherited from: ConductingEquipment
1..1	SvStatus	0..*	SvStatus	inherited from: ConductingEquipment
0..*	ProtectionEquipments	0..*	ProtectionEquipment	inherited from: ConductingEquipment
1..1	Terminals	0..*	Terminal	inherited from: ConductingEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	inherited from: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	inherited from: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment
0..1	Faults	0..*	Fault	inherited from: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	inherited from: Equipment
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.4.29 Jumper

A short section of conductor with negligible impedance which can be manually removed and replaced if the circuit is de-energized. Note that zero-impedance branches can potentially be modelled by other equipment types.

Table 197 shows all attributes of Jumper.

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Table 197 – Attributes of Wires::Jumper

name	mult	type	description
normalOpen	0..1	Boolean	inherited from: Switch
ratedCurrent	0..1	CurrentFlow	inherited from: Switch
switchOnCount	0..1	Integer	(deprecated) inherited from: Switch
switchOnDate	0..1	DateTime	(deprecated) inherited from: Switch
retained	0..1	Boolean	inherited from: Switch
open	0..1	Boolean	inherited from: Switch
locked	0..1	Boolean	inherited from: Switch
aggregate	0..1	Boolean	inherited from: Equipment
inService	0..1	Boolean	inherited from: Equipment
networkAnalysisEnabled	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 198 shows all association ends of Jumper with other classes.

Table 198 – Association ends of Wires::Jumper with other classes

mult from	name	mult to	type	description
1..1	SwitchPhase	0..*	SwitchPhase	inherited from: Switch
1..1	SwitchSchedules	0..*	SwitchSchedule	inherited from: Switch
0..*	CompositeSwitch	0..1	CompositeSwitch	inherited from: Switch
1..1	SvSwitch	0..*	SvSwitch	inherited from: Switch
0..*	BaseVoltage	0..1	BaseVoltage	inherited from: ConductingEquipment
1..1	SvStatus	0..*	SvStatus	inherited from: ConductingEquipment
0..*	ProtectionEquipments	0..*	ProtectionEquipment	inherited from: ConductingEquipment
1..1	Terminals	0..*	Terminal	inherited from: ConductingEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	inherited from: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	inherited from: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment
0..1	Faults	0..*	Fault	inherited from: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	inherited from: Equipment
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

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6.4.30 Junction

A point where one or more conducting equipments are connected with zero resistance.

Table 199 shows all attributes of Junction.

Table 199 – Attributes of Wires::Junction

name	mult	type	description
aggregate	0..1	Boolean	inherited from: Equipment
inService	0..1	Boolean	inherited from: Equipment
networkAnalysisEnabled	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 200 shows all association ends of Junction with other classes.

Table 200 – Association ends of Wires::Junction with other classes

mult from	name	mult to	type	description
0..*	BaseVoltage	0..1	BaseVoltage	inherited from: ConductingEquipment
1..1	SvStatus	0..*	SvStatus	inherited from: ConductingEquipment
0..*	ProtectionEquipments	0..*	ProtectionEquipment	inherited from: ConductingEquipment
1..1	Terminals	0..*	Terminal	inherited from: ConductingEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	inherited from: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	inherited from: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment
0..1	Faults	0..*	Fault	inherited from: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	inherited from: Equipment
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

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6.4.31 Line

Contains equipment beyond a substation belonging to a power transmission line.

Table 201 shows all attributes of Line.

Table 201 – Attributes of Wires::Line

name	mult	type	description
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 202 shows all association ends of Line with other classes.

Table 202 – Association ends of Wires::Line with other classes

mult from	name	mult to	type	description
0..*	Region	0..1	SubGeographicalRegion	The sub-geographical region of the line.
0..1	Equipments	0..*	Equipment	inherited from: EquipmentContainer
0..*	AdditionalGroupedEquipment	0..*	Equipment	inherited from: EquipmentContainer
1..1	ConnectivityNodes	0..*	ConnectivityNode	inherited from: ConnectivityNodeContainer
0..1	TopologicalNode	0..*	TopologicalNode	inherited from: ConnectivityNodeContainer
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.4.32 LinearShuntCompensator

A linear shunt compensator has banks or sections with equal admittance values.

Table 203 shows all attributes of LinearShuntCompensator.

Table 203 – Attributes of Wires::LinearShuntCompensator

name	mult	type	description
b0PerSection	0..1	Susceptance	Zero sequence shunt (charging) susceptance per section.
bPerSection	0..1	Susceptance	Positive sequence shunt (charging) susceptance per section.
g0PerSection	0..1	Conductance	Zero sequence shunt (charging) conductance per section.
gPerSection	0..1	Conductance	Positive sequence shunt (charging) conductance per section.
aVRDelay	0..1	Seconds	inherited from: ShuntCompensator
grounded	0..1	Boolean	inherited from: ShuntCompensator
maximumSections	0..1	Integer	inherited from: ShuntCompensator
nomU	0..1	Voltage	inherited from: ShuntCompensator

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name	mult	type	description
normalSections	0..1	Integer	inherited from: ShuntCompensator
phaseConnection	0..1	PhaseShuntConnectionKind	inherited from: ShuntCompensator
switchOnCount	0..1	Integer	(deprecated) inherited from: ShuntCompensator
switchOnDate	0..1	DateTime	(deprecated) inherited from: ShuntCompensator
voltageSensitivity	0..1	VoltagePerReactivePower	inherited from: ShuntCompensator
sections	0..1	Float	inherited from: ShuntCompensator
controlEnabled	0..1	Boolean	inherited from: RegulatingCondEq
aggregate	0..1	Boolean	inherited from: Equipment
inService	0..1	Boolean	inherited from: Equipment
networkAnalysisEnabled	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 204 shows all association ends of LinearShuntCompensator with other classes.

Table 204 – Association ends of Wires::LinearShuntCompensator with other classes

mult from	name	mult to	type	description
1..1	ShuntCompensatorPhase	0..*	ShuntCompensatorPhase	inherited from: ShuntCompensator
1..1	SvShuntCompensatorSections	0..*	SvShuntCompensatorSections	inherited from: ShuntCompensator
~~1~~0..*	RegulatingControl	0..1	RegulatingControl	inherited from: RegulatingCondEq
0..*	BaseVoltage	0..1	BaseVoltage	inherited from: ConductingEquipment
1..1	SvStatus	0..*	SvStatus	inherited from: ConductingEquipment
0..*	ProtectionEquipments	0..*	ProtectionEquipment	inherited from: ConductingEquipment
1..1	Terminals	0..*	Terminal	inherited from: ConductingEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	inherited from: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	inherited from: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment
0..1	Faults	0..*	Fault	inherited from: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	inherited from: Equipment
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

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6.4.33 LinearShuntCompensatorPhase

A per phase linear shunt compensator has banks or sections with equal admittance values.

Table 205 shows all attributes of LinearShuntCompensatorPhase.

Table 205 – Attributes of Wires::LinearShuntCompensatorPhase

name	mult	type	description
bPerSection	0..1	Susceptance	Susceptance per section of the phase if shunt compensator is wye connected. Susceptance per section phase to phase if shunt compensator is delta connected.
gPerSection	0..1	Conductance	Conductance per section for this phase if shunt compensator is wye connected. Conductance per section phase to phase if shunt compensator is delta connected.
maximumSections	0..1	Integer	inherited from: ShuntCompensatorPhase
normalSections	0..1	Integer	inherited from: ShuntCompensatorPhase
sections	0..1	Float	inherited from: ShuntCompensatorPhase
phase	0..1	SinglePhaseKind	inherited from: ShuntCompensatorPhase
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 206 shows all association ends of LinearShuntCompensatorPhase with other classes.

Table 206 – Association ends of Wires::LinearShuntCompensatorPhase with other classes

mult from	name	mult to	type	description
0..*	ShuntCompensator	1..1	ShuntCompensator	inherited from: ShuntCompensatorPhase
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

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6.4.34 LoadBreakSwitch

A mechanical switching device capable of making, carrying, and breaking currents under normal operating conditions.

Table 207 shows all attributes of LoadBreakSwitch.

Table 207 – Attributes of Wires::LoadBreakSwitch

name	mult	type	description
breakingCapacity	0..1	CurrentFlow	inherited from: ProtectedSwitch
normalOpen	0..1	Boolean	inherited from: Switch
ratedCurrent	0..1	CurrentFlow	inherited from: Switch
switchOnCount	0..1	Integer	(deprecated) inherited from: Switch
switchOnDate	0..1	DateTime	(deprecated) inherited from: Switch
retained	0..1	Boolean	inherited from: Switch
open	0..1	Boolean	inherited from: Switch
locked	0..1	Boolean	inherited from: Switch
aggregate	0..1	Boolean	inherited from: Equipment
inService	0..1	Boolean	inherited from: Equipment
networkAnalysisEnabled	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 208 shows all association ends of LoadBreakSwitch with other classes.

Table 208 – Association ends of Wires::LoadBreakSwitch with other classes

mult from	name	mult to	type	description
0..*	OperatedByProtectionEquipment	0..*	ProtectionEquipment	inherited from: ProtectedSwitch
1..1	RecloseSequences	0..*	RecloseSequence	inherited from: ProtectedSwitch
1..1	SwitchPhase	0..*	SwitchPhase	inherited from: Switch
1..1	SwitchSchedules	0..*	SwitchSchedule	inherited from: Switch
0..*	CompositeSwitch	0..1	CompositeSwitch	inherited from: Switch
1..1	SvSwitch	0..*	SvSwitch	inherited from: Switch
0..*	BaseVoltage	0..1	BaseVoltage	inherited from: ConductingEquipment
1..1	SvStatus	0..*	SvStatus	inherited from: ConductingEquipment
0..*	ProtectionEquipments	0..*	ProtectionEquipment	inherited from: ConductingEquipment
1..1	Terminals	0..*	Terminal	inherited from: ConductingEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	inherited from: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	inherited from: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment
0..1	Faults	0..*	Fault	inherited from: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	inherited from: Equipment
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource

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mult from	name	mult to	type	description
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.4.35 MutualCoupling

This class represents the zero sequence line mutual coupling.

Table 209 shows all attributes of MutualCoupling.

Table 209 – Attributes of Wires::MutualCoupling

name	mult	type	description
b0ch	0..1	Susceptance	Zero sequence mutual coupling shunt (charging) susceptance, uniformly distributed, of the entire line section.
distance11	0..1	Length	Distance to the start of the coupled region from the first line's terminal having sequence number equal to 1.
distance12	0..1	Length	Distance to the end of the coupled region from the first line's terminal with sequence number equal to 1.
distance21	0..1	Length	Distance to the start of coupled region from the second line's terminal with sequence number equal to 1.
distance22	0..1	Length	Distance to the end of coupled region from the second line's terminal with sequence number equal to 1.
g0ch	0..1	Conductance	Zero sequence mutual coupling shunt (charging) conductance, uniformly distributed, of the entire line section.
r0	0..1	Resistance	Zero sequence branch-to-branch mutual impedance coupling, resistance.
x0	0..1	Reactance	Zero sequence branch-to-branch mutual impedance coupling, reactance.
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 210 shows all association ends of MutualCoupling with other classes.

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Table 210 – Association ends of Wires::MutualCoupling with other classes

mult from	name	mult to	type	description
0..*	First_Terminal	1..1	Terminal	The starting terminal for the calculation of distances along the first branch of the mutual coupling. Normally MutualCoupling would only be used for terminals of AC line segments. The first and second terminals of a mutual coupling should point to different AC line segments.
0..*	Second_Terminal	1..1	Terminal	The starting terminal for the calculation of distances along the second branch of the mutual coupling.
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.4.36 NonlinearShuntCompensator

A non linear shunt compensator has bank or section admittance values that differ. The attributes g, b, g0 and b0 of the associated NonlinearShuntCompensatorPoint describe the total conductance and admittance of a NonlinearShuntCompensatorPoint at a section number specified by NonlinearShuntCompensatorPoint.sectionNumber.

Table 211 shows all attributes of NonlinearShuntCompensator.

Table 211 – Attributes of Wires::NonlinearShuntCompensator

name	mult	type	description
aVRDelay	0..1	Seconds	inherited from: ShuntCompensator
grounded	0..1	Boolean	inherited from: ShuntCompensator
maximumSections	0..1	Integer	inherited from: ShuntCompensator
nomU	0..1	Voltage	inherited from: ShuntCompensator
normalSections	0..1	Integer	inherited from: ShuntCompensator
phaseConnection	0..1	PhaseShuntConnectionKind	inherited from: ShuntCompensator
switchOnCount	0..1	Integer	(deprecated) inherited from: ShuntCompensator
switchOnDate	0..1	DateTime	(deprecated) inherited from: ShuntCompensator
voltageSensitivity	0..1	VoltagePerReactivePower	inherited from: ShuntCompensator
sections	0..1	Float	inherited from: ShuntCompensator
controlEnabled	0..1	Boolean	inherited from: RegulatingCondEq
aggregate	0..1	Boolean	inherited from: Equipment
inService	0..1	Boolean	inherited from: Equipment
networkAnalysisEnabled	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

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Table 212 shows all association ends of NonlinearShuntCompensator with other classes.

Table 212 – Association ends of Wires::NonlinearShuntCompensator with other classes

mult from	name	mult to	type	description
1..1	NonlinearShuntCompensatorPoints	1..*	NonlinearShuntCompensatorPoint	All points of the non-linear shunt compensator.
1..1	ShuntCompensatorPhase	0..*	ShuntCompensatorPhase	inherited from: ShuntCompensator
1..1	SvShuntCompensatorSections	0..*	SvShuntCompensatorSections	inherited from: ShuntCompensator
~~1~~0..*	RegulatingControl	0..1	RegulatingControl	inherited from: RegulatingCondEq
0..*	BaseVoltage	0..1	BaseVoltage	inherited from: ConductingEquipment
1..1	SvStatus	0..*	SvStatus	inherited from: ConductingEquipment
0..*	ProtectionEquipments	0..*	ProtectionEquipment	inherited from: ConductingEquipment
1..1	Terminals	0..*	Terminal	inherited from: ConductingEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	inherited from: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	inherited from: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment
0..1	Faults	0..*	Fault	inherited from: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	inherited from: Equipment
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.4.37 NonlinearShuntCompensatorPhase

A per phase non linear shunt compensator has bank or section admittance values that differ. The attributes g and b of the associated NonlinearShuntCompensatorPhasePoint describe the total conductance and admittance of a NonlinearShuntCompensatorPhasePoint at a section number specified by NonlinearShuntCompensatorPhasePoint.sectionNumber.

Table 213 shows all attributes of NonlinearShuntCompensatorPhase.

Table 213 – Attributes of Wires::NonlinearShuntCompensatorPhase

name	mult	type	description
maximumSections	0..1	Integer	inherited from: ShuntCompensatorPhase
normalSections	0..1	Integer	inherited from: ShuntCompensatorPhase
sections	0..1	Float	inherited from: ShuntCompensatorPhase
phase	0..1	SinglePhaseKind	inherited from: ShuntCompensatorPhase
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject

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name	mult	type	description
name	0..1	String	inherited from: IdentifiedObject

Table 214 shows all association ends of NonlinearShuntCompensatorPhase with other classes.

Table 214 – Association ends of Wires::NonlinearShuntCompensatorPhase with other classes

mult from	name	mult to	type	description
1..1	NonlinearShuntCompensatorPhasePoints	1..*	NonlinearShuntCompensatorPhasePoint	All points of the non-linear shunt compensator phase.
0..*	ShuntCompensator	1..1	ShuntCompensator	inherited from: ShuntCompensatorPhase
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.4.38 NonlinearShuntCompensatorPhasePoint root class

A per phase non linear shunt compensator bank or section admittance value. The number of NonlinearShuntCompenstorPhasePoint instances associated with a NonlinearShuntCompensatorPhase shall be equal to ShuntCompensatorPhase.maximumSections. ShuntCompensator.sections shall only be set to one of the NonlinearShuntCompenstorPhasePoint.sectionNumber. There is no interpolation between NonlinearShuntCompenstorPhasePoint-s.

Table 215 shows all attributes of NonlinearShuntCompensatorPhasePoint.

Table 215 – Attributes of Wires::NonlinearShuntCompensatorPhasePoint

name	mult	type	description
b	0..1	Susceptance	Positive sequence shunt (charging) susceptance per section.
g	0..1	Conductance	Positive sequence shunt (charging) conductance per section.
sectionNumber	0..1	Integer	The number of the section.

Table 216 shows all association ends of NonlinearShuntCompensatorPhasePoint with other classes.

Table 216 – Association ends of Wires::NonlinearShuntCompensatorPhasePoint with other classes

mult from	name	mult to	type	description
1..*	NonlinearShuntCompensatorPhase	1..1	NonlinearShuntCompensatorPhase	Non-linear shunt compensator phase owning this point.

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6.4.39 NonlinearShuntCompensatorPoint root class

A non linear shunt compensator bank or section admittance value. The number of NonlinearShuntCompenstorPoint instances associated with a NonlinearShuntCompensator shall be equal to ShuntCompensator.maximumSections. ShuntCompensator.sections shall only be set to one of the NonlinearShuntCompenstorPoint.sectionNumber. There is no interpolation between NonlinearShuntCompenstorPoint-s.

Table 217 shows all attributes of NonlinearShuntCompensatorPoint.

Table 217 – Attributes of Wires::NonlinearShuntCompensatorPoint

name	mult	type	description
b	0..1	Susceptance	Positive sequence shunt (charging) susceptance per section.
b0	0..1	Susceptance	Zero sequence shunt (charging) susceptance per section.
g	0..1	Conductance	Positive sequence shunt (charging) conductance per section.
g0	0..1	Conductance	Zero sequence shunt (charging) conductance per section.
sectionNumber	0..1	Integer	The number of the section.

Table 218 shows all association ends of NonlinearShuntCompensatorPoint with other classes.

Table 218 – Association ends of Wires::NonlinearShuntCompensatorPoint with other classes

mult from	name	mult to	type	description
1..*	NonlinearShuntCompensator	1..1	NonlinearShuntCompensator	Non-linear shunt compensator owning this point.

6.4.40 PerLengthImpedance

Common type for per-length impedance electrical catalogues.

Table 219 shows all attributes of PerLengthImpedance.

Table 219 – Attributes of Wires::PerLengthImpedance

name	mult	type	description
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 220 shows all association ends of PerLengthImpedance with other classes.

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Table 220 – Association ends of Wires::PerLengthImpedance with other classes

mult from	name	mult to	type	description
0..1	ACLineSegments	0..*	ACLineSegment	All line segments described by this per-length impedance.
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.4.41 PerLengthLineParameter

Common type for per-length electrical catalogues describing line parameters.

Table 221 shows all attributes of PerLengthLineParameter.

Table 221 – Attributes of Wires::PerLengthLineParameter

name	mult	type	description
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 222 shows all association ends of PerLengthLineParameter with other classes.

Table 222 – Association ends of Wires::PerLengthLineParameter with other classes

mult from	name	mult to	type	description
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.4.42 PerLengthPhaseImpedance

Impedance and admittance parameters per unit length for n-wire unbalanced lines, in matrix form.

Table 223 shows all attributes of PerLengthPhaseImpedance.

Table 223 – Attributes of Wires::PerLengthPhaseImpedance

name	mult	type	description
conductorCount	0..1	Integer	Number of phase, neutral, and other wires retained. Constrains the number of matrix elements and the phase codes that can be used with this matrix.
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

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Table 224 shows all association ends of PerLengthPhaseImpedance with other classes.

Table 224 – Association ends of Wires::PerLengthPhaseImpedance with other classes

mult from	name	mult to	type	description
1..1	PhaseImpedanceData	1..*	PhaseImpedanceData	All data that belong to this conductor phase impedance.
0..1	ACLineSegments	0..*	ACLineSegment	inherited from: PerLengthImpedance
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.4.43 PerLengthSequenceImpedance

Sequence impedance and admittance parameters per unit length, for transposed lines of 1, 2, or 3 phases. For 1-phase lines, define x=x0=xself. For 2-phase lines, define x=xs-xm and x0=xs+xm.

Table 225 shows all attributes of PerLengthSequenceImpedance.

Table 225 – Attributes of Wires::PerLengthSequenceImpedance

name	mult	type	description
b0ch	0..1	SusceptancePerLength	Zero sequence shunt (charging) susceptance, per unit of length.
bch	0..1	SusceptancePerLength	Positive sequence shunt (charging) susceptance, per unit of length.
g0ch	0..1	ConductancePerLength	Zero sequence shunt (charging) conductance, per unit of length.
gch	0..1	ConductancePerLength	Positive sequence shunt (charging) conductance, per unit of length.
r	0..1	ResistancePerLength	Positive sequence series resistance, per unit of length.
r0	0..1	ResistancePerLength	Zero sequence series resistance, per unit of length.
x	0..1	ReactancePerLength	Positive sequence series reactance, per unit of length.
x0	0..1	ReactancePerLength	Zero sequence series reactance, per unit of length.
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 226 shows all association ends of PerLengthSequenceImpedance with other classes.

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Table 226 – Association ends of Wires::PerLengthSequenceImpedance with other classes

mult from	name	mult to	type	description
0..1	ACLineSegments	0..*	ACLineSegment	inherited from: PerLengthImpedance
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.4.44 PetersenCoil

A variable impedance device normally used to offset line charging during single line faults in an ungrounded section of network.

Table 227 shows all attributes of PetersenCoil.

Table 227 – Attributes of Wires::PetersenCoil

name	mult	type	description
mode	0..1	PetersenCoilModeKind	The mode of operation of the Petersen coil.
nominalU	0..1	Voltage	The nominal voltage for which the coil is designed.
offsetCurrent	0..1	CurrentFlow	The offset current that the Petersen coil controller is operating from the resonant point. This is normally a fixed amount for which the controller is configured and could be positive or negative. Typically 0 to 60 A depending on voltage and resonance conditions.
positionCurrent	0..1	CurrentFlow	The control current used to control the Petersen coil also known as the position current. Typically in the range of 20 mA to 200 mA.
xGroundMax	0..1	Reactance	The maximum reactance.
xGroundMin	0..1	Reactance	The minimum reactance.
xGroundNominal	0..1	Reactance	The nominal reactance. This is the operating point (normally over compensation) that is defined based on the resonance point in the healthy network condition. The impedance is calculated based on nominal voltage divided by position current.
r	0..1	Resistance	inherited from: EarthFaultCompensator
aggregate	0..1	Boolean	inherited from: Equipment
inService	0..1	Boolean	inherited from: Equipment
networkAnalysisEnabled	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 228 shows all association ends of PetersenCoil with other classes.

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Table 228 – Association ends of Wires::PetersenCoil with other classes

mult from	name	mult to	type	description
0..*	BaseVoltage	0..1	BaseVoltage	inherited from: ConductingEquipment
1..1	SvStatus	0..*	SvStatus	inherited from: ConductingEquipment
0..*	ProtectionEquipments	0..*	ProtectionEquipment	inherited from: ConductingEquipment
1..1	Terminals	0..*	Terminal	inherited from: ConductingEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	inherited from: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	inherited from: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment
0..1	Faults	0..*	Fault	inherited from: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	inherited from: Equipment
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.4.45 PetersenCoilModeKind enumeration

The mode of operation for a Petersen coil.

Table 229 shows all literals of PetersenCoilModeKind.

Table 229 – Literals of Wires::PetersenCoilModeKind

literal	value	description
fixed		Fixed position.
manual		Manual positioning.
automaticPositioning		Automatic positioning.

6.4.46 PhaseImpedanceData root class

Impedance and conductance matrix element values.

The diagonal elements are described by the elements having the same toPhase and fromPhase value and the off diagonal elements have different toPhase and fromPhase values. The matrix can also be stored in symmetric lower triangular format using the row and column attributes, which map to ACLineSegmentPhase.sequenceNumber.

Table 230 shows all attributes of PhaseImpedanceData.

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Table 230 – Attributes of Wires::PhaseImpedanceData

name	mult	type	description
b	0..1	SusceptancePerLength	Susceptance matrix element value, per length of unit.
r	0..1	ResistancePerLength	Resistance matrix element value, per length of unit.
g	0..1	ConductancePerLength	Conductance matrix element value, per length of unit.
x	0..1	ReactancePerLength	Reactance matrix element value, per length of unit.
fromPhase	0..1	SinglePhaseKind	Refer to the class description.
toPhase	0..1	SinglePhaseKind	Refer to the class description.
row	0..1	Integer	The matrix element's row number, in the range 1 to PerLengthPhaseImpedance.conductorCount. Only the lower triangle needs to be stored. This row number matches ACLineSegmentPhase.sequenceNumber.
column	0..1	Integer	The matrix element's column number, in the range 1 to row. Only the lower triangle needs to be stored. This column number matches ACLineSegmentPhase.sequenceNumber.

Table 231 shows all association ends of PhaseImpedanceData with other classes.

Table 231 – Association ends of Wires::PhaseImpedanceData with other classes

mult from	name	mult to	type	description
1..*	PhaseImpedance	1..1	PerLengthPhaseImpedance	Conductor phase impedance to which this data belongs.

6.4.47 PhaseShuntConnectionKind enumeration

The configuration of phase connections for a single terminal device such as a load or capacitor.

Table 232 shows all literals of PhaseShuntConnectionKind.

Table 232 – Literals of Wires::PhaseShuntConnectionKind

literal	value	description
D	1	Delta connection.
Y	2	Wye connection.
Yn	3	Wye, with neutral brought out for grounding.
I	4	Independent winding, for single-phase connections.
G	5	Ground connection; use when explicit connection to ground needs to be expressed in combination with the phase code, such as for electrical wire/cable or for meters.

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6.4.48 PhaseTapChanger

A transformer phase shifting tap model that controls the phase angle difference across the power transformer and potentially the active power flow through the power transformer. This phase tap model may also impact the voltage magnitude.

Table 233 shows all attributes of PhaseTapChanger.

Table 233 – Attributes of Wires::PhaseTapChanger

name	mult	type	description
controlEnabled	0..1	Boolean	inherited from: TapChanger
highStep	0..1	Integer	inherited from: TapChanger
initialDelay	0..1	Seconds	inherited from: TapChanger
lowStep	0..1	Integer	inherited from: TapChanger
ltcFlag	0..1	Boolean	inherited from: TapChanger
neutralStep	0..1	Integer	inherited from: TapChanger
neutralU	0..1	Voltage	inherited from: TapChanger
normalStep	0..1	Integer	inherited from: TapChanger
subsequentDelay	0..1	Seconds	inherited from: TapChanger
step	0..1	Float	inherited from: TapChanger
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 234 shows all association ends of PhaseTapChanger with other classes.

Table 234 – Association ends of Wires::PhaseTapChanger with other classes

mult from	name	mult to	type	description
0..1	TransformerEnd	1..1	TransformerEnd	Transformer end to which this phase tap changer belongs.
1..*	TapChangerControl	0..1	TapChangerControl	inherited from: TapChanger
1..1	SvTapStep	0..1	SvTapStep	inherited from: TapChanger
1..1	TapSchedules	0..*	TapSchedule	inherited from: TapChanger
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

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6.4.49 PhaseTapChangerAsymmetrical

Describes the tap model for an asymmetrical phase shifting transformer in which the difference voltage vector adds to the in-phase winding. The out-of-phase winding is the transformer end where the tap changer is located. The angle between the in-phase and out-of-phase windings is named the winding connection angle. The phase shift depends on both the difference voltage magnitude and the winding connection angle.

Table 235 shows all attributes of PhaseTapChangerAsymmetrical.

Table 235 – Attributes of Wires::PhaseTapChangerAsymmetrical

name	mult	type	description
windingConnectionAngle	0..1	AngleDegrees	The phase angle between the in-phase winding and the out-of -phase winding used for creating phase shift. The out-of-phase winding produces what is known as the difference voltage. Setting this angle to 90 degrees is not the same as a symmetrical transformer. The attribute can only be multiples of 30 degrees. The allowed range is -150 degrees to 150 degrees excluding 0.
voltageStepIncrement	0..1	PerCent	inherited from: PhaseTapChangerNonLinear
xMax	0..1	Reactance	inherited from: PhaseTapChangerNonLinear
xMin	0..1	Reactance	(deprecated) inherited from: PhaseTapChangerNonLinear
controlEnabled	0..1	Boolean	inherited from: TapChanger
highStep	0..1	Integer	inherited from: TapChanger
initialDelay	0..1	Seconds	inherited from: TapChanger
lowStep	0..1	Integer	inherited from: TapChanger
ltcFlag	0..1	Boolean	inherited from: TapChanger
neutralStep	0..1	Integer	inherited from: TapChanger
neutralU	0..1	Voltage	inherited from: TapChanger
normalStep	0..1	Integer	inherited from: TapChanger
subsequentDelay	0..1	Seconds	inherited from: TapChanger
step	0..1	Float	inherited from: TapChanger
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 236 shows all association ends of PhaseTapChangerAsymmetrical with other classes.

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Table 236 – Association ends of Wires::PhaseTapChangerAsymmetrical with other classes

mult from	name	mult to	type	description
0..1	TransformerEnd	1..1	TransformerEnd	inherited from: PhaseTapChanger
1..*	TapChangerControl	0..1	TapChangerControl	inherited from: TapChanger
1..1	SvTapStep	0..1	SvTapStep	inherited from: TapChanger
1..1	TapSchedules	0..*	TapSchedule	inherited from: TapChanger
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.4.50 PhaseTapChangerLinear

Describes a tap changer with a linear relation between the tap step and the phase angle difference across the transformer. This is a mathematical model that is an approximation of a real phase tap changer.

The phase angle is computed as stepPhaseShiftIncrement times the tap position.

The voltage magnitude of both sides is the same.

Table 237 shows all attributes of PhaseTapChangerLinear.

Table 237 – Attributes of Wires::PhaseTapChangerLinear

name	mult	type	description
stepPhaseShiftIncrement	0..1	AngleDegrees	Phase shift per step position. A positive value indicates a positive angle variation from the Terminal at the PowerTransformerEnd, where the TapChanger is located, into the transformer. The actual phase shift increment might be more accurately computed from the symmetrical or asymmetrical models or a tap step table lookup if those are available.
xMax	0..1	Reactance	The reactance depends on the tap position according to a "u" shaped curve. The maximum reactance (xMax) appears at the low and high tap positions. Depending on the “u” curve the attribute can be either higher or lower than PowerTransformerEnd.x.
xMin	0..1	Reactance	(deprecated) The reactance depends on the tap position according to a "u" shaped curve. The minimum reactance (xMin) appears at the mid tap position. PowerTransformerEnd.x shall be consistent with PhaseTapChangerLinear.xMin and PhaseTapChangerNonLinear.xMin. In case of inconsistency, PowerTransformerEnd.x shall be used.
controlEnabled	0..1	Boolean	inherited from: TapChanger
highStep	0..1	Integer	inherited from: TapChanger

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name	mult	type	description
initialDelay	0..1	Seconds	inherited from: TapChanger
lowStep	0..1	Integer	inherited from: TapChanger
ltcFlag	0..1	Boolean	inherited from: TapChanger
neutralStep	0..1	Integer	inherited from: TapChanger
neutralU	0..1	Voltage	inherited from: TapChanger
normalStep	0..1	Integer	inherited from: TapChanger
subsequentDelay	0..1	Seconds	inherited from: TapChanger
step	0..1	Float	inherited from: TapChanger
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 238 shows all association ends of PhaseTapChangerLinear with other classes.

Table 238 – Association ends of Wires::PhaseTapChangerLinear with other classes

mult from	name	mult to	type	description
0..1	TransformerEnd	1..1	TransformerEnd	inherited from: PhaseTapChanger
1..*	TapChangerControl	0..1	TapChangerControl	inherited from: TapChanger
1..1	SvTapStep	0..1	SvTapStep	inherited from: TapChanger
1..1	TapSchedules	0..*	TapSchedule	inherited from: TapChanger
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.4.51 PhaseTapChangerNonLinear

The non-linear phase tap changer describes the non-linear behaviour of a phase tap changer. This is a base class for the symmetrical and asymmetrical phase tap changer models. The details of these models can be found in IEC 61970-301.

Table 239 shows all attributes of PhaseTapChangerNonLinear.

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Table 239 – Attributes of Wires::PhaseTapChangerNonLinear

name	mult	type	description
voltageStepIncrement	0..1	PerCent	The voltage step increment on the out of phase winding (the PowerTransformerEnd where the TapChanger is located) specified in percent of rated voltage of the PowerTransformerEnd. A positive value means a positive voltage variation from the Terminal at the PowerTransformerEnd, where the TapChanger is located, into the transformer. When the increment is negative, the voltage decreases when the tap step increases.
xMax	0..1	Reactance	The reactance depends on the tap position according to a "u" shaped curve. The maximum reactance (xMax) appears at the low and high tap positions. Depending on the "u" curve the attribute can be either higher or lower than PowerTransformerEnd.x.
xMin	0..1	Reactance	(deprecated) The reactance depend on the tap position according to a "u" shaped curve. The minimum reactance (xMin) appear at the mid tap position. PowerTransformerEnd.x shall be consistent with PhaseTapChangerLinear.xMin and PhaseTapChangerNonLinear.xMin. In case of inconsistency, PowerTransformerEnd.x shall be used.
controlEnabled	0..1	Boolean	inherited from: TapChanger
highStep	0..1	Integer	inherited from: TapChanger
initialDelay	0..1	Seconds	inherited from: TapChanger
lowStep	0..1	Integer	inherited from: TapChanger
ltcFlag	0..1	Boolean	inherited from: TapChanger
neutralStep	0..1	Integer	inherited from: TapChanger
neutralU	0..1	Voltage	inherited from: TapChanger
normalStep	0..1	Integer	inherited from: TapChanger
subsequentDelay	0..1	Seconds	inherited from: TapChanger
step	0..1	Float	inherited from: TapChanger
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 240 shows all association ends of PhaseTapChangerNonLinear with other classes.

Table 240 – Association ends of Wires::PhaseTapChangerNonLinear with other classes

mult from	name	mult to	type	description
0..1	TransformerEnd	1..1	TransformerEnd	inherited from: PhaseTapChanger
1..*	TapChangerControl	0..1	TapChangerControl	inherited from: TapChanger
1..1	SvTapStep	0..1	SvTapStep	inherited from: TapChanger
1..1	TapSchedules	0..*	TapSchedule	inherited from: TapChanger
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource

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mult from	name	mult to	type	description
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.4.52 PhaseTapChangerSymmetrical

Describes a symmetrical phase shifting transformer tap model in which the voltage magnitude of both sides is the same. The difference voltage magnitude is the base in an equal-sided triangle where the sides corresponds to the primary and secondary voltages. The phase angle difference corresponds to the top angle and can be expressed as twice the arctangent of half the total difference voltage.

Table 241 shows all attributes of PhaseTapChangerSymmetrical.

Table 241 – Attributes of Wires::PhaseTapChangerSymmetrical

name	mult	type	description
voltageStepIncrement	0..1	PerCent	inherited from: PhaseTapChangerNonLinear
xMax	0..1	Reactance	inherited from: PhaseTapChangerNonLinear
xMin	0..1	Reactance	(deprecated) inherited from: PhaseTapChangerNonLinear
controlEnabled	0..1	Boolean	inherited from: TapChanger
highStep	0..1	Integer	inherited from: TapChanger
initialDelay	0..1	Seconds	inherited from: TapChanger
lowStep	0..1	Integer	inherited from: TapChanger
ltcFlag	0..1	Boolean	inherited from: TapChanger
neutralStep	0..1	Integer	inherited from: TapChanger
neutralU	0..1	Voltage	inherited from: TapChanger
normalStep	0..1	Integer	inherited from: TapChanger
subsequentDelay	0..1	Seconds	inherited from: TapChanger
step	0..1	Float	inherited from: TapChanger
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 242 shows all association ends of PhaseTapChangerSymmetrical with other classes.

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Table 242 – Association ends of Wires::PhaseTapChangerSymmetrical with other classes

mult from	name	mult to	type	description
0..1	TransformerEnd	1..1	TransformerEnd	inherited from: PhaseTapChanger
1..*	TapChangerControl	0..1	TapChangerControl	inherited from: TapChanger
1..1	SvTapStep	0..1	SvTapStep	inherited from: TapChanger
1..1	TapSchedules	0..*	TapSchedule	inherited from: TapChanger
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.4.53 PhaseTapChangerTable

Describes a tabular curve for how the phase angle difference and impedance varies with the tap step.

Table 243 shows all attributes of PhaseTapChangerTable.

Table 243 – Attributes of Wires::PhaseTapChangerTable

name	mult	type	description
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 244 shows all association ends of PhaseTapChangerTable with other classes.

Table 244 – Association ends of Wires::PhaseTapChangerTable with other classes

mult from	name	mult to	type	description
0..1	PhaseTapChangerTabular	0..*	PhaseTapChangerTabular	The phase tap changers to which this phase tap table applies.
1..1	PhaseTapChangerTablePoint	1..*	PhaseTapChangerTablePoint	The points of this table.
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.4.54 PhaseTapChangerTablePoint

Describes each tap step in the phase tap changer tabular curve.

Table 245 shows all attributes of PhaseTapChangerTablePoint.

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Table 245 – Attributes of Wires::PhaseTapChangerTablePoint

name	mult	type	description
angle	0..1	AngleDegrees	The angle difference in degrees. A positive value indicates a positive angle variation from the Terminal at the PowerTransformerEnd, where the TapChanger is located, into the transformer.
b	0..1	PerCent	inherited from: TapChangerTablePoint
g	0..1	PerCent	inherited from: TapChangerTablePoint
r	0..1	PerCent	inherited from: TapChangerTablePoint
ratio	0..1	Float	inherited from: TapChangerTablePoint
step	0..1	Integer	inherited from: TapChangerTablePoint
x	0..1	PerCent	inherited from: TapChangerTablePoint

Table 246 shows all association ends of PhaseTapChangerTablePoint with other classes.

Table 246 – Association ends of Wires::PhaseTapChangerTablePoint with other classes

mult from	name	mult to	type	description
1..*	PhaseTapChangerTable	1..1	PhaseTapChangerTable	The table of this point.

6.4.55 PhaseTapChangerTabular

Describes a tap changer with a table defining the relation between the tap step and the phase angle difference across the transformer.

Table 247 shows all attributes of PhaseTapChangerTabular.

Table 247 – Attributes of Wires::PhaseTapChangerTabular

name	mult	type	description
controlEnabled	0..1	Boolean	inherited from: TapChanger
highStep	0..1	Integer	inherited from: TapChanger
initialDelay	0..1	Seconds	inherited from: TapChanger
lowStep	0..1	Integer	inherited from: TapChanger
ltcFlag	0..1	Boolean	inherited from: TapChanger
neutralStep	0..1	Integer	inherited from: TapChanger
neutralU	0..1	Voltage	inherited from: TapChanger
normalStep	0..1	Integer	inherited from: TapChanger
subsequentDelay	0..1	Seconds	inherited from: TapChanger
step	0..1	Float	inherited from: TapChanger
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 248 shows all association ends of PhaseTapChangerTabular with other classes.

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Table 248 – Association ends of Wires::PhaseTapChangerTabular with other classes

mult from	name	mult to	type	description
0..*	PhaseTapChangerTable	0..1	PhaseTapChangerTable	The phase tap changer table for this phase tap changer.
0..1	TransformerEnd	1..1	TransformerEnd	inherited from: PhaseTapChanger
1..*	TapChangerControl	0..1	TapChangerControl	inherited from: TapChanger
1..1	SvTapStep	0..1	SvTapStep	inherited from: TapChanger
1..1	TapSchedules	0..*	TapSchedule	inherited from: TapChanger
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.4.56 Plant

A Plant is a collection of equipment for purposes of generation.

Table 249 shows all attributes of Plant.

Table 249 – Attributes of Wires::Plant

name	mult	type	description
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 250 shows all association ends of Plant with other classes.

Table 250 – Association ends of Wires::Plant with other classes

mult from	name	mult to	type	description
0..1	Equipments	0..*	Equipment	inherited from: EquipmentContainer
0..*	AdditionalGroupedEquipment	0..*	Equipment	inherited from: EquipmentContainer
1..1	ConnectivityNodes	0..*	ConnectivityNode	inherited from: ConnectivityNodeContainer
0..1	TopologicalNode	0..*	TopologicalNode	inherited from: ConnectivityNodeContainer
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource

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mult from	name	mult to	type	description
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.4.57 PowerElectronicsConnection

A connection to the AC network for energy production or consumption that uses power electronics rather than rotating machines.

Table 251 shows all attributes of PowerElectronicsConnection.

Table 251 – Attributes of Wires::PowerElectronicsConnection

name	mult	type	description
maxQ	0..1	ReactivePower	Maximum reactive power limit. This is the maximum (nameplate) limit for the unit.
minQ	0..1	ReactivePower	Minimum reactive power limit for the unit. This is the minimum (nameplate) limit for the unit.
ratedS	0..1	ApparentPower	Nameplate apparent power rating for the unit. The attribute shall have a positive value.
ratedU	0..1	Voltage	Rated voltage (nameplate data, Ur in IEC 60909-0). It is primarily used for short circuit data exchange according to IEC 60909. The attribute shall be a positive value.
p	0..1	ActivePower	Active power injection. Load sign convention is used, i.e. positive sign means flow out from a node. Starting value for a steady state solution.
q	0..1	ReactivePower	Reactive power injection. Load sign convention is used, i.e. positive sign means flow out from a node. Starting value for a steady state solution.
r	0..1	Resistance	(deprecated) Equivalent resistance (RG) of generator. RG is considered for the calculation of all currents, except for the calculation of the peak current ip. Used for short circuit data exchange according to IEC 60909.
r0	0..1	Resistance	(deprecated) Zero sequence resistance of the synchronous machine.
rn	0..1	Resistance	(deprecated) Negative sequence Thevenin resistance.
x	0..1	Reactance	(deprecated) Positive sequence Thevenin reactance.
x0	0..1	Reactance	(deprecated) Zero sequence Thevenin reactance.
xn	0..1	Reactance	(deprecated) Negative sequence Thevenin reactance.
maxIFault	0..1	PU	Maximum fault current this device will contribute, in per-unit of rated current, before the converter protection will trip or bypass.
controlEnabled	0..1	Boolean	inherited from: RegulatingCondEq
aggregate	0..1	Boolean	inherited from: Equipment
inService	0..1	Boolean	inherited from: Equipment
networkAnalysisEnabled	0..1	Boolean	inherited from: Equipment

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name	mult	type	description
normallyInService	0..1	Boolean	inherited from: Equipment
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 252 shows all association ends of PowerElectronicsConnection with other classes.

Table 252 – Association ends of Wires::PowerElectronicsConnection with other classes

mult from	name	mult to	type	description
1..1	PowerElectronicsUnit	0..*	PowerElectronicsUnit	An AC network connection may have several power electronics units connecting through it.
1..1	PowerElectronicsConnectionPhase	0..*	PowerElectronicsConnectionPhase	The individual phases models for the power electronics connection.
1..1	WindTurbineType3or4Dynamics	0..1	WindTurbineType3or4Dynamics	The wind turbine type 3 or type 4 dynamics model associated with this power electronics connection.
~~1~~0..*	RegulatingControl	0..1	RegulatingControl	inherited from: RegulatingCondEq
0..*	BaseVoltage	0..1	BaseVoltage	inherited from: ConductingEquipment
1..1	SvStatus	0..*	SvStatus	inherited from: ConductingEquipment
0..*	ProtectionEquipments	0..*	ProtectionEquipment	inherited from: ConductingEquipment
1..1	Terminals	0..*	Terminal	inherited from: ConductingEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	inherited from: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	inherited from: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment
0..1	Faults	0..*	Fault	inherited from: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	inherited from: Equipment
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

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6.4.58 PowerElectronicsConnectionPhase

A single phase of a power electronics connection.

Table 253 shows all attributes of PowerElectronicsConnectionPhase.

Table 253 – Attributes of Wires::PowerElectronicsConnectionPhase

name	mult	type	description
phase	0..1	SinglePhaseKind	Phase of this energy producer component. If the energy producer is wye connected, the connection is from the indicated phase to the central ground or neutral point. If the energy producer is delta connected, the phase indicates an energy producer connected from the indicated phase to the next logical non-neutral phase.
p	0..1	ActivePower	Active power injection. Load sign convention is used, i.e. positive sign means flow into the equipment from the network.
q	0..1	ReactivePower	Reactive power injection. Load sign convention is used, i.e. positive sign means flow into the equipment from the network.
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 254 shows all association ends of PowerElectronicsConnectionPhase with other classes.

Table 254 – Association ends of Wires::PowerElectronicsConnectionPhase with other classes

mult from	name	mult to	type	description
0..*	PowerElectronicsConnection	1..1	PowerElectronicsConnection	Power electronics connection of this power electronics connection phase.
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.4.59 PowerTransformer

An electrical device consisting of two or more coupled windings, with or without a magnetic core, for introducing mutual coupling between electric circuits. Transformers can be used to control voltage and phase shift (active power flow).

A power transformer may be composed of separate transformer tanks that need not be identical.

A power transformer can be modelled with or without tanks and is intended for use in both balanced and unbalanced representations. A power transformer typically has two terminals, but may have one (grounding), three or more terminals.

The inherited association ConductingEquipment.BaseVoltage should not be used. The association from TransformerEnd to BaseVoltage should be used instead.

Table 255 shows all attributes of PowerTransformer.

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Table 255 – Attributes of Wires::PowerTransformer

name	mult	type	description
beforeShCircuitHighestOperatingCurrent	0..1	CurrentFlow	The highest operating current (Ib in IEC 60909-0) before short circuit (depends on network configuration and relevant reliability philosophy). It is used for calculation of the impedance correction factor KT defined in IEC 60909-0.
beforeShCircuitHighestOperatingVoltage	0..1	Voltage	The highest operating voltage (Ub in IEC 60909-0) before short circuit. It is used for calculation of the impedance correction factor KT defined in IEC 60909-0. This is worst case voltage on the low side winding (3.7.1 of IEC 60909:2001). Used to define operating conditions.
beforeShortCircuitAnglePf	0..1	AngleDegrees	The angle of power factor before short circuit (phib in IEC 60909-0). It is used for calculation of the impedance correction factor KT defined in IEC 60909-0. This is the worst case power factor. Used to define operating conditions.
highSideMinOperatingU	0..1	Voltage	The minimum operating voltage (uQmin in IEC 60909-0) at the high voltage side (Q side) of the unit transformer of the power station unit. A value well established from long-term operating experience of the system. It is used for calculation of the impedance correction factor KG defined in IEC 60909-0.
isPartOfGeneratorUnit	0..1	Boolean	Indicates whether the machine is part of a power station unit. Used for short circuit data exchange according to IEC 60909. It has an impact on how the correction factors are calculated for transformers, since the transformer is not necessarily part of a synchronous machine and generating unit. It is not always possible to derive this information from the model. This is why the attribute is necessary.
operationalValuesConsidered	0..1	Boolean	It is used to define if the data (other attributes related to short circuit data exchange) defines long term operational conditions or not. Used for short circuit data exchange according to IEC 60909.
vectorGroup	0..1	String	Vector group of the transformer for protective relaying, e.g., Dyn1. For unbalanced transformers, this may not be simply determined from the constituent winding connections and phase angle displacements. The vectorGroup string consists of the following components in the order listed: high voltage winding connection, mid voltage winding connection (for three winding transformers), phase displacement clock number from 0 to 11, low voltage winding connection phase displacement clock number from 0 to 11. The winding connections are D (delta), Y (wye), YN (wye with neutral), Z (zigzag), ZN (zigzag with neutral), A (auto transformer). Upper case means the high voltage, lower case mid or low. The high voltage winding always has clock position 0 and is not included in the vector group string. Some examples: YNy0 (two winding wye to wye with no phase displacement), YNd11 (two winding wye to delta with 330 degrees phase displacement), YNyn0d5 (three winding transformer wye with neutral high voltage, wye with neutral mid voltage and no phase displacement, delta low voltage with 150 degrees displacement). Phase displacement is defined as the angular difference between the phasors representing the voltages between the neutral point (real or

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name	mult	type	description
			imaginary) and the corresponding terminals of two windings, a positive sequence voltage system being applied to the high-voltage terminals, following each other in alphabetical sequence if they are lettered, or in numerical sequence if they are numbered: the phasors are assumed to rotate in a counter-clockwise sense.
aggregate	0..1	Boolean	inherited from: Equipment
inService	0..1	Boolean	inherited from: Equipment
networkAnalysisEnabled	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 256 shows all association ends of PowerTransformer with other classes.

Table 256 – Association ends of Wires::PowerTransformer with other classes

mult from	name	mult to	type	description
0..1	PowerTransformerEnd	0..*	PowerTransformerEnd	The ends of this power transformer.
0..1	TransformerTanks	0..*	TransformerTank	All transformers that belong to this bank.
0..*	BaseVoltage	0..1	BaseVoltage	inherited from: ConductingEquipment
1..1	SvStatus	0..*	SvStatus	inherited from: ConductingEquipment
0..*	ProtectionEquipments	0..*	ProtectionEquipment	inherited from: ConductingEquipment
1..1	Terminals	0..*	Terminal	inherited from: ConductingEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	inherited from: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	inherited from: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment
0..1	Faults	0..*	Fault	inherited from: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	inherited from: Equipment
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

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6.4.60 PowerTransformerEnd

A PowerTransformerEnd is associated with each Terminal of a PowerTransformer.

The impedance values r, r0, x, and x0 of a PowerTransformerEnd represents a star equivalent as follows.

1) for a two Terminal PowerTransformer the high voltage (TransformerEnd.endNumber=1) PowerTransformerEnd has non zero values on r, r0, x, and x0 while the low voltage (TransformerEnd.endNumber=2) PowerTransformerEnd has zero values for r, r0, x, and x0. Parameters are always provided, even if the PowerTransformerEnds have the same rated voltage. In this case, the parameters are provided at the PowerTransformerEnd which has TransformerEnd.endNumber equal to 1.
2) for a three Terminal PowerTransformer the three PowerTransformerEnds represent a star equivalent with each leg in the star represented by r, r0, x, and x0 values.
3) For a three Terminal transformer each PowerTransformerEnd shall have g, g0, b and b0 values corresponding to the no load losses distributed on the three PowerTransformerEnds. The total no load loss shunt impedances may also be placed at one of the PowerTransformerEnds, preferably the end numbered 1, having the shunt values on end 1. This is the preferred way.
4) for a PowerTransformer with more than three Terminals the PowerTransformerEnd impedance values cannot be used. Instead use the TransformerMeshImpedance or split the transformer into multiple PowerTransformers.

Each PowerTransformerEnd must be contained by a PowerTransformer. Because a PowerTransformerEnd (or any other object) can not be contained by more than one parent, a PowerTransformerEnd can not have an association to an EquipmentContainer (Substation, VoltageLevel, etc).

Table 257 shows all attributes of PowerTransformerEnd.

Table 257 – Attributes of Wires::PowerTransformerEnd

name	mult	type	description
b	0..1	Susceptance	Magnetizing branch susceptance (B mag). The value can be positive or negative.
b0	0..1	Susceptance	Zero sequence magnetizing branch susceptance.
connectionKind	0..1	WindingConnection	Kind of connection.
g	0..1	Conductance	Magnetizing branch conductance.
g0	0..1	Conductance	Zero sequence magnetizing branch conductance (star-model).
phaseAngleClock	0..1	Integer	Terminal voltage phase angle displacement where 360 degrees are represented with clock hours. The valid values are 0 to 11. For example, for the secondary side end of a transformer with vector group code of 'Dyn11', specify the connection kind as wye with neutral and specify the phase angle of the clock as 11. The clock value of the transformer end number specified as 1, is assumed to be zero. Note the transformer end number is not assumed to be the same as the terminal sequence number.
r	0..1	Resistance	Resistance (star-model) of the transformer end. The attribute shall be equal to or greater than zero for non-equivalent transformers.
r0	0..1	Resistance	Zero sequence series resistance (star-model) of the transformer end.
ratedS	0..1	ApparentPower	Normal apparent power rating. The attribute shall be a positive value. For a two-winding transformer the values for the high and low voltage sides shall be identical.

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name	mult	type	description
ratedU	0..1	Voltage	Rated voltage: phase-phase for three-phase windings, and either phase-phase or phase-neutral for single-phase windings. A high voltage side, as given by TransformerEnd.endNumber, shall have a ratedU that is greater than or equal to ratedU for the lower voltage sides. The attribute shall be a positive value.
x	0..1	Reactance	Positive sequence series reactance (star-model) of the transformer end.
x0	0..1	Reactance	Zero sequence series reactance of the transformer end.
bmagSat	0..1	PerCent	inherited from: TransformerEnd
endNumber	0..1	Integer	inherited from: TransformerEnd
grounded	0..1	Boolean	inherited from: TransformerEnd
magBaseU	0..1	Voltage	inherited from: TransformerEnd
magSatFlux	0..1	PerCent	inherited from: TransformerEnd
rground	0..1	Resistance	inherited from: TransformerEnd
xground	0..1	Reactance	inherited from: TransformerEnd
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 258 shows all association ends of PowerTransformerEnd with other classes.

Table 258 – Association ends of Wires::PowerTransformerEnd with other classes

mult from	name	mult to	type	description
0..*	PowerTransformer	0..1	PowerTransformer	The power transformer of this power transformer end.
0..*	BaseVoltage	0..1	BaseVoltage	inherited from: TransformerEnd
0..*	Terminal	0..1	Terminal	inherited from: TransformerEnd
1..1	PhaseTapChanger	0..1	PhaseTapChanger	inherited from: TransformerEnd
1..1	RatioTapChanger	0..1	RatioTapChanger	inherited from: TransformerEnd
0..*	StarImpedance	0..1	TransformerStarImpedance	inherited from: TransformerEnd
0..*	CoreAdmittance	0..1	TransformerCoreAdmittance	inherited from: TransformerEnd
1..*	ToMeshImpedance	0..*	TransformerMeshImpedance	inherited from: TransformerEnd
1..1	FromMeshImpedance	0..*	TransformerMeshImpedance	inherited from: TransformerEnd
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.4.61 ProtectedSwitch

A ProtectedSwitch is a switching device that can be operated by ProtectionEquipment.

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Table 259 shows all attributes of ProtectedSwitch.

Table 259 – Attributes of Wires::ProtectedSwitch

name	mult	type	description
breakingCapacity	0..1	CurrentFlow	The maximum fault current a breaking device can break safely under prescribed conditions of use.
normalOpen	0..1	Boolean	inherited from: Switch
ratedCurrent	0..1	CurrentFlow	inherited from: Switch
switchOnCount	0..1	Integer	(deprecated) inherited from: Switch
switchOnDate	0..1	DateTime	(deprecated) inherited from: Switch
retained	0..1	Boolean	inherited from: Switch
open	0..1	Boolean	inherited from: Switch
locked	0..1	Boolean	inherited from: Switch
aggregate	0..1	Boolean	inherited from: Equipment
inService	0..1	Boolean	inherited from: Equipment
networkAnalysisEnabled	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 260 shows all association ends of ProtectedSwitch with other classes.

Table 260 – Association ends of Wires::ProtectedSwitch with other classes

mult from	name	mult to	type	description
0..*	OperatedByProtectionEquipment	0..*	ProtectionEquipment	Protection equipments that operate this ProtectedSwitch.
1..1	RecloseSequences	0..*	RecloseSequence	A breaker may have zero or more automatic reclosures after a trip occurs.
1..1	SwitchPhase	0..*	SwitchPhase	inherited from: Switch
1..1	SwitchSchedules	0..*	SwitchSchedule	inherited from: Switch
0..*	CompositeSwitch	0..1	CompositeSwitch	inherited from: Switch
1..1	SvSwitch	0..*	SvSwitch	inherited from: Switch
0..*	BaseVoltage	0..1	BaseVoltage	inherited from: ConductingEquipment
1..1	SvStatus	0..*	SvStatus	inherited from: ConductingEquipment
0..*	ProtectionEquipments	0..*	ProtectionEquipment	inherited from: ConductingEquipment
1..1	Terminals	0..*	Terminal	inherited from: ConductingEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	inherited from: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	inherited from: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment
0..1	Faults	0..*	Fault	inherited from: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	inherited from: Equipment
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource

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mult from	name	mult to	type	description
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.4.62 RatioTapChanger

A tap changer that changes the voltage ratio impacting the voltage magnitude but not the phase angle across the transformer.

Angle sign convention (general): Positive value indicates a positive phase shift from the winding where the tap is located to the other winding (for a two-winding transformer).

Table 261 shows all attributes of RatioTapChanger.

Table 261 – Attributes of Wires::RatioTapChanger

name	mult	type	description
stepVoltageIncrement	0..1	PerCent	Tap step increment, in per cent of rated voltage of the power transformer end, per step position. When the increment is negative, the voltage decreases when the tap step increases.
tculControlMode	0..1	TransformerControlMode	(deprecated) Specifies the regulation control mode (voltage or reactive) of the RatioTapChanger.
controlEnabled	0..1	Boolean	inherited from: TapChanger
highStep	0..1	Integer	inherited from: TapChanger
initialDelay	0..1	Seconds	inherited from: TapChanger
lowStep	0..1	Integer	inherited from: TapChanger
ltcFlag	0..1	Boolean	inherited from: TapChanger
neutralStep	0..1	Integer	inherited from: TapChanger
neutralU	0..1	Voltage	inherited from: TapChanger
normalStep	0..1	Integer	inherited from: TapChanger
subsequentDelay	0..1	Seconds	inherited from: TapChanger
step	0..1	Float	inherited from: TapChanger
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 262 shows all association ends of RatioTapChanger with other classes.

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Table 262 – Association ends of Wires::RatioTapChanger with other classes

mult from	name	mult to	type	description
0..*	RatioTapChangerTable	0..1	RatioTapChangerTable	The tap ratio table for this ratio tap changer.
0..1	TransformerEnd	1..1	TransformerEnd	Transformer end to which this ratio tap changer belongs.
1..*	TapChangerControl	0..1	TapChangerControl	inherited from: TapChanger
1..1	SvTapStep	0..1	SvTapStep	inherited from: TapChanger
1..1	TapSchedules	0..*	TapSchedule	inherited from: TapChanger
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.4.63 RatioTapChangerTable

Describes a curve for how the voltage magnitude and impedance varies with the tap step.

Table 263 shows all attributes of RatioTapChangerTable.

Table 263 – Attributes of Wires::RatioTapChangerTable

name	mult	type	description
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 264 shows all association ends of RatioTapChangerTable with other classes.

Table 264 – Association ends of Wires::RatioTapChangerTable with other classes

mult from	name	mult to	type	description
0..1	RatioTapChanger	0..*	RatioTapChanger	The ratio tap changer of this tap ratio table.
1..1	RatioTapChangerTablePoint	1..*	RatioTapChangerTablePoint	Points of this table.
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.4.64 RatioTapChangerTablePoint

Describes each tap step in the ratio tap changer tabular curve.

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Table 265 shows all attributes of RatioTapChangerTablePoint.

Table 265 – Attributes of Wires::RatioTapChangerTablePoint

name	mult	type	description
b	0..1	PerCent	inherited from: TapChangerTablePoint
g	0..1	PerCent	inherited from: TapChangerTablePoint
r	0..1	PerCent	inherited from: TapChangerTablePoint
ratio	0..1	Float	inherited from: TapChangerTablePoint
step	0..1	Integer	inherited from: TapChangerTablePoint
x	0..1	PerCent	inherited from: TapChangerTablePoint

Table 266 shows all association ends of RatioTapChangerTablePoint with other classes.

Table 266 – Association ends of Wires::RatioTapChangerTablePoint with other classes

mult from	name	mult to	type	description
1..*	RatioTapChangerTable	1..1	RatioTapChangerTable	Table of this point.

6.4.65 ReactiveCapabilityCurve

Reactive power rating envelope versus the synchronous machine's active power, in both the generating and motoring modes. For each active power value there is a corresponding high and low reactive power limit value. Typically there will be a separate curve for each coolant condition, such as hydrogen pressure. The Y1 axis values represent reactive minimum and the Y2 axis values represent reactive maximum.

Table 267 shows all attributes of ReactiveCapabilityCurve.

Table 267 – Attributes of Wires::ReactiveCapabilityCurve

name	mult	type	description
coolantTemperature	0..1	Temperature	The machine's coolant temperature (e.g., ambient air or stator circulating water).
hydrogenPressure	0..1	Pressure	The hydrogen coolant pressure.
curveStyle	0..1	CurveStyle	inherited from: Curve
xMultiplier	0..1	UnitMultiplier	inherited from: Curve
xUnit	0..1	UnitSymbol	inherited from: Curve
y1Multiplier	0..1	UnitMultiplier	inherited from: Curve
y1Unit	0..1	UnitSymbol	inherited from: Curve
y2Multiplier	0..1	UnitMultiplier	inherited from: Curve
y2Unit	0..1	UnitSymbol	inherited from: Curve
y3Multiplier	0..1	UnitMultiplier	inherited from: Curve
y3Unit	0..1	UnitSymbol	inherited from: Curve
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

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Table 268 shows all association ends of ReactiveCapabilityCurve with other classes.

Table 268 – Association ends of Wires::ReactiveCapabilityCurve with other classes

mult from	name	mult to	type	description
0..1	EquivalentInjection	0..*	EquivalentInjection	The equivalent injection using this reactive capability curve.
0..1	InitiallyUsedBySynchronousMachines	1..*	SynchronousMachine	Synchronous machines using this curve as default.
0..*	SynchronousMachines	1..*	SynchronousMachine	Synchronous machines using this curve.
1..1	CurveDatas	0..*	CurveData	inherited from: Curve
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.4.66 Recloser

Pole-mounted fault interrupter with built-in phase and ground relays, current transformer (CT), and supplemental controls.

Table 269 shows all attributes of Recloser.

Table 269 – Attributes of Wires::Recloser

name	mult	type	description
breakingCapacity	0..1	CurrentFlow	inherited from: ProtectedSwitch
normalOpen	0..1	Boolean	inherited from: Switch
ratedCurrent	0..1	CurrentFlow	inherited from: Switch
switchOnCount	0..1	Integer	(deprecated) inherited from: Switch
switchOnDate	0..1	DateTime	(deprecated) inherited from: Switch
retained	0..1	Boolean	inherited from: Switch
open	0..1	Boolean	inherited from: Switch
locked	0..1	Boolean	inherited from: Switch
aggregate	0..1	Boolean	inherited from: Equipment
inService	0..1	Boolean	inherited from: Equipment
networkAnalysisEnabled	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 270 shows all association ends of Recloser with other classes.

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Table 270 – Association ends of Wires::Recloser with other classes

mult from	name	mult to	type	description
0..*	OperatedByProtectionEquipment	0..*	ProtectionEquipment	inherited from: ProtectedSwitch
1..1	RecloseSequences	0..*	RecloseSequence	inherited from: ProtectedSwitch
1..1	SwitchPhase	0..*	SwitchPhase	inherited from: Switch
1..1	SwitchSchedules	0..*	SwitchSchedule	inherited from: Switch
0..*	CompositeSwitch	0..1	CompositeSwitch	inherited from: Switch
1..1	SvSwitch	0..*	SvSwitch	inherited from: Switch
0..*	BaseVoltage	0..1	BaseVoltage	inherited from: ConductingEquipment
1..1	SvStatus	0..*	SvStatus	inherited from: ConductingEquipment
0..*	ProtectionEquipments	0..*	ProtectionEquipment	inherited from: ConductingEquipment
1..1	Terminals	0..*	Terminal	inherited from: ConductingEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	inherited from: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	inherited from: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment
0..1	Faults	0..*	Fault	inherited from: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	inherited from: Equipment
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.4.67 RegulatingCondEq

A type of conducting equipment that can regulate a quantity (i.e. voltage or flow) at a specific point in the network.

Table 271 shows all attributes of RegulatingCondEq.

Table 271 – Attributes of Wires::RegulatingCondEq

name	mult	type	description
controlEnabled	0..1	Boolean	Specifies the regulation status of the equipment. True is regulating, false is not regulating.
aggregate	0..1	Boolean	inherited from: Equipment
inService	0..1	Boolean	inherited from: Equipment
networkAnalysisEnabled	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

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Table 272 shows all association ends of RegulatingCondEq with other classes.

Table 272 – Association ends of Wires::RegulatingCondEq with other classes

mult from	name	mult to	type	description
~~1~~0..*	RegulatingControl	0..1	RegulatingControl	The regulating control scheme in which this equipment participates.
0..*	BaseVoltage	0..1	BaseVoltage	inherited from: ConductingEquipment
1..1	SvStatus	0..*	SvStatus	inherited from: ConductingEquipment
0..*	ProtectionEquipments	0..*	ProtectionEquipment	inherited from: ConductingEquipment
1..1	Terminals	0..*	Terminal	inherited from: ConductingEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	inherited from: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	inherited from: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment
0..1	Faults	0..*	Fault	inherited from: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	inherited from: Equipment
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.4.68 RegulatingControl

Specifies a set of equipment that works together to control a power system quantity such as voltage or flow.

Remote bus voltage control is possible by specifying the controlled terminal located at some place remote from the controlling equipment.

The specified terminal shall be associated with the connectivity node of the controlled point. The most specific subtype of RegulatingControl shall be used in case such equipment participate in the control, e.g. TapChangerControl for tap changers.

For flow control, load sign convention is used, i.e. positive sign means flow out from a TopologicalNode (bus) into the conducting equipment.

The attribute minAllowedTargetValue and maxAllowedTargetValue are required in the following cases:

– For a power generating module operated in power factor control mode to specify maximum and minimum power factor values;

– Whenever it is necessary to have an off center target voltage for the tap changer regulator. For instance, due to long cables to off shore wind farms and the need to have a simpler setup at the off shore transformer platform, the voltage is controlled from the land at the connection point for the off shore wind farm. Since there usually is a voltage rise along the cable, there is typical and overvoltage of up 3-4 kV compared to the on shore station. Thus in normal operation the tap changer on the on shore station is operated with a target set point, which is in the lower parts of the dead band.

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The attributes minAllowedTargetValue and maxAllowedTargetValue are not related to the attribute targetDeadband and thus they are not treated as an alternative of the targetDeadband. They are needed due to limitations in the local substation controller. The attribute targetDeadband is used to prevent the power flow from move the tap position in circles (hunting) that is to be used regardless of the attributes minAllowedTargetValue and maxAllowedTargetValue.

Table 273 shows all attributes of RegulatingControl.

Table 273 – Attributes of Wires::RegulatingControl

name	mult	type	description
discrete	0..1	Boolean	The regulation is performed in a discrete mode. This applies to equipment with discrete controls, e.g. tap changers and shunt compensators.
enabled	0..1	Boolean	The flag tells if regulation is enabled.
mode	0..1	RegulatingControlModeKind	The regulating control mode presently available. This specification allows for determining the kind of regulation without need for obtaining the units from a schedule.
monitoredPhase	0..1	PhaseCode	Phase voltage controlling this regulator, measured at regulator location.
targetDeadband	0..1	Float	This is a deadband used with discrete control to avoid excessive update of controls like tap changers and shunt compensator banks while regulating. The units of those appropriate for the mode. The attribute shall be a positive value or zero. If RegulatingControl.discrete is set to "false", the RegulatingControl.targetDeadband is to be ignored. Note that for instance, if the targetValue is 100 kV and the targetDeadband is 2 kV the range is from 99 to 101 kV.
targetValue	0..1	Float	The target value specified for case input. This value can be used for the target value without the use of schedules. The value has the units appropriate to the mode attribute.
targetValueUnitMultiplier	0..1	UnitMultiplier	Specify the multiplier for used for the targetValue.
maxAllowedTargetValue	0..1	Float	Maximum allowed target value (RegulatingControl.targetValue).
minAllowedTargetValue	0..1	Float	Minimum allowed target value (RegulatingControl.targetValue).
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 274 shows all association ends of RegulatingControl with other classes.

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Table 274 – Association ends of Wires::RegulatingControl with other classes

mult from	name	mult to	type	description
0..*	Terminal	0..1	Terminal	The terminal associated with this regulating control. The terminal is associated instead of a node, since the terminal could connect into either a topological node or a connectivity node. Sometimes it is useful to model regulation at a terminal of a bus bar object.
0..1	RegulatingCondEq	~~1~~0..*	RegulatingCondEq	The equipment that participates in this regulating control scheme.
1..1	RegulationSchedule	0..*	RegulationSchedule	Schedule for this regulating control.
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.4.69 RegulatingControlModeKind enumeration

The kind of regulation model. For example regulating voltage, reactive power, active power, etc.

Table 275 shows all literals of RegulatingControlModeKind.

Table 275 – Literals of Wires::RegulatingControlModeKind

literal	value	description
voltage		Voltage is specified.
activePower		Active power is specified.
reactivePower		Reactive power is specified.
currentFlow		Current flow is specified.
admittance		Admittance is specified.
timeScheduled		Control switches on/off by time of day. The times may change on the weekend, or in different seasons.
temperature		Control switches on/off based on the local temperature (i.e., a thermostat).
powerFactor		Power factor is specified.

6.4.70 RegulationSchedule

A pre-established pattern over time for a controlled variable, e.g., busbar voltage.

Table 276 shows all attributes of RegulationSchedule.

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Table 276 – Attributes of Wires::RegulationSchedule

name	mult	type	description
endTime	0..1	DateTime	inherited from: RegularIntervalSchedule
timeStep	0..1	Seconds	inherited from: RegularIntervalSchedule
startTime	0..1	DateTime	inherited from: BasicIntervalSchedule
value1Multiplier	0..1	UnitMultiplier	inherited from: BasicIntervalSchedule
value1Unit	0..1	UnitSymbol	inherited from: BasicIntervalSchedule
value2Multiplier	0..1	UnitMultiplier	inherited from: BasicIntervalSchedule
value2Unit	0..1	UnitSymbol	inherited from: BasicIntervalSchedule
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 277 shows all association ends of RegulationSchedule with other classes.

Table 277 – Association ends of Wires::RegulationSchedule with other classes

mult from	name	mult to	type	description
0..*	RegulatingControl	1..1	RegulatingControl	Regulating controls that have this schedule.
0..1	VoltageControlZones	0..*	VoltageControlZone	A VoltageControlZone may have a voltage regulation schedule.
0..*	DayType	0..1	DayType	inherited from: SeasonDayTypeSchedule
0..*	Season	0..1	Season	inherited from: SeasonDayTypeSchedule
1..1	TimePoints	1..*	RegularTimePoint	inherited from: RegularIntervalSchedule
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.4.71 RotatingMachine

A rotating machine which may be used as a generator or motor.

Table 278 shows all attributes of RotatingMachine.

Table 278 – Attributes of Wires::RotatingMachine

name	mult	type	description
ratedPowerFactor	0..1	Float	Power factor (nameplate data). It is primarily used for short circuit data exchange according to IEC 60909. The attribute cannot be a negative value.
p	0..1	ActivePower	Active power injection. Load sign convention is used, i.e. positive sign means flow out from a node. Starting value for a steady state solution.
ratedS	0..1	ApparentPower	Nameplate apparent power rating for the unit. The attribute shall have a positive value.

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name	mult	type	description
q	0..1	ReactivePower	Reactive power injection. Load sign convention is used, i.e. positive sign means flow out from a node. Starting value for a steady state solution.
ratedU	0..1	Voltage	Rated voltage (nameplate data, Ur in IEC 60909-0). It is primarily used for short circuit data exchange according to IEC 60909. The attribute shall be a positive value.
controlEnabled	0..1	Boolean	inherited from: RegulatingCondEq
aggregate	0..1	Boolean	inherited from: Equipment
inService	0..1	Boolean	inherited from: Equipment
networkAnalysisEnabled	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 279 shows all association ends of RotatingMachine with other classes.

Table 279 – Association ends of Wires::RotatingMachine with other classes

mult from	name	mult to	type	description
1..1	HydroPump	0..1	HydroPump	The synchronous machine drives the turbine which moves the water from a low elevation to a higher elevation. The direction of machine rotation for pumping may or may not be the same as for generating.
0..*	GeneratingUnit	0..1	GeneratingUnit	A synchronous machine may operate as a generator and as such becomes a member of a generating unit.
~~1~~0..*	RegulatingControl	0..1	RegulatingControl	inherited from: RegulatingCondEq
0..*	BaseVoltage	0..1	BaseVoltage	inherited from: ConductingEquipment
1..1	SvStatus	0..*	SvStatus	inherited from: ConductingEquipment
0..*	ProtectionEquipments	0..*	ProtectionEquipment	inherited from: ConductingEquipment
1..1	Terminals	0..*	Terminal	inherited from: ConductingEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	inherited from: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	inherited from: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment
0..1	Faults	0..*	Fault	inherited from: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	inherited from: Equipment
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject

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mult from	name	mult to	type	description
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.4.72 Sectionaliser

Automatic switch that will lock open to isolate a faulted section. It may, or may not, have load breaking capability. Its primary purpose is to provide fault sectionalising at locations where the fault current is either too high, or too low, for proper coordination of fuses.

Table 280 shows all attributes of Sectionaliser.

Table 280 – Attributes of Wires::Sectionaliser

name	mult	type	description
normalOpen	0..1	Boolean	inherited from: Switch
ratedCurrent	0..1	CurrentFlow	inherited from: Switch
switchOnCount	0..1	Integer	(deprecated) inherited from: Switch
switchOnDate	0..1	DateTime	(deprecated) inherited from: Switch
retained	0..1	Boolean	inherited from: Switch
open	0..1	Boolean	inherited from: Switch
locked	0..1	Boolean	inherited from: Switch
aggregate	0..1	Boolean	inherited from: Equipment
inService	0..1	Boolean	inherited from: Equipment
networkAnalysisEnabled	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 281 shows all association ends of Sectionaliser with other classes.

Table 281 – Association ends of Wires::Sectionaliser with other classes

mult from	name	mult to	type	description
1..1	SwitchPhase	0..*	SwitchPhase	inherited from: Switch
1..1	SwitchSchedules	0..*	SwitchSchedule	inherited from: Switch
0..*	CompositeSwitch	0..1	CompositeSwitch	inherited from: Switch
1..1	SvSwitch	0..*	SvSwitch	inherited from: Switch
0..*	BaseVoltage	0..1	BaseVoltage	inherited from: ConductingEquipment
1..1	SvStatus	0..*	SvStatus	inherited from: ConductingEquipment
0..*	ProtectionEquipments	0..*	ProtectionEquipment	inherited from: ConductingEquipment
1..1	Terminals	0..*	Terminal	inherited from: ConductingEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	inherited from: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	inherited from: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment

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mult from	name	mult to	type	description
0..1	Faults	0..*	Fault	inherited from: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	inherited from: Equipment
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.4.73 SeriesCompensator

A Series Compensator is a series capacitor or reactor or an AC transmission line without charging susceptance. It is a two terminal device.

Table 282 shows all attributes of SeriesCompensator.

Table 282 – Attributes of Wires::SeriesCompensator

name	mult	type	description
r	0..1	Resistance	Positive sequence resistance.
r0	0..1	Resistance	Zero sequence resistance.
x	0..1	Reactance	Positive sequence reactance.
x0	0..1	Reactance	Zero sequence reactance.
varistorPresent	0..1	Boolean	Describe if a metal oxide varistor (mov) for over voltage protection is configured in parallel with the series compensator. It is used for short circuit calculations.
varistorRatedCurrent	0..1	CurrentFlow	The maximum current the varistor is designed to handle at specified duration. It is used for short circuit calculations and exchanged only if SeriesCompensator.varistorPresent is true. The attribute shall be a positive value.
varistorVoltageThreshold	0..1	Voltage	The DC voltage at which the varistor starts conducting. It is used for short circuit calculations and exchanged only if SeriesCompensator.varistorPresent is true.
aggregate	0..1	Boolean	inherited from: Equipment
inService	0..1	Boolean	inherited from: Equipment
networkAnalysisEnabled	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 283 shows all association ends of SeriesCompensator with other classes.

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Table 283 – Association ends of Wires::SeriesCompensator with other classes

mult from	name	mult to	type	description
0..*	BaseVoltage	0..1	BaseVoltage	inherited from: ConductingEquipment
1..1	SvStatus	0..*	SvStatus	inherited from: ConductingEquipment
0..*	ProtectionEquipments	0..*	ProtectionEquipment	inherited from: ConductingEquipment
1..1	Terminals	0..*	Terminal	inherited from: ConductingEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	inherited from: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	inherited from: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment
0..1	Faults	0..*	Fault	inherited from: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	inherited from: Equipment
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.4.74 ShortCircuitRotorKind enumeration

Type of rotor, used by short circuit applications.

Table 284 shows all literals of ShortCircuitRotorKind.

Table 284 – Literals of Wires::ShortCircuitRotorKind

literal	value	description
salientPole1		Salient pole 1 in IEC 60909.
salientPole2		Salient pole 2 in IEC 60909.
turboSeries1		Turbo Series 1 in IEC 60909.
turboSeries2		Turbo series 2 in IEC 60909.

6.4.75 ShuntCompensator

A shunt capacitor or reactor or switchable bank of shunt capacitors or reactors. A section of a shunt compensator is an individual capacitor or reactor. A negative value for ~~reactivePerSection~~ bPerSection indicates that the compensator is a reactor. ShuntCompensator is a single terminal device. Ground is implied.

Table 285 shows all attributes of ShuntCompensator.

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Table 285 – Attributes of Wires::ShuntCompensator

name	mult	type	description
aVRDelay	0..1	Seconds	An automatic voltage regulation delay (AVRDelay) which is the time delay from a change in voltage to when the capacitor is allowed to change state. This filters out temporary changes in voltage.
grounded	0..1	Boolean	Used for Yn and Zn connections. True if the neutral is solidly grounded.
maximumSections	0..1	Integer	The maximum number of sections that may be switched in.
nomU	0..1	Voltage	The voltage at which the nominal reactive power may be calculated. This should normally be within 10% of the voltage at which the capacitor is connected to the network.
normalSections	0..1	Integer	The normal number of sections switched in. The value shall be between zero and ShuntCompensator.maximumSections.
phaseConnection	0..1	PhaseShuntConnectionKind	The type of phase connection, such as wye or delta.
switchOnCount	0..1	Integer	(deprecated) The switch on count since the capacitor count was last reset or initialized.
switchOnDate	0..1	DateTime	(deprecated) The date and time when the capacitor bank was last switched on.
voltageSensitivity	0..1	VoltagePerReactivePower	Voltage sensitivity required for the device to regulate the bus voltage, in voltage/reactive power.
sections	0..1	Float	Shunt compensator sections in use. Starting value for steady state solution. The attribute shall be a positive value or zero. Non integer values are allowed to support continuous variables. The reasons for continuous value are to support study cases where no discrete shunt compensators has yet been designed, a solutions where a narrow voltage band force the sections to oscillate or accommodate for a continuous solution as input. For LinearShuntConpensator the value shall be between zero and ShuntCompensator.maximumSections. At value zero the shunt compensator conductance and admittance is zero. Linear interpolation of conductance and admittance between the previous and next integer section is applied in case of non-integer values. For NonlinearShuntCompensator-s shall only be set to one of the NonlinearShuntCompenstorPoint.sectionNumber. There is no interpolation between NonlinearShuntCompenstorPoint-s.
controlEnabled	0..1	Boolean	inherited from: RegulatingCondEq
aggregate	0..1	Boolean	inherited from: Equipment
inService	0..1	Boolean	inherited from: Equipment
networkAnalysisEnabled	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

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Table 286 shows all association ends of ShuntCompensator with other classes.

Table 286 – Association ends of Wires::ShuntCompensator with other classes

mult from	name	mult to	type	description
1..1	ShuntCompensatorPhase	0..*	ShuntCompensatorPhase	The individual phases models for the shunt compensator.
1..1	SvShuntCompensatorSections	0..*	SvShuntCompensatorSections	The state for the number of shunt compensator sections in service.
~~1~~0..*	RegulatingControl	0..1	RegulatingControl	inherited from: RegulatingCondEq
0..*	BaseVoltage	0..1	BaseVoltage	inherited from: ConductingEquipment
1..1	SvStatus	0..*	SvStatus	inherited from: ConductingEquipment
0..*	ProtectionEquipments	0..*	ProtectionEquipment	inherited from: ConductingEquipment
1..1	Terminals	0..*	Terminal	inherited from: ConductingEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	inherited from: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	inherited from: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment
0..1	Faults	0..*	Fault	inherited from: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	inherited from: Equipment
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.4.76 ShuntCompensatorPhase

Single phase of a multi-phase shunt compensator when its attributes might be different per phase.

Table 287 shows all attributes of ShuntCompensatorPhase.

Table 287 – Attributes of Wires::ShuntCompensatorPhase

name	mult	type	description
maximumSections	0..1	Integer	The maximum number of sections that may be switched in for this phase.
normalSections	0..1	Integer	For the capacitor phase, the normal number of sections switched in. The value shall be between zero and ShuntCompensatorPhase.maximumSections.
sections	0..1	Float	Shunt compensator sections in use. Starting value for steady state solution. The attribute shall be a positive value or zero. Non integer values are allowed to support continuous variables. The reasons for continuous value are to support study cases where no discrete shunt compensators has yet been designed, a solutions where a narrow voltage band force the sections to oscillate or accommodate for a continuous solution as input.

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name	mult	type	description
			For LinearShuntConpensator the value shall be between zero and ShuntCompensatorPhase.maximumSections. At value zero the shunt compensator conductance and admittance is zero. Linear interpolation of conductance and admittance between the previous and next integer section is applied in case of non-integer values. For NonlinearShuntCompensator-s shall only be set to one of the NonlinearShuntCompenstorPhasePoint.sectionNumber. There is no interpolation between NonlinearShuntCompenstorPhasePoint-s.
phase	0..1	SinglePhaseKind	Phase of this shunt compensator component. If the shunt compensator is wye connected, the connection is from the indicated phase to the central ground or neutral point. If the shunt compensator is delta connected, the phase indicates a shunt compensator connected from the indicated phase to the next logical non-neutral phase.
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 288 shows all association ends of ShuntCompensatorPhase with other classes.

Table 288 – Association ends of Wires::ShuntCompensatorPhase with other classes

mult from	name	mult to	type	description
0..*	ShuntCompensator	1..1	ShuntCompensator	Shunt compensator of this shunt compensator phase.
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.4.77 SinglePhaseKind enumeration

Enumeration of single phase identifiers. Allows designation of single phases for both transmission and distribution equipment, circuits and loads.

Table 289 shows all literals of SinglePhaseKind.

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Table 289 – Literals of Wires::SinglePhaseKind

literal	value	description
A		Phase A.
B		Phase B.
C		Phase C.
N		Neutral.
s1		Secondary phase 1.
s2		Secondary phase 2.

6.4.78 StaticVarCompensator

A facility for providing variable and controllable shunt reactive power. The SVC typically consists of a stepdown transformer, filter, thyristor-controlled reactor, and thyristor-switched capacitor arms.

The SVC may operate in fixed MVar output mode or in voltage control mode. When in voltage control mode, the output of the SVC will be proportional to the deviation of voltage at the controlled bus from the voltage setpoint. The SVC characteristic slope defines the proportion. If the voltage at the controlled bus is equal to the voltage setpoint, the SVC MVar output is zero.

Table 290 shows all attributes of StaticVarCompensator.

Table 290 – Attributes of Wires::StaticVarCompensator

name	mult	type	description
capacitiveRating	0..1	Reactance	Capacitive reactance at maximum capacitive reactive power. Shall always be positive.
inductiveRating	0..1	Reactance	Inductive reactance at maximum inductive reactive power. Shall always be negative.
slope	0..1	VoltagePerReactivePower	The characteristics slope of an SVC defines how the reactive power output changes in proportion to the difference between the regulated bus voltage and the voltage setpoint. The attribute shall be a positive value or zero.
q	0..1	ReactivePower	Reactive power injection. Load sign convention is used, i.e. positive sign means flow out from a node. Starting value for a steady state solution.
sVCControlMode	0..1	SVCControlMode	SVC control mode.
voltageSetPoint	0..1	Voltage	The reactive power output of the SVC is proportional to the difference between the voltage at the regulated bus and the voltage setpoint. When the regulated bus voltage is equal to the voltage setpoint, the reactive power output is zero.
controlEnabled	0..1	Boolean	inherited from: RegulatingCondEq
aggregate	0..1	Boolean	inherited from: Equipment
inService	0..1	Boolean	inherited from: Equipment
networkAnalysisEnabled	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject

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name	mult	type	description
name	0..1	String	inherited from: IdentifiedObject

Table 291 shows all association ends of StaticVarCompensator with other classes.

Table 291 – Association ends of Wires::StaticVarCompensator with other classes

mult from	name	mult to	type	description
1..1	StaticVarCompensatorDynamics	0..1	StaticVarCompensatorDynamics	Static Var Compensator dynamics model used to describe dynamic behaviour of this Static Var Compensator.
~~1~~0..*	RegulatingControl	0..1	RegulatingControl	inherited from: RegulatingCondEq
0..*	BaseVoltage	0..1	BaseVoltage	inherited from: ConductingEquipment
1..1	SvStatus	0..*	SvStatus	inherited from: ConductingEquipment
0..*	ProtectionEquipments	0..*	ProtectionEquipment	inherited from: ConductingEquipment
1..1	Terminals	0..*	Terminal	inherited from: ConductingEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	inherited from: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	inherited from: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment
0..1	Faults	0..*	Fault	inherited from: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	inherited from: Equipment
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.4.79 SVCControlMode enumeration

Static VAr Compensator control mode.

Table 292 shows all literals of SVCControlMode.

Table 292 – Literals of Wires::SVCControlMode

literal	value	description
reactivePower		Reactive power control.
voltage		Voltage control.

6.4.80 Switch

A generic device designed to close, or open, or both, one or more electric circuits. All switches are two terminal devices including grounding switches. The ACDCTerminal.connected at the two sides of the switch shall not be considered for assessing switch connectivity, i.e. only Switch.open, .normalOpen and .locked are relevant.

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Table 293 shows all attributes of Switch.

Table 293 – Attributes of Wires::Switch

name	mult	type	description
normalOpen	0..1	Boolean	The attribute is used in cases when no Measurement for the status value is present. If the Switch has a status measurement the Discrete.normalValue is expected to match with the Switch.normalOpen.
ratedCurrent	0..1	CurrentFlow	The maximum continuous current carrying capacity in amps governed by the device material and construction. The attribute shall be a positive value.
switchOnCount	0..1	Integer	(deprecated) The switch on count since the switch was last reset or initialized.
switchOnDate	0..1	DateTime	(deprecated) The date and time when the switch was last switched on.
retained	0..1	Boolean	Branch is retained in the topological solution. The flow through retained switches will normally be calculated in power flow.
open	0..1	Boolean	The attribute tells if the switch is considered open when used as input to topology processing.
locked	0..1	Boolean	If true, the switch is locked. The resulting switch state is a combination of locked and Switch.open attributes as follows: – locked=true and Switch.open=true. The resulting state is open and locked; – locked=false and Switch.open=true. The resulting state is open; – locked=false and Switch.open=false. The resulting state is closed.
aggregate	0..1	Boolean	inherited from: Equipment
inService	0..1	Boolean	inherited from: Equipment
networkAnalysisEnabled	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 294 shows all association ends of Switch with other classes.

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Table 294 – Association ends of Wires::Switch with other classes

mult from	name	mult to	type	description
1..1	SwitchPhase	0..*	SwitchPhase	The individual switch phases for the switch.
1..1	SwitchSchedules	0..*	SwitchSchedule	A Switch can be associated with SwitchSchedules.
0..*	CompositeSwitch	0..1	CompositeSwitch	Composite switch to which this Switch belongs.
1..1	SvSwitch	0..*	SvSwitch	The switch state associated with the switch.
0..*	BaseVoltage	0..1	BaseVoltage	inherited from: ConductingEquipment
1..1	SvStatus	0..*	SvStatus	inherited from: ConductingEquipment
0..*	ProtectionEquipments	0..*	ProtectionEquipment	inherited from: ConductingEquipment
1..1	Terminals	0..*	Terminal	inherited from: ConductingEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	inherited from: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	inherited from: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment
0..1	Faults	0..*	Fault	inherited from: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	inherited from: Equipment
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.4.81 SwitchPhase

Single phase of a multi-phase switch when its attributes might be different per phase.

Table 295 shows all attributes of SwitchPhase.

Table 295 – Attributes of Wires::SwitchPhase

name	mult	type	description
normalOpen	0..1	Boolean	Used in cases when no Measurement for the status value is present. If the SwitchPhase has a status measurement the Discrete.normalValue is expected to match with this value.
phaseSide1	0..1	SinglePhaseKind	Phase of this SwitchPhase on the side with terminal sequence number equal to 1. Should be a phase contained in that terminal's phases attribute.
phaseSide2	0..1	SinglePhaseKind	Phase of this SwitchPhase on the side with terminal sequence number equal to 2. Should be a phase contained in that terminal's Terminal.phases attribute.
closed	0..1	Boolean	The attribute tells if the switch is considered closed when used as input to topology processing.

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name	mult	type	description
ratedCurrent	0..1	CurrentFlow	The maximum continuous current carrying capacity in amps governed by the device material and construction. The attribute shall be a positive value.
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 296 shows all association ends of SwitchPhase with other classes.

Table 296 – Association ends of Wires::SwitchPhase with other classes

mult from	name	mult to	type	description
0..*	Switch	1..1	Switch	The switch of the switch phase.
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.4.82 SwitchSchedule

A schedule of switch positions. If RegularTimePoint.value1 is 0, the switch is open. If 1, the switch is closed.

Table 297 shows all attributes of SwitchSchedule.

Table 297 – Attributes of Wires::SwitchSchedule

name	mult	type	description
endTime	0..1	DateTime	inherited from: RegularIntervalSchedule
timeStep	0..1	Seconds	inherited from: RegularIntervalSchedule
startTime	0..1	DateTime	inherited from: BasicIntervalSchedule
value1Multiplier	0..1	UnitMultiplier	inherited from: BasicIntervalSchedule
value1Unit	0..1	UnitSymbol	inherited from: BasicIntervalSchedule
value2Multiplier	0..1	UnitMultiplier	inherited from: BasicIntervalSchedule
value2Unit	0..1	UnitSymbol	inherited from: BasicIntervalSchedule
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 298 shows all association ends of SwitchSchedule with other classes.

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Table 298 – Association ends of Wires::SwitchSchedule with other classes

mult from	name	mult to	type	description
0..*	Switch	1..1	Switch	A SwitchSchedule is associated with a Switch.
0..*	DayType	0..1	DayType	inherited from: SeasonDayTypeSchedule
0..*	Season	0..1	Season	inherited from: SeasonDayTypeSchedule
1..1	TimePoints	1..*	RegularTimePoint	inherited from: RegularIntervalSchedule
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.4.83 SynchronousMachine

An electromechanical device that operates with shaft rotating synchronously with the network. It is a single machine operating either as a generator or synchronous condenser or pump.

Table 299 shows all attributes of SynchronousMachine.

Table 299 – Attributes of Wires::SynchronousMachine

name	mult	type	description
aVRToManualLag	0..1	Seconds	Time delay required when switching from Automatic Voltage Regulation (AVR) to Manual for a lagging MVAr violation.
aVRToManualLead	0..1	Seconds	Time delay required when switching from Automatic Voltage Regulation (AVR) to Manual for a leading MVAr violation.
baseQ	0..1	ReactivePower	Default base reactive power value. This value represents the initial reactive power that can be used by any application function.
condenserP	0..1	ActivePower	Active power consumed when in condenser mode operation.
coolantCondition	0..1	Float	Temperature or pressure of coolant medium.
coolantType	0..1	CoolantType	Method of cooling the machine.
earthing	0..1	Boolean	Indicates whether or not the generator is earthed. Used for short circuit data exchange according to IEC 60909.
earthingStarPointR	0..1	Resistance	Generator star point earthing resistance (Re). Used for short circuit data exchange according to IEC 60909.
earthingStarPointX	0..1	Reactance	Generator star point earthing reactance (Xe). Used for short circuit data exchange according to IEC 60909.
ikk	0..1	CurrentFlow	Steady-state short-circuit current (in A for the profile) of generator with compound excitation during 3-phase short circuit. – Ikk=0: Generator with no compound excitation. – Ikk<>0: Generator with compound excitation. Ikk is used to calculate the minimum steady-state short-circuit current for generators with compound excitation. (4.6.1.2 in IEC 60909-0:2001). Used only for single fed short circuit on a generator. (4.3.4.2. in IEC 60909-0:2001).

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name	mult	type	description
manualToAVR	0..1	Seconds	Time delay required when switching from Manual to Automatic Voltage Regulation. This value is used in the accelerating power reference frame for powerflow solutions.
maxQ	0..1	ReactivePower	Maximum reactive power limit. This is the maximum (nameplate) limit for the unit.
maxU	0..1	Voltage	Maximum voltage limit for the unit.
minQ	0..1	ReactivePower	Minimum reactive power limit for the unit.
minU	0..1	Voltage	Minimum voltage limit for the unit.
mu	0..1	Float	Factor to calculate the breaking current (Section 4.5.2.1 in IEC 60909-0). Used only for single fed short circuit on a generator (Section 4.3.4.2. in IEC 60909-0).
operatingMode	0..1	SynchronousMachineOperatingMode	Current mode of operation.
qPercent	0..1	PerCent	Part of the coordinated reactive control that comes from this machine. The attribute is used as a participation factor not necessarily summing up to 100% for the participating devices in the control.
r	0..1	Resistance	Equivalent resistance (RG) of generator. RG is considered for the calculation of all currents, except for the calculation of the peak current ip. Used for short circuit data exchange according to IEC 60909.
r0	0..1	Resistance	Zero sequence resistance of the synchronous machine.
r2	0..1	Resistance	Negative sequence resistance.
referencePriority	0..1	Integer	Priority of unit for use as powerflow voltage phase angle reference bus selection. 0 = don t care (default) 1 = highest priority. 2 is less than 1 and so on.
satDirectSubtransX	0..1	PU	Direct-axis subtransient reactance saturated, also known as Xd"sat.
satDirectSyncX	0..1	PU	Direct-axes saturated synchronous reactance (xdsat); reciprocal of short-circuit ration. Used for short circuit data exchange, only for single fed short circuit on a generator. (4.3.4.2. in IEC 60909-0:2001).
satDirectTransX	0..1	PU	Saturated Direct-axis transient reactance. The attribute is primarily used for short circuit calculations according to ANSI.
shortCircuitRotorType	0..1	ShortCircuitRotorKind	Type of rotor, used by short circuit applications, only for single fed short circuit according to IEC 60909.
type	0..1	SynchronousMachineKind	Modes that this synchronous machine can operate in.
voltageRegulationRange	0..1	PerCent	Range of generator voltage regulation (PG in IEC 60909-0) used for calculation of the impedance correction factor KG defined in IEC 60909-0. This attribute is used to describe the operating voltage of the generating unit.
x0	0..1	Reactance	Zero sequence reactance of the synchronous machine.
x2	0..1	Reactance	Negative sequence reactance.
ratedPowerFactor	0..1	Float	inherited from: RotatingMachine
p	0..1	ActivePower	inherited from: RotatingMachine

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name	mult	type	description
ratedS	0..1	ApparentPower	inherited from: RotatingMachine
q	0..1	ReactivePower	inherited from: RotatingMachine
ratedU	0..1	Voltage	inherited from: RotatingMachine
controlEnabled	0..1	Boolean	inherited from: RegulatingCondEq
aggregate	0..1	Boolean	inherited from: Equipment
inService	0..1	Boolean	inherited from: Equipment
networkAnalysisEnabled	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 300 shows all association ends of SynchronousMachine with other classes.

Table 300 – Association ends of Wires::SynchronousMachine with other classes

mult from	name	mult to	type	description
1..*	InitialReactiveCapabilityCurve	0..1	ReactiveCapabilityCurve	The default reactive capability curve for use by a synchronous machine.
1..*	ReactiveCapabilityCurves	0..*	ReactiveCapabilityCurve	All available reactive capability curves for this synchronous machine.
0..*	PrimeMovers	0..*	PrimeMover	Prime movers that drive this SynchronousMachine.
1..1	SynchronousMachineDynamics	0..1	SynchronousMachineDynamics	Synchronous machine dynamics model used to describe dynamic behaviour of this synchronous machine.
1..1	HydroPump	0..1	HydroPump	inherited from: RotatingMachine
0..*	GeneratingUnit	0..1	GeneratingUnit	inherited from: RotatingMachine
~~1~~0..*	RegulatingControl	0..1	RegulatingControl	inherited from: RegulatingCondEq
0..*	BaseVoltage	0..1	BaseVoltage	inherited from: ConductingEquipment
1..1	SvStatus	0..*	SvStatus	inherited from: ConductingEquipment
0..*	ProtectionEquipments	0..*	ProtectionEquipment	inherited from: ConductingEquipment
1..1	Terminals	0..*	Terminal	inherited from: ConductingEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	inherited from: Equipment
1..*	ContingencyEquipment	0..*	ContingencyEquipment	inherited from: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment
0..1	Faults	0..*	Fault	inherited from: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	inherited from: Equipment
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject

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mult from	name	mult to	type	description
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.4.84 SynchronousMachineOperatingMode enumeration

Synchronous machine operating mode.

Table 301 shows all literals of SynchronousMachineOperatingMode.

Table 301 – Literals of Wires::SynchronousMachineOperatingMode

literal	value	description
generator		Operating as generator.
condenser		Operating as condenser.
motor		Operating as motor.

6.4.85 SynchronousMachineKind enumeration

Synchronous machine type.

Table 302 shows all literals of SynchronousMachineKind.

Table 302 – Literals of Wires::SynchronousMachineKind

literal	value	description
generator		Indicates the synchronous machine can operate as a generator.
condenser		Indicates the synchronous machine can operate as a condenser.
generatorOrCondenser		Indicates the synchronous machine can operate as a generator or as a condenser.
motor		Indicates the synchronous machine can operate as a motor.
generatorOrMotor		Indicates the synchronous machine can operate as a generator or as a motor.
motorOrCondenser		Indicates the synchronous machine can operate as a motor or as a condenser.
generatorOrCondenserOrMotor		Indicates the synchronous machine can operate as a generator or as a condenser or as a motor.

6.4.86 TapChanger

Mechanism for changing transformer winding tap positions.

Table 303 shows all attributes of TapChanger.

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Table 303 – Attributes of Wires::TapChanger

name	mult	type	description
controlEnabled	0..1	Boolean	Specifies the regulation status of the equipment. True is regulating, false is not regulating.
highStep	0..1	Integer	Highest possible tap step position, advance from neutral. The attribute shall be greater than lowStep.
initialDelay	0..1	Seconds	For an LTC, the delay for initial tap changer operation (first step change).
lowStep	0..1	Integer	Lowest possible tap step position, retard from neutral.
ltcFlag	0..1	Boolean	Specifies whether or not a TapChanger has load tap changing capabilities.
neutralStep	0..1	Integer	The neutral tap step position for this winding. The attribute shall be equal to or greater than lowStep and equal or less than highStep. It is the step position where the voltage is neutralU when the other terminals of the transformer are at the ratedU. If there are other tap changers on the transformer those taps are kept constant at their neutralStep.
neutralU	0..1	Voltage	Voltage at which the winding operates at the neutral tap setting. It is the voltage at the terminal of the PowerTransformerEnd associated with the tap changer when all tap changers on the transformer are at their neutralStep position. Normally neutralU of the tap changer is the same as ratedU of the PowerTransformerEnd, but it can differ in special cases such as when the tapping mechanism is separate from the winding more common on lower voltage transformers. This attribute is not relevant for PhaseTapChangerAsymmetrical, PhaseTapChangerSymmetrical and PhaseTapChangerLinear.
normalStep	0..1	Integer	The tap step position used in "normal" network operation for this winding. For a "Fixed" tap changer indicates the current physical tap setting. The attribute shall be equal to or greater than lowStep and equal to or less than highStep.
subsequentDelay	0..1	Seconds	For an LTC, the delay for subsequent tap changer operation (second and later step changes).
step	0..1	Float	Tap changer position. Starting step for a steady state solution. Non integer values are allowed to support continuous tap variables. The reasons for continuous value are to support study cases where no discrete tap changer has yet been designed, a solution where a narrow voltage band forces the tap step to oscillate or to accommodate for a continuous solution as input. The attribute shall be equal to or greater than lowStep and equal to or less than highStep.
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

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Table 304 shows all association ends of TapChanger with other classes.

Table 304 – Association ends of Wires::TapChanger with other classes

mult from	name	mult to	type	description
1..*	TapChangerControl	0..1	TapChangerControl	The regulating control scheme in which this tap changer participates.
1..1	SvTapStep	0..1	SvTapStep	The tap step state associated with the tap changer.
1..1	TapSchedules	0..*	TapSchedule	A TapChanger can have TapSchedules.
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.4.87 TapChangerControl

Describes behaviour specific to tap changers, e.g. how the voltage at the end of a line varies with the load level and compensation of the voltage drop by tap adjustment.

Table 305 shows all attributes of TapChangerControl.

Table 305 – Attributes of Wires::TapChangerControl

name	mult	type	description
limitVoltage	0..1	Voltage	Maximum allowed regulated voltage on the PT secondary, regardless of line drop compensation. Sometimes referred to as first-house protection.
lineDropCompensation	0..1	Boolean	If true, the line drop compensation is to be applied.
lineDropR	0..1	Resistance	Line drop compensator resistance setting for normal (forward) power flow.
lineDropX	0..1	Reactance	Line drop compensator reactance setting for normal (forward) power flow.
reverseLineDropR	0..1	Resistance	Line drop compensator resistance setting for reverse power flow.
reverseLineDropX	0..1	Reactance	Line drop compensator reactance setting for reverse power flow.
discrete	0..1	Boolean	inherited from: RegulatingControl
enabled	0..1	Boolean	inherited from: RegulatingControl
mode	0..1	RegulatingControlModeKind	inherited from: RegulatingControl
monitoredPhase	0..1	PhaseCode	inherited from: RegulatingControl
targetDeadband	0..1	Float	inherited from: RegulatingControl
targetValue	0..1	Float	inherited from: RegulatingControl
targetValueUnitMultiplier	0..1	UnitMultiplier	inherited from: RegulatingControl
maxAllowedTargetValue	0..1	Float	inherited from: RegulatingControl

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name	mult	type	description
minAllowedTargetValue	0..1	Float	inherited from: RegulatingControl
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 306 shows all association ends of TapChangerControl with other classes.

Table 306 – Association ends of Wires::TapChangerControl with other classes

mult from	name	mult to	type	description
0..1	TapChanger	1..*	TapChanger	The tap changers that participates in this regulating tap control scheme.
0..*	Terminal	0..1	Terminal	inherited from: RegulatingControl
0..1	RegulatingCondEq	~~1~~0..*	RegulatingCondEq	inherited from: RegulatingControl
1..1	RegulationSchedule	0..*	RegulationSchedule	inherited from: RegulatingControl
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.4.88 TapChangerTablePoint root class

Describes each tap step in the tabular curve.

Table 307 shows all attributes of TapChangerTablePoint.

Table 307 – Attributes of Wires::TapChangerTablePoint

name	mult	type	description
b	0..1	PerCent	The magnetizing branch susceptance deviation as a percentage of nominal value. The actual susceptance is calculated as follows: calculated magnetizing susceptance = b(nominal) * (1 + b(from this class)/100). The b(nominal) is defined as the static magnetizing susceptance on the associated power transformer end or ends. This model assumes the star impedance (pi model) form.
g	0..1	PerCent	The magnetizing branch conductance deviation as a percentage of nominal value. The actual conductance is calculated as follows: calculated magnetizing conductance = g(nominal) * (1 + g(from this class)/100). The g(nominal) is defined as the static magnetizing conductance on the associated power transformer end or ends. This model assumes the star impedance (pi model) form.

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name	mult	type	description
r	0..1	PerCent	The resistance deviation as a percentage of nominal value. The actual reactance is calculated as follows: calculated resistance = r(nominal) * (1 + r(from this class)/100). The r(nominal) is defined as the static resistance on the associated power transformer end or ends. This model assumes the star impedance (pi model) form.
ratio	0..1	Float	The voltage at the tap step divided by rated voltage of the transformer end having the tap changer. Hence this is a value close to one. For example, if the ratio at step 1 is 1.01, and the rated voltage of the transformer end is 110kV, then the voltage obtained by setting the tap changer to step 1 to is 111.1kV.
step	0..1	Integer	The tap step.
x	0..1	PerCent	The series reactance deviation as a percentage of nominal value. The actual reactance is calculated as follows: calculated reactance = x(nominal) * (1 + x(from this class)/100). The x(nominal) is defined as the static series reactance on the associated power transformer end or ends. This model assumes the star impedance (pi model) form.

6.4.89 TapSchedule

A pre-established pattern over time for a tap step.

Table 308 shows all attributes of TapSchedule.

Table 308 – Attributes of Wires::TapSchedule

name	mult	type	description
endTime	0..1	DateTime	inherited from: RegularIntervalSchedule
timeStep	0..1	Seconds	inherited from: RegularIntervalSchedule
startTime	0..1	DateTime	inherited from: BasicIntervalSchedule
value1Multiplier	0..1	UnitMultiplier	inherited from: BasicIntervalSchedule
value1Unit	0..1	UnitSymbol	inherited from: BasicIntervalSchedule
value2Multiplier	0..1	UnitMultiplier	inherited from: BasicIntervalSchedule
value2Unit	0..1	UnitSymbol	inherited from: BasicIntervalSchedule
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 309 shows all association ends of TapSchedule with other classes.

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Table 309 – Association ends of Wires::TapSchedule with other classes

mult from	name	mult to	type	description
0..*	TapChanger	1..1	TapChanger	A TapSchedule is associated with a TapChanger.
0..*	DayType	0..1	DayType	inherited from: SeasonDayTypeSchedule
0..*	Season	0..1	Season	inherited from: SeasonDayTypeSchedule
1..1	TimePoints	1..*	RegularTimePoint	inherited from: RegularIntervalSchedule
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.4.90 TransformerControlMode enumeration

Control modes for a transformer.

Table 310 shows all literals of TransformerControlMode.

Table 310 – Literals of Wires::TransformerControlMode

literal	value	description
volt		Voltage control.
reactive		Reactive power flow control.

6.4.91 TransformerCoreAdmittance

The transformer core admittance. Used to specify the core admittance of a transformer in a manner that can be shared among power transformers.

Table 311 shows all attributes of TransformerCoreAdmittance.

Table 311 – Attributes of Wires::TransformerCoreAdmittance

name	mult	type	description
b	0..1	Susceptance	Magnetizing branch susceptance (B mag). The value can be positive or negative.
b0	0..1	Susceptance	Zero sequence magnetizing branch susceptance.
g	0..1	Conductance	Magnetizing branch conductance (G mag).
g0	0..1	Conductance	Zero sequence magnetizing branch conductance.
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 312 shows all association ends of TransformerCoreAdmittance with other classes.

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Table 312 – Association ends of Wires::TransformerCoreAdmittance with other classes

mult from	name	mult to	type	description
0..1	TransformerEnd	0..*	TransformerEnd	All transformer ends having this core admittance.
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.4.92 TransformerEnd

A conducting connection point of a power transformer. It corresponds to a physical transformer winding terminal. In earlier CIM versions, the TransformerWinding class served a similar purpose, but this class is more flexible because it associates to terminal but is not a specialization of ConductingEquipment.

Table 313 shows all attributes of TransformerEnd.

Table 313 – Attributes of Wires::TransformerEnd

name	mult	type	description
bmagSat	0..1	PerCent	Core shunt magnetizing susceptance in the saturation region.
endNumber	0..1	Integer	Number for this transformer end, corresponding to the end's order in the power transformer vector group or phase angle clock number. Highest voltage winding should be 1. Each end within a power transformer should have a unique subsequent end number. Note the transformer end number need not match the terminal sequence number.
grounded	0..1	Boolean	(for Yn and Zn connections) True if the neutral is solidly grounded.
magBaseU	0..1	Voltage	The reference voltage at which the magnetizing saturation measurements were made.
magSatFlux	0..1	PerCent	Core magnetizing saturation curve knee flux level.
rground	0..1	Resistance	(for Yn and Zn connections) Resistance part of neutral impedance where 'grounded' is true.
xground	0..1	Reactance	(for Yn and Zn connections) Reactive part of neutral impedance where 'grounded' is true.
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 314 shows all association ends of TransformerEnd with other classes.

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Table 314 – Association ends of Wires::TransformerEnd with other classes

mult from	name	mult to	type	description
0..*	BaseVoltage	0..1	BaseVoltage	Base voltage of the transformer end. This is essential for PU calculation.
0..*	Terminal	0..1	Terminal	Terminal of the power transformer to which this transformer end belongs.
1..1	PhaseTapChanger	0..1	PhaseTapChanger	Phase tap changer associated with this transformer end.
1..1	RatioTapChanger	0..1	RatioTapChanger	Ratio tap changer associated with this transformer end.
0..*	StarImpedance	0..1	TransformerStarImpedance	(accurate for 2- or 3-winding transformers only) Pi-model impedances of this transformer end. By convention, for a two winding transformer, the full values of the transformer should be entered on the high voltage end (endNumber=1).
0..*	CoreAdmittance	0..1	TransformerCoreAdmittance	Core admittance of this transformer end, representing magnetising current and core losses. The full values of the transformer should be supplied for one transformer end only.
1..*	ToMeshImpedance	0..*	TransformerMeshImpedance	All mesh impedances between this 'from' and other 'to' transformer ends.
1..1	FromMeshImpedance	0..*	TransformerMeshImpedance	All mesh impedances between this 'to' and other 'from' transformer ends.
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.4.93 TransformerMeshImpedance

Transformer mesh impedance (Delta-model) between transformer ends.

The typical case is that this class describes the impedance between two transformer ends pair-wise, i.e. the cardinalities at both transformer end associations are 1. However, in cases where two or more transformer ends are modelled the cardinalities are larger than 1.

Table 315 shows all attributes of TransformerMeshImpedance.

Table 315 – Attributes of Wires::TransformerMeshImpedance

name	mult	type	description
r	0..1	Resistance	Resistance between the 'from' and the 'to' end, seen from the 'from' end.
r0	0..1	Resistance	Zero-sequence resistance between the 'from' and the 'to' end, seen from the 'from' end.
x	0..1	Reactance	Reactance between the 'from' and the 'to' end, seen from the 'from' end.
x0	0..1	Reactance	Zero-sequence reactance between the 'from' and the 'to' end, seen from the 'from' end.
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

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Table 316 shows all association ends of TransformerMeshImpedance with other classes.

Table 316 – Association ends of Wires::TransformerMeshImpedance with other classes

mult from	name	mult to	type	description
0..*	ToTransformerEnd	1..*	TransformerEnd	All transformer ends this mesh impedance is connected to.
0..*	FromTransformerEnd	1..1	TransformerEnd	From end this mesh impedance is connected to. It determines the voltage reference.
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.4.94 TransformerStarImpedance

Transformer star impedance (Pi-model) that accurately reflects impedance for transformers with 2 or 3 windings. For transformers with 4 or more windings, TransformerMeshImpedance class shall be used.

For transmission networks use PowerTransformerEnd impedances (r, r0, x, x0, b, b0, g and g0).

Table 317 shows all attributes of TransformerStarImpedance.

Table 317 – Attributes of Wires::TransformerStarImpedance

name	mult	type	description
r	0..1	Resistance	Resistance of the transformer end.
r0	0..1	Resistance	Zero sequence series resistance of the transformer end.
x	0..1	Reactance	Positive sequence series reactance of the transformer end.
x0	0..1	Reactance	Zero sequence series reactance of the transformer end.
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 318 shows all association ends of TransformerStarImpedance with other classes.

Table 318 – Association ends of Wires::TransformerStarImpedance with other classes

mult from	name	mult to	type	description
0..1	TransformerEnd	0..*	TransformerEnd	All transformer ends having this star impedance.
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

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6.4.95 TransformerTank

An assembly of two or more coupled windings that transform electrical power between voltage levels. These windings are bound on a common core and placed in the same tank. Transformer tank can be used to model both single-phase and 3-phase transformers.

Table 319 shows all attributes of TransformerTank.

Table 319 – Attributes of Wires::TransformerTank

name	mult	type	description
aggregate	0..1	Boolean	inherited from: Equipment
inService	0..1	Boolean	inherited from: Equipment
networkAnalysisEnabled	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 320 shows all association ends of TransformerTank with other classes.

Table 320 – Association ends of Wires::TransformerTank with other classes

mult from	name	mult to	type	description
0..*	PowerTransformer	0..1	PowerTransformer	Bank this transformer belongs to.
0..1	TransformerTankEnds	1..*	TransformerTankEnd	All windings of this transformer.
0..1	OperationalLimitSet	0..*	OperationalLimitSet	inherited from: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	inherited from: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment
0..1	Faults	0..*	Fault	inherited from: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	inherited from: Equipment
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

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6.4.96 TransformerTankEnd

Transformer tank end represents an individual winding for unbalanced models or for transformer tanks connected into a bank (and bank is modelled with the PowerTransformer).

Table 321 shows all attributes of TransformerTankEnd.

Table 321 – Attributes of Wires::TransformerTankEnd

name	mult	type	description
phases	0..1	PhaseCode	Describes the phases carried by a conducting equipment.
bmagSat	0..1	PerCent	inherited from: TransformerEnd
endNumber	0..1	Integer	inherited from: TransformerEnd
grounded	0..1	Boolean	inherited from: TransformerEnd
magBaseU	0..1	Voltage	inherited from: TransformerEnd
magSatFlux	0..1	PerCent	inherited from: TransformerEnd
rground	0..1	Resistance	inherited from: TransformerEnd
xground	0..1	Reactance	inherited from: TransformerEnd
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 322 shows all association ends of TransformerTankEnd with other classes.

Table 322 – Association ends of Wires::TransformerTankEnd with other classes

mult from	name	mult to	type	description
1..*	TransformerTank	0..1	TransformerTank	Transformer this winding belongs to.
0..*	BaseVoltage	0..1	BaseVoltage	inherited from: TransformerEnd
0..*	Terminal	0..1	Terminal	inherited from: TransformerEnd
1..1	PhaseTapChanger	0..1	PhaseTapChanger	inherited from: TransformerEnd
1..1	RatioTapChanger	0..1	RatioTapChanger	inherited from: TransformerEnd
0..*	StarImpedance	0..1	TransformerStarImpedance	inherited from: TransformerEnd
0..*	CoreAdmittance	0..1	TransformerCoreAdmittance	inherited from: TransformerEnd
1..*	ToMeshImpedance	0..*	TransformerMeshImpedance	inherited from: TransformerEnd
1..1	FromMeshImpedance	0..*	TransformerMeshImpedance	inherited from: TransformerEnd
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

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6.4.97 VoltageControlZone

An area of the power system network which is defined for secondary voltage control purposes. A voltage control zone consists of a collection of substations with a designated bus bar section whose voltage will be controlled.

Table 323 shows all attributes of VoltageControlZone.

Table 323 – Attributes of Wires::VoltageControlZone

name	mult	type	description
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 324 shows all association ends of VoltageControlZone with other classes.

Table 324 – Association ends of Wires::VoltageControlZone with other classes

mult from	name	mult to	type	description
0..1	BusbarSection	1..1	BusbarSection	A VoltageControlZone is controlled by a designated BusbarSection.
0..*	RegulationSchedule	0..1	RegulationSchedule	A VoltageControlZone may have a voltage regulation schedule.
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.4.98 WireSegment

A two terminal and power conducting device of negligible impedance and length represented as zero impedance device that can be used to connect auxiliary equipment to its terminals.

Table 325 shows all attributes of WireSegment.

Table 325 – Attributes of Wires::WireSegment

name	mult	type	description
length	0..1	Length	inherited from: Conductor
aggregate	0..1	Boolean	inherited from: Equipment
inService	0..1	Boolean	inherited from: Equipment
networkAnalysisEnabled	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 326 shows all association ends of WireSegment with other classes.

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Table 326 – Association ends of Wires::WireSegment with other classes

mult from	name	mult to	type	description
1..1	WireSegmentPhases	0..*	WireSegmentPhase	The wire segment phases which belong to the wire segment.
0..*	BaseVoltage	0..1	BaseVoltage	inherited from: ConductingEquipment
1..1	SvStatus	0..*	SvStatus	inherited from: ConductingEquipment
0..*	ProtectionEquipments	0..*	ProtectionEquipment	inherited from: ConductingEquipment
1..1	Terminals	0..*	Terminal	inherited from: ConductingEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	inherited from: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	inherited from: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment
0..1	Faults	0..*	Fault	inherited from: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	inherited from: Equipment
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.4.99 WireSegmentPhase

Represents a single wire of an alternating current wire segment.

Table 327 shows all attributes of WireSegmentPhase.

Table 327 – Attributes of Wires::WireSegmentPhase

name	mult	type	description
phase	0..1	SinglePhaseKind	The phase connection of the wire at both ends.
sequenceNumber	0..1	Integer	Number designation for this wire segment phase. Each wire segment phase within a wire segment should have a unique sequence number.
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 328 shows all association ends of WireSegmentPhase with other classes.

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Table 328 – Association ends of Wires::WireSegmentPhase with other classes

mult from	name	mult to	type	description
0..*	WireSegment	1..1	WireSegment	The wire segment to which the phase belongs.
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.4.100 WindingConnection enumeration

Winding connection type.

Table 329 shows all literals of WindingConnection.

Table 329 – Literals of Wires::WindingConnection

literal	value	description
D		Delta.
Y		Wye.
Z		ZigZag.
Yn		Wye, with neutral brought out for grounding.
Zn		ZigZag, with neutral brought out for grounding.
A		Autotransformer common winding.
I		Independent winding, for single-phase connections.

6.5 Package LoadModel

6.5.1 General

This package is responsible for modelling the energy consumers and the system load as curves and associated curve data. Special circumstances that may affect the load, such as seasons and day types, are also included here.

This information is used by Load Forecasting and Load Management.

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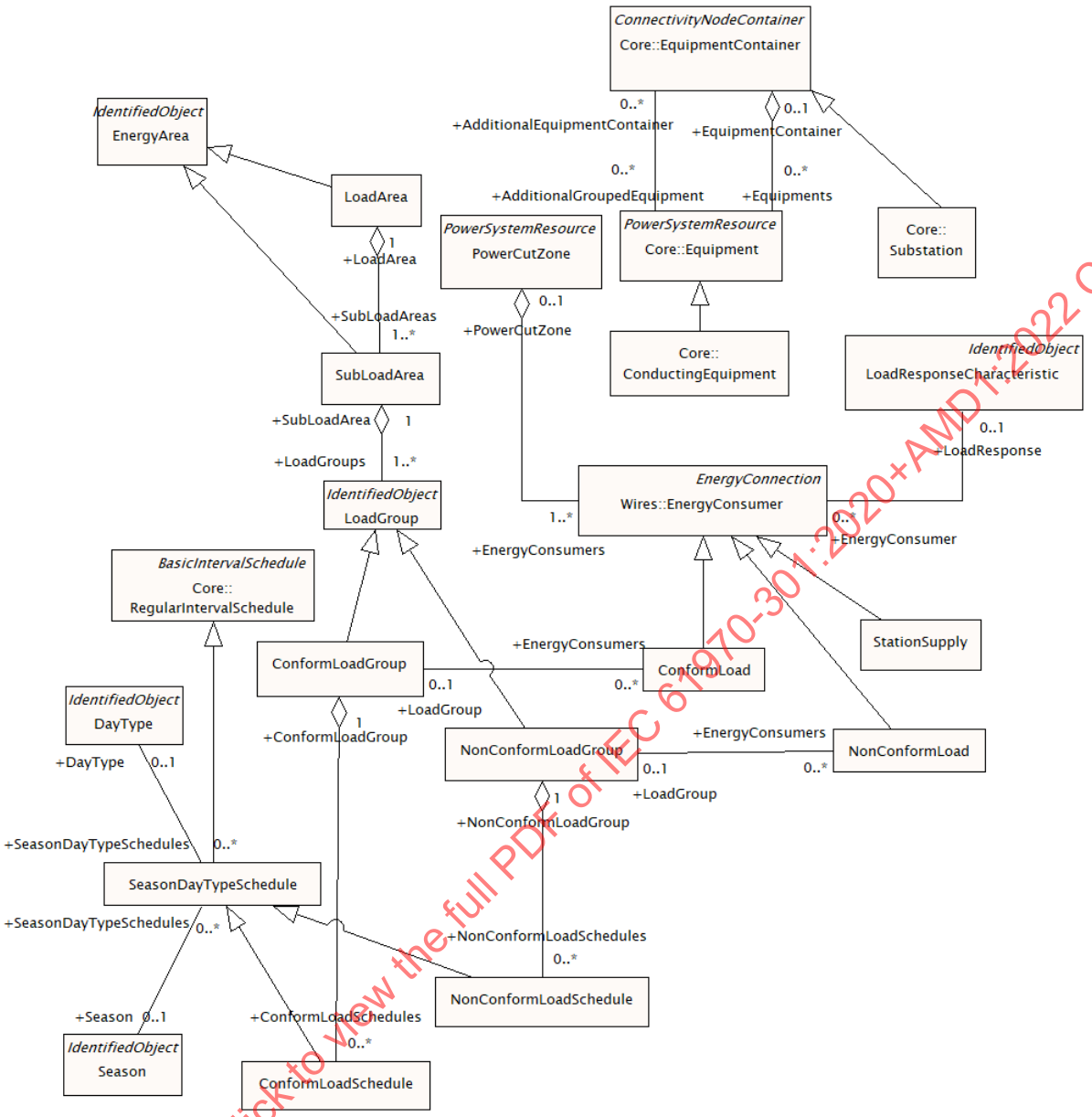


Figure 102 – Class diagram LoadModel::Main

Figure 102: This diagram shows all classes included in the LoadModel package as well as the key external classes that have associations with LoadModel classes.

6.5.2 ConformLoad

ConformLoad represent loads that follow a daily load change pattern where the pattern can be used to scale the load with a system load.

Table 330 shows all attributes of ConformLoad.

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Table 330 – Attributes of LoadModel::ConformLoad

name	mult	type	description
customerCount	0..1	Integer	inherited from: EnergyConsumer
grounded	0..1	Boolean	inherited from: EnergyConsumer
pfixed	0..1	ActivePower	inherited from: EnergyConsumer
pfixedPct	0..1	PerCent	inherited from: EnergyConsumer
phaseConnection	0..1	PhaseShuntConnectionKind	inherited from: EnergyConsumer
qfixed	0..1	ReactivePower	inherited from: EnergyConsumer
qfixedPct	0..1	PerCent	inherited from: EnergyConsumer
p	0..1	ActivePower	inherited from: EnergyConsumer
q	0..1	ReactivePower	inherited from: EnergyConsumer
aggregate	0..1	Boolean	inherited from: Equipment
inService	0..1	Boolean	inherited from: Equipment
networkAnalysisEnabled	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 331 shows all association ends of ConformLoad with other classes.

Table 331 – Association ends of LoadModel::ConformLoad with other classes

mult from	name	mult to	type	description
0..*	LoadGroup	0..1	ConformLoadGroup	Group of this ConformLoad.
0..*	LoadResponse	0..1	LoadResponseCharacteristic	inherited from: EnergyConsumer
1..1	EnergyConsumerPhase	0..*	EnergyConsumerPhase	inherited from: EnergyConsumer
1..*	PowerCutZone	0..1	PowerCutZone	inherited from: EnergyConsumer
0..*	LoadDynamics	0..1	LoadDynamics	inherited from: EnergyConsumer
0..*	BaseVoltage	0..1	BaseVoltage	inherited from: ConductingEquipment
1..1	SvStatus	0..*	SvStatus	inherited from: ConductingEquipment
0..*	ProtectionEquipments	0..*	ProtectionEquipment	inherited from: ConductingEquipment
1..1	Terminals	0..*	Terminal	inherited from: ConductingEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	inherited from: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	inherited from: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment
0..1	Faults	0..*	Fault	inherited from: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	inherited from: Equipment
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource

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mult from	name	mult to	type	description
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.5.3 ConformLoadGroup

A group of loads conforming to an allocation pattern.

Table 332 shows all attributes of ConformLoadGroup.

Table 332 – Attributes of LoadModel::ConformLoadGroup

name	mult	type	description
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 333 shows all association ends of ConformLoadGroup with other classes.

Table 333 – Association ends of LoadModel::ConformLoadGroup with other classes

mult from	name	mult to	type	description
0..1	EnergyConsumers	0..*	ConformLoad	Conform loads assigned to this ConformLoadGroup.
1..1	ConformLoadSchedules	0..*	ConformLoadSchedule	The ConformLoadSchedules in the ConformLoadGroup.
1..*	SubLoadArea	1..1	SubLoadArea	inherited from: LoadGroup
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.5.4 ConformLoadSchedule

A curve of load versus time (X-axis) showing the active power values (Y1-axis) and reactive power (Y2-axis) for each unit of the period covered. This curve represents a typical pattern of load over the time period for a given day type and season.

Table 334 shows all attributes of ConformLoadSchedule.

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Table 334 – Attributes of LoadModel::ConformLoadSchedule

name	mult	type	description
endTime	0..1	DateTime	inherited from: RegularIntervalSchedule
timeStep	0..1	Seconds	inherited from: RegularIntervalSchedule
startTime	0..1	DateTime	inherited from: BasicIntervalSchedule
value1Multiplier	0..1	UnitMultiplier	inherited from: BasicIntervalSchedule
value1Unit	0..1	UnitSymbol	inherited from: BasicIntervalSchedule
value2Multiplier	0..1	UnitMultiplier	inherited from: BasicIntervalSchedule
value2Unit	0..1	UnitSymbol	inherited from: BasicIntervalSchedule
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 335 shows all association ends of ConformLoadSchedule with other classes.

Table 335 – Association ends of LoadModel::ConformLoadSchedule with other classes

mult from	name	mult to	type	description
0..*	ConformLoadGroup	1..1	ConformLoadGroup	The ConformLoadGroup where the ConformLoadSchedule belongs.
0..*	DayType	0..1	DayType	inherited from: SeasonDayTypeSchedule
0..*	Season	0..1	Season	inherited from: SeasonDayTypeSchedule
1..1	TimePoints	1..*	RegularTimePoint	inherited from: RegularIntervalSchedule
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.5.5 DayType

Group of similar days. For example it could be used to represent weekdays, weekend, or holidays.

Table 336 shows all attributes of DayType.

Table 336 – Attributes of LoadModel::DayType

name	mult	type	description
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 337 shows all association ends of DayType with other classes.

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Table 337 – Association ends of LoadModel::DayType with other classes

mult from	name	mult to	type	description
0..1	SeasonDayTypeSchedules	0..*	SeasonDayTypeSchedule	Schedules that use this DayType.
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.5.6 EnergyArea

Describes an area having energy production or consumption. Specializations are intended to support the load allocation function as typically required in energy management systems or planning studies to allocate hypothesized load levels to individual load points for power flow analysis. Often the energy area can be linked to both measured and forecast load levels.

Table 338 shows all attributes of EnergyArea.

Table 338 – Attributes of LoadModel::EnergyArea

name	mult	type	description
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 339 shows all association ends of EnergyArea with other classes.

Table 339 – Association ends of LoadModel::EnergyArea with other classes

mult from	name	mult to	type	description
0..1	ControlArea	0..1	ControlArea	The control area specification that is used for the load forecast.
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.5.7 LoadArea

The class is the root or first level in a hierarchical structure for grouping of loads for the purpose of load flow load scaling.

Table 340 shows all attributes of LoadArea.

Table 340 – Attributes of LoadModel::LoadArea

name	mult	type	description
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 341 shows all association ends of LoadArea with other classes.

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Table 341 – Association ends of LoadModel::LoadArea with other classes

mult from	name	mult to	type	description
1..1	SubLoadAreas	1..*	SubLoadArea	The SubLoadAreas in the LoadArea.
0..1	ControlArea	0..1	ControlArea	inherited from: EnergyArea
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.5.8 LoadGroup

The class is the third level in a hierarchical structure for grouping of loads for the purpose of load flow load scaling.

Table 342 shows all attributes of LoadGroup.

Table 342 – Attributes of LoadModel::LoadGroup

name	mult	type	description
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 343 shows all association ends of LoadGroup with other classes.

Table 343 – Association ends of LoadModel::LoadGroup with other classes

mult from	name	mult to	type	description
1..*	SubLoadArea	1..1	SubLoadArea	The SubLoadArea where the Loadgroup belongs.
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.5.9 LoadResponseCharacteristic

Models the characteristic response of the load demand due to changes in system conditions such as voltage and frequency. It is not related to demand response.

If LoadResponseCharacteristic.exponentModel is True, the exponential voltage or frequency dependent models are specified and used as to calculate active and reactive power components of the load model.

The equations to calculate active and reactive power components of the load model are internal to the power flow calculation, hence they use different quantities depending on the use case of the data exchange.

The equations for exponential voltage dependent load model injected power are:

pInjection= Pnominal* (Voltage/cim:BaseVoltage.nominalVoltage) ** cim:LoadResponseCharacteristic.pVoltageExponent

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qInjection= Qnominal* (Voltage/cim:BaseVoltage.nominalVoltage) ** cim:LoadResponseCharacteristic.qVoltageExponent

Where:

1) * means "multiply" and ** is "raised to power of";
2) Pnominal and Qnominal represent the active power and reactive power at nominal voltage as any load described by the voltage exponential model shall be given at nominal voltage. This means that EnergyConsumer.p and EnergyConsumer.q are at nominal voltage.
3) After power flow is solved:
   – pInjection and qInjection correspond to SvPowerflow.p and SvPowerflow.q respectively.
   – Voltage corresponds to SvVoltage.v at the TopologicalNode where the load is connected.

Table 344 shows all attributes of LoadResponseCharacteristic.

Table 344 – Attributes of LoadModel::LoadResponseCharacteristic

name	mult	type	description
exponentModel	0..1	Boolean	Indicates the exponential voltage dependency model is to be used. If false, the coefficient model is to be used. The exponential voltage dependency model consists of the attributes: – pVoltageExponent – qVoltageExponent – pFrequencyExponent – qFrequencyExponent. The coefficient model consists of the attributes: – pConstantImpedance – pConstantCurrent – pConstantPower – qConstantImpedance – qConstantCurrent – qConstantPower. The sum of pConstantImpedance, pConstantCurrent and pConstantPower shall equal 1. The sum of qConstantImpedance, qConstantCurrent and qConstantPower shall equal 1.
pConstantCurrent	0..1	Float	Portion of active power load modelled as constant current.
pConstantImpedance	0..1	Float	Portion of active power load modelled as constant impedance.
pConstantPower	0..1	Float	Portion of active power load modelled as constant power.
pFrequencyExponent	0..1	Float	Exponent of per unit frequency effecting active power.
pVoltageExponent	0..1	Float	Exponent of per unit voltage effecting real power.
qConstantCurrent	0..1	Float	Portion of reactive power load modelled as constant current.
qConstantImpedance	0..1	Float	Portion of reactive power load modelled as constant impedance.

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name	mult	type	description
qConstantPower	0..1	Float	Portion of reactive power load modelled as constant power.
qFrequencyExponent	0..1	Float	Exponent of per unit frequency effecting reactive power.
qVoltageExponent	0..1	Float	Exponent of per unit voltage effecting reactive power.
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 345 shows all association ends of LoadResponseCharacteristic with other classes.

Table 345 – Association ends of LoadModel::LoadResponseCharacteristic with other classes

mult from	name	mult to	type	description
0..1	EnergyConsumer	0..*	EnergyConsumer	The set of loads that have the response characteristics.
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.5.10 NonConformLoad

NonConformLoad represents loads that do not follow a daily load change pattern and whose changes are not correlated with the daily load change pattern.

Table 346 shows all attributes of NonConformLoad.

Table 346 – Attributes of LoadModel::NonConformLoad

name	mult	type	description
customerCount	0..1	Integer	inherited from: EnergyConsumer
grounded	0..1	Boolean	inherited from: EnergyConsumer
pfixed	0..1	ActivePower	inherited from: EnergyConsumer
pfixedPct	0..1	PerCent	inherited from: EnergyConsumer
phaseConnection	0..1	PhaseShuntConnectionKind	inherited from: EnergyConsumer
qfixed	0..1	ReactivePower	inherited from: EnergyConsumer
qfixedPct	0..1	PerCent	inherited from: EnergyConsumer
p	0..1	ActivePower	inherited from: EnergyConsumer
q	0..1	ReactivePower	inherited from: EnergyConsumer
aggregate	0..1	Boolean	inherited from: Equipment
inService	0..1	Boolean	inherited from: Equipment
networkAnalysisEnabled	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject

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name	mult	type	description
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 347 shows all association ends of NonConformLoad with other classes.

Table 347 – Association ends of LoadModel::NonConformLoad with other classes

mult from	name	mult to	type	description
0..*	LoadGroup	0..1	NonConformLoadGroup	Group of this ConformLoad.
0..*	LoadResponse	0..1	LoadResponseCharacteristic	inherited from: EnergyConsumer
1..1	EnergyConsumerPhase	0..*	EnergyConsumerPhase	inherited from: EnergyConsumer
1..*	PowerCutZone	0..1	PowerCutZone	inherited from: EnergyConsumer
0..*	LoadDynamics	0..1	LoadDynamics	inherited from: EnergyConsumer
0..*	BaseVoltage	0..1	BaseVoltage	inherited from: ConductingEquipment
1..1	SvStatus	0..*	SvStatus	inherited from: ConductingEquipment
0..*	ProtectionEquipments	0..*	ProtectionEquipment	inherited from: ConductingEquipment
1..1	Terminals	0..*	Terminal	inherited from: ConductingEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	inherited from: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	inherited from: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment
0..1	Faults	0..*	Fault	inherited from: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	inherited from: Equipment
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.5.11 NonConformLoadGroup

Loads that do not follow a daily and seasonal load variation pattern.

Table 348 shows all attributes of NonConformLoadGroup.

Table 348 – Attributes of LoadModel::NonConformLoadGroup

name	mult	type	description
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

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Table 349 shows all association ends of NonConformLoadGroup with other classes.

Table 349 – Association ends of LoadModel::NonConformLoadGroup with other classes

mult from	name	mult to	type	description
0..1	EnergyConsumers	0..*	NonConformLoad	Conform loads assigned to this ConformLoadGroup.
1..1	NonConformLoadSchedules	0..*	NonConformLoadSchedule	The NonConformLoadSchedules in the NonConformLoadGroup.
1..*	SubLoadArea	1..1	SubLoadArea	inherited from: LoadGroup
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.5.12 NonConformLoadSchedule

An active power (Y1-axis) and reactive power (Y2-axis) schedule (curves) versus time (X-axis) for non-conforming loads, e.g., large industrial load or power station service (where modelled).

Table 350 shows all attributes of NonConformLoadSchedule.

Table 350 – Attributes of LoadModel::NonConformLoadSchedule

name	mult	type	description
endTime	0..1	DateTime	inherited from: RegularIntervalSchedule
timeStep	0..1	Seconds	inherited from: RegularIntervalSchedule
startTime	0..1	DateTime	inherited from: BasicIntervalSchedule
value1Multiplier	0..1	UnitMultiplier	inherited from: BasicIntervalSchedule
value1Unit	0..1	UnitSymbol	inherited from: BasicIntervalSchedule
value2Multiplier	0..1	UnitMultiplier	inherited from: BasicIntervalSchedule
value2Unit	0..1	UnitSymbol	inherited from: BasicIntervalSchedule
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 351 shows all association ends of NonConformLoadSchedule with other classes.

Table 351 – Association ends of LoadModel::NonConformLoadSchedule with other classes

mult from	name	mult to	type	description
0..*	NonConformLoadGroup	1..1	NonConformLoadGroup	The NonConformLoadGroup where the NonConformLoadSchedule belongs.
0..*	DayType	0..1	DayType	inherited from: SeasonDayTypeSchedule
0..*	Season	0..1	Season	inherited from: SeasonDayTypeSchedule
1..1	TimePoints	1..*	RegularTimePoint	inherited from: RegularIntervalSchedule
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

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6.5.13 PowerCutZone

An area or zone of the power system which is used for load shedding purposes.

Table 352 shows all attributes of PowerCutZone.

Table 352 – Attributes of LoadModel::PowerCutZone

name	mult	type	description
cutLevel1	0..1	PerCent	First level (amount) of load to cut as a percentage of total zone load.
cutLevel2	0..1	PerCent	Second level (amount) of load to cut as a percentage of total zone load.
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 353 shows all association ends of PowerCutZone with other classes.

Table 353 – Association ends of LoadModel::PowerCutZone with other classes

mult from	name	mult to	type	description
0..1	EnergyConsumers	1..*	EnergyConsumer	Energy consumer is assigned to the power cut zone.
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.5.14 Season

A specified time period of the year.

Table 354 shows all attributes of Season.

Table 354 – Attributes of LoadModel::Season

name	mult	type	description
endDate	0..1	MonthDay	Date season ends.
startDate	0..1	MonthDay	Date season starts.
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

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Table 355 shows all association ends of Season with other classes.

Table 355 – Association ends of LoadModel::Season with other classes

mult from	name	mult to	type	description
0..1	SeasonDayTypeSchedules	0..*	SeasonDayTypeSchedule	Schedules that use this Season.
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.5.15 SeasonDayTypeSchedule

A time schedule covering a 24 hour period, with curve data for a specific type of season and day.

Table 356 shows all attributes of SeasonDayTypeSchedule.

Table 356 – Attributes of LoadModel::SeasonDayTypeSchedule

name	mult	type	description
endTime	0..1	DateTime	inherited from: RegularIntervalSchedule
timeStep	0..1	Seconds	inherited from: RegularIntervalSchedule
startTime	0..1	DateTime	inherited from: BasicIntervalSchedule
value1Multiplier	0..1	UnitMultiplier	inherited from: BasicIntervalSchedule
value1Unit	0..1	UnitSymbol	inherited from: BasicIntervalSchedule
value2Multiplier	0..1	UnitMultiplier	inherited from: BasicIntervalSchedule
value2Unit	0..1	UnitSymbol	inherited from: BasicIntervalSchedule
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 357 shows all association ends of SeasonDayTypeSchedule with other classes.

Table 357 – Association ends of LoadModel::SeasonDayTypeSchedule with other classes

mult from	name	mult to	type	description
0..*	DayType	0..1	DayType	DayType for the Schedule.
0..*	Season	0..1	Season	Season for the Schedule.
1..1	TimePoints	1..*	RegularTimePoint	inherited from: RegularIntervalSchedule
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.5.16 StationSupply

Station supply with load derived from the station output.

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Table 358 shows all attributes of StationSupply.

Table 358 – Attributes of LoadModel::StationSupply

name	mult	type	description
customerCount	0..1	Integer	inherited from: EnergyConsumer
grounded	0..1	Boolean	inherited from: EnergyConsumer
pfixed	0..1	ActivePower	inherited from: EnergyConsumer
pfixedPct	0..1	PerCent	inherited from: EnergyConsumer
phaseConnection	0..1	PhaseShuntConnectionKind	inherited from: EnergyConsumer
qfixed	0..1	ReactivePower	inherited from: EnergyConsumer
qfixedPct	0..1	PerCent	inherited from: EnergyConsumer
p	0..1	ActivePower	inherited from: EnergyConsumer
q	0..1	ReactivePower	inherited from: EnergyConsumer
aggregate	0..1	Boolean	inherited from: Equipment
inService	0..1	Boolean	inherited from: Equipment
networkAnalysisEnabled	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 359 shows all association ends of StationSupply with other classes.

Table 359 – Association ends of LoadModel::StationSupply with other classes

mult from	name	mult to	type	description
0..*	LoadResponse	0..1	LoadResponseCharacteristic	inherited from: EnergyConsumer
1..1	EnergyConsumerPhase	0..*	EnergyConsumerPhase	inherited from: EnergyConsumer
1..*	PowerCutZone	0..1	PowerCutZone	inherited from: EnergyConsumer
0..*	LoadDynamics	0..1	LoadDynamics	inherited from: EnergyConsumer
0..*	BaseVoltage	0..1	BaseVoltage	inherited from: ConductingEquipment
1..1	SvStatus	0..*	SvStatus	inherited from: ConductingEquipment
0..*	ProtectionEquipments	0..*	ProtectionEquipment	inherited from: ConductingEquipment
1..1	Terminals	0..*	Terminal	inherited from: ConductingEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	inherited from: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	inherited from: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment
0..1	Faults	0..*	Fault	inherited from: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	inherited from: Equipment
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource

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mult from	name	mult to	type	description
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.5.17 SubLoadArea

The class is the second level in a hierarchical structure for grouping of loads for the purpose of load flow load scaling.

Table 360 shows all attributes of SubLoadArea.

Table 360 – Attributes of LoadModel::SubLoadArea

name	mult	type	description
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 361 shows all association ends of SubLoadArea with other classes.

Table 361 – Association ends of LoadModel::SubLoadArea with other classes

mult from	name	mult to	type	description
1..1	LoadGroups	1..*	LoadGroup	The Loadgroups in the SubLoadArea.
1..*	LoadArea	1..1	LoadArea	The LoadArea where the SubLoadArea belongs.
0..1	ControlArea	0..1	ControlArea	inherited from: EnergyArea
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.6 Package Generation

6.6.1 General

This package contains packages that have information for Unit Commitment and Economic Dispatch of hydro and thermal generating units, Load Forecasting, Automatic Generation Control, and unit modeling for Training Simulation.

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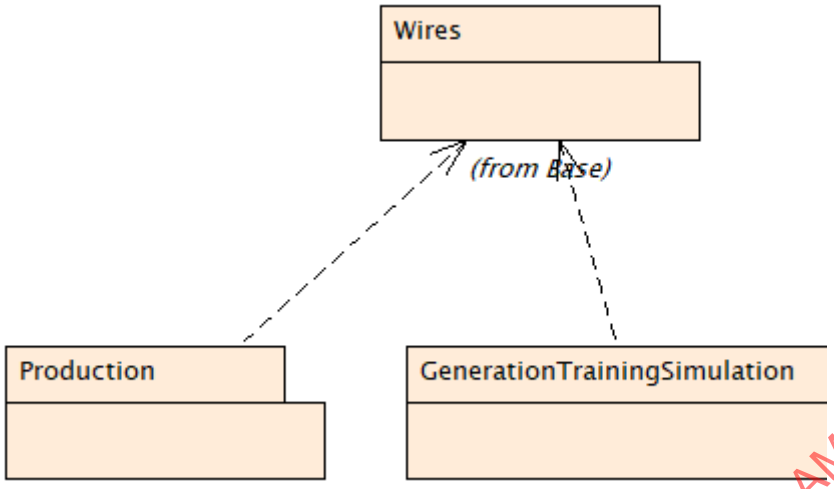


Figure 103 – Class diagram Generation::Main

Figure 103: This diagram shows the main generation packages and their dependency relationships to other packages.

6.6.2 Package GenerationTrainingSimulation

6.6.2.1 General

The GenerationTrainingSimululation package contains prime movers, such as turbines and boilers, which are needed for simulation and educational purposes.

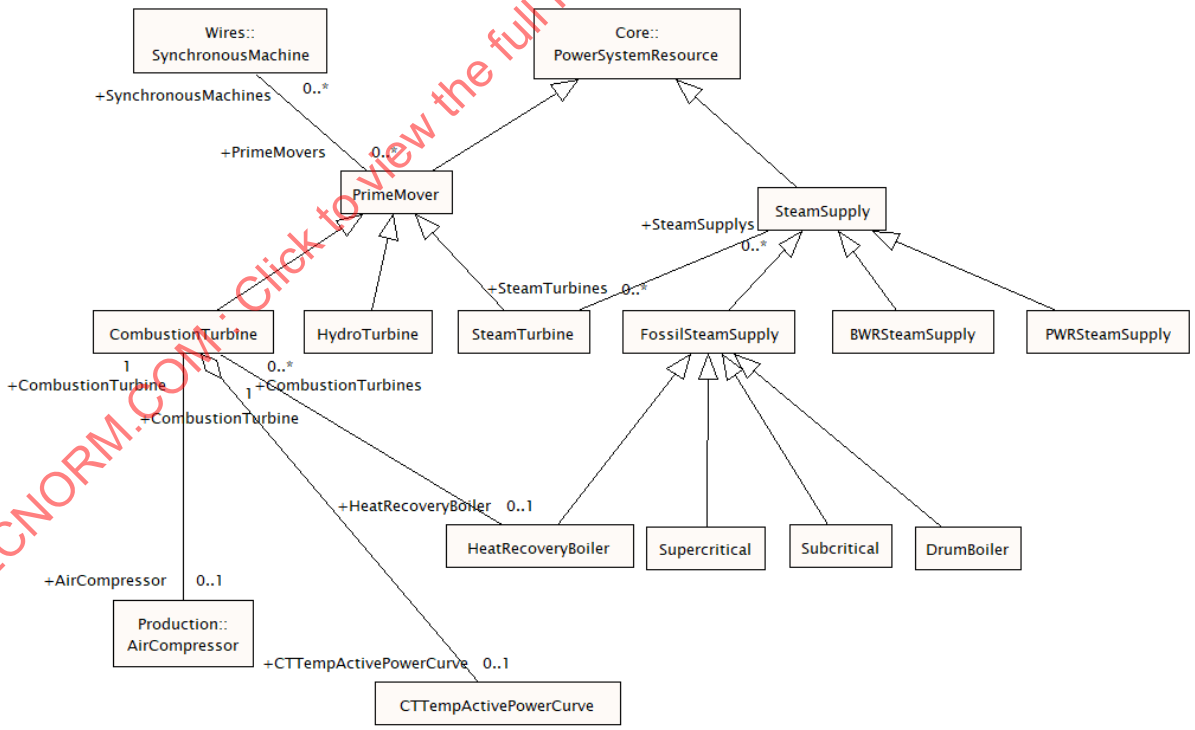


Figure 104 – Class diagram GenerationTrainingSimulation::Main

Figure 104: This diagram shows all classes included in the GenerationDynamics package as well as the key external classes that have associations with these classes.

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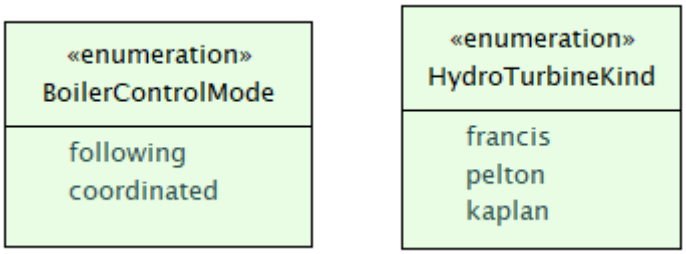


Figure 105 – Class diagram GenerationTrainingSimulation::Datatypes

Figure 105: This diagram shows the data types specific to the GenerationTrainingSimulation package.

6.6.2.2 BWRSteamSupply

Boiling water reactor used as a steam supply to a steam turbine.

Table 362 shows all attributes of BWRSteamSupply.

Table 362 – Attributes of GenerationTrainingSimulation::BWRSteamSupply

name	mult	type	description
highPowerLimit	0..1	PU	High power limit.
inCoreThermalTC	0..1	Seconds	In-core thermal time constant.
integralGain	0..1	Float	Integral gain.
lowerLimit	0..1	PU	Initial lower limit.
lowPowerLimit	0..1	PU	Low power limit.
pressureLimit	0..1	PU	Pressure limit.
pressureSetpointGA	0..1	Float	Pressure setpoint gain adjuster.
pressureSetpointTC1	0..1	Seconds	Pressure setpoint time constant.
pressureSetpointTC2	0..1	Seconds	Pressure setpoint time constant.
proportionalGain	0..1	Float	Proportional gain.
rfAux1	0..1	PU	Coefficient for modelling the effect of off-nominal frequency and voltage on recirculation and core flow, which affects the BWR power output.
rfAux2	0..1	PU	Coefficient for modelling the effect of off-nominal frequency and voltage on recirculation and core flow, which affects the BWR power output.
rfAux3	0..1	PU	Coefficient for modelling the effect of off-nominal frequency and voltage on recirculation and core flow, which affects the BWR power output.
rfAux4	0..1	PU	Coefficient for modelling the effect of off-nominal frequency and voltage on recirculation and core flow, which affects the BWR power output.
rfAux5	0..1	PU	Coefficient for modelling the effect of off-nominal frequency and voltage on recirculation and core flow, which affects the BWR power output.
rfAux6	0..1	PU	Coefficient for modelling the effect of off-nominal frequency and voltage on recirculation and core flow, which affects the BWR power output.
rfAux7	0..1	PU	Coefficient for modelling the effect of off-nominal frequency and voltage on recirculation and core flow, which affects the BWR power output.

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name	mult	type	description
rfAux8	0..1	PU	Coefficient for modelling the effect of off-nominal frequency and voltage on recirculation and core flow, which affects the BWR power output.
rodPattern	0..1	PU	Rod pattern.
rodPatternConstant	0..1	Float	Constant associated with rod pattern.
upperLimit	0..1	PU	Initial upper limit.
steamSupplyRating	0..1	Float	inherited from: SteamSupply
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 363 shows all association ends of BWRSteamSupply with other classes.

Table 363 – Association ends of GenerationTrainingSimulation::BWRSteamSupply with other classes

mult from	name	mult to	type	description
0..*	SteamTurbines	0..*	SteamTurbine	inherited from: SteamSupply
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.6.2.3 BoilerControlMode enumeration

Boiler control mode.

Table 364 shows all literals of BoilerControlMode.

Table 364 – Literals of GenerationTrainingSimulation::BoilerControlMode

literal	value	description
following		Following.
coordinated		Coordinated.

6.6.2.4 CTTempActivePowerCurve

Relationship between the combustion turbine's power output rating in gross active power (X-axis) and the ambient air temperature (Y-axis).

Table 365 shows all attributes of CTTempActivePowerCurve.

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Table 365 – Attributes of GenerationTrainingSimulation::CTTempActivePowerCurve

name	mult	type	description
curveStyle	0..1	CurveStyle	inherited from: Curve
xMultiplier	0..1	UnitMultiplier	inherited from: Curve
xUnit	0..1	UnitSymbol	inherited from: Curve
y1Multiplier	0..1	UnitMultiplier	inherited from: Curve
y1Unit	0..1	UnitSymbol	inherited from: Curve
y2Multiplier	0..1	UnitMultiplier	inherited from: Curve
y2Unit	0..1	UnitSymbol	inherited from: Curve
y3Multiplier	0..1	UnitMultiplier	inherited from: Curve
y3Unit	0..1	UnitSymbol	inherited from: Curve
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 366 shows all association ends of CTTempActivePowerCurve with other classes.

Table 366 – Association ends of GenerationTrainingSimulation::CTTempActivePowerCurve with other classes

mult from	name	mult to	type	description
0..1	CombustionTurbine	1..1	CombustionTurbine	A combustion turbine may have an active power versus ambient temperature relationship.
1..1	CurveDatas	0..*	CurveData	inherited from: Curve
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.6.2.5 CombustionTurbine

A prime mover that is typically fuelled by gas or light oil.

Table 367 shows all attributes of CombustionTurbine.

Table 367 – Attributes of GenerationTrainingSimulation::CombustionTurbine

name	mult	type	description
ambientTemp	0..1	Temperature	Default ambient temperature to be used in modelling applications.
auxPowerVersusFrequency	0..1	PU	Off-nominal frequency effect on turbine auxiliaries. Per unit reduction in auxiliary active power consumption versus per unit reduction in frequency (from rated frequency).
auxPowerVersusVoltage	0..1	PU	Off-nominal voltage effect on turbine auxiliaries. Per unit reduction in auxiliary active power consumption versus per unit reduction in auxiliary bus voltage (from a specified voltage level).

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name	mult	type	description
capabilityVersusFrequency	0..1	PU	Off-nominal frequency effect on turbine capability. Per unit reduction in unit active power capability versus per unit reduction in frequency (from rated frequency).
heatRecoveryFlag	0..1	Boolean	Flag that is set to true if the combustion turbine is associated with a heat recovery boiler.
powerVariationByTemp	0..1	PU	Per unit change in power per (versus) unit change in ambient temperature.
referenceTemp	0..1	Temperature	Reference temperature at which the output of the turbine was defined.
timeConstant	0..1	Seconds	The time constant for the turbine.
primeMoverRating	0..1	Float	inherited from: PrimeMover
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 368 shows all association ends of CombustionTurbine with other classes.

Table 368 – Association ends of GenerationTrainingSimulation::CombustionTurbine with other classes

mult from	name	mult to	type	description
1..1	AirCompressor	0..1	AirCompressor	A CAES air compressor is driven by combustion turbine.
1..1	CTTempActivePowerCurve	0..1	CTTempActivePowerCurve	A combustion turbine may have an active power versus ambient temperature relationship.
0..*	HeatRecoveryBoiler	0..1	HeatRecoveryBoiler	A combustion turbine may have a heat recovery boiler for making steam.
0..*	SynchronousMachines	0..*	SynchronousMachine	inherited from: PrimeMover
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

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6.6.2.6 DrumBoiler

Drum boiler.

Table 369 shows all attributes of DrumBoiler.

Table 369 – Attributes of GenerationTrainingSimulation::DrumBoiler

name	mult	type	description
drumBoilerRating	0..1	Float	Rating of drum boiler in steam units.
auxPowerVersusFrequency	0..1	PU	inherited from: FossilSteamSupply
auxPowerVersusVoltage	0..1	PU	inherited from: FossilSteamSupply
boilerControlMode	0..1	BoilerControlMode	inherited from: FossilSteamSupply
controlErrorBiasP	0..1	Float	inherited from: FossilSteamSupply
controlIC	0..1	Float	inherited from: FossilSteamSupply
controlPC	0..1	Float	inherited from: FossilSteamSupply
controlPEB	0..1	Float	inherited from: FossilSteamSupply
controlPED	0..1	PU	inherited from: FossilSteamSupply
controlTC	0..1	Float	inherited from: FossilSteamSupply
feedWaterIG	0..1	Float	inherited from: FossilSteamSupply
feedWaterPG	0..1	Float	inherited from: FossilSteamSupply
feedWaterTC	0..1	Seconds	inherited from: FossilSteamSupply
fuelDemandLimit	0..1	PU	inherited from: FossilSteamSupply
fuelSupplyDelay	0..1	Seconds	inherited from: FossilSteamSupply
fuelSupplyTC	0..1	Seconds	inherited from: FossilSteamSupply
maxErrorRateP	0..1	Float	inherited from: FossilSteamSupply
mechPowerSensorLag	0..1	Seconds	inherited from: FossilSteamSupply
minErrorRateP	0..1	Float	inherited from: FossilSteamSupply
pressureCtrlDG	0..1	Float	inherited from: FossilSteamSupply
pressureCtrlIG	0..1	Float	inherited from: FossilSteamSupply
pressureCtrlPG	0..1	Float	inherited from: FossilSteamSupply
pressureFeedback	0..1	Integer	inherited from: FossilSteamSupply
superHeater1Capacity	0..1	Float	inherited from: FossilSteamSupply
superHeater2Capacity	0..1	Float	inherited from: FossilSteamSupply
superHeaterPipePD	0..1	Float	inherited from: FossilSteamSupply
throttlePressureSP	0..1	PU	inherited from: FossilSteamSupply
steamSupplyRating	0..1	Float	inherited from: SteamSupply
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 370 shows all association ends of DrumBoiler with other classes.

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Table 370 – Association ends of GenerationTrainingSimulation::DrumBoiler with other classes

mult from	name	mult to	type	description
0..*	SteamTurbines	0..*	SteamTurbine	inherited from: SteamSupply
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.6.2.7 FossilSteamSupply

Fossil fuelled boiler (e.g., coal, oil, gas).

Table 371 shows all attributes of FossilSteamSupply.

Table 371 – Attributes of GenerationTrainingSimulation::FossilSteamSupply

name	mult	type	description
auxPowerVersusFrequency	0..1	PU	Off nominal frequency effect on auxiliary real power. Per unit active power variation versus per unit frequency variation.
auxPowerVersusVoltage	0..1	PU	Off nominal voltage effect on auxiliary real power. Per unit active power variation versus per unit voltage variation.
boilerControlMode	0..1	BoilerControlMode	The control mode of the boiler.
controlErrorBiasP	0..1	Float	Active power error bias ratio.
controlIC	0..1	Float	Integral constant.
controlPC	0..1	Float	Proportional constant.
controlPEB	0..1	Float	Pressure error bias ratio.
controlPED	0..1	PU	Pressure error deadband.
controlTC	0..1	Float	Time constant.
feedWaterIG	0..1	Float	Feedwater integral gain ratio.
feedWaterPG	0..1	Float	Feedwater proportional gain ratio.
feedWaterTC	0..1	Seconds	Feedwater time constant ratio.
fuelDemandLimit	0..1	PU	Fuel demand limit.
fuelSupplyDelay	0..1	Seconds	Fuel delay.
fuelSupplyTC	0..1	Seconds	Fuel supply time constant.
maxErrorRateP	0..1	Float	Active power maximum error rate limit.
mechPowerSensorLag	0..1	Seconds	Mechanical power sensor lag.
minErrorRateP	0..1	Float	Active power minimum error rate limit.
pressureCtrlDG	0..1	Float	Pressure control derivative gain ratio.
pressureCtrlIG	0..1	Float	Pressure control integral gain ratio.
pressureCtrlPG	0..1	Float	Pressure control proportional gain ratio.
pressureFeedback	0..1	Integer	Pressure feedback indicator.

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name	mult	type	description
superHeater1Capacity	0..1	Float	Drum/primary superheater capacity.
superHeater2Capacity	0..1	Float	Secondary superheater capacity.
superHeaterPipePD	0..1	Float	Superheater pipe pressure drop constant.
throttlePressureSP	0..1	PU	Throttle pressure setpoint.
steamSupplyRating	0..1	Float	inherited from: SteamSupply
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 372 shows all association ends of FossilSteamSupply with other classes.

Table 372 – Association ends of GenerationTrainingSimulation::FossilSteamSupply with other classes

mult from	name	mult to	type	description
0..*	SteamTurbines	0..*	SteamTurbine	inherited from: SteamSupply
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.6.2.8 HeatRecoveryBoiler

The heat recovery system associated with combustion turbines in order to produce steam for combined cycle plants.

Table 373 shows all attributes of HeatRecoveryBoiler.

Table 373 – Attributes of GenerationTrainingSimulation::HeatRecoveryBoiler

name	mult	type	description
steamSupplyRating2	0..1	Float	The steam supply rating in kilopounds per hour, if dual pressure boiler.
auxPowerVersusFrequency	0..1	PU	inherited from: FossilSteamSupply
auxPowerVersusVoltage	0..1	PU	inherited from: FossilSteamSupply
boilerControlMode	0..1	BoilerControlMode	inherited from: FossilSteamSupply
controlErrorBiasP	0..1	Float	inherited from: FossilSteamSupply
controlIC	0..1	Float	inherited from: FossilSteamSupply
controlPC	0..1	Float	inherited from: FossilSteamSupply
controlPEB	0..1	Float	inherited from: FossilSteamSupply
controlPED	0..1	PU	inherited from: FossilSteamSupply

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name	mult	type	description
controlTC	0..1	Float	inherited from: FossilSteamSupply
feedWaterIG	0..1	Float	inherited from: FossilSteamSupply
feedWaterPG	0..1	Float	inherited from: FossilSteamSupply
feedWaterTC	0..1	Seconds	inherited from: FossilSteamSupply
fuelDemandLimit	0..1	PU	inherited from: FossilSteamSupply
fuelSupplyDelay	0..1	Seconds	inherited from: FossilSteamSupply
fuelSupplyTC	0..1	Seconds	inherited from: FossilSteamSupply
maxErrorRateP	0..1	Float	inherited from: FossilSteamSupply
mechPowerSensorLag	0..1	Seconds	inherited from: FossilSteamSupply
minErrorRateP	0..1	Float	inherited from: FossilSteamSupply
pressureCtrlDG	0..1	Float	inherited from: FossilSteamSupply
pressureCtrlIG	0..1	Float	inherited from: FossilSteamSupply
pressureCtrlPG	0..1	Float	inherited from: FossilSteamSupply
pressureFeedback	0..1	Integer	inherited from: FossilSteamSupply
superHeater1Capacity	0..1	Float	inherited from: FossilSteamSupply
superHeater2Capacity	0..1	Float	inherited from: FossilSteamSupply
superHeaterPipePD	0..1	Float	inherited from: FossilSteamSupply
throttlePressureSP	0..1	PU	inherited from: FossilSteamSupply
steamSupplyRating	0..1	Float	inherited from: SteamSupply
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 374 shows all association ends of HeatRecoveryBoiler with other classes.

Table 374 – Association ends of GenerationTrainingSimulation::HeatRecoveryBoiler with other classes

mult from	name	mult to	type	description
0..1	CombustionTurbines	0..*	CombustionTurbine	A combustion turbine may have a heat recovery boiler for making steam.
0..*	SteamTurbines	0..*	SteamTurbine	inherited from: SteamSupply
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

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6.6.2.9 HydroTurbine

A water driven prime mover. Typical turbine types are: Francis, Kaplan, and Pelton.

Table 375 shows all attributes of HydroTurbine.

Table 375 – Attributes of GenerationTrainingSimulation::HydroTurbine

name	mult	type	description
gateRateLimit	0..1	Float	Gate rate limit.
gateUpperLimit	0..1	PU	Gate upper limit.
maxHeadMaxP	0..1	ActivePower	Maximum efficiency active power at maximum head conditions.
minHeadMaxP	0..1	ActivePower	Maximum efficiency active power at minimum head conditions.
speedRating	0..1	RotationSpeed	Rated speed in number of revolutions. The attribute shall be a positive value.
speedRegulation	0..1	PU	Speed regulation.
transientDroopTime	0..1	Seconds	Transient droop time constant.
transientRegulation	0..1	PU	Transient regulation.
turbineRating	0..1	ActivePower	Rated turbine active power. The attribute shall be a positive value.
turbineType	0..1	HydroTurbineKind	Type of turbine.
waterStartingTime	0..1	Seconds	Water starting time.
primeMoverRating	0..1	Float	inherited from: PrimeMover
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 376 shows all association ends of HydroTurbine with other classes.

Table 376 – Association ends of GenerationTrainingSimulation::HydroTurbine with other classes

mult from	name	mult to	type	description
0..*	SynchronousMachines	0..*	SynchronousMachine	inherited from: PrimeMover
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

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6.6.2.10 PWRSteamSupply

Pressurized water reactor used as a steam supply to a steam turbine.

Table 377 shows all attributes of PWRSteamSupply.

Table 377 – Attributes of GenerationTrainingSimulation::PWRSteamSupply

name	mult	type	description
coldLegFBLagTC	0..1	PU	Cold leg feedback lag time constant.
coldLegFBLeadTC1	0..1	PU	Cold leg feedback lead time constant.
coldLegFBLeadTC2	0..1	PU	Cold leg feedback lead time constant.
coldLegFG1	0..1	PU	Cold leg feedback gain 1.
coldLegFG2	0..1	PU	Cold leg feedback gain 2.
coldLegLagTC	0..1	PU	Cold leg lag time constant.
coreHTLagTC1	0..1	PU	Core heat transfer lag time constant.
coreHTLagTC2	0..1	PU	Core heat transfer lag time constant.
coreNeutronicsEffTC	0..1	PU	Core neutronics effective time constant.
coreNeutronicsHT	0..1	PU	Core neutronics and heat transfer.
feedbackFactor	0..1	PU	Feedback factor.
hotLegLagTC	0..1	PU	Hot leg lag time constant.
hotLegSteamGain	0..1	PU	Hot leg steam gain.
hotLegToColdLegGain	0..1	PU	Hot leg to cold leg gain.
pressureCG	0..1	PU	Pressure control gain.
steamFlowFG	0..1	PU	Steam flow feedback gain.
steamPressureDropLagTC	0..1	PU	Steam pressure drop lag time constant.
steamPressureFG	0..1	PU	Steam pressure feedback gain.
throttlePressureFactor	0..1	PU	Throttle pressure factor.
throttlePressureSP	0..1	PU	Throttle pressure setpoint.
steamSupplyRating	0..1	Float	inherited from: SteamSupply
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 378 shows all association ends of PWRSteamSupply with other classes.

Table 378 – Association ends of GenerationTrainingSimulation::PWRSteamSupply with other classes

mult from	name	mult to	type	description
0..*	SteamTurbines	0..*	SteamTurbine	inherited from: SteamSupply
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

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6.6.2.11 PrimeMover

The machine used to develop mechanical energy used to drive a generator.

Table 379 shows all attributes of PrimeMover.

Table 379 – Attributes of GenerationTrainingSimulation::PrimeMover

name	mult	type	description
primeMoverRating	0..1	Float	Rating of prime mover.
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 380 shows all association ends of PrimeMover with other classes.

Table 380 – Association ends of GenerationTrainingSimulation::PrimeMover with other classes

mult from	name	mult to	type	description
0..*	SynchronousMachines	0..*	SynchronousMachine	Synchronous machines this Prime mover drives.
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.6.2.12 SteamSupply

Steam supply for steam turbine.

Table 381 shows all attributes of SteamSupply.

Table 381 – Attributes of GenerationTrainingSimulation::SteamSupply

name	mult	type	description
steamSupplyRating	0..1	Float	Rating of steam supply.
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 382 shows all association ends of SteamSupply with other classes.

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Table 382 – Association ends of GenerationTrainingSimulation::SteamSupply with other classes

mult from	name	mult to	type	description
0..*	SteamTurbines	0..*	SteamTurbine	Steam turbines may have steam supplied by a steam supply.
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.6.2.13 SteamTurbine

Steam turbine.

Table 383 shows all attributes of SteamTurbine.

Table 383 – Attributes of GenerationTrainingSimulation::SteamTurbine

name	mult	type	description
crossoverTC	0..1	Seconds	Crossover time constant.
reheater1TC	0..1	Seconds	First reheater time constant.
reheater2TC	0..1	Seconds	Second reheater time constant.
shaft1PowerHP	0..1	Float	Fraction of power from shaft 1 high pressure turbine output.
shaft1PowerIP	0..1	Float	Fraction of power from shaft 1 intermediate pressure turbine output.
shaft1PowerLP1	0..1	Float	Fraction of power from shaft 1 first low pressure turbine output.
shaft1PowerLP2	0..1	Float	Fraction of power from shaft 1 second low pressure turbine output.
shaft2PowerHP	0..1	Float	Fraction of power from shaft 2 high pressure turbine output.
shaft2PowerIP	0..1	Float	Fraction of power from shaft 2 intermediate pressure turbine output.
shaft2PowerLP1	0..1	Float	Fraction of power from shaft 2 first low pressure turbine output.
shaft2PowerLP2	0..1	Float	Fraction of power from shaft 2 second low pressure turbine output.
steamChestTC	0..1	Seconds	Steam chest time constant.
primeMoverRating	0..1	Float	inherited from: PrimeMover
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 384 shows all association ends of SteamTurbine with other classes.

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Table 384 – Association ends of GenerationTrainingSimulation::SteamTurbine with other classes

mult from	name	mult to	type	description
0..*	SteamSupplys	0..*	SteamSupply	Steam turbines may have steam supplied by a steam supply.
0..*	SynchronousMachines	0..*	SynchronousMachine	inherited from: PrimeMover
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.6.2.14 Subcritical

Once-through subcritical boiler.

Table 385 shows all attributes of Subcritical.

Table 385 – Attributes of GenerationTrainingSimulation::Subcritical

name	mult	type	description
auxPowerVersusFrequency	0..1	PU	inherited from: FossilSteamSupply
auxPowerVersusVoltage	0..1	PU	inherited from: FossilSteamSupply
boilerControlMode	0..1	BoilerControlMode	inherited from: FossilSteamSupply
controlErrorBiasP	0..1	Float	inherited from: FossilSteamSupply
controlIC	0..1	Float	inherited from: FossilSteamSupply
controlPC	0..1	Float	inherited from: FossilSteamSupply
controlPEB	0..1	Float	inherited from: FossilSteamSupply
controlPED	0..1	PU	inherited from: FossilSteamSupply
controlTC	0..1	Float	inherited from: FossilSteamSupply
feedWaterIG	0..1	Float	inherited from: FossilSteamSupply
feedWaterPG	0..1	Float	inherited from: FossilSteamSupply
feedWaterTC	0..1	Seconds	inherited from: FossilSteamSupply
fuelDemandLimit	0..1	PU	inherited from: FossilSteamSupply
fuelSupplyDelay	0..1	Seconds	inherited from: FossilSteamSupply
fuelSupplyTC	0..1	Seconds	inherited from: FossilSteamSupply
maxErrorRateP	0..1	Float	inherited from: FossilSteamSupply
mechPowerSensorLag	0..1	Seconds	inherited from: FossilSteamSupply
minErrorRateP	0..1	Float	inherited from: FossilSteamSupply
pressureCtrlDG	0..1	Float	inherited from: FossilSteamSupply
pressureCtrlIG	0..1	Float	inherited from: FossilSteamSupply
pressureCtrlPG	0..1	Float	inherited from: FossilSteamSupply
pressureFeedback	0..1	Integer	inherited from: FossilSteamSupply

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name	mult	type	description
superHeater1Capacity	0..1	Float	inherited from: FossilSteamSupply
superHeater2Capacity	0..1	Float	inherited from: FossilSteamSupply
superHeaterPipePD	0..1	Float	inherited from: FossilSteamSupply
throttlePressureSP	0..1	PU	inherited from: FossilSteamSupply
steamSupplyRating	0..1	Float	inherited from: SteamSupply
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 386 shows all association ends of Subcritical with other classes.

Table 386 – Association ends of GenerationTrainingSimulation::Subcritical with other classes

mult from	name	mult to	type	description
0..*	SteamTurbines	0..*	SteamTurbine	inherited from: SteamSupply
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.6.2.15 Supercritical

Once-through supercritical boiler.

Table 387 shows all attributes of Supercritical.

Table 387 – Attributes of GenerationTrainingSimulation::Supercritical

name	mult	type	description
auxPowerVersusFrequency	0..1	PU	inherited from: FossilSteamSupply
auxPowerVersusVoltage	0..1	PU	inherited from: FossilSteamSupply
boilerControlMode	0..1	BoilerControlMode	inherited from: FossilSteamSupply
controlErrorBiasP	0..1	Float	inherited from: FossilSteamSupply
controlIC	0..1	Float	inherited from: FossilSteamSupply
controlPC	0..1	Float	inherited from: FossilSteamSupply
controlPEB	0..1	Float	inherited from: FossilSteamSupply
controlPED	0..1	PU	inherited from: FossilSteamSupply
controlTC	0..1	Float	inherited from: FossilSteamSupply
feedWaterIG	0..1	Float	inherited from: FossilSteamSupply
feedWaterPG	0..1	Float	inherited from: FossilSteamSupply

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name	mult	type	description
feedWaterTC	0..1	Seconds	inherited from: FossilSteamSupply
fuelDemandLimit	0..1	PU	inherited from: FossilSteamSupply
fuelSupplyDelay	0..1	Seconds	inherited from: FossilSteamSupply
fuelSupplyTC	0..1	Seconds	inherited from: FossilSteamSupply
maxErrorRateP	0..1	Float	inherited from: FossilSteamSupply
mechPowerSensorLag	0..1	Seconds	inherited from: FossilSteamSupply
minErrorRateP	0..1	Float	inherited from: FossilSteamSupply
pressureCtrlDG	0..1	Float	inherited from: FossilSteamSupply
pressureCtrlIG	0..1	Float	inherited from: FossilSteamSupply
pressureCtrlPG	0..1	Float	inherited from: FossilSteamSupply
pressureFeedback	0..1	Integer	inherited from: FossilSteamSupply
superHeater1Capacity	0..1	Float	inherited from: FossilSteamSupply
superHeater2Capacity	0..1	Float	inherited from: FossilSteamSupply
superHeaterPipePD	0..1	Float	inherited from: FossilSteamSupply
throttlePressureSP	0..1	PU	inherited from: FossilSteamSupply
steamSupplyRating	0..1	Float	inherited from: SteamSupply
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 388 shows all association ends of Supercritical with other classes.

Table 388 – Association ends of GenerationTrainingSimulation::Supercritical with other classes

mult from	name	mult to	type	description
0..*	SteamTurbines	0..*	SteamTurbine	inherited from: SteamSupply
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

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6.6.2.16 HydroTurbineKind enumeration

Type of turbine.

Table 389 shows all literals of HydroTurbineKind.

Table 389 – Literals of GenerationTrainingSimulation::HydroTurbineKind

literal	value	description
francis		Francis.
pelton		Pelton.
kaplan		Kaplan.

6.6.3 Package Production

6.6.3.1 General

The production package is responsible for classes which describe various kinds of generators. These classes also provide production costing information which is used to economically allocate demand among committed units and calculate reserve quantities.

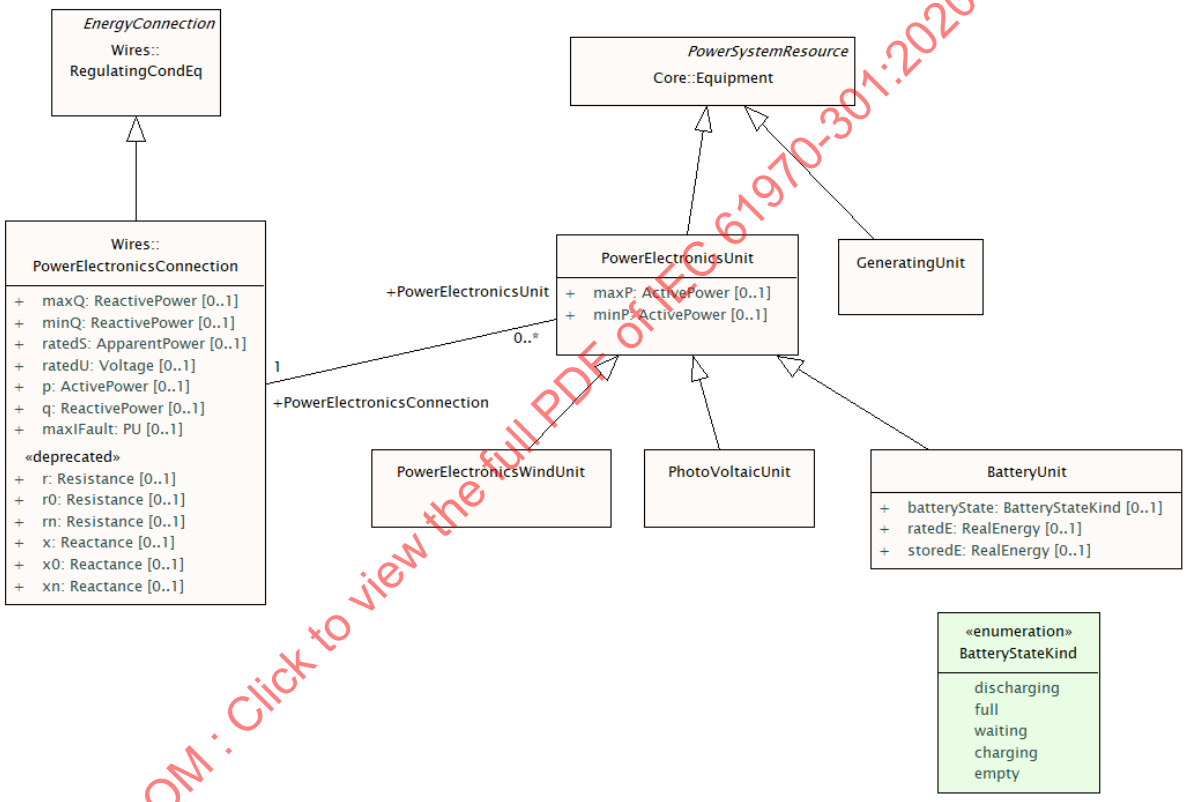


Figure 106 – Class diagram Production::PowerElectronics

Figure 106: This diagram shows power electronics classes and inheritance.

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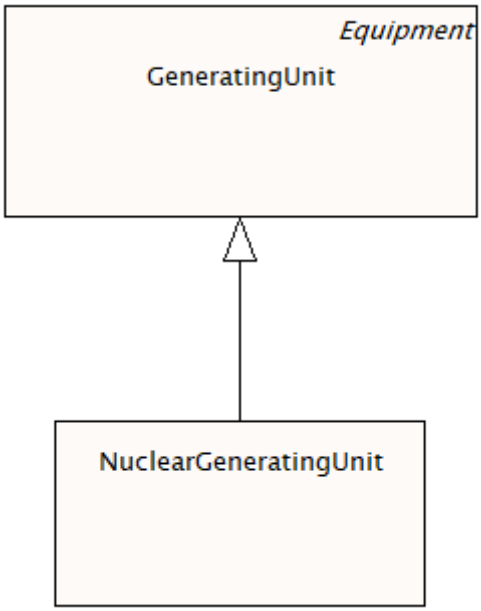


Figure 107 – Class diagram Production::Nuclear

Figure 107: This diagram shows nuclear generation inheritance.

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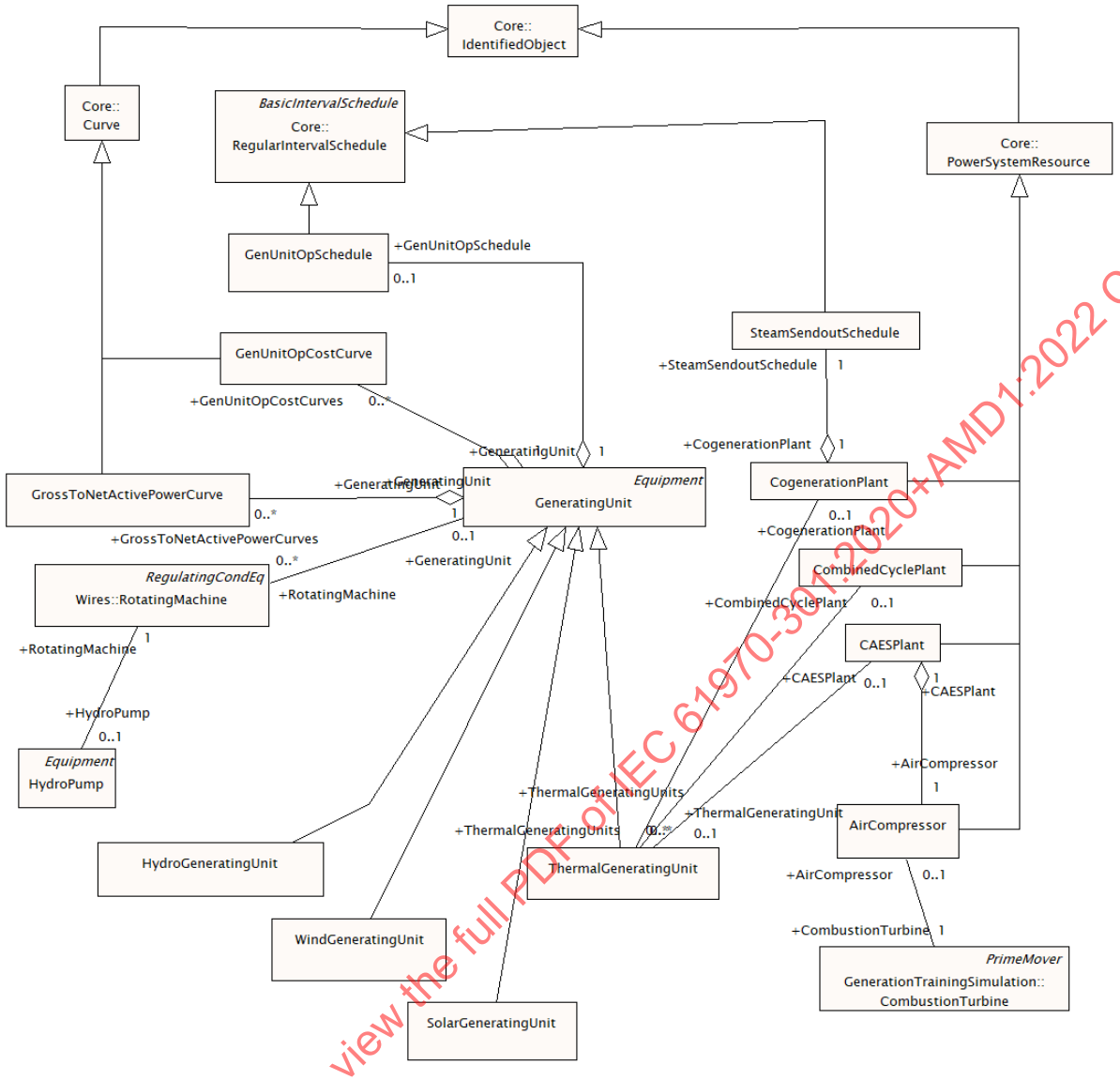


Figure 108 – Class diagram Production::Main

Figure 108: This diagram shows all classes included in the Production package that are needed by both Hydro and Thermal generation. It also shows key external classes that have associations with Production classes.

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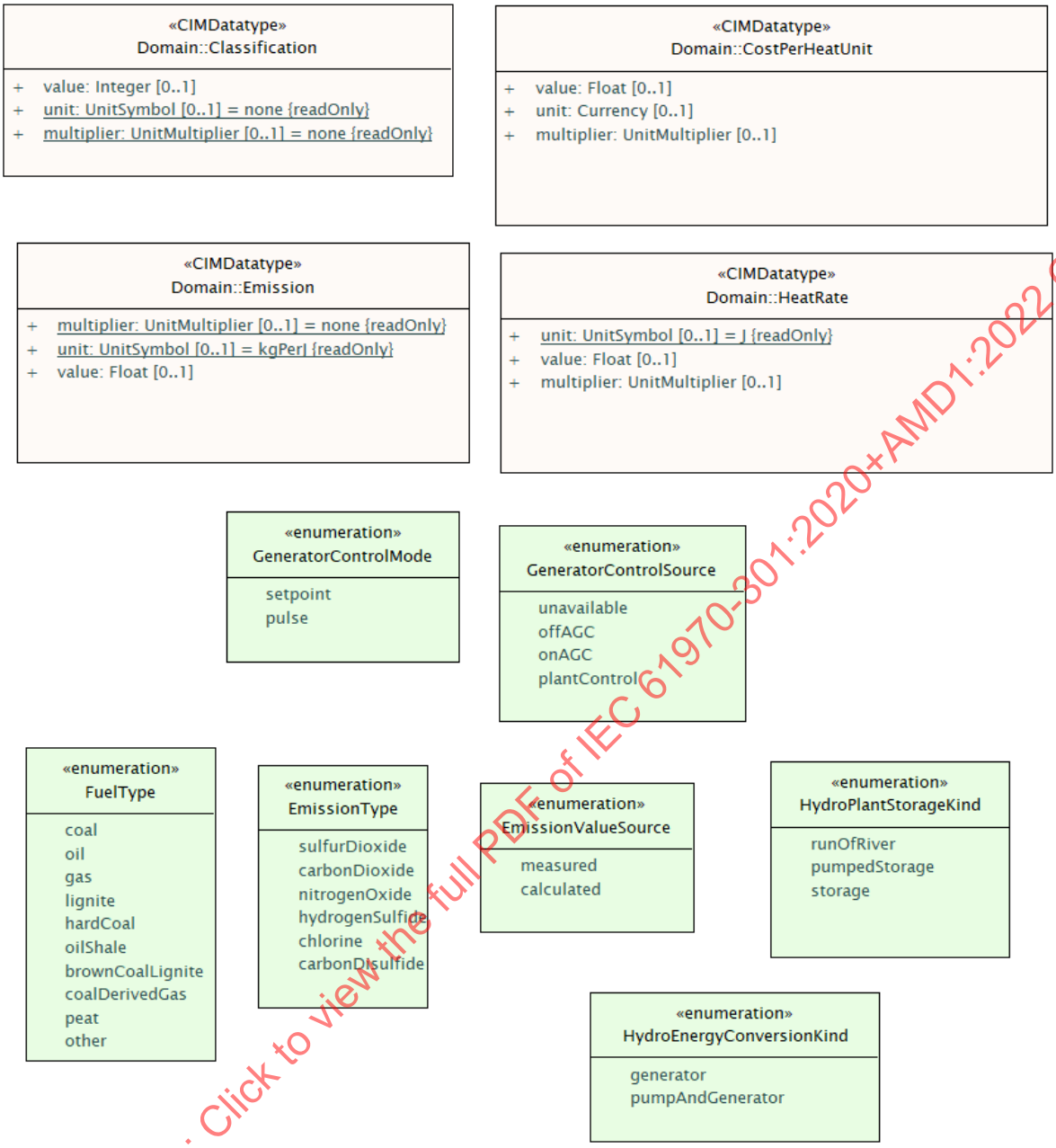


Figure 109 – Class diagram Production::Datatypes

Figure 109: This diagram show the data types specific to the Production package.

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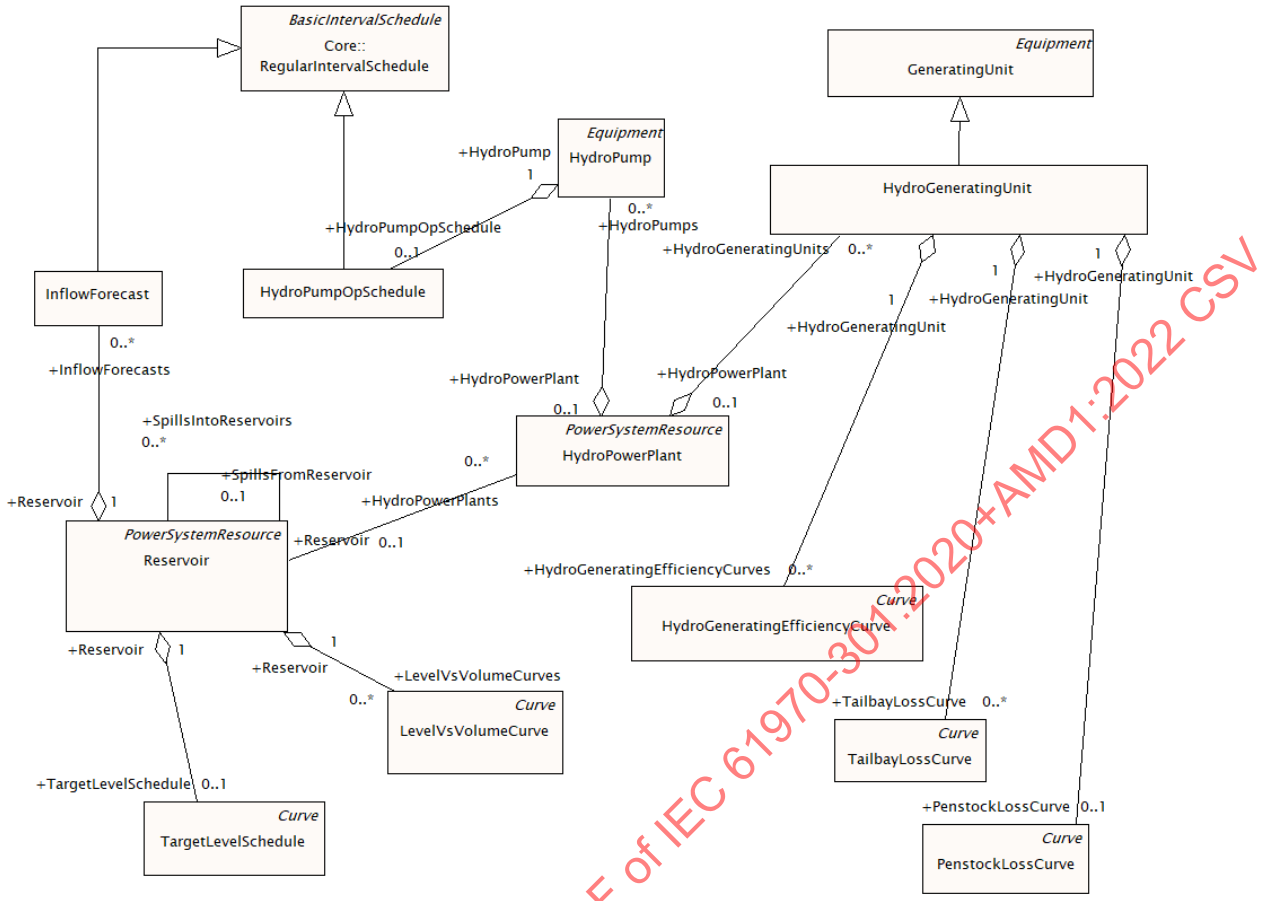


Figure 110 – Class diagram Production::Hydro

Figure 110: This diagram shows all classes included in the Hydro package as well as the key external classes that have associations with Hydro classes.

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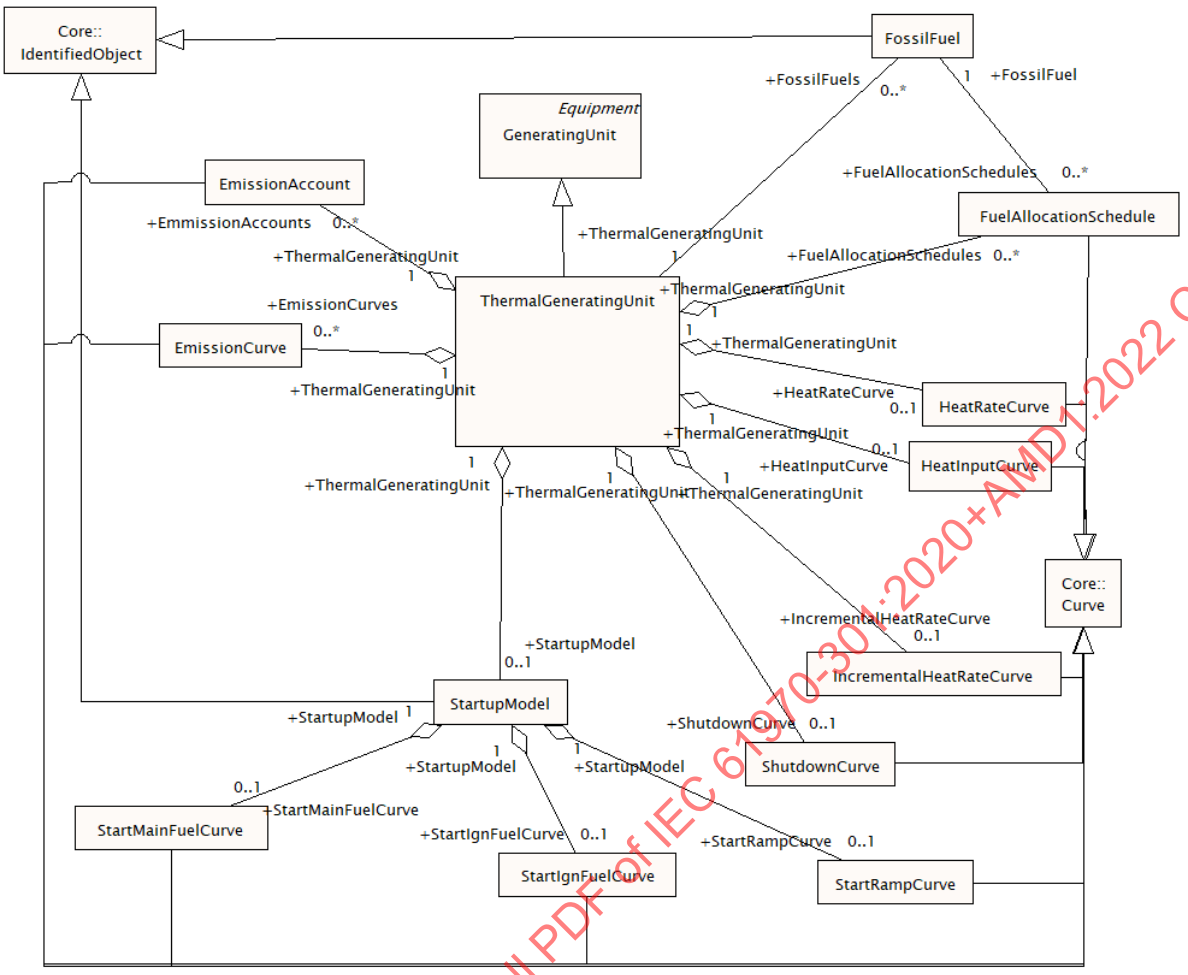


Figure 111 – Class diagram Production::Thermal

Figure 111: This diagram shows all classes included in the Thermal package as well as the key external classes that have associations with Thermal classes.

6.6.3.2 AirCompressor

Combustion turbine air compressor which is an integral part of a compressed air energy storage (CAES) plant.

Table 390 shows all attributes of AirCompressor.

Table 390 – Attributes of Production::AirCompressor

name	mult	type	description
airCompressorRating	0..1	Float	Rating of the CAES air compressor.
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 391 shows all association ends of AirCompressor with other classes.

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Table 391 – Association ends of Production::AirCompressor with other classes

mult from	name	mult to	type	description
0..1	CombustionTurbine	1..1	CombustionTurbine	A CAES air compressor is driven by combustion turbine.
1..1	CAESPlant	1..1	CAESPlant	An air compressor may be a member of a compressed air energy storage plant.
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.6.3.3 BatteryStateKind enumeration

The state of the battery unit.

Table 392 shows all literals of BatteryStateKind.

Table 392 – Literals of Production::BatteryStateKind

literal	value	description
discharging		Stored energy is decreasing.
full		Unable to charge, and not discharging.
waiting		Neither charging nor discharging, but able to do so.
charging		Stored energy is increasing.
empty		Unable to discharge, and not charging.

6.6.3.4 BatteryUnit

An electrochemical energy storage device.

Table 393 shows all attributes of BatteryUnit.

Table 393 – Attributes of Production::BatteryUnit

name	mult	type	description
batteryState	0..1	BatteryStateKind	The current state of the battery (charging, full, etc.).
ratedE	0..1	RealEnergy	Full energy storage capacity of the battery. The attribute shall be a positive value.
storedE	0..1	RealEnergy	Amount of energy currently stored. The attribute shall be a positive value or zero and lower than BatteryUnit.ratedE.
maxP	0..1	ActivePower	inherited from: PowerElectronicsUnit
minP	0..1	ActivePower	inherited from: PowerElectronicsUnit
aggregate	0..1	Boolean	inherited from: Equipment
inService	0..1	Boolean	inherited from: Equipment

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name	mult	type	description
networkAnalysisEnabled	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 394 shows all association ends of BatteryUnit with other classes.

Table 394 – Association ends of Production::BatteryUnit with other classes

mult from	name	mult to	type	description
0..*	PowerElectronicsConnection	1..1	PowerElectronicsConnection	inherited from: PowerElectronicsUnit
0..1	OperationalLimitSet	0..*	OperationalLimitSet	inherited from: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	inherited from: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment
0..1	Faults	0..*	Fault	inherited from: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	inherited from: Equipment
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.6.3.5 CAESPlant

Compressed air energy storage plant.

Table 395 shows all attributes of CAESPlant.

Table 395 – Attributes of Production::CAESPlant

name	mult	type	description
energyStorageCapacity	0..1	RealEnergy	The rated energy storage capacity. The attribute shall be a positive value.
ratedCapacityP	0..1	ActivePower	The CAES plant's gross rated generating capacity. The attribute shall be a positive value.
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

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Table 396 shows all association ends of CAESPlant with other classes.

Table 396 – Association ends of Production::CAESPlant with other classes

mult from	name	mult to	type	description
1..1	AirCompressor	1..1	AirCompressor	An air compressor may be a member of a compressed air energy storage plant.
0..1	ThermalGeneratingUnit	0..1	ThermalGeneratingUnit	A thermal generating unit may be a member of a compressed air energy storage plant.
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.6.3.6 CogenerationPlant

A set of thermal generating units for the production of electrical energy and process steam (usually from the output of the steam turbines). The steam sendout is typically used for industrial purposes or for municipal heating and cooling.

Table 397 shows all attributes of CogenerationPlant.

Table 397 – Attributes of Production::CogenerationPlant

name	mult	type	description
cogenHPSendoutRating	0..1	Float	The high pressure steam sendout.
cogenHPSteamRating	0..1	Float	The high pressure steam rating.
cogenLPSendoutRating	0..1	Float	The low pressure steam sendout.
cogenLPSteamRating	0..1	Float	The low pressure steam rating.
ratedP	0..1	ActivePower	The rated output active power of the cogeneration plant. The attribute shall be a positive value.
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 398 shows all association ends of CogenerationPlant with other classes.

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Table 398 – Association ends of Production::CogenerationPlant with other classes

mult from	name	mult to	type	description
0..1	ThermalGeneratingUnits	0..*	ThermalGeneratingUnit	A thermal generating unit may be a member of a cogeneration plant.
1..1	SteamSendoutSchedule	1..1	SteamSendoutSchedule	A cogeneration plant has a steam sendout schedule.
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.6.3.7 CombinedCyclePlant

A set of combustion turbines and steam turbines where the exhaust heat from the combustion turbines is recovered to make steam for the steam turbines, resulting in greater overall plant efficiency.

Table 399 shows all attributes of CombinedCyclePlant.

Table 399 – Attributes of Production::CombinedCyclePlant

name	mult	type	description
combCyclePlantRating	0..1	ActivePower	The combined cycle plant's active power output rating.
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 400 shows all association ends of CombinedCyclePlant with other classes.

Table 400 – Association ends of Production::CombinedCyclePlant with other classes

mult from	name	mult to	type	description
0..1	ThermalGeneratingUnits	0..*	ThermalGeneratingUnit	A thermal generating unit may be a member of a combined cycle plant.
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

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6.6.3.8 EmissionAccount

Accounts for tracking emissions usage and credits for thermal generating units. A unit may have zero or more emission accounts and will typically have one for tracking usage and one for tracking credits.

Table 401 shows all attributes of EmissionAccount.

Table 401 – Attributes of Production::EmissionAccount

name	mult	type	description
emissionType	0..1	EmissionType	The type of emission, for example sulfur dioxide (SO2). The y1AxisUnits of the curve contains the unit of measure (e.g. kg) and the emissionType is the type of emission (e.g. sulfur dioxide).
emissionValueSource	0..1	EmissionValueSource	The source of the emission value.
curveStyle	0..1	CurveStyle	inherited from: Curve
xMultiplier	0..1	UnitMultiplier	inherited from: Curve
xUnit	0..1	UnitSymbol	inherited from: Curve
y1Multiplier	0..1	UnitMultiplier	inherited from: Curve
y1Unit	0..1	UnitSymbol	inherited from: Curve
y2Multiplier	0..1	UnitMultiplier	inherited from: Curve
y2Unit	0..1	UnitSymbol	inherited from: Curve
y3Multiplier	0..1	UnitMultiplier	inherited from: Curve
y3Unit	0..1	UnitSymbol	inherited from: Curve
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 402 shows all association ends of EmissionAccount with other classes.

Table 402 – Association ends of Production::EmissionAccount with other classes

mult from	name	mult to	type	description
0..*	ThermalGeneratingUnit	1..1	ThermalGeneratingUnit	A thermal generating unit may have one or more emission allowance accounts.
1..1	CurveDatas	0..*	CurveData	inherited from: Curve
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

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6.6.3.9 EmissionCurve

Relationship between the unit's emission rate in units of mass per hour (Y-axis) and output active power (X-axis) for a given type of emission. This curve applies when only one type of fuel is being burned.

Table 403 shows all attributes of EmissionCurve.

Table 403 – Attributes of Production::EmissionCurve

name	mult	type	description
emissionContent	0..1	Emission	The emission content per quantity of fuel burned.
emissionType	0..1	EmissionType	The type of emission, which also gives the production rate measurement unit. The y1AxisUnits of the curve contains the unit of measure (e.g. kg) and the emissionType is the type of emission (e.g. sulfur dioxide).
isNetGrossP	0..1	Boolean	Flag is set to true when output is expressed in net active power.
curveStyle	0..1	CurveStyle	inherited from: Curve
xMultiplier	0..1	UnitMultiplier	inherited from: Curve
xUnit	0..1	UnitSymbol	inherited from: Curve
y1Multiplier	0..1	UnitMultiplier	inherited from: Curve
y1Unit	0..1	UnitSymbol	inherited from: Curve
y2Multiplier	0..1	UnitMultiplier	inherited from: Curve
y2Unit	0..1	UnitSymbol	inherited from: Curve
y3Multiplier	0..1	UnitMultiplier	inherited from: Curve
y3Unit	0..1	UnitSymbol	inherited from: Curve
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 404 shows all association ends of EmissionCurve with other classes.

Table 404 – Association ends of Production::EmissionCurve with other classes

mult from	name	mult to	type	description
0..*	ThermalGeneratingUnit	1..1	ThermalGeneratingUnit	A thermal generating unit may have one or more emission curves.
1..1	CurveDatas	0..*	CurveData	inherited from: Curve
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.6.3.10 EmissionType enumeration

The type of emission.

Table 405 shows all literals of EmissionType.

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Table 405 – Literals of Production::EmissionType

literal	value	description
sulfurDioxide		Sulfur dioxide.
carbonDioxide		Carbon dioxide.
nitrogenOxide		Nitrogen oxide.
hydrogenSulfide		Hydrogen sulfide.
chlorine		Chlorine.
carbonDisulfide		Carbon disulfide.

6.6.3.11 WindGenUnitKind enumeration

Kind of wind generating unit.

Table 406 shows all literals of WindGenUnitKind.

Table 406 – Literals of Production::WindGenUnitKind

literal	value	description
offshore		The wind generating unit is located offshore.
onshore		The wind generating unit is located onshore.

6.6.3.12 EmissionValueSource enumeration

The source of the emission value.

Table 407 shows all literals of EmissionValueSource.

Table 407 – Literals of Production::EmissionValueSource

literal	value	description
measured		Measured.
calculated		Calculated.

6.6.3.13 FossilFuel

The fossil fuel consumed by the non-nuclear thermal generating unit. For example, coal, oil, gas, etc. These are the specific fuels that the generating unit can consume.

Table 408 shows all attributes of FossilFuel.

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Table 408 – Attributes of Production::FossilFuel

name	mult	type	description
fossilFuelType	0..1	FuelType	The type of fossil fuel, such as coal, oil, or gas.
fuelCost	0..1	CostPerHeatUnit	The cost in terms of heat value for the given type of fuel.
fuelDispatchCost	0..1	CostPerHeatUnit	The cost of fuel used for economic dispatching which includes: fuel cost, transportation cost, and incremental maintenance cost.
fuelEffFactor	0..1	PU	The efficiency factor for the fuel (per unit) in terms of the effective energy absorbed.
fuelHandlingCost	0..1	CostPerHeatUnit	Handling and processing cost associated with this fuel.
fuelHeatContent	0..1	Float	The amount of heat per weight (or volume) of the given type of fuel.
fuelMixture	0..1	PerCent	Relative amount of the given type of fuel, when multiple fuels are being consumed.
fuelSulfur	0..1	PU	The fuel's fraction of pollution credit per unit of heat content.
highBreakpointP	0..1	ActivePower	The active power output level of the unit at which the given type of fuel is switched on. This fuel (e.g., oil) is sometimes used to supplement the base fuel (e.g., coal) at high active power output levels.
lowBreakpointP	0..1	ActivePower	The active power output level of the unit at which the given type of fuel is switched off. This fuel (e.g., oil) is sometimes used to stabilize the base fuel (e.g., coal) at low active power output levels.
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 409 shows all association ends of FossilFuel with other classes.

Table 409 – Association ends of Production::FossilFuel with other classes

mult from	name	mult to	type	description
1..1	FuelAllocationSchedules	0..*	FuelAllocationSchedule	A fuel allocation schedule shall have a fossil fuel.
0..*	ThermalGeneratingUnit	1..1	ThermalGeneratingUnit	A thermal generating unit may have one or more fossil fuels.
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

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6.6.3.14 FuelAllocationSchedule

The amount of fuel of a given type which is allocated for consumption over a specified period of time.

Table 410 shows all attributes of FuelAllocationSchedule.

Table 410 – Attributes of Production::FuelAllocationSchedule

name	mult	type	description
fuelAllocationEndDate	0..1	DateTime	The end time and date of the fuel allocation schedule.
fuelAllocationStartDate	0..1	DateTime	The start time and date of the fuel allocation schedule.
fuelType	0..1	FuelType	The type of fuel, which also indicates the corresponding measurement unit.
maxFuelAllocation	0..1	Float	The maximum amount of fuel that is allocated for consumption for the scheduled time period.
minFuelAllocation	0..1	Float	The minimum amount of fuel that is allocated for consumption for the scheduled time period, e.g., based on a "take-or-pay" contract.
curveStyle	0..1	CurveStyle	inherited from: Curve
xMultiplier	0..1	UnitMultiplier	inherited from: Curve
xUnit	0..1	UnitSymbol	inherited from: Curve
y1Multiplier	0..1	UnitMultiplier	inherited from: Curve
y1Unit	0..1	UnitSymbol	inherited from: Curve
y2Multiplier	0..1	UnitMultiplier	inherited from: Curve
y2Unit	0..1	UnitSymbol	inherited from: Curve
y3Multiplier	0..1	UnitMultiplier	inherited from: Curve
y3Unit	0..1	UnitSymbol	inherited from: Curve
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 411 shows all association ends of FuelAllocationSchedule with other classes.

Table 411 – Association ends of Production::FuelAllocationSchedule with other classes

mult from	name	mult to	type	description
0..*	ThermalGeneratingUnit	1..1	ThermalGeneratingUnit	A thermal generating unit may have one or more fuel allocation schedules.
0..*	FossilFuel	1..1	FossilFuel	A fuel allocation schedule shall have a fossil fuel.
1..1	CurveDatas	0..*	CurveData	inherited from: Curve
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

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6.6.3.15 FuelType enumeration

Type of fuel.

Table 412 shows all literals of FuelType.

Table 412 – Literals of Production::FuelType

literal	value	description
coal		Generic coal, not including lignite type.
oil		Oil.
gas		Natural gas.
lignite		The fuel is lignite coal. Note that this is a special type of coal, so the other enum of coal is reserved for hard coal types or if the exact type of coal is not known.
hardCoal		Hard coal.
oilShale		Oil Shale.
brownCoalLignite		Brown coal lignite.
coalDerivedGas		Coal derived gas.
peat		Peat.
other		Any fuel type not included in the rest of the enumerated value.

6.6.3.16 GenUnitOpCostCurve

Relationship between unit operating cost (Y-axis) and unit output active power (X-axis). The operating cost curve for thermal units is derived from heat input and fuel costs. The operating cost curve for hydro units is derived from water flow rates and equivalent water costs.

Table 413 shows all attributes of GenUnitOpCostCurve.

Table 413 – Attributes of Production::GenUnitOpCostCurve

name	mult	type	description
isNetGrossP	0..1	Boolean	Flag is set to true when output is expressed in net active power.
curveStyle	0..1	CurveStyle	inherited from: Curve
xMultiplier	0..1	UnitMultiplier	inherited from: Curve
xUnit	0..1	UnitSymbol	inherited from: Curve
y1Multiplier	0..1	UnitMultiplier	inherited from: Curve
y1Unit	0..1	UnitSymbol	inherited from: Curve
y2Multiplier	0..1	UnitMultiplier	inherited from: Curve
y2Unit	0..1	UnitSymbol	inherited from: Curve
y3Multiplier	0..1	UnitMultiplier	inherited from: Curve
y3Unit	0..1	UnitSymbol	inherited from: Curve
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 414 shows all association ends of GenUnitOpCostCurve with other classes.

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Table 414 – Association ends of Production::GenUnitOpCostCurve with other classes

mult from	name	mult to	type	description
0..*	GeneratingUnit	1..1	GeneratingUnit	A generating unit may have one or more cost curves, depending upon fuel mixture and fuel cost.
1..1	CurveDatas	0..*	CurveData	inherited from: Curve
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.6.3.17 GenUnitOpSchedule

The generating unit's Operator-approved current operating schedule (or plan), typically produced with the aid of unit commitment type analyses. The X-axis represents absolute time. The Y1-axis represents the status (0=off-line and unavailable: 1=available: 2=must run: 3=must run at fixed power value: etc.). The Y2-axis represents the must run fixed power value where required.

Table 415 shows all attributes of GenUnitOpSchedule.

Table 415 – Attributes of Production::GenUnitOpSchedule

name	mult	type	description
endTime	0..1	DateTime	inherited from: RegularIntervalSchedule
timeStep	0..1	Seconds	inherited from: RegularIntervalSchedule
startTime	0..1	DateTime	inherited from: BasicIntervalSchedule
value1Multiplier	0..1	UnitMultiplier	inherited from: BasicIntervalSchedule
value1Unit	0..1	UnitSymbol	inherited from: BasicIntervalSchedule
value2Multiplier	0..1	UnitMultiplier	inherited from: BasicIntervalSchedule
value2Unit	0..1	UnitSymbol	inherited from: BasicIntervalSchedule
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 416 shows all association ends of GenUnitOpSchedule with other classes.

Table 416 – Association ends of Production::GenUnitOpSchedule with other classes

mult from	name	mult to	type	description
0..1	GeneratingUnit	1..1	GeneratingUnit	A generating unit may have an operating schedule, indicating the planned operation of the unit.
1..1	TimePoints	1..*	RegularTimePoint	inherited from: RegularIntervalSchedule
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

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6.6.3.18 GeneratingUnit

A single or set of synchronous machines for converting mechanical power into alternating-current power. For example, individual machines within a set may be defined for scheduling purposes while a single control signal is derived for the set. In this case there would be a GeneratingUnit for each member of the set and an additional GeneratingUnit corresponding to the set.

Table 417 shows all attributes of GeneratingUnit.

Table 417 – Attributes of Production::GeneratingUnit

name	mult	type	description
allocSpinResP	0..1	ActivePower	The planned unused capacity (spinning reserve) which can be used to support emergency load.
autoCntrlMarginP	0..1	ActivePower	The planned unused capacity which can be used to support automatic control overruns.
baseP	0..1	ActivePower	For dispatchable units, this value represents the economic active power basepoint, for units that are not dispatchable, this value represents the fixed generation value. The value shall be between the operating low and high limits.
controlDeadband	0..1	ActivePower	Unit control error deadband. When a unit's desired active power change is less than this deadband, then no control pulses will be sent to the unit.
controlPulseHigh	0..1	Seconds	Pulse high limit which is the largest control pulse that the unit can respond to.
controlPulseLow	0..1	Seconds	Pulse low limit which is the smallest control pulse that the unit can respond to.
controlResponseRate	0..1	ActivePowerChangeRate	Unit response rate which specifies the active power change for a control pulse of one second in the most responsive loading level of the unit.
efficiency	0..1	PerCent	The efficiency of the unit in converting mechanical energy, from the prime mover, into electrical energy.
genControlMode	0..1	GeneratorControlMode	The unit control mode.
genControlSource	0..1	GeneratorControlSource	The source of controls for a generating unit. Defines the control status of the generating unit.
governorMPL	0..1	PU	Governor motor position limit.
governorSCD	0..1	PerCent	Governor Speed Changer Droop. This is the change in generator power output divided by the change in frequency normalized by the nominal power of the generator and the nominal frequency and expressed in percent and negated. A positive value of speed change droop provides additional generator output upon a drop in frequency.
highControlLimit	0..1	ActivePower	High limit for secondary (AGC) control.
initialP	0..1	ActivePower	Default initial active power which is used to store a powerflow result for the initial active power for this unit in this network configuration.
longPF	0..1	Float	Generating unit long term economic participation factor.
lowControlLimit	0..1	ActivePower	Low limit for secondary (AGC) control.
lowerRampRate	0..1	ActivePowerChangeRate	The normal maximum rate the generating unit active power output can be lowered by control actions.

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name	mult	type	description
maxEconomicP	0..1	ActivePower	Maximum high economic active power limit, that should not exceed the maximum operating active power limit.
maximumAllowableSpinningReserve	0..1	ActivePower	Maximum allowable spinning reserve. Spinning reserve will never be considered greater than this value regardless of the current operating point.
maxOperatingP	0..1	ActivePower	This is the maximum operating active power limit the dispatcher can enter for this unit.
minEconomicP	0..1	ActivePower	Low economic active power limit that shall be greater than or equal to the minimum operating active power limit.
minimumOffTime	0..1	Seconds	Minimum time interval between unit shutdown and startup.
minOperatingP	0..1	ActivePower	This is the minimum operating active power limit the dispatcher can enter for this unit.
modelDetail	0..1	Classification	Detail level of the generator model data.
nominalP	0..1	ActivePower	The nominal power of the generating unit. Used to give precise meaning to percentage based attributes such as the governor speed change droop (governorSCD attribute). The attribute shall be a positive value equal to or less than RotatingMachine.ratedS.
normalPF	0..1	Float	Generating unit economic participation factor. The sum of the participation factors across generating units does not have to sum to one. It is used for representing distributed slack participation factor. The attribute shall be a positive value or zero.
penaltyFactor	0..1	Float	Defined as: 1 / (1 – Incremental Transmission Loss); with the Incremental Transmission Loss expressed as a plus or minus value. The typical range of penalty factors is (0.9 to 1.1).
raiseRampRate	0..1	ActivePowerChangeRate	The normal maximum rate the generating unit active power output can be raised by control actions.
ratedGrossMaxP	0..1	ActivePower	The unit's gross rated maximum capacity (book value). The attribute shall be a positive value.
ratedGrossMinP	0..1	ActivePower	The gross rated minimum generation level which the unit can safely operate at while delivering power to the transmission grid. The attribute shall be a positive value.
ratedNetMaxP	0..1	ActivePower	The net rated maximum capacity determined by subtracting the auxiliary power used to operate the internal plant machinery from the rated gross maximum capacity. The attribute shall be a positive value.
shortPF	0..1	Float	Generating unit short term economic participation factor.
startupCost	0..1	Money	The initial startup cost incurred for each start of the GeneratingUnit.
startupTime	0..1	Seconds	Time it takes to get the unit on-line, from the time that the prime mover mechanical power is applied.
tieLinePF	0..1	Float	Generating unit economic participation factor.
totalEfficiency	0..1	PerCent	The efficiency of the unit in converting the fuel into electrical energy.

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name	mult	type	description
variableCost	0..1	Money	The variable cost component of production per unit of ActivePower.
aggregate	0..1	Boolean	inherited from: Equipment
inService	0..1	Boolean	inherited from: Equipment
networkAnalysisEnabled	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 418 shows all association ends of GeneratingUnit with other classes.

Table 418 – Association ends of Production::GeneratingUnit with other classes

mult from	name	mult to	type	description
0..1	RotatingMachine	0..*	RotatingMachine	A synchronous machine may operate as a generator and as such becomes a member of a generating unit.
1..1	GenUnitOpCostCurves	0..*	GenUnitOpCostCurve	A generating unit may have one or more cost curves, depending upon fuel mixture and fuel cost.
1..1	GenUnitOpSchedule	0..1	GenUnitOpSchedule	A generating unit may have an operating schedule, indicating the planned operation of the unit.
1..1	ControlAreaGeneratingUnit	0..*	ControlAreaGeneratingUnit	ControlArea specifications for this generating unit.
1..1	GrossToNetActivePowerCurves	0..*	GrossToNetActivePowerCurve	A generating unit may have a gross active power to net active power curve, describing the losses and auxiliary power requirements of the unit.
0..1	OperationalLimitSet	0..*	OperationalLimitSet	inherited from: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	inherited from: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment
0..1	Faults	0..*	Fault	inherited from: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	inherited from: Equipment
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.6.3.19 GeneratorControlMode enumeration

Unit control modes.

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Table 419 shows all literals of GeneratorControlMode.

Table 419 – Literals of Production::GeneratorControlMode

literal	value	description
setpoint		Setpoint control mode.
pulse		Pulse control mode.

6.6.3.20 GeneratorControlSource enumeration

The source of controls for a generating unit.

Table 420 shows all literals of GeneratorControlSource.

Table 420 – Literals of Production::GeneratorControlSource

literal	value	description
unavailable		Not available.
offAGC		Off of automatic generation control (AGC).
onAGC		On automatic generation control (AGC).
plantControl		Plant is controlling.

6.6.3.21 GrossToNetActivePowerCurve

Relationship between the generating unit's gross active power output on the X-axis (measured at the terminals of the machine(s)) and the generating unit's net active power output on the Y-axis (based on utility-defined measurements at the power station). Station service loads, when modelled, should be treated as non-conforming bus loads. There may be more than one curve, depending on the auxiliary equipment that is in service.

Table 421 shows all attributes of GrossToNetActivePowerCurve.

Table 421 – Attributes of Production::GrossToNetActivePowerCurve

name	mult	type	description
curveStyle	0..1	CurveStyle	inherited from: Curve
xMultiplier	0..1	UnitMultiplier	inherited from: Curve
xUnit	0..1	UnitSymbol	inherited from: Curve
y1Multiplier	0..1	UnitMultiplier	inherited from: Curve
y1Unit	0..1	UnitSymbol	inherited from: Curve
y2Multiplier	0..1	UnitMultiplier	inherited from: Curve
y2Unit	0..1	UnitSymbol	inherited from: Curve
y3Multiplier	0..1	UnitMultiplier	inherited from: Curve
y3Unit	0..1	UnitSymbol	inherited from: Curve
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

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Table 422 shows all association ends of GrossToNetActivePowerCurve with other classes.

Table 422 – Association ends of Production::GrossToNetActivePowerCurve with other classes

mult from	name	mult to	type	description
0..*	GeneratingUnit	1..1	GeneratingUnit	A generating unit may have a gross active power to net active power curve, describing the losses and auxiliary power requirements of the unit.
1..1	CurveDatas	0..*	CurveData	inherited from: Curve
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.6.3.22 HeatInputCurve

Relationship between unit heat input in energy per time for main fuel (Y1-axis) and supplemental fuel (Y2-axis) versus unit output in active power (X-axis). The quantity of main fuel used to sustain generation at this output level is prorated for throttling between definition points. The quantity of supplemental fuel used at this output level is fixed and not prorated.

Table 423 shows all attributes of HeatInputCurve.

Table 423 – Attributes of Production::HeatInputCurve

name	mult	type	description
auxPowerMult	0..1	PU	Power output – auxiliary power multiplier adjustment factor.
auxPowerOffset	0..1	ActivePower	Power output – auxiliary power offset adjustment factor.
heatInputEff	0..1	PU	Heat input – efficiency multiplier adjustment factor.
heatInputOffset	0..1	HeatRate	Heat input – offset adjustment factor.
isNetGrossP	0..1	Boolean	Flag is set to true when output is expressed in net active power.
curveStyle	0..1	CurveStyle	inherited from: Curve
xMultiplier	0..1	UnitMultiplier	inherited from: Curve
xUnit	0..1	UnitSymbol	inherited from: Curve
y1Multiplier	0..1	UnitMultiplier	inherited from: Curve
y1Unit	0..1	UnitSymbol	inherited from: Curve
y2Multiplier	0..1	UnitMultiplier	inherited from: Curve
y2Unit	0..1	UnitSymbol	inherited from: Curve
y3Multiplier	0..1	UnitMultiplier	inherited from: Curve
y3Unit	0..1	UnitSymbol	inherited from: Curve
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 424 shows all association ends of HeatInputCurve with other classes.

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Table 424 – Association ends of Production::HeatInputCurve with other classes

mult from	name	mult to	type	description
0..1	ThermalGeneratingUnit	1..1	ThermalGeneratingUnit	A thermal generating unit may have a heat input curve.
1..1	CurveDatas	0..*	CurveData	inherited from: Curve
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.6.3.23 HeatRateCurve

Relationship between unit heat rate per active power (Y-axis) and unit output (X-axis). The heat input is from all fuels.

Table 425 shows all attributes of HeatRateCurve.

Table 425 – Attributes of Production::HeatRateCurve

name	mult	type	description
isNetGrossP	0..1	Boolean	Flag is set to true when output is expressed in net active power.
curveStyle	0..1	CurveStyle	inherited from: Curve
xMultiplier	0..1	UnitMultiplier	inherited from: Curve
xUnit	0..1	UnitSymbol	inherited from: Curve
y1Multiplier	0..1	UnitMultiplier	inherited from: Curve
y1Unit	0..1	UnitSymbol	inherited from: Curve
y2Multiplier	0..1	UnitMultiplier	inherited from: Curve
y2Unit	0..1	UnitSymbol	inherited from: Curve
y3Multiplier	0..1	UnitMultiplier	inherited from: Curve
y3Unit	0..1	UnitSymbol	inherited from: Curve
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 426 shows all association ends of HeatRateCurve with other classes.

Table 426 – Association ends of Production::HeatRateCurve with other classes

mult from	name	mult to	type	description
0..1	ThermalGeneratingUnit	1..1	ThermalGeneratingUnit	A thermal generating unit may have a heat rate curve.
1..1	CurveDatas	0..*	CurveData	inherited from: Curve
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

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6.6.3.24 HydroEnergyConversionKind enumeration

Specifies the capability of the hydro generating unit to convert energy as a generator or pump.

Table 427 shows all literals of HydroEnergyConversionKind.

Table 427 – Literals of Production::HydroEnergyConversionKind

literal	value	description
generator		Able to generate power, but not able to pump water for energy storage.
pumpAndGenerator		Able to both generate power and pump water for energy storage.

6.6.3.25 HydroGeneratingEfficiencyCurve

Relationship between unit efficiency as percentage and unit output active power for a given net head in meters. The relationship between efficiency, discharge, head, and power output is expressed as follows:

$$E = KP/HQ$$

where: E is the efficiency, as a percentage; P is the active power; H is the height; Q is the discharge, volume/time unit; K is a constant.

For example, a curve instance for a given net head could show efficiency (Y-axis) versus active power output (X-axis) or versus discharge on the X-axis.

Table 428 shows all attributes of HydroGeneratingEfficiencyCurve.

Table 428 – Attributes of Production::HydroGeneratingEfficiencyCurve

name	mult	type	description
curveStyle	0..1	CurveStyle	inherited from: Curve
xMultiplier	0..1	UnitMultiplier	inherited from: Curve
xUnit	0..1	UnitSymbol	inherited from: Curve
y1Multiplier	0..1	UnitMultiplier	inherited from: Curve
y1Unit	0..1	UnitSymbol	inherited from: Curve
y2Multiplier	0..1	UnitMultiplier	inherited from: Curve
y2Unit	0..1	UnitSymbol	inherited from: Curve
y3Multiplier	0..1	UnitMultiplier	inherited from: Curve
y3Unit	0..1	UnitSymbol	inherited from: Curve
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 429 shows all association ends of HydroGeneratingEfficiencyCurve with other classes.

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Table 429 – Association ends of Production::HydroGeneratingEfficiencyCurve with other classes

mult from	name	mult to	type	description
0..*	HydroGeneratingUnit	1..1	HydroGeneratingUnit	A hydro generating unit has an efficiency curve.
1..1	CurveDatas	0..*	CurveData	inherited from: Curve
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.6.3.26 HydroGeneratingUnit

A generating unit whose prime mover is a hydraulic turbine (e.g., Francis, Pelton, Kaplan).

Table 430 shows all attributes of HydroGeneratingUnit.

Table 430 – Attributes of Production::HydroGeneratingUnit

name	mult	type	description
energyConversionCapability	0..1	HydroEnergyConversionKind	Energy conversion capability for generating.
hydroUnitWaterCost	0..1	CostPerVolume	The equivalent cost of water that drives the hydro turbine.
dropHeight	0..1	Length	The height water drops from the reservoir mid-point to the turbine.
turbineType	0..1	HydroTurbineKind	Type of turbine.
allocSpinResP	0..1	ActivePower	inherited from: GeneratingUnit
autoCntrlMarginP	0..1	ActivePower	inherited from: GeneratingUnit
baseP	0..1	ActivePower	inherited from: GeneratingUnit
controlDeadband	0..1	ActivePower	inherited from: GeneratingUnit
controlPulseHigh	0..1	Seconds	inherited from: GeneratingUnit
controlPulseLow	0..1	Seconds	inherited from: GeneratingUnit
controlResponseRate	0..1	ActivePowerChangeRate	inherited from: GeneratingUnit
efficiency	0..1	PerCent	inherited from: GeneratingUnit
genControlMode	0..1	GeneratorControlMode	inherited from: GeneratingUnit
genControlSource	0..1	GeneratorControlSource	inherited from: GeneratingUnit
governorMPL	0..1	PU	inherited from: GeneratingUnit
governorSCD	0..1	PerCent	inherited from: GeneratingUnit
highControlLimit	0..1	ActivePower	inherited from: GeneratingUnit
initialP	0..1	ActivePower	inherited from: GeneratingUnit
longPF	0..1	Float	inherited from: GeneratingUnit
lowControlLimit	0..1	ActivePower	inherited from: GeneratingUnit
lowerRampRate	0..1	ActivePowerChangeRate	inherited from: GeneratingUnit
maxEconomicP	0..1	ActivePower	inherited from: GeneratingUnit
maximumAllowableSpinningReserve	0..1	ActivePower	inherited from: GeneratingUnit
maxOperatingP	0..1	ActivePower	inherited from: GeneratingUnit
minEconomicP	0..1	ActivePower	inherited from: GeneratingUnit
minimumOffTime	0..1	Seconds	inherited from: GeneratingUnit

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name	mult	type	description
minOperatingP	0..1	ActivePower	inherited from: GeneratingUnit
modelDetail	0..1	Classification	inherited from: GeneratingUnit
nominalP	0..1	ActivePower	inherited from: GeneratingUnit
normalPF	0..1	Float	inherited from: GeneratingUnit
penaltyFactor	0..1	Float	inherited from: GeneratingUnit
raiseRampRate	0..1	ActivePowerChangeRate	inherited from: GeneratingUnit
ratedGrossMaxP	0..1	ActivePower	inherited from: GeneratingUnit
ratedGrossMinP	0..1	ActivePower	inherited from: GeneratingUnit
ratedNetMaxP	0..1	ActivePower	inherited from: GeneratingUnit
shortPF	0..1	Float	inherited from: GeneratingUnit
startupCost	0..1	Money	inherited from: GeneratingUnit
startupTime	0..1	Seconds	inherited from: GeneratingUnit
tieLinePF	0..1	Float	inherited from: GeneratingUnit
totalEfficiency	0..1	PerCent	inherited from: GeneratingUnit
variableCost	0..1	Money	inherited from: GeneratingUnit
aggregate	0..1	Boolean	inherited from: Equipment
inService	0..1	Boolean	inherited from: Equipment
networkAnalysisEnabled	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 431 shows all association ends of HydroGeneratingUnit with other classes.

Table 431 – Association ends of Production::HydroGeneratingUnit with other classes

mult from	name	mult to	type	description
1..1	HydroGeneratingEfficiencyCurves	0..*	HydroGeneratingEfficiencyCurve	A hydro generating unit has an efficiency curve.
1..1	TailbayLossCurve	0..*	TailbayLossCurve	A hydro generating unit has a tailbay loss curve.
0..*	HydroPowerPlant	0..1	HydroPowerPlant	The hydro generating unit belongs to a hydro power plant.
1..1	PenstockLossCurve	0..1	PenstockLossCurve	A hydro generating unit has a penstock loss curve.
0..1	RotatingMachine	0..*	RotatingMachine	inherited from: GeneratingUnit
1..1	GenUnitOpCostCurves	0..*	GenUnitOpCostCurve	inherited from: GeneratingUnit
1..1	GenUnitOpSchedule	0..1	GenUnitOpSchedule	inherited from: GeneratingUnit
1..1	ControlAreaGeneratingUnit	0..*	ControlAreaGeneratingUnit	inherited from: GeneratingUnit
1..1	GrossToNetActivePowerCurves	0..*	GrossToNetActivePowerCurve	inherited from: GeneratingUnit
0..1	OperationalLimitSet	0..*	OperationalLimitSet	inherited from: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	inherited from: Equipment

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mult from	name	mult to	type	description
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment
0..1	Faults	0..*	Fault	inherited from: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	inherited from: Equipment
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.6.3.27 HydroPlantStorageKind enumeration

The type of hydro power plant.

Table 432 shows all literals of HydroPlantStorageKind.

Table 432 – Literals of Production::HydroPlantStorageKind

literal	value	description
runOfRiver		Run of river.
pumpedStorage		Pumped storage.
storage		Storage.

6.6.3.28 HydroPowerPlant

A hydro power station which can generate or pump. When generating, the generator turbines receive water from an upper reservoir. When pumping, the pumps receive their water from a lower reservoir.

Table 433 shows all attributes of HydroPowerPlant.

Table 433 – Attributes of Production::HydroPowerPlant

name	mult	type	description
dischargeTravelDelay	0..1	Seconds	Water travel delay from tailbay to next downstream hydro power station.
genRatedP	0..1	ActivePower	The hydro plant's generating rating active power for rated head conditions. The attribute shall be a positive value.
hydroPlantStorageType	0..1	HydroPlantStorageKind	The type of hydro power plant water storage.
penstockType	0..1	String	Type and configuration of hydro plant penstock(s).
plantDischargeCapacity	0..1	VolumeFlowRate	Total plant discharge capacity.
plantRatedHead	0..1	Length	The plant's rated gross head. The attribute shall be a positive value.
pumpRatedP	0..1	ActivePower	The hydro plant's pumping rating active power for rated head conditions.

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name	mult	type	description
			The attribute shall be a positive value.
surgeTankCode	0..1	String	A code describing the type (or absence) of surge tank that is associated with the hydro power plant.
surgeTankCrestLevel	0..1	WaterLevel	The level at which the surge tank spills.
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 434 shows all association ends of HydroPowerPlant with other classes.

Table 434 – Association ends of Production::HydroPowerPlant with other classes

mult from	name	mult to	type	description
0..1	HydroGeneratingUnits	0..*	HydroGeneratingUnit	The hydro generating unit belongs to a hydro power plant.
0..1	HydroPumps	0..*	HydroPump	The hydro pump may be a member of a pumped storage plant or a pump for distributing water.
0..*	Reservoir	0..1	Reservoir	Generators discharge water to or pumps are supplied water from a downstream reservoir.
0..*	GenSourcePumpDischargeReservoir	1..1	Reservoir	Generators are supplied water from or pumps discharge water to an upstream reservoir.
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.6.3.29 HydroPump

A synchronous motor-driven pump, typically associated with a pumped storage plant.

Table 435 shows all attributes of HydroPump.

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Table 435 – Attributes of Production::HydroPump

name	mult	type	description
pumpDischAtMaxHead	0..1	VolumeFlowRate	The pumping discharge under maximum head conditions, usually at full gate.
pumpDischAtMinHead	0..1	VolumeFlowRate	The pumping discharge under minimum head conditions, usually at full gate.
pumpPowerAtMaxHead	0..1	ActivePower	The pumping power under maximum head conditions, usually at full gate.
pumpPowerAtMinHead	0..1	ActivePower	The pumping power under minimum head conditions, usually at full gate.
aggregate	0..1	Boolean	inherited from: Equipment
inService	0..1	Boolean	inherited from: Equipment
networkAnalysisEnabled	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 436 shows all association ends of HydroPump with other classes.

Table 436 – Association ends of Production::HydroPump with other classes

mult from	name	mult to	type	description
0..1	RotatingMachine	1..1	RotatingMachine	The synchronous machine drives the turbine which moves the water from a low elevation to a higher elevation. The direction of machine rotation for pumping may or may not be the same as for generating.
0..*	HydroPowerPlant	0..1	HydroPowerPlant	The hydro pump may be a member of a pumped storage plant or a pump for distributing water.
1..1	HydroPumpOpSchedule	0..1	HydroPumpOpSchedule	The hydro pump has a pumping schedule over time, indicating when pumping is to occur.
0..1	OperationalLimitSet	0..*	OperationalLimitSet	inherited from: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	inherited from: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment
0..1	Faults	0..*	Fault	inherited from: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	inherited from: Equipment
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

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6.6.3.30 HydroPumpOpSchedule

The hydro pump's Operator-approved current operating schedule (or plan), typically produced with the aid of unit commitment type analyses. The unit's operating schedule status is typically given as: (0=unavailable) (1=available to startup or shutdown) (2=must pump).

Table 437 shows all attributes of HydroPumpOpSchedule.

Table 437 – Attributes of Production::HydroPumpOpSchedule

name	mult	type	description
endTime	0..1	DateTime	inherited from: RegularIntervalSchedule
timeStep	0..1	Seconds	inherited from: RegularIntervalSchedule
startTime	0..1	DateTime	inherited from: BasicIntervalSchedule
value1Multiplier	0..1	UnitMultiplier	inherited from: BasicIntervalSchedule
value1Unit	0..1	UnitSymbol	inherited from: BasicIntervalSchedule
value2Multiplier	0..1	UnitMultiplier	inherited from: BasicIntervalSchedule
value2Unit	0..1	UnitSymbol	inherited from: BasicIntervalSchedule
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 438 shows all association ends of HydroPumpOpSchedule with other classes.

Table 438 – Association ends of Production::HydroPumpOpSchedule with other classes

mult from	name	mult to	type	description
0..1	HydroPump	1..1	HydroPump	The hydro pump has a pumping schedule over time, indicating when pumping is to occur.
1..1	TimePoints	1..*	RegularTimePoint	inherited from: RegularIntervalSchedule
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.6.3.31 IncrementalHeatRateCurve

Relationship between unit incremental heat rate in (delta energy/time) per (delta active power) and unit output in active power. The IHR curve represents the slope of the HeatInputCurve. Note that the "incremental heat rate" and the "heat rate" have the same engineering units.

Table 439 shows all attributes of IncrementalHeatRateCurve.

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Table 439 – Attributes of Production::IncrementalHeatRateCurve

name	mult	type	description
isNetGrossP	0..1	Boolean	Flag is set to true when output is expressed in net active power.
curveStyle	0..1	CurveStyle	inherited from: Curve
xMultiplier	0..1	UnitMultiplier	inherited from: Curve
xUnit	0..1	UnitSymbol	inherited from: Curve
y1Multiplier	0..1	UnitMultiplier	inherited from: Curve
y1Unit	0..1	UnitSymbol	inherited from: Curve
y2Multiplier	0..1	UnitMultiplier	inherited from: Curve
y2Unit	0..1	UnitSymbol	inherited from: Curve
y3Multiplier	0..1	UnitMultiplier	inherited from: Curve
y3Unit	0..1	UnitSymbol	inherited from: Curve
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 440 shows all association ends of IncrementalHeatRateCurve with other classes.

Table 440 – Association ends of Production::IncrementalHeatRateCurve with other classes

mult from	name	mult to	type	description
0..1	ThermalGeneratingUnit	1..1	ThermalGeneratingUnit	A thermal generating unit may have an incremental heat rate curve.
1..1	CurveDatas	0..*	CurveData	inherited from: Curve
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.6.3.32 InflowForecast

Natural water inflow to a reservoir, usually forecasted from predicted rain and snowmelt. Typically in one hour increments for up to 10 days. The forecast is given in average cubic meters per second over the time increment.

Table 441 shows all attributes of InflowForecast.

Table 441 – Attributes of Production::InflowForecast

name	mult	type	description
endTime	0..1	DateTime	inherited from: RegularIntervalSchedule
timeStep	0..1	Seconds	inherited from: RegularIntervalSchedule
startTime	0..1	DateTime	inherited from: BasicIntervalSchedule
value1Multiplier	0..1	UnitMultiplier	inherited from: BasicIntervalSchedule
value1Unit	0..1	UnitSymbol	inherited from: BasicIntervalSchedule
value2Multiplier	0..1	UnitMultiplier	inherited from: BasicIntervalSchedule

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name	mult	type	description
value2Unit	0..1	UnitSymbol	inherited from: BasicIntervalSchedule
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 442 shows all association ends of InflowForecast with other classes.

Table 442 – Association ends of Production::InflowForecast with other classes

mult from	name	mult to	type	description
0..*	Reservoir	1..1	Reservoir	A reservoir may have a "natural" inflow forecast.
1..1	TimePoints	1..*	RegularTimePoint	inherited from: RegularIntervalSchedule
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.6.3.33 LevelVsVolumeCurve

Relationship between reservoir volume and reservoir level. The volume is at the Y-axis and the reservoir level at the X-axis.

Table 443 shows all attributes of LevelVsVolumeCurve.

Table 443 – Attributes of Production::LevelVsVolumeCurve

name	mult	type	description
curveStyle	0..1	CurveStyle	inherited from: Curve
xMultiplier	0..1	UnitMultiplier	inherited from: Curve
xUnit	0..1	UnitSymbol	inherited from: Curve
y1Multiplier	0..1	UnitMultiplier	inherited from: Curve
y1Unit	0..1	UnitSymbol	inherited from: Curve
y2Multiplier	0..1	UnitMultiplier	inherited from: Curve
y2Unit	0..1	UnitSymbol	inherited from: Curve
y3Multiplier	0..1	UnitMultiplier	inherited from: Curve
y3Unit	0..1	UnitSymbol	inherited from: Curve
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 444 shows all association ends of LevelVsVolumeCurve with other classes.

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Table 444 – Association ends of Production::LevelVsVolumeCurve with other classes

mult from	name	mult to	type	description
0..*	Reservoir	1..1	Reservoir	A reservoir may have a level versus volume relationship.
1..1	CurveDatas	0..*	CurveData	inherited from: Curve
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.6.3.34 NuclearGeneratingUnit

A nuclear generating unit.

Table 445 shows all attributes of NuclearGeneratingUnit.

Table 445 – Attributes of Production::NuclearGeneratingUnit

name	mult	type	description
allocSpinResP	0..1	ActivePower	inherited from: GeneratingUnit
autoCntrlMarginP	0..1	ActivePower	inherited from: GeneratingUnit
baseP	0..1	ActivePower	inherited from: GeneratingUnit
controlDeadband	0..1	ActivePower	inherited from: GeneratingUnit
controlPulseHigh	0..1	Seconds	inherited from: GeneratingUnit
controlPulseLow	0..1	Seconds	inherited from: GeneratingUnit
controlResponseRate	0..1	ActivePowerChangeRate	inherited from: GeneratingUnit
efficiency	0..1	PerCent	inherited from: GeneratingUnit
genControlMode	0..1	GeneratorControlMode	inherited from: GeneratingUnit
genControlSource	0..1	GeneratorControlSource	inherited from: GeneratingUnit
governorMPL	0..1	PU	inherited from: GeneratingUnit
governorSCD	0..1	PerCent	inherited from: GeneratingUnit
highControlLimit	0..1	ActivePower	inherited from: GeneratingUnit
initialP	0..1	ActivePower	inherited from: GeneratingUnit
longPF	0..1	Float	inherited from: GeneratingUnit
lowControlLimit	0..1	ActivePower	inherited from: GeneratingUnit
lowerRampRate	0..1	ActivePowerChangeRate	inherited from: GeneratingUnit
maxEconomicP	0..1	ActivePower	inherited from: GeneratingUnit
maximumAllowableSpinningReserve	0..1	ActivePower	inherited from: GeneratingUnit
maxOperatingP	0..1	ActivePower	inherited from: GeneratingUnit
minEconomicP	0..1	ActivePower	inherited from: GeneratingUnit
minimumOffTime	0..1	Seconds	inherited from: GeneratingUnit
minOperatingP	0..1	ActivePower	inherited from: GeneratingUnit
modelDetail	0..1	Classification	inherited from: GeneratingUnit
nominalP	0..1	ActivePower	inherited from: GeneratingUnit
normalPF	0..1	Float	inherited from: GeneratingUnit
penaltyFactor	0..1	Float	inherited from: GeneratingUnit
raiseRampRate	0..1	ActivePowerChangeRate	inherited from: GeneratingUnit

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name	mult	type	description
ratedGrossMaxP	0..1	ActivePower	inherited from: GeneratingUnit
ratedGrossMinP	0..1	ActivePower	inherited from: GeneratingUnit
ratedNetMaxP	0..1	ActivePower	inherited from: GeneratingUnit
shortPF	0..1	Float	inherited from: GeneratingUnit
startupCost	0..1	Money	inherited from: GeneratingUnit
startupTime	0..1	Seconds	inherited from: GeneratingUnit
tieLinePF	0..1	Float	inherited from: GeneratingUnit
totalEfficiency	0..1	PerCent	inherited from: GeneratingUnit
variableCost	0..1	Money	inherited from: GeneratingUnit
aggregate	0..1	Boolean	inherited from: Equipment
inService	0..1	Boolean	inherited from: Equipment
networkAnalysisEnabled	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 446 shows all association ends of NuclearGeneratingUnit with other classes.

Table 446 – Association ends of Production::NuclearGeneratingUnit with other classes

mult from	name	mult to	type	description
0..1	RotatingMachine	0..*	RotatingMachine	inherited from: GeneratingUnit
1..1	GenUnitOpCostCurves	0..*	GenUnitOpCostCurve	inherited from: GeneratingUnit
1..1	GenUnitOpSchedule	0..1	GenUnitOpSchedule	inherited from: GeneratingUnit
1..1	ControlAreaGeneratingUnit	0..*	ControlAreaGeneratingUnit	inherited from: GeneratingUnit
1..1	GrossToNetActivePowerCurves	0..*	GrossToNetActivePowerCurve	inherited from: GeneratingUnit
0..1	OperationalLimitSet	0..*	OperationalLimitSet	inherited from: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	inherited from: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment
0..1	Faults	0..*	Fault	inherited from: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	inherited from: Equipment
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

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6.6.3.35 PenstockLossCurve

Relationship between penstock head loss (in meters) and total discharge through the penstock (in cubic meters per second). One or more turbines may be connected to the same penstock.

Table 447 shows all attributes of PenstockLossCurve.

Table 447 – Attributes of Production::PenstockLossCurve

name	mult	type	description
curveStyle	0..1	CurveStyle	inherited from: Curve
xMultiplier	0..1	UnitMultiplier	inherited from: Curve
xUnit	0..1	UnitSymbol	inherited from: Curve
y1Multiplier	0..1	UnitMultiplier	inherited from: Curve
y1Unit	0..1	UnitSymbol	inherited from: Curve
y2Multiplier	0..1	UnitMultiplier	inherited from: Curve
y2Unit	0..1	UnitSymbol	inherited from: Curve
y3Multiplier	0..1	UnitMultiplier	inherited from: Curve
y3Unit	0..1	UnitSymbol	inherited from: Curve
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 448 shows all association ends of PenstockLossCurve with other classes.

Table 448 – Association ends of Production::PenstockLossCurve with other classes

mult from	name	mult to	type	description
0..1	HydroGeneratingUnit	1..1	HydroGeneratingUnit	A hydro generating unit has a penstock loss curve.
1..1	CurveDatas	0..*	CurveData	inherited from: Curve
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.6.3.36 PhotoVoltaicUnit

A photovoltaic device or an aggregation of such devices.

Table 449 shows all attributes of PhotoVoltaicUnit.

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Table 449 – Attributes of Production::PhotoVoltaicUnit

name	mult	type	description
maxP	0..1	ActivePower	inherited from: PowerElectronicsUnit
minP	0..1	ActivePower	inherited from: PowerElectronicsUnit
aggregate	0..1	Boolean	inherited from: Equipment
inService	0..1	Boolean	inherited from: Equipment
networkAnalysisEnabled	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 450 shows all association ends of PhotoVoltaicUnit with other classes.

Table 450 – Association ends of Production::PhotoVoltaicUnit with other classes

mult from	name	mult to	type	description
0..*	PowerElectronicsConnection	1..1	PowerElectronicsConnection	inherited from: PowerElectronicsUnit
0..1	OperationalLimitSet	0..*	OperationalLimitSet	inherited from: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	inherited from: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment
0..1	Faults	0..*	Fault	inherited from: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	inherited from: Equipment
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.6.3.37 PowerElectronicsUnit

A generating unit or battery or aggregation that connects to the AC network using power electronics rather than rotating machines.

Table 451 shows all attributes of PowerElectronicsUnit.

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Table 451 – Attributes of Production::PowerElectronicsUnit

name	mult	type	description
maxP	0..1	ActivePower	Maximum active power limit. This is the maximum (nameplate) limit for the unit.
minP	0..1	ActivePower	Minimum active power limit. This is the minimum (nameplate) limit for the unit.
aggregate	0..1	Boolean	inherited from: Equipment
inService	0..1	Boolean	inherited from: Equipment
networkAnalysisEnabled	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 452 shows all association ends of PowerElectronicsUnit with other classes.

Table 452 – Association ends of Production::PowerElectronicsUnit with other classes

mult from	name	mult to	type	description
0..*	PowerElectronicsConnection	1..1	PowerElectronicsConnection	A power electronics unit has a connection to the AC network.
0..1	OperationalLimitSet	0..*	OperationalLimitSet	inherited from: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	inherited from: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment
0..1	Faults	0..*	Fault	inherited from: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	inherited from: Equipment
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.6.3.38 PowerElectronicsWindUnit

A wind generating unit that connects to the AC network with power electronics rather than rotating machines or an aggregation of such units.

Table 453 shows all attributes of PowerElectronicsWindUnit.

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Table 453 – Attributes of Production::PowerElectronicsWindUnit

name	mult	type	description
maxP	0..1	ActivePower	inherited from: PowerElectronicsUnit
minP	0..1	ActivePower	inherited from: PowerElectronicsUnit
aggregate	0..1	Boolean	inherited from: Equipment
inService	0..1	Boolean	inherited from: Equipment
networkAnalysisEnabled	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 454 shows all association ends of PowerElectronicsWindUnit with other classes.

Table 454 – Association ends of Production::PowerElectronicsWindUnit with other classes

mult from	name	mult to	type	description
0..*	PowerElectronicsConnection	1..1	PowerElectronicsConnection	inherited from: PowerElectronicsUnit
0..1	OperationalLimitSet	0..*	OperationalLimitSet	inherited from: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	inherited from: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment
0..1	Faults	0..*	Fault	inherited from: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	inherited from: Equipment
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.6.3.39 Reservoir

A water storage facility within a hydro system, including: ponds, lakes, lagoons, and rivers. The storage is usually behind some type of dam.

Table 455 shows all attributes of Reservoir.

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Table 455 – Attributes of Production::Reservoir

name	mult	type	description
activeStorageCapacity	0..1	Volume	Storage volume between the full supply level and the normal minimum operating level.
energyStorageRating	0..1	Float	The reservoir's energy storage rating in energy for given head conditions.
fullSupplyLevel	0..1	WaterLevel	Full supply level, above which water will spill. This can be the spillway crest level or the top of closed gates.
grossCapacity	0..1	Volume	Total capacity of reservoir.
normalMinOperateLevel	0..1	WaterLevel	Normal minimum operating level below which the penstocks will draw air.
riverOutletWorks	0..1	String	River outlet works for riparian right releases or other purposes.
spillTravelDelay	0..1	Seconds	The spillway water travel delay to the next downstream reservoir.
spillwayCapacity	0..1	Float	The flow capacity of the spillway in cubic meters per second.
spillwayCrestLength	0..1	Length	The length of the spillway crest.
spillwayCrestLevel	0..1	WaterLevel	Spillway crest level above which water will spill.
spillWayGateType	0..1	String	Type of spillway gate, including parameters.
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 456 shows all association ends of Reservoir with other classes.

Table 456 – Association ends of Production::Reservoir with other classes

mult from	name	mult to	type	description
0..1	SpillsIntoReservoirs	0..*	Reservoir	A reservoir may spill into a downstream reservoir.
0..1	HydroPowerPlants	0..*	HydroPowerPlant	Generators discharge water to or pumps are supplied water from a downstream reservoir.
1..1	UpstreamFromHydroPowerPlants	0..*	HydroPowerPlant	Generators are supplied water from or pumps discharge water to an upstream reservoir.
1..1	InflowForecasts	0..*	InflowForecast	A reservoir may have a "natural" inflow forecast.
1..1	LevelVsVolumeCurves	0..*	LevelVsVolumeCurve	A reservoir may have a level versus volume relationship.
1..1	TargetLevelSchedule	0..1	TargetLevelSchedule	A reservoir may have a water level target schedule.
0..*	SpillsFromReservoir	0..1	Reservoir	A reservoir may spill into a downstream reservoir.
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource

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mult from	name	mult to	type	description
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.6.3.40 ShutdownCurve

Relationship between the rate in gross active power/minute (Y-axis) at which a unit should be shutdown and its present gross MW output (X-axis).

Table 457 shows all attributes of ShutdownCurve.

Table 457 – Attributes of Production::ShutdownCurve

name	mult	type	description
shutdownCost	0..1	Money	Fixed shutdown cost.
shutdownDate	0..1	DateTime	The date and time of the most recent generating unit shutdown.
curveStyle	0..1	CurveStyle	inherited from: Curve
xMultiplier	0..1	UnitMultiplier	inherited from: Curve
xUnit	0..1	UnitSymbol	inherited from: Curve
y1Multiplier	0..1	UnitMultiplier	inherited from: Curve
y1Unit	0..1	UnitSymbol	inherited from: Curve
y2Multiplier	0..1	UnitMultiplier	inherited from: Curve
y2Unit	0..1	UnitSymbol	inherited from: Curve
y3Multiplier	0..1	UnitMultiplier	inherited from: Curve
y3Unit	0..1	UnitSymbol	inherited from: Curve
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 458 shows all association ends of ShutdownCurve with other classes.

Table 458 – Association ends of Production::ShutdownCurve with other classes

mult from	name	mult to	type	description
0..1	ThermalGeneratingUnit	1..1	ThermalGeneratingUnit	A thermal generating unit may have a shutdown curve.
1..1	CurveDatas	0..*	CurveData	inherited from: Curve
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.6.3.41 SolarGeneratingUnit

A solar thermal generating unit, connected to the grid by means of a rotating machine. This class does not represent photovoltaic (PV) generation.

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Table 459 shows all attributes of SolarGeneratingUnit.

Table 459 – Attributes of Production::SolarGeneratingUnit

name	mult	type	description
allocSpinResP	0..1	ActivePower	inherited from: GeneratingUnit
autoCntrlMarginP	0..1	ActivePower	inherited from: GeneratingUnit
baseP	0..1	ActivePower	inherited from: GeneratingUnit
controlDeadband	0..1	ActivePower	inherited from: GeneratingUnit
controlPulseHigh	0..1	Seconds	inherited from: GeneratingUnit
controlPulseLow	0..1	Seconds	inherited from: GeneratingUnit
controlResponseRate	0..1	ActivePowerChangeRate	inherited from: GeneratingUnit
efficiency	0..1	PerCent	inherited from: GeneratingUnit
genControlMode	0..1	GeneratorControlMode	inherited from: GeneratingUnit
genControlSource	0..1	GeneratorControlSource	inherited from: GeneratingUnit
governorMPL	0..1	PU	inherited from: GeneratingUnit
governorSCD	0..1	PerCent	inherited from: GeneratingUnit
highControlLimit	0..1	ActivePower	inherited from: GeneratingUnit
initialP	0..1	ActivePower	inherited from: GeneratingUnit
longPF	0..1	Float	inherited from: GeneratingUnit
lowControlLimit	0..1	ActivePower	inherited from: GeneratingUnit
lowerRampRate	0..1	ActivePowerChangeRate	inherited from: GeneratingUnit
maxEconomicP	0..1	ActivePower	inherited from: GeneratingUnit
maximumAllowableSpinningReserve	0..1	ActivePower	inherited from: GeneratingUnit
maxOperatingP	0..1	ActivePower	inherited from: GeneratingUnit
minEconomicP	0..1	ActivePower	inherited from: GeneratingUnit
minimumOffTime	0..1	Seconds	inherited from: GeneratingUnit
minOperatingP	0..1	ActivePower	inherited from: GeneratingUnit
modelDetail	0..1	Classification	inherited from: GeneratingUnit
nominalP	0..1	ActivePower	inherited from: GeneratingUnit
normalPF	0..1	Float	inherited from: GeneratingUnit
penaltyFactor	0..1	Float	inherited from: GeneratingUnit
raiseRampRate	0..1	ActivePowerChangeRate	inherited from: GeneratingUnit
ratedGrossMaxP	0..1	ActivePower	inherited from: GeneratingUnit
ratedGrossMinP	0..1	ActivePower	inherited from: GeneratingUnit
ratedNetMaxP	0..1	ActivePower	inherited from: GeneratingUnit
shortPF	0..1	Float	inherited from: GeneratingUnit
startupCost	0..1	Money	inherited from: GeneratingUnit
startupTime	0..1	Seconds	inherited from: GeneratingUnit
tieLinePF	0..1	Float	inherited from: GeneratingUnit
totalEfficiency	0..1	PerCent	inherited from: GeneratingUnit
variableCost	0..1	Money	inherited from: GeneratingUnit
aggregate	0..1	Boolean	inherited from: Equipment
inService	0..1	Boolean	inherited from: Equipment
networkAnalysisEnabled	0..1	Boolean	inherited from: Equipment

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name	mult	type	description
normallyInService	0..1	Boolean	inherited from: Equipment
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 460 shows all association ends of SolarGeneratingUnit with other classes.

Table 460 – Association ends of Production::SolarGeneratingUnit with other classes

mult from	name	mult to	type	description
0..1	RotatingMachine	0..*	RotatingMachine	inherited from: GeneratingUnit
1..1	GenUnitOpCostCurves	0..*	GenUnitOpCostCurve	inherited from: GeneratingUnit
1..1	GenUnitOpSchedule	0..1	GenUnitOpSchedule	inherited from: GeneratingUnit
1..1	ControlAreaGeneratingUnit	0..*	ControlAreaGeneratingUnit	inherited from: GeneratingUnit
1..1	GrossToNetActivePowerCurves	0..*	GrossToNetActivePowerCurve	inherited from: GeneratingUnit
0..1	OperationalLimitSet	0..*	OperationalLimitSet	inherited from: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	inherited from: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment
0..1	Faults	0..*	Fault	inherited from: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	inherited from: Equipment
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.6.3.42 StartIgnFuelCurve

The quantity of ignition fuel (Y-axis) used to restart and repay the auxiliary power consumed versus the number of hours (X-axis) the unit was off line.

Table 461 shows all attributes of StartIgnFuelCurve.

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Table 461 – Attributes of Production::StartIgnFuelCurve

name	mult	type	description
ignitionFuelType	0..1	FuelType	Type of ignition fuel.
curveStyle	0..1	CurveStyle	inherited from: Curve
xMultiplier	0..1	UnitMultiplier	inherited from: Curve
xUnit	0..1	UnitSymbol	inherited from: Curve
y1Multiplier	0..1	UnitMultiplier	inherited from: Curve
y1Unit	0..1	UnitSymbol	inherited from: Curve
y2Multiplier	0..1	UnitMultiplier	inherited from: Curve
y2Unit	0..1	UnitSymbol	inherited from: Curve
y3Multiplier	0..1	UnitMultiplier	inherited from: Curve
y3Unit	0..1	UnitSymbol	inherited from: Curve
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 462 shows all association ends of StartIgnFuelCurve with other classes.

Table 462 – Association ends of Production::StartIgnFuelCurve with other classes

mult from	name	mult to	type	description
0..1	StartupModel	1..1	StartupModel	The unit's startup model may have a startup ignition fuel curve.
1..1	CurveDatas	0..*	CurveData	inherited from: Curve
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.6.3.43 StartMainFuelCurve

The quantity of main fuel (Y-axis) used to restart and repay the auxiliary power consumed versus the number of hours (X-axis) the unit was off line.

Table 463 shows all attributes of StartMainFuelCurve.

Table 463 – Attributes of Production::StartMainFuelCurve

name	mult	type	description
mainFuelType	0..1	FuelType	Type of main fuel.
curveStyle	0..1	CurveStyle	inherited from: Curve
xMultiplier	0..1	UnitMultiplier	inherited from: Curve
xUnit	0..1	UnitSymbol	inherited from: Curve
y1Multiplier	0..1	UnitMultiplier	inherited from: Curve
y1Unit	0..1	UnitSymbol	inherited from: Curve
y2Multiplier	0..1	UnitMultiplier	inherited from: Curve
y2Unit	0..1	UnitSymbol	inherited from: Curve

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name	mult	type	description
y3Multiplier	0..1	UnitMultiplier	inherited from: Curve
y3Unit	0..1	UnitSymbol	inherited from: Curve
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 464 shows all association ends of StartMainFuelCurve with other classes.

Table 464 – Association ends of Production::StartMainFuelCurve with other classes

mult from	name	mult to	type	description
0..1	StartupModel	1..1	StartupModel	The unit's startup model may have a startup main fuel curve.
1..1	CurveDatas	0..*	CurveData	inherited from: Curve
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.6.3.44 StartRampCurve

Rate in gross active power per minute (Y-axis) at which a unit can be loaded versus the number of hours (X-axis) the unit was off line.

Table 465 shows all attributes of StartRampCurve.

Table 465 – Attributes of Production::StartRampCurve

name	mult	type	description
hotStandbyRamp	0..1	ActivePowerChangeRate	The startup ramp rate in gross for a unit that is on hot standby.
curveStyle	0..1	CurveStyle	inherited from: Curve
xMultiplier	0..1	UnitMultiplier	inherited from: Curve
xUnit	0..1	UnitSymbol	inherited from: Curve
y1Multiplier	0..1	UnitMultiplier	inherited from: Curve
y1Unit	0..1	UnitSymbol	inherited from: Curve
y2Multiplier	0..1	UnitMultiplier	inherited from: Curve
y2Unit	0..1	UnitSymbol	inherited from: Curve
y3Multiplier	0..1	UnitMultiplier	inherited from: Curve
y3Unit	0..1	UnitSymbol	inherited from: Curve
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 466 shows all association ends of StartRampCurve with other classes.

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Table 466 – Association ends of Production::StartRampCurve with other classes

mult from	name	mult to	type	description
0..1	StartupModel	1..1	StartupModel	The unit's startup model may have a startup ramp curve.
1..1	CurveDatas	0..*	CurveData	inherited from: Curve
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.6.3.45 StartupModel

Unit start up characteristics depending on how long the unit has been off line.

Table 467 shows all attributes of StartupModel.

Table 467 – Attributes of Production::StartupModel

name	mult	type	description
fixedMaintCost	0..1	CostRate	Fixed maintenance cost.
hotStandbyHeat	0..1	HeatRate	The amount of heat input per time unit required for hot standby operation.
incrementalMaintCost	0..1	CostPerEnergyUnit	Incremental maintenance cost.
minimumDownTime	0..1	Hours	The minimum number of hours the unit must be down before restart.
minimumRunTime	0..1	Hours	The minimum number of hours the unit must be operating before being allowed to shut down.
riskFactorCost	0..1	Money	The opportunity cost associated with the return in monetary unit. This represents the restart's "share" of the unit depreciation and risk of an event which would damage the unit.
startupCost	0..1	Money	Total miscellaneous start up costs.
startupDate	0..1	DateTime	The date and time of the most recent generating unit startup.
startupPriority	0..1	Integer	Startup priority within control area where lower numbers indicate higher priorities. More than one unit in an area may be assigned the same priority.
stbyAuxP	0..1	ActivePower	The unit's auxiliary active power consumption to maintain standby mode.
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 468 shows all association ends of StartupModel with other classes.

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Table 468 – Association ends of Production::StartupModel with other classes

mult from	name	mult to	type	description
0..1	ThermalGeneratingUnit	1..1	ThermalGeneratingUnit	A thermal generating unit may have a startup model.
1..1	StartIgnFuelCurve	0..1	StartIgnFuelCurve	The unit's startup model may have a startup ignition fuel curve.
1..1	StartMainFuelCurve	0..1	StartMainFuelCurve	The unit's startup model may have a startup main fuel curve.
1..1	StartRampCurve	0..1	StartRampCurve	The unit's startup model may have a startup ramp curve.
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.6.3.46 SteamSendoutSchedule

The cogeneration plant's steam sendout schedule in volume per time unit.

Table 469 shows all attributes of SteamSendoutSchedule.

Table 469 – Attributes of Production::SteamSendoutSchedule

name	mult	type	description
endTime	0..1	DateTime	inherited from: RegularIntervalSchedule
timeStep	0..1	Seconds	inherited from: RegularIntervalSchedule
startTime	0..1	DateTime	inherited from: BasicIntervalSchedule
value1Multiplier	0..1	UnitMultiplier	inherited from: BasicIntervalSchedule
value1Unit	0..1	UnitSymbol	inherited from: BasicIntervalSchedule
value2Multiplier	0..1	UnitMultiplier	inherited from: BasicIntervalSchedule
value2Unit	0..1	UnitSymbol	inherited from: BasicIntervalSchedule
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 470 shows all association ends of SteamSendoutSchedule with other classes.

Table 470 – Association ends of Production::SteamSendoutSchedule with other classes

mult from	name	mult to	type	description
1..1	CogenerationPlant	1..1	CogenerationPlant	A cogeneration plant has a steam sendout schedule.
1..1	TimePoints	1..*	RegularTimePoint	inherited from: RegularIntervalSchedule
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

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6.6.3.47 TailbayLossCurve

Relationship between tailbay head loss height (Y-axis) and the total discharge into the power station's tailbay volume per time unit (X-axis). There could be more than one curve depending on the level of the tailbay reservoir or river level.

Table 471 shows all attributes of TailbayLossCurve.

Table 471 – Attributes of Production::TailbayLossCurve

name	mult	type	description
curveStyle	0..1	CurveStyle	inherited from: Curve
xMultiplier	0..1	UnitMultiplier	inherited from: Curve
xUnit	0..1	UnitSymbol	inherited from: Curve
y1Multiplier	0..1	UnitMultiplier	inherited from: Curve
y1Unit	0..1	UnitSymbol	inherited from: Curve
y2Multiplier	0..1	UnitMultiplier	inherited from: Curve
y2Unit	0..1	UnitSymbol	inherited from: Curve
y3Multiplier	0..1	UnitMultiplier	inherited from: Curve
y3Unit	0..1	UnitSymbol	inherited from: Curve
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 472 shows all association ends of TailbayLossCurve with other classes.

Table 472 – Association ends of Production::TailbayLossCurve with other classes

mult from	name	mult to	type	description
0..*	HydroGeneratingUnit	1..1	HydroGeneratingUnit	A hydro generating unit has a tailbay loss curve.
1..1	CurveDatas	0..*	CurveData	inherited from: Curve
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.6.3.48 TargetLevelSchedule

Reservoir water level targets from advanced studies or "rule curves". Typically in one hour increments for up to 10 days.

Table 473 shows all attributes of TargetLevelSchedule.

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Table 473 – Attributes of Production::TargetLevelSchedule

name	mult	type	description
highLevelLimit	0..1	WaterLevel	High target level limit, above which the reservoir operation will be penalized.
lowLevelLimit	0..1	WaterLevel	Low target level limit, below which the reservoir operation will be penalized.
curveStyle	0..1	CurveStyle	inherited from: Curve
xMultiplier	0..1	UnitMultiplier	inherited from: Curve
xUnit	0..1	UnitSymbol	inherited from: Curve
y1Multiplier	0..1	UnitMultiplier	inherited from: Curve
y1Unit	0..1	UnitSymbol	inherited from: Curve
y2Multiplier	0..1	UnitMultiplier	inherited from: Curve
y2Unit	0..1	UnitSymbol	inherited from: Curve
y3Multiplier	0..1	UnitMultiplier	inherited from: Curve
y3Unit	0..1	UnitSymbol	inherited from: Curve
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 474 shows all association ends of TargetLevelSchedule with other classes.

Table 474 – Association ends of Production::TargetLevelSchedule with other classes

mult from	name	mult to	type	description
0..1	Reservoir	1..1	Reservoir	A reservoir may have a water level target schedule.
1..1	CurveDatas	0..*	CurveData	inherited from: Curve
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.6.3.49 ThermalGeneratingUnit

A generating unit whose prime mover could be a steam turbine, combustion turbine, or diesel engine.

Table 475 shows all attributes of ThermalGeneratingUnit.

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Table 475 – Attributes of Production::ThermalGeneratingUnit

name	mult	type	description
oMCost	0..1	CostPerHeatUnit	Operating and maintenance cost for the thermal unit.
allocSpinResP	0..1	ActivePower	inherited from: GeneratingUnit
autoCntrlMarginP	0..1	ActivePower	inherited from: GeneratingUnit
baseP	0..1	ActivePower	inherited from: GeneratingUnit
controlDeadband	0..1	ActivePower	inherited from: GeneratingUnit
controlPulseHigh	0..1	Seconds	inherited from: GeneratingUnit
controlPulseLow	0..1	Seconds	inherited from: GeneratingUnit
controlResponseRate	0..1	ActivePowerChangeRate	inherited from: GeneratingUnit
efficiency	0..1	PerCent	inherited from: GeneratingUnit
genControlMode	0..1	GeneratorControlMode	inherited from: GeneratingUnit
genControlSource	0..1	GeneratorControlSource	inherited from: GeneratingUnit
governorMPL	0..1	PU	inherited from: GeneratingUnit
governorSCD	0..1	PerCent	inherited from: GeneratingUnit
highControlLimit	0..1	ActivePower	inherited from: GeneratingUnit
initialP	0..1	ActivePower	inherited from: GeneratingUnit
longPF	0..1	Float	inherited from: GeneratingUnit
lowControlLimit	0..1	ActivePower	inherited from: GeneratingUnit
lowerRampRate	0..1	ActivePowerChangeRate	inherited from: GeneratingUnit
maxEconomicP	0..1	ActivePower	inherited from: GeneratingUnit
maximumAllowableSpinningReserve	0..1	ActivePower	inherited from: GeneratingUnit
maxOperatingP	0..1	ActivePower	inherited from: GeneratingUnit
minEconomicP	0..1	ActivePower	inherited from: GeneratingUnit
minimumOffTime	0..1	Seconds	inherited from: GeneratingUnit
minOperatingP	0..1	ActivePower	inherited from: GeneratingUnit
modelDetail	0..1	Classification	inherited from: GeneratingUnit
nominalP	0..1	ActivePower	inherited from: GeneratingUnit
normalPF	0..1	Float	inherited from: GeneratingUnit
penaltyFactor	0..1	Float	inherited from: GeneratingUnit
raiseRampRate	0..1	ActivePowerChangeRate	inherited from: GeneratingUnit
ratedGrossMaxP	0..1	ActivePower	inherited from: GeneratingUnit
ratedGrossMinP	0..1	ActivePower	inherited from: GeneratingUnit
ratedNetMaxP	0..1	ActivePower	inherited from: GeneratingUnit
shortPF	0..1	Float	inherited from: GeneratingUnit
startupCost	0..1	Money	inherited from: GeneratingUnit
startupTime	0..1	Seconds	inherited from: GeneratingUnit
tieLinePF	0..1	Float	inherited from: GeneratingUnit
totalEfficiency	0..1	PerCent	inherited from: GeneratingUnit
variableCost	0..1	Money	inherited from: GeneratingUnit
aggregate	0..1	Boolean	inherited from: Equipment
inService	0..1	Boolean	inherited from: Equipment

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name	mult	type	description
networkAnalysisEnabled	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 476 shows all association ends of ThermalGeneratingUnit with other classes.

Table 476 – Association ends of Production::ThermalGeneratingUnit with other classes

mult from	name	mult to	type	description
0..1	CAESPlant	0..1	CAESPlant	A thermal generating unit may be a member of a compressed air energy storage plant.
0..*	CogenerationPlant	0..1	CogenerationPlant	A thermal generating unit may be a member of a cogeneration plant.
0..*	CombinedCyclePlant	0..1	CombinedCyclePlant	A thermal generating unit may be a member of a combined cycle plant.
1..1	EmmissionAccounts	0..*	EmissionAccount	A thermal generating unit may have one or more emission allowance accounts.
1..1	EmissionCurves	0..*	EmissionCurve	A thermal generating unit may have one or more emission curves.
1..1	FossilFuels	0..*	FossilFuel	A thermal generating unit may have one or more fossil fuels.
1..1	FuelAllocationSchedules	0..*	FuelAllocationSchedule	A thermal generating unit may have one or more fuel allocation schedules.
1..1	HeatInputCurve	0..1	HeatInputCurve	A thermal generating unit may have a heat input curve.
1..1	HeatRateCurve	0..1	HeatRateCurve	A thermal generating unit may have a heat rate curve.
1..1	IncrementalHeatRateCurve	0..1	IncrementalHeatRateCurve	A thermal generating unit may have an incremental heat rate curve.
1..1	ShutdownCurve	0..1	ShutdownCurve	A thermal generating unit may have a shutdown curve.
1..1	StartupModel	0..1	StartupModel	A thermal generating unit may have a startup model.
0..1	RotatingMachine	0..*	RotatingMachine	inherited from: GeneratingUnit
1..1	GenUnitOpCostCurves	0..*	GenUnitOpCostCurve	inherited from: GeneratingUnit
1..1	GenUnitOpSchedule	0..1	GenUnitOpSchedule	inherited from: GeneratingUnit
1..1	ControlAreaGeneratingUnit	0..*	ControlAreaGeneratingUnit	inherited from: GeneratingUnit
1..1	GrossToNetActivePowerCurves	0..*	GrossToNetActivePowerCurve	inherited from: GeneratingUnit
0..1	OperationalLimitSet	0..*	OperationalLimitSet	inherited from: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	inherited from: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment
0..1	Faults	0..*	Fault	inherited from: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	inherited from: Equipment

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mult from	name	mult to	type	description
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.6.3.50 WindGeneratingUnit

A wind driven generating unit, connected to the grid by means of a rotating machine. May be used to represent a single turbine or an aggregation.

Table 477 shows all attributes of WindGeneratingUnit.

Table 477 – Attributes of Production::WindGeneratingUnit

name	mult	type	description
windGenUnitType	0..1	WindGenUnitKind	The kind of wind generating unit.
allocSpinResP	0..1	ActivePower	inherited from: GeneratingUnit
autoCntrlMarginP	0..1	ActivePower	inherited from: GeneratingUnit
baseP	0..1	ActivePower	inherited from: GeneratingUnit
controlDeadband	0..1	ActivePower	inherited from: GeneratingUnit
controlPulseHigh	0..1	Seconds	inherited from: GeneratingUnit
controlPulseLow	0..1	Seconds	inherited from: GeneratingUnit
controlResponseRate	0..1	ActivePowerChangeRate	inherited from: GeneratingUnit
efficiency	0..1	PerCent	inherited from: GeneratingUnit
genControlMode	0..1	GeneratorControlMode	inherited from: GeneratingUnit
genControlSource	0..1	GeneratorControlSource	inherited from: GeneratingUnit
governorMPL	0..1	PU	inherited from: GeneratingUnit
governorSCD	0..1	PerCent	inherited from: GeneratingUnit
highControlLimit	0..1	ActivePower	inherited from: GeneratingUnit
initialP	0..1	ActivePower	inherited from: GeneratingUnit
longPF	0..1	Float	inherited from: GeneratingUnit
lowControlLimit	0..1	ActivePower	inherited from: GeneratingUnit
lowerRampRate	0..1	ActivePowerChangeRate	inherited from: GeneratingUnit
maxEconomicP	0..1	ActivePower	inherited from: GeneratingUnit
maximumAllowableSpinningReserve	0..1	ActivePower	inherited from: GeneratingUnit
maxOperatingP	0..1	ActivePower	inherited from: GeneratingUnit
minEconomicP	0..1	ActivePower	inherited from: GeneratingUnit
minimumOffTime	0..1	Seconds	inherited from: GeneratingUnit
minOperatingP	0..1	ActivePower	inherited from: GeneratingUnit
modelDetail	0..1	Classification	inherited from: GeneratingUnit
nominalP	0..1	ActivePower	inherited from: GeneratingUnit

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name	mult	type	description
normalPF	0..1	Float	inherited from: GeneratingUnit
penaltyFactor	0..1	Float	inherited from: GeneratingUnit
raiseRampRate	0..1	ActivePowerChangeRate	inherited from: GeneratingUnit
ratedGrossMaxP	0..1	ActivePower	inherited from: GeneratingUnit
ratedGrossMinP	0..1	ActivePower	inherited from: GeneratingUnit
ratedNetMaxP	0..1	ActivePower	inherited from: GeneratingUnit
shortPF	0..1	Float	inherited from: GeneratingUnit
startupCost	0..1	Money	inherited from: GeneratingUnit
startupTime	0..1	Seconds	inherited from: GeneratingUnit
tieLinePF	0..1	Float	inherited from: GeneratingUnit
totalEfficiency	0..1	PerCent	inherited from: GeneratingUnit
variableCost	0..1	Money	inherited from: GeneratingUnit
aggregate	0..1	Boolean	inherited from: Equipment
inService	0..1	Boolean	inherited from: Equipment
networkAnalysisEnabled	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 478 shows all association ends of WindGeneratingUnit with other classes.

Table 478 – Association ends of Production::WindGeneratingUnit with other classes

mult from	name	mult to	type	description
0..1	RotatingMachine	0..*	RotatingMachine	inherited from: GeneratingUnit
1..1	GenUnitOpCostCurves	0..*	GenUnitOpCostCurve	inherited from: GeneratingUnit
1..1	GenUnitOpSchedule	0..1	GenUnitOpSchedule	inherited from: GeneratingUnit
1..1	ControlAreaGeneratingUnit	0..*	ControlAreaGeneratingUnit	inherited from: GeneratingUnit
1..1	GrossToNetActivePowerCurves	0..*	GrossToNetActivePowerCurve	inherited from: GeneratingUnit
0..1	OperationalLimitSet	0..*	OperationalLimitSet	inherited from: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	inherited from: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment
0..1	Faults	0..*	Fault	inherited from: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	inherited from: Equipment
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject

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mult from	name	mult to	type	description
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.7 Package DC

6.7.1 General

This package contains model for direct current equipment and controls.

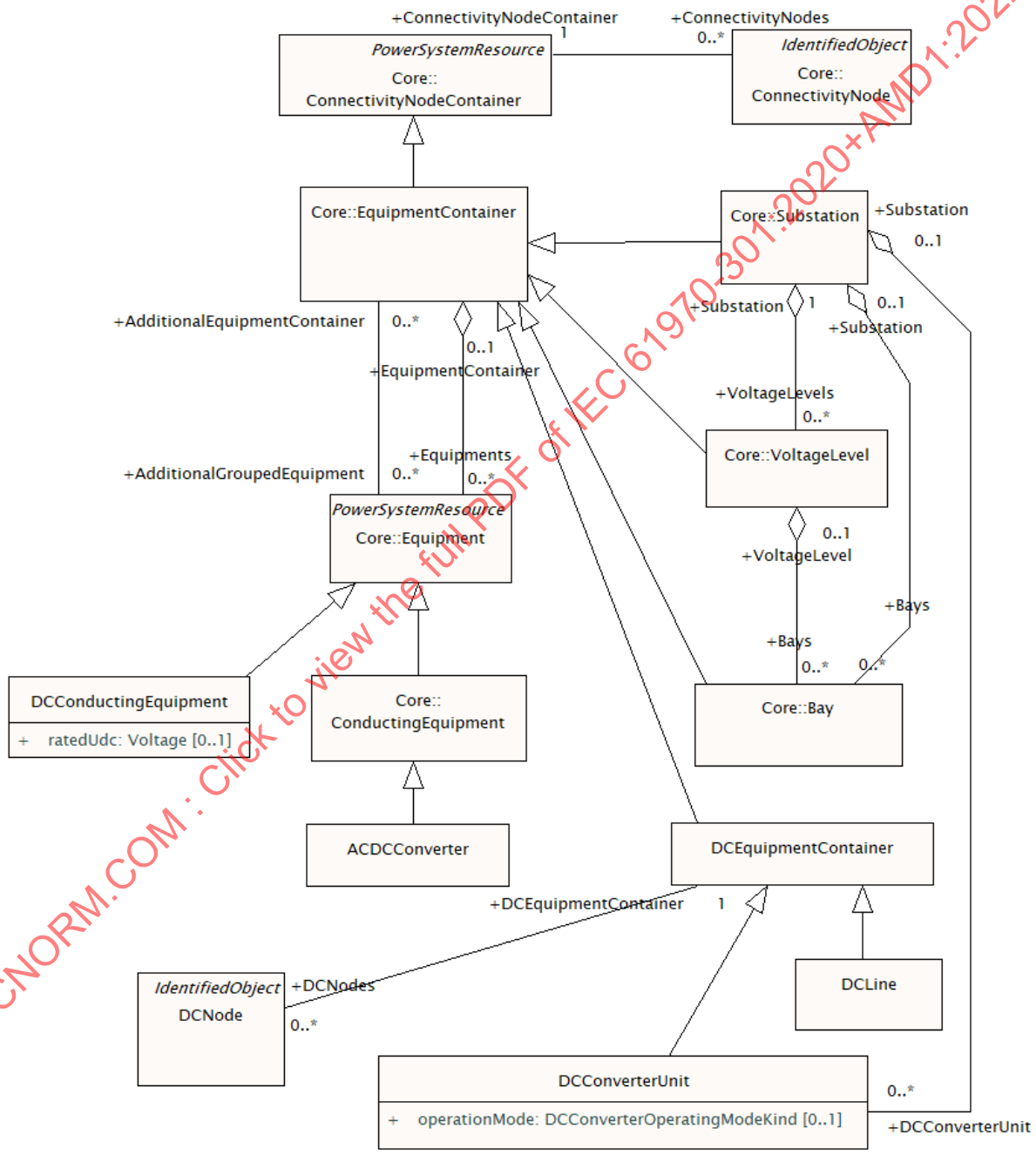


Figure 112 – Class diagram DC::DCContainment

Figure 112: The diagram show the DC containment model.

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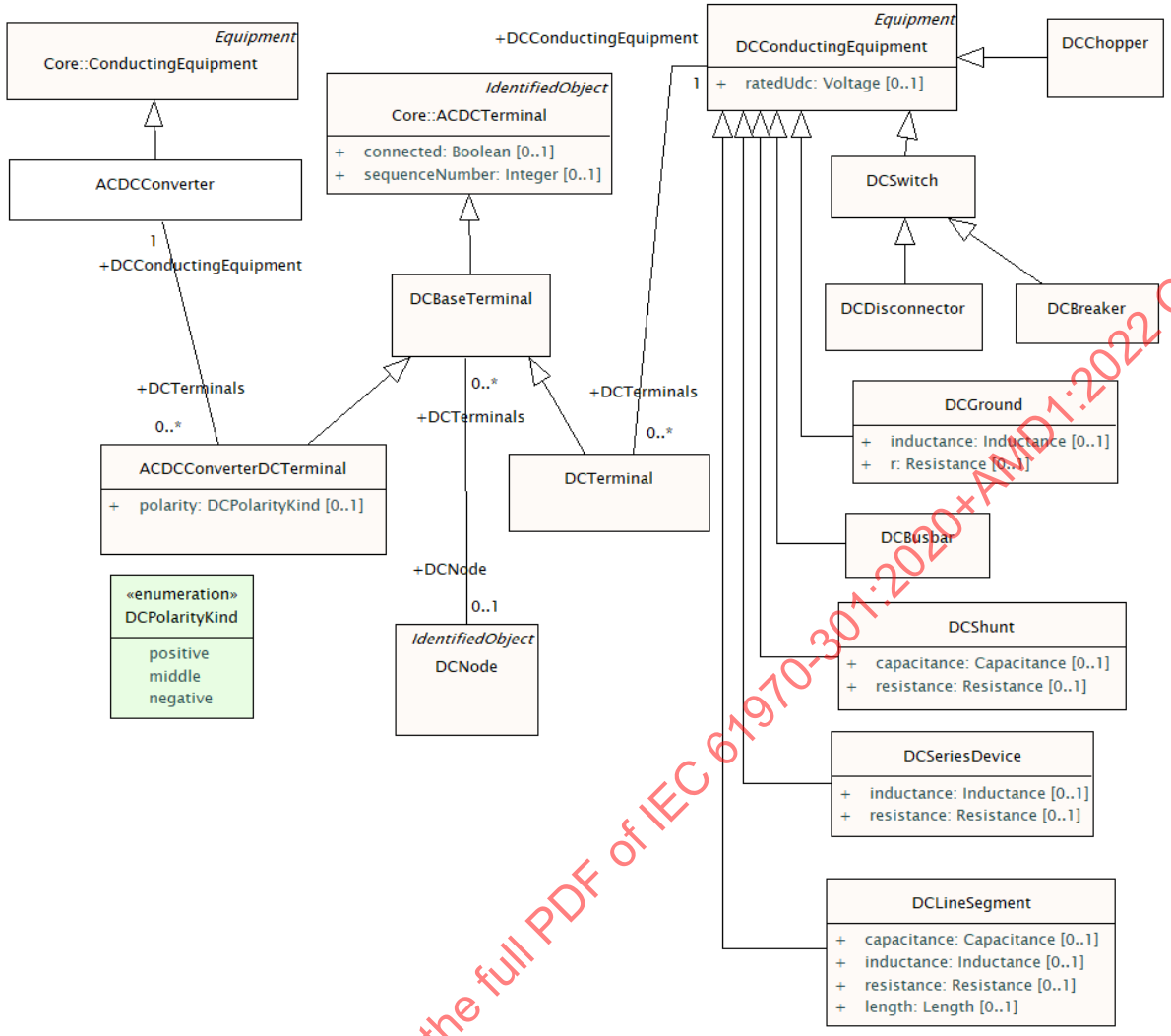


Figure 113 – Class diagram DC::DCEquipment

Figure 113: The diagram show the DC equipment model.

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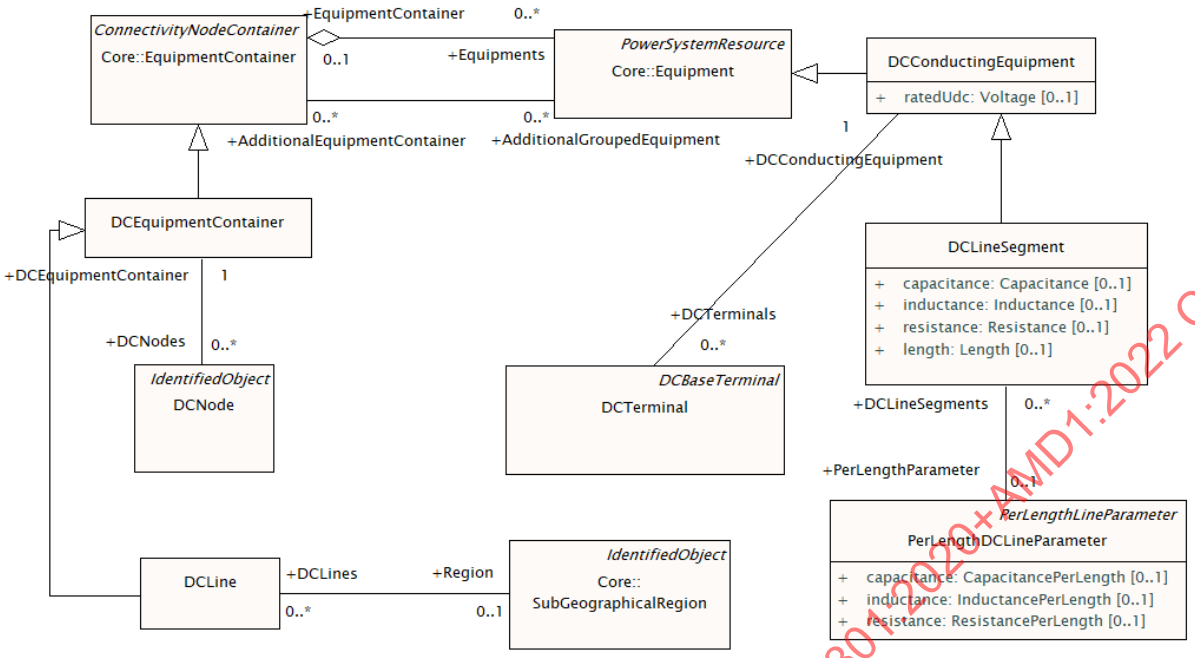
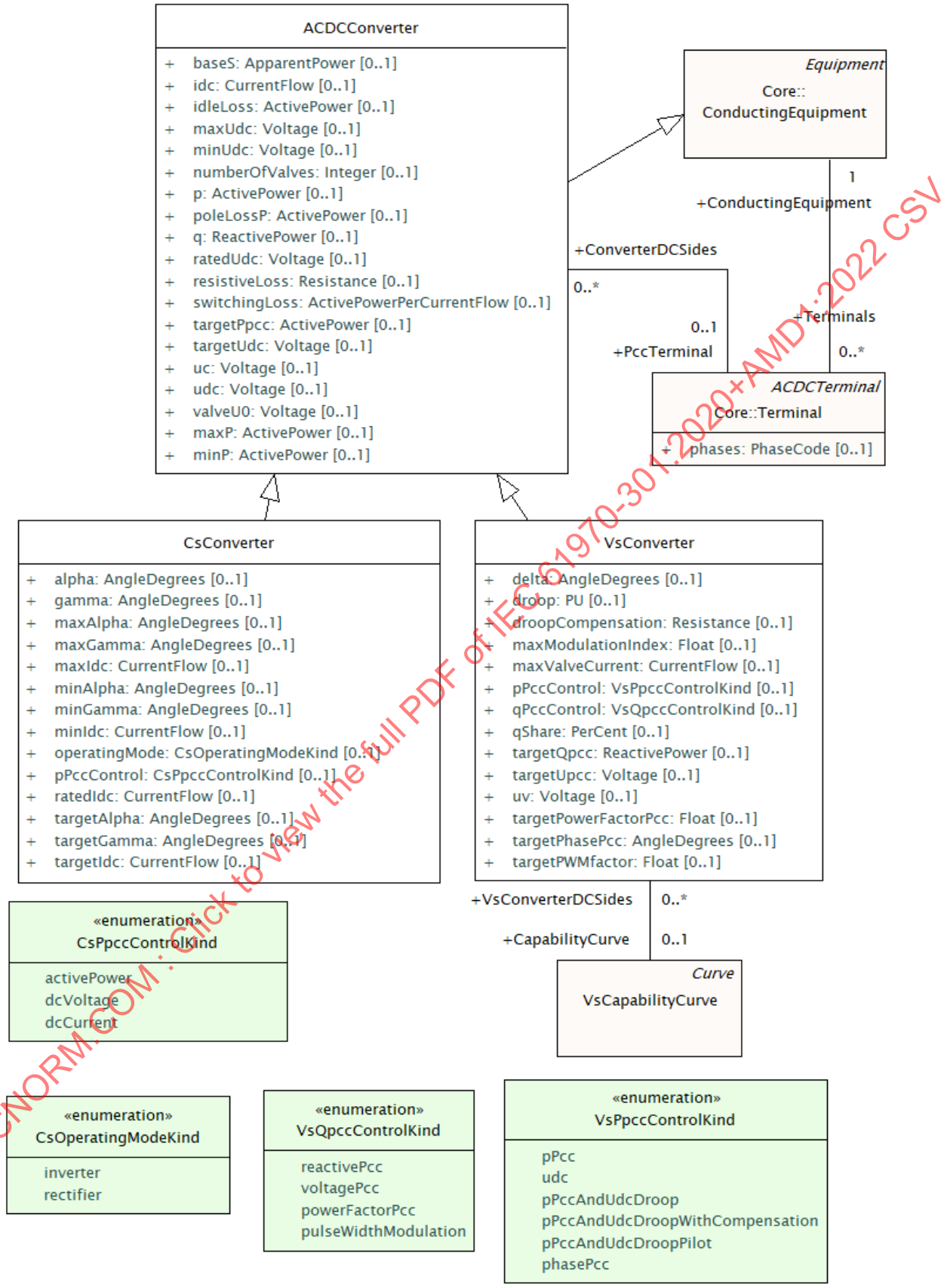


Figure 114 – Class diagram DC::DCLineModel

Figure 114: The diagram show the DC line model.

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Figure 115 – Class diagram DC::ACDCConverter

Figure 115: This diagram shows classes used to model DC converters.

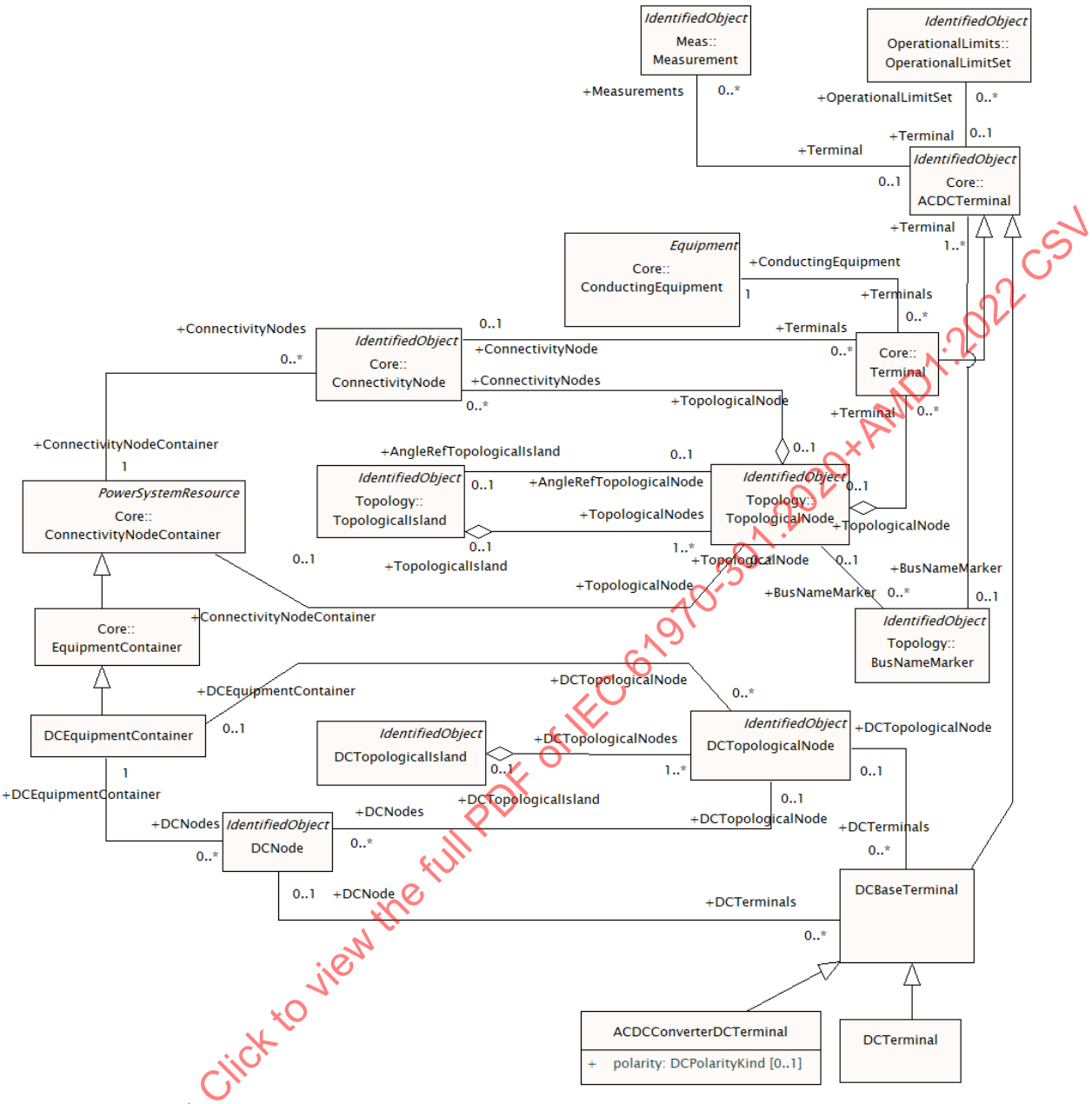


Figure 116 – Class diagram DC::ACDCConnectivityModel

Figure 116: This diagram shows connectivity and topology model for both AC and DC networks.

6.7.2 ACDCConverter

A unit with valves for three phases, together with unit control equipment, essential protective and switching devices, DC storage capacitors, phase reactors and auxiliaries, if any, used for conversion.

Table 479 shows all attributes of ACDCConverter.

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Table 479 – Attributes of DC::ACDCConverter

name	mult	type	description
baseS	0..1	ApparentPower	Base apparent power of the converter pole. The attribute shall be a positive value.
idc	0..1	CurrentFlow	Converter DC current, also called Id. It is converter's state variable, result from power flow.
idleLoss	0..1	ActivePower	Active power loss in pole at no power transfer. It is converter's configuration data used in power flow. The attribute shall be a positive value.
maxUdc	0..1	Voltage	The maximum voltage on the DC side at which the converter should operate. It is converter's configuration data used in power flow. The attribute shall be a positive value.
minUdc	0..1	Voltage	The minimum voltage on the DC side at which the converter should operate. It is converter's configuration data used in power flow. The attribute shall be a positive value.
numberOfValves	0..1	Integer	Number of valves in the converter. Used in loss calculations.
p	0..1	ActivePower	Active power at the point of common coupling. Load sign convention is used, i.e. positive sign means flow out from a node. Starting value for a steady state solution in the case a simplified power flow model is used.
poleLossP	0..1	ActivePower	The active power loss at a DC Pole = idleLoss + switchingLoss*|Idc| + resitiveLoss*Idc^2. For lossless operation Pdc=Pac. For rectifier operation with losses Pdc=Pac-lossP. For inverter operation with losses Pdc=Pac+lossP. It is converter's state variable used in power flow. The attribute shall be a positive value.
q	0..1	ReactivePower	Reactive power at the point of common coupling. Load sign convention is used, i.e. positive sign means flow out from a node. Starting value for a steady state solution in the case a simplified power flow model is used.
ratedUdc	0..1	Voltage	Rated converter DC voltage, also called UdN. The attribute shall be a positive value. It is converter's configuration data used in power flow. For instance a bipolar HVDC link with value 200 kV has a 400kV difference between the DC lines.
resistiveLoss	0..1	Resistance	It is converter's configuration data used in power flow. Refer to poleLossP. The attribute shall be a positive value.
switchingLoss	0..1	ActivePowerPerCurrentFlow	Switching losses, relative to the base apparent power 'baseS'. Refer to poleLossP. The attribute shall be a positive value.
targetPpcc	0..1	ActivePower	Real power injection target in AC grid, at point of common coupling. Load sign convention is used, i.e. positive sign means flow out from a node.
targetUdc	0..1	Voltage	Target value for DC voltage magnitude. The attribute shall be a positive value.

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name	mult	type	description
uc	0..1	Voltage	Line-to-line converter voltage, the voltage at the AC side of the valve. It is converter's state variable, result from power flow. The attribute shall be a positive value.
udc	0..1	Voltage	Converter voltage at the DC side, also called Ud. It is converter's state variable, result from power flow. The attribute shall be a positive value.
valveU0	0..1	Voltage	Valve threshold voltage, also called Uvalve. Forward voltage drop when the valve is conducting. Used in loss calculations, i.e. the switchLoss depend on numberOfValves * valveU0.
maxP	0..1	ActivePower	Maximum active power limit. The value is overwritten by values of VsCapabilityCurve, if present.
minP	0..1	ActivePower	Minimum active power limit. The value is overwritten by values of VsCapabilityCurve, if present.
aggregate	0..1	Boolean	inherited from: Equipment
inService	0..1	Boolean	inherited from: Equipment
networkAnalysisEnabled	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 480 shows all association ends of ACDCConverter with other classes.

Table 480 – Association ends of DC::ACDCConverter with other classes

mult from	name	mult to	type	description
0..*	PccTerminal	0..1	Terminal	Point of common coupling terminal for this converter DC side. It is typically the terminal on the power transformer (or switch) closest to the AC network.
1..1	DCTerminals	0..*	ACDCConverterDCTerminal	A DC converter have DC converter terminals. A converter has two DC converter terminals.
0..*	BaseVoltage	0..1	BaseVoltage	inherited from: ConductingEquipment
1..1	SvStatus	0..*	SvStatus	inherited from: ConductingEquipment
0..*	ProtectionEquipments	0..*	ProtectionEquipment	inherited from: ConductingEquipment
1..1	Terminals	0..*	Terminal	inherited from: ConductingEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	inherited from: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	inherited from: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment
0..1	Faults	0..*	Fault	inherited from: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	inherited from: Equipment
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource

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mult from	name	mult to	type	description
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.7.3 ACDCConverterDCTerminal

A DC electrical connection point at the AC/DC converter. The AC/DC converter is electrically connected also to the AC side. The AC connection is inherited from the AC conducting equipment in the same way as any other AC equipment. The AC/DC converter DC terminal is separate from generic DC terminal to restrict the connection with the AC side to AC/DC converter and so that no other DC conducting equipment can be connected to the AC side.

Table 481 shows all attributes of ACDCConverterDCTerminal.

Table 481 – Attributes of DC::ACDCConverterDCTerminal

name	mult	type	description
polarity	0..1	DCPolarityKind	Represents the normal network polarity condition. Depending on the converter configuration the value shall be set as follows: - For a monopole with two converter terminals use DCPolarityKind “positive” and “negative”. - For a bi-pole or symmetric monopole with three converter terminals use DCPolarityKind “positive”, “middle” and “negative”.
connected	0..1	Boolean	inherited from: ACDCTerminal
sequenceNumber	0..1	Integer	inherited from: ACDCTerminal
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 482 shows all association ends of ACDCConverterDCTerminal with other classes.

Table 482 – Association ends of DC::ACDCConverterDCTerminal with other classes

mult from	name	mult to	type	description
0..*	DCConductingEquipment	1..1	ACDCConverter	A DC converter terminal belong to an DC converter.
0..*	DCTopologicalNode	0..1	DCTopologicalNode	inherited from: DCBaseTerminal
0..*	DCNode	0..1	DCNode	inherited from: DCBaseTerminal
1..*	BusNameMarker	0..1	BusNameMarker	inherited from: ACDCTerminal
0..1	OperationalLimitSet	0..*	OperationalLimitSet	inherited from: ACDCTerminal
0..1	Measurements	0..*	Measurement	inherited from: ACDCTerminal
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

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6.7.4 CsConverter

DC side of the current source converter (CSC).

The firing angle controls the DC voltage at the converter, both for rectifier and inverter. The difference between the DC voltages of the rectifier and inverter determines the DC current. The extinction angle is used to limit the DC voltage at the inverter, if needed, and is not used in active power control. The firing angle, transformer tap position and number of connected filters are the primary means to control a current source DC line. Higher level controls are built on top, e.g. DC voltage, DC current and active power. From a steady state perspective it is sufficient to specify the wanted active power transfer (ACDCConverter.targetPpcc) and the control functions will set the DC voltage, DC current, firing angle, transformer tap position and number of connected filters to meet this. Therefore, attributes targetAlpha and targetGamma are not applicable in this case.

The reactive power consumed by the converter is a function of the firing angle, transformer tap position and number of connected filters, which can be approximated with half of the active power. The losses are a function of the DC voltage and DC current.

The attributes minAlpha and maxAlpha define the range of firing angles for rectifier operation between which no discrete tap changer action takes place. The range is typically 10 to 18 degrees.

The attributes minGamma and maxGamma define the range of extinction angles for inverter operation between which no discrete tap changer action takes place. The range is typically 17 to 20 degrees.

Table 483 shows all attributes of CsConverter.

Table 483 – Attributes of DC::CsConverter

name	mult	type	description
alpha	0..1	AngleDegrees	Firing angle that determines the DC voltage at the converter DC terminal. Typical value between 10 degrees and 18 degrees for a rectifier. It is converter's state variable, result from power flow. The attribute shall be a positive value.
gamma	0..1	AngleDegrees	Extinction angle. It is used to limit the DC voltage at the inverter if needed. Typical value between 17 degrees and 20 degrees for an inverter. It is converter's state variable, result from power flow. The attribute shall be a positive value.
maxAlpha	0..1	AngleDegrees	Maximum firing angle. It is converter's configuration data used in power flow. The attribute shall be a positive value.
maxGamma	0..1	AngleDegrees	Maximum extinction angle. It is converter's configuration data used in power flow. The attribute shall be a positive value.
maxIdc	0..1	CurrentFlow	The maximum direct current (Id) on the DC side at which the converter should operate. It is converter's configuration data use in power flow. The attribute shall be a positive value.
minAlpha	0..1	AngleDegrees	Minimum firing angle. It is converter's configuration data used in power flow. The attribute shall be a positive value.
minGamma	0..1	AngleDegrees	Minimum extinction angle. It is converter's configuration data used in power flow. The attribute shall be a positive value.

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name	mult	type	description
minIdc	0..1	CurrentFlow	The minimum direct current (Id) on the DC side at which the converter should operate. It is converter's configuration data used in power flow. The attribute shall be a positive value.
operatingMode	0..1	CsOperatingModeKind	Indicates whether the DC pole is operating as an inverter or as a rectifier. It is converter's control variable used in power flow.
pPccControl	0..1	CsPpccControlKind	Kind of active power control.
ratedIdc	0..1	CurrentFlow	Rated converter DC current, also called IdN. The attribute shall be a positive value. It is converter's configuration data used in power flow.
targetAlpha	0..1	AngleDegrees	Target firing angle. It is converter's control variable used in power flow. It is only applicable for rectifier if continuous tap changer control is used. Allowed values are within the range minAlpha<=targetAlpha<=maxAlpha. The attribute shall be a positive value.
targetGamma	0..1	AngleDegrees	Target extinction angle. It is converter's control variable used in power flow. It is only applicable for inverter if continuous tap changer control is used. Allowed values are within the range minGamma<=targetGamma<=maxGamma. The attribute shall be a positive value.
targetIdc	0..1	CurrentFlow	DC current target value. It is converter's control variable used in power flow. The attribute shall be a positive value.
baseS	0..1	ApparentPower	inherited from: ACDCConverter
idc	0..1	CurrentFlow	inherited from: ACDCConverter
idleLoss	0..1	ActivePower	inherited from: ACDCConverter
maxUdc	0..1	Voltage	inherited from: ACDCConverter
minUdc	0..1	Voltage	inherited from: ACDCConverter
numberOfValves	0..1	Integer	inherited from: ACDCConverter
p	0..1	ActivePower	inherited from: ACDCConverter
poleLossP	0..1	ActivePower	inherited from: ACDCConverter
q	0..1	ReactivePower	inherited from: ACDCConverter
ratedUdc	0..1	Voltage	inherited from: ACDCConverter
resistiveLoss	0..1	Resistance	inherited from: ACDCConverter
switchingLoss	0..1	ActivePowerPerCurrentFlow	inherited from: ACDCConverter
targetPpcc	0..1	ActivePower	inherited from: ACDCConverter
targetUdc	0..1	Voltage	inherited from: ACDCConverter
uc	0..1	Voltage	inherited from: ACDCConverter
udc	0..1	Voltage	inherited from: ACDCConverter
valveU0	0..1	Voltage	inherited from: ACDCConverter
maxP	0..1	ActivePower	inherited from: ACDCConverter
minP	0..1	ActivePower	inherited from: ACDCConverter
aggregate	0..1	Boolean	inherited from: Equipment
inService	0..1	Boolean	inherited from: Equipment
networkAnalysisEnabled	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject

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name	mult	type	description
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 484 shows all association ends of CsConverter with other classes.

Table 484 – Association ends of DC::CsConverter with other classes

mult from	name	mult to	type	description
1..1	CSCDynamics	0..1	CSCDynamics	Current source converter dynamics model used to describe dynamic behaviour of this converter.
0..*	PccTerminal	0..1	Terminal	inherited from: ACDCConverter
1..1	DCTerminals	0..*	ACDCConverterDCTerminal	inherited from: ACDCConverter
0..*	BaseVoltage	0..1	BaseVoltage	inherited from: ConductingEquipment
1..1	SvStatus	0..*	SvStatus	inherited from: ConductingEquipment
0..*	ProtectionEquipments	0..*	ProtectionEquipment	inherited from: ConductingEquipment
1..1	Terminals	0..*	Terminal	inherited from: ConductingEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	inherited from: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	inherited from: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment
0..1	Faults	0..*	Fault	inherited from: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	inherited from: Equipment
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.7.5 DCTopologicalNode

DC bus.

Table 485 shows all attributes of DCTopologicalNode.

Table 485 – Attributes of DC::DCTopologicalNode

name	mult	type	description
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 486 shows all association ends of DCTopologicalNode with other classes.

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Table 486 – Association ends of DC::DCTopologicalNode with other classes

mult from	name	mult to	type	description
1..*	DCTopologicalIsland	0..1	DCTopologicalIsland	A DC topological node belongs to a DC topological island.
0..1	DCTerminals	0..*	DCBaseTerminal	See association end TopologicalNode.Terminal.
0..1	DCNodes	0..*	DCNode	The DC connectivity nodes combined together to form this DC topological node. May depend on the current state of switches in the network.
0..*	DCEquipmentContainer	0..1	DCEquipmentContainer	The connectivity node container to which the topological node belongs.
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.7.6 CsOperatingModeKind enumeration

Operating mode for HVDC line operating as Current Source Converter.

Table 487 shows all literals of CsOperatingModeKind.

Table 487 – Literals of DC::CsOperatingModeKind

literal	value	description
inverter		Operating as inverter, which is the power receiving end.
rectifier		Operating as rectifier, which is the power sending end.

6.7.7 CsPpccControlKind enumeration

Active power control modes for HVDC line operating as Current Source Converter.

Table 488 shows all literals of CsPpccControlKind.

Table 488 – Literals of DC::CsPpccControlKind

literal	value	description
activePower		Control is active power control at AC side, at point of common coupling. Target is provided by ACDCConverter.targetPpcc.
dcVoltage		Control is DC voltage with target value provided by ACDCConverter.targetUdc.
dcCurrent		Control is DC current with target value provided by CsConverter.targetIdc.

6.7.8 DCBaseTerminal

An electrical connection point at a piece of DC conducting equipment. DC terminals are connected at one physical DC node that may have multiple DC terminals connected. A DC node is similar to an AC connectivity node. The model requires that DC connections are distinct from AC connections.

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Table 489 shows all attributes of DCBaseTerminal.

Table 489 – Attributes of DC::DCBaseTerminal

name	mult	type	description
connected	0..1	Boolean	inherited from: ACDCTerminal
sequenceNumber	0..1	Integer	inherited from: ACDCTerminal
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 490 shows all association ends of DCBaseTerminal with other classes.

Table 490 – Association ends of DC::DCBaseTerminal with other classes

mult from	name	mult to	type	description
0..*	DCTopologicalNode	0..1	DCTopologicalNode	See association end Terminal.TopologicalNode.
0..*	DCNode	0..1	DCNode	The DC connectivity node to which this DC base terminal connects with zero impedance.
1..*	BusNameMarker	0..1	BusNameMarker	inherited from: ACDCTerminal
0..1	OperationalLimitSet	0..*	OperationalLimitSet	inherited from: ACDCTerminal
0..1	Measurements	0..*	Measurement	inherited from: ACDCTerminal
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.7.9 DCBreaker

A breaker within a DC system.

Table 491 shows all attributes of DCBreaker.

Table 491 – Attributes of DC::DCBreaker

name	mult	type	description
ratedUdc	0..1	Voltage	inherited from: DCConductingEquipment
aggregate	0..1	Boolean	inherited from: Equipment
inService	0..1	Boolean	inherited from: Equipment
networkAnalysisEnabled	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 492 shows all association ends of DCBreaker with other classes.

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Table 492 – Association ends of DC::DCBreaker with other classes

mult from	name	mult to	type	description
1..1	DCTerminals	0..*	DCTerminal	inherited from: DCConductingEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	inherited from: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	inherited from: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment
0..1	Faults	0..*	Fault	inherited from: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	inherited from: Equipment
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.7.10 DCBusbar

A busbar within a DC system.

Table 493 shows all attributes of DCBusbar.

Table 493 – Attributes of DC::DCBusbar

name	mult	type	description
ratedUdc	0..1	Voltage	inherited from: DCConductingEquipment
aggregate	0..1	Boolean	inherited from: Equipment
inService	0..1	Boolean	inherited from: Equipment
networkAnalysisEnabled	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 494 shows all association ends of DCBusbar with other classes.

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Table 494 – Association ends of DC::DCBusbar with other classes

mult from	name	mult to	type	description
1..1	DCTerminals	0..*	DCTerminal	inherited from: DCConductingEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	inherited from: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	inherited from: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment
0..1	Faults	0..*	Fault	inherited from: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	inherited from: Equipment
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.7.11 DCChopper

Low resistance equipment used in the internal DC circuit to balance voltages. It has typically positive and negative pole terminals and a ground.

Table 495 shows all attributes of DCChopper.

Table 495 – Attributes of DC::DCChopper

name	mult	type	description
ratedUdc	0..1	Voltage	inherited from: DCConductingEquipment
aggregate	0..1	Boolean	inherited from: Equipment
inService	0..1	Boolean	inherited from: Equipment
networkAnalysisEnabled	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 496 shows all association ends of DCChopper with other classes.

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Table 496 – Association ends of DC::DCChopper with other classes

mult from	name	mult to	type	description
1..1	DCTerminals	0..*	DCTerminal	inherited from: DCConductingEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	inherited from: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	inherited from: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment
0..1	Faults	0..*	Fault	inherited from: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	inherited from: Equipment
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.7.12 DCConductingEquipment

The parts of the DC power system that are designed to carry current or that are conductively connected through DC terminals.

Table 497 shows all attributes of DCConductingEquipment.

Table 497 – Attributes of DC::DCConductingEquipment

name	mult	type	description
ratedUdc	0..1	Voltage	Rated DC device voltage. The attribute shall be a positive value. It is configuration data used in power flow.
aggregate	0..1	Boolean	inherited from: Equipment
inService	0..1	Boolean	inherited from: Equipment
networkAnalysisEnabled	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 498 shows all association ends of DCConductingEquipment with other classes.

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Table 498 – Association ends of DC::DCConductingEquipment with other classes

mult from	name	mult to	type	description
1..1	DCTerminals	0..*	DCTerminal	A DC conducting equipment has DC terminals.
0..1	OperationalLimitSet	0..*	OperationalLimitSet	inherited from: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	inherited from: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment
0..1	Faults	0..*	Fault	inherited from: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	inherited from: Equipment
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.7.13 DCConverterOperatingModeKind enumeration

The operating mode of an HVDC bipole.

Table 499 shows all literals of DCConverterOperatingModeKind.

Table 499 – Literals of DC::DCConverterOperatingModeKind

literal	value	description
bipolar		Bipolar operation.
monopolarMetallicReturn		Monopolar operation with metallic return.
monopolarGroundReturn		Monopolar operation with ground return.

6.7.14 DCConverterUnit

Indivisible operative unit comprising all equipment between the point of common coupling on the AC side and the point of common coupling – DC side, essentially one or more converters, together with one or more converter transformers, converter control equipment, essential protective and switching devices and auxiliaries, if any, used for conversion.

Table 500 shows all attributes of DCConverterUnit.

Table 500 – Attributes of DC::DCConverterUnit

name	mult	type	description
operationMode	0..1	DCConverterOperatingModeKind	The operating mode of an HVDC bipole (bipolar, monopolar metallic return, etc).
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

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Table 501 shows all association ends of DCConverterUnit with other classes.

Table 501 – Association ends of DC::DCConverterUnit with other classes

mult from	name	mult to	type	description
0..*	Substation	0..1	Substation	The containing substation of the DC converter unit.
0..1	DCTopologicalNode	0..*	DCTopologicalNode	inherited from: DCEquipmentContainer
1..1	DCNodes	0..*	DCNode	inherited from: DCEquipmentContainer
0..1	Equipments	0..*	Equipment	inherited from: EquipmentContainer
0..*	AdditionalGroupedEquipment	0..*	Equipment	inherited from: EquipmentContainer
1..1	ConnectivityNodes	0..*	ConnectivityNode	inherited from: ConnectivityNodeContainer
0..1	TopologicalNode	0..*	TopologicalNode	inherited from: ConnectivityNodeContainer
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.7.15 DCDisconnector

A disconnector within a DC system.

Table 502 shows all attributes of DCDisconnector.

Table 502 – Attributes of DC::DCDisconnector

name	mult	type	description
ratedUdc	0..1	Voltage	inherited from: DCConductingEquipment
aggregate	0..1	Boolean	inherited from: Equipment
inService	0..1	Boolean	inherited from: Equipment
networkAnalysisEnabled	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 503 shows all association ends of DCDisconnector with other classes.

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Table 503 – Association ends of DC::DCDisconnector with other classes

mult from	name	mult to	type	description
1..1	DCTerminals	0..*	DCTerminal	inherited from: DCConductingEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	inherited from: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	inherited from: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment
0..1	Faults	0..*	Fault	inherited from: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	inherited from: Equipment
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.7.16 DCEquipmentContainer

A modelling construct to provide a root class for containment of DC as well as AC equipment. The class differ from the EquipmentContaner for AC in that it may also contain DCNode-s. Hence it can contain both AC and DC equipment.

Table 504 shows all attributes of DCEquipmentContainer.

Table 504 – Attributes of DC::DCEquipmentContainer

name	mult	type	description
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 505 shows all association ends of DCEquipmentContainer with other classes.

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Table 505 – Association ends of DC::DCEquipmentContainer with other classes

mult from	name	mult to	type	description
0..1	DCTopologicalNode	0..*	DCTopologicalNode	The topological nodes which belong to this connectivity node container.
1..1	DCNodes	0..*	DCNode	The DC nodes contained in the DC equipment container.
0..1	Equipments	0..*	Equipment	inherited from: EquipmentContainer
0..*	AdditionalGroupedEquipment	0..*	Equipment	inherited from: EquipmentContainer
1..1	ConnectivityNodes	0..*	ConnectivityNode	inherited from: ConnectivityNodeContainer
0..1	TopologicalNode	0..*	TopologicalNode	inherited from: ConnectivityNodeContainer
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.7.17 DCGround

A ground within a DC system.

Table 506 shows all attributes of DCGround.

Table 506 – Attributes of DC::DCGround

name	mult	type	description
inductance	0..1	Inductance	Inductance to ground.
r	0..1	Resistance	Resistance to ground.
ratedUdc	0..1	Voltage	inherited from: DCConductingEquipment
aggregate	0..1	Boolean	inherited from: Equipment
inService	0..1	Boolean	inherited from: Equipment
networkAnalysisEnabled	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 507 shows all association ends of DCGround with other classes.

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Table 507 – Association ends of DC::DCGround with other classes

mult from	name	mult to	type	description
1..1	DCTerminals	0..*	DCTerminal	inherited from: DCConductingEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	inherited from: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	inherited from: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment
0..1	Faults	0..*	Fault	inherited from: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	inherited from: Equipment
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.7.18 DCLine

Overhead lines and/or cables connecting two or more HVDC substations.

Table 508 shows all attributes of DCLine.

Table 508 – Attributes of DC::DCLine

name	mult	type	description
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 509 shows all association ends of DCLine with other classes.

Table 509 – Association ends of DC::DCLine with other classes

mult from	name	mult to	type	description
0..*	Region	0..1	SubGeographicalRegion	The SubGeographicalRegion containing the DC line.
0..1	DCTopologicalNode	0..*	DCTopologicalNode	inherited from: DCEquipmentContainer
1..1	DCNodes	0..*	DCNode	inherited from: DCEquipmentContainer
0..1	Equipments	0..*	Equipment	inherited from: EquipmentContainer
0..*	AdditionalGroupedEquipment	0..*	Equipment	inherited from: EquipmentContainer
1..1	ConnectivityNodes	0..*	ConnectivityNode	inherited from: ConnectivityNodeContainer
0..1	TopologicalNode	0..*	TopologicalNode	inherited from: ConnectivityNodeContainer

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mult from	name	mult to	type	description
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.7.19 DCLineSegment

A wire or combination of wires not insulated from one another, with consistent electrical characteristics, used to carry direct current between points in the DC region of the power system.

Table 510 shows all attributes of DCLineSegment.

Table 510 – Attributes of DC::DCLineSegment

name	mult	type	description
capacitance	0..1	Capacitance	Capacitance of the DC line segment. Significant for cables only.
inductance	0..1	Inductance	Inductance of the DC line segment. Negligible compared with DCSeriesDevice used for smoothing.
resistance	0..1	Resistance	Resistance of the DC line segment.
length	0..1	Length	Segment length for calculating line section capabilities.
ratedUdc	0..1	Voltage	inherited from: DCConductingEquipment
aggregate	0..1	Boolean	inherited from: Equipment
inService	0..1	Boolean	inherited from: Equipment
networkAnalysisEnabled	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 511 shows all association ends of DCLineSegment with other classes.

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Table 511 – Association ends of DC::DCLineSegment with other classes

mult from	name	mult to	type	description
0..*	PerLengthParameter	0..1	PerLengthDCLineParameter	Set of per-length parameters for this line segment.
1..1	DCTerminals	0..*	DCTerminal	inherited from: DCConductingEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	inherited from: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	inherited from: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment
0..1	Faults	0..*	Fault	inherited from: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	inherited from: Equipment
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.7.20 DCNode

DC nodes are points where terminals of DC conducting equipment are connected together with zero impedance.

Table 512 shows all attributes of DCNode.

Table 512 – Attributes of DC::DCNode

name	mult	type	description
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 513 shows all association ends of DCNode with other classes.

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Table 513 – Association ends of DC::DCNode with other classes

mult from	name	mult to	type	description
0..*	DCTopologicalNode	0..1	DCTopologicalNode	The DC topological node to which this DC connectivity node is assigned. May depend on the current state of switches in the network.
0..1	DCTerminals	0..*	DCBaseTerminal	DC base terminals interconnected with zero impedance at this DC connectivity node.
0..*	DCEquipmentContainer	1..1	DCEquipmentContainer	The DC container for the DC nodes.
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.7.21 DCPolarityKind enumeration

Polarity for DC circuits.

Table 514 shows all literals of DCPolarityKind.

Table 514 – Literals of DC::DCPolarityKind

literal	value	description
positive		Positive pole. The converter terminal is intended to operate at a positive voltage relative the midpoint or negative terminal.
middle		Middle pole. The converter terminal is the midpoint in a bipolar or symmetric monopole configuration. The midpoint can be grounded and/or have a metallic return.
negative		Negative pole. The converter terminal is intended to operate at a negative voltage relative the midpoint or positive terminal.

6.7.22 DCSeriesDevice

A series device within the DC system, typically a reactor used for filtering or smoothing. Needed for transient and short circuit studies.

Table 515 shows all attributes of DCSeriesDevice.

Table 515 – Attributes of DC::DCSeriesDevice

name	mult	type	description
inductance	0..1	Inductance	Inductance of the device.
resistance	0..1	Resistance	Resistance of the DC device.
ratedUdc	0..1	Voltage	inherited from: DCConductingEquipment
aggregate	0..1	Boolean	inherited from: Equipment
inService	0..1	Boolean	inherited from: Equipment
networkAnalysisEnabled	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject

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name	mult	type	description
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 516 shows all association ends of DCSeriesDevice with other classes.

Table 516 – Association ends of DC::DCSeriesDevice with other classes

mult from	name	mult to	type	description
1..1	DCTerminals	0..*	DCTerminal	inherited from: DCConductingEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	inherited from: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	inherited from: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment
0..1	Faults	0..*	Fault	inherited from: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	inherited from: Equipment
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.7.23 DCShunt

A shunt device within the DC system, typically used for filtering. Needed for transient and short circuit studies.

Table 517 shows all attributes of DCShunt.

Table 517 – Attributes of DC::DCShunt

name	mult	type	description
capacitance	0..1	Capacitance	Capacitance of the DC shunt.
resistance	0..1	Resistance	Resistance of the DC device.
ratedUdc	0..1	Voltage	inherited from: DCConductingEquipment
aggregate	0..1	Boolean	inherited from: Equipment
inService	0..1	Boolean	inherited from: Equipment
networkAnalysisEnabled	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

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Table 518 shows all association ends of DCShunt with other classes.

Table 518 – Association ends of DC::DCShunt with other classes

mult from	name	mult to	type	description
1..1	DCTerminals	0..*	DCTerminal	inherited from: DCConductingEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	inherited from: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	inherited from: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment
0..1	Faults	0..*	Fault	inherited from: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	inherited from: Equipment
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.7.24 DCSwitch

A switch within the DC system.

Table 519 shows all attributes of DCSwitch.

Table 519 – Attributes of DC::DCSwitch

name	mult	type	description
ratedUdc	0..1	Voltage	inherited from: DCConductingEquipment
aggregate	0..1	Boolean	inherited from: Equipment
inService	0..1	Boolean	inherited from: Equipment
networkAnalysisEnabled	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 520 shows all association ends of DCSwitch with other classes.

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Table 520 – Association ends of DC::DCSwitch with other classes

mult from	name	mult to	type	description
1..1	DCTerminals	0..*	DCTerminal	inherited from: DCConductingEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	inherited from: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	inherited from: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment
0..1	Faults	0..*	Fault	inherited from: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	inherited from: Equipment
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.7.25 DCTerminal

An electrical connection point to generic DC conducting equipment.

Table 521 shows all attributes of DCTerminal.

Table 521 – Attributes of DC::DCTerminal

name	mult	type	description
connected	0..1	Boolean	inherited from: ACDCTerminal
sequenceNumber	0..1	Integer	inherited from: ACDCTerminal
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 522 shows all association ends of DCTerminal with other classes.

Table 522 – Association ends of DC::DCTerminal with other classes

mult from	name	mult to	type	description
0..*	DCConductingEquipment	1..1	DCConductingEquipment	An DC terminal belong to a DC conducting equipment.
0..*	DCTopologicalNode	0..1	DCTopologicalNode	inherited from: DCBaseTerminal
0..*	DCNode	0..1	DCNode	inherited from: DCBaseTerminal
1..*	BusNameMarker	0..1	BusNameMarker	inherited from: ACDCTerminal
0..1	OperationalLimitSet	0..*	OperationalLimitSet	inherited from: ACDCTerminal
0..1	Measurements	0..*	Measurement	inherited from: ACDCTerminal
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

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6.7.26 DCTopologicalIsland

An electrically connected subset of the network. DC topological islands can change as the current network state changes, e.g. due to:

– disconnect switches or breakers changing state in a SCADA/EMS.
– manual creation, change or deletion of topological nodes in a planning tool.

Only energised TopologicalNode-s shall be part of the topological island.

Table 523 shows all attributes of DCTopologicalIsland.

Table 523 – Attributes of DC::DCTopologicalIsland

name	mult	type	description
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 524 shows all association ends of DCTopologicalIsland with other classes.

Table 524 – Association ends of DC::DCTopologicalIsland with other classes

mult from	name	mult to	type	description
0..1	DCTopologicalNodes	1..*	DCTopologicalNode	The DC topological nodes in a DC topological island.
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.7.27 PerLengthDCLineParameter

Common type for per-length electrical catalogues describing DC line parameters.

Table 525 shows all attributes of PerLengthDCLineParameter.

Table 525 – Attributes of DC::PerLengthDCLineParameter

name	mult	type	description
capacitance	0..1	CapacitancePerLength	Capacitance per unit of length of the DC line segment; significant for cables only.
inductance	0..1	InductancePerLength	Inductance per unit of length of the DC line segment.
resistance	0..1	ResistancePerLength	Resistance per length of the DC line segment.
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 526 shows all association ends of PerLengthDCLineParameter with other classes.

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Table 526 – Association ends of DC::PerLengthDCLineParameter with other classes

mult from	name	mult to	type	description
0..1	DCLineSegments	0..*	DCLineSegment	All line segments described by this set of per-length parameters.
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.7.28 VsCapabilityCurve

The P-Q capability curve for a voltage source converter, with P on X-axis and Qmin and Qmax on Y1-axis and Y2-axis.

Table 527 shows all attributes of VsCapabilityCurve.

Table 527 – Attributes of DC::VsCapabilityCurve

name	mult	type	description
curveStyle	0..1	CurveStyle	inherited from: Curve
xMultiplier	0..1	UnitMultiplier	inherited from: Curve
xUnit	0..1	UnitSymbol	inherited from: Curve
y1Multiplier	0..1	UnitMultiplier	inherited from: Curve
y1Unit	0..1	UnitSymbol	inherited from: Curve
y2Multiplier	0..1	UnitMultiplier	inherited from: Curve
y2Unit	0..1	UnitSymbol	inherited from: Curve
y3Multiplier	0..1	UnitMultiplier	inherited from: Curve
y3Unit	0..1	UnitSymbol	inherited from: Curve
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 528 shows all association ends of VsCapabilityCurve with other classes.

Table 528 – Association ends of DC::VsCapabilityCurve with other classes

mult from	name	mult to	type	description
0..1	VsConverterDCSides	0..*	VsConverter	All converters with this capability curve.
1..1	CurveDatas	0..*	CurveData	inherited from: Curve
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.7.29 VsConverter

DC side of the voltage source converter (VSC).

Table 529 shows all attributes of VsConverter.

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Table 529 – Attributes of DC::VsConverter

name	mult	type	description
delta	0..1	AngleDegrees	Angle between VsConverter.uv and ACDCConverter.uc. It is converter's state variable used in power flow. The attribute shall be a positive value or zero.
droop	0..1	PU	Droop constant. The pu value is obtained as D [kV/MW] x Sb / Ubdc. The attribute shall be a positive value.
droopCompensation	0..1	Resistance	Compensation constant. Used to compensate for voltage drop when controlling voltage at a distant bus. The attribute shall be a positive value.
maxModulationIndex	0..1	Float	The maximum quotient between the AC converter voltage (Uc) and DC voltage (Ud). A factor typically less than 1. It is converter's configuration data used in power flow.
maxValveCurrent	0..1	CurrentFlow	The maximum current through a valve. It is converter's configuration data.
pPccControl	0..1	VsPpccControlKind	Kind of control of real power and/or DC voltage.
qPccControl	0..1	VsQpccControlKind	Kind of reactive power control.
qShare	0..1	PerCent	Reactive power sharing factor among parallel converters on Uac control. The attribute shall be a positive value or zero.
targetQpcc	0..1	ReactivePower	Reactive power injection target in AC grid, at point of common coupling. Load sign convention is used, i.e. positive sign means flow out from a node.
targetUpcc	0..1	Voltage	Voltage target in AC grid, at point of common coupling. The attribute shall be a positive value.
uv	0..1	Voltage	Line-to-line voltage on the valve side of the converter transformer. It is converter's state variable, result from power flow. The attribute shall be a positive value.
targetPowerFactorPcc	0..1	Float	Power factor target at the AC side, at point of common coupling. The attribute shall be a positive value.
targetPhasePcc	0..1	AngleDegrees	Phase target at AC side, at point of common coupling. The attribute shall be a positive value.
targetPWMfactor	0..1	Float	Magnitude of pulse-modulation factor. The attribute shall be a positive value.
baseS	0..1	ApparentPower	inherited from: ACDCConverter
idc	0..1	CurrentFlow	inherited from: ACDCConverter
idleLoss	0..1	ActivePower	inherited from: ACDCConverter
maxUdc	0..1	Voltage	inherited from: ACDCConverter
minUdc	0..1	Voltage	inherited from: ACDCConverter
numberOfValves	0..1	Integer	inherited from: ACDCConverter
p	0..1	ActivePower	inherited from: ACDCConverter
poleLossP	0..1	ActivePower	inherited from: ACDCConverter
q	0..1	ReactivePower	inherited from: ACDCConverter
ratedUdc	0..1	Voltage	inherited from: ACDCConverter
resistiveLoss	0..1	Resistance	inherited from: ACDCConverter
switchingLoss	0..1	ActivePowerPerCurrentFlow	inherited from: ACDCConverter
targetPpcc	0..1	ActivePower	inherited from: ACDCConverter

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name	mult	type	description
targetUdc	0..1	Voltage	inherited from: ACDCConverter
uc	0..1	Voltage	inherited from: ACDCConverter
udc	0..1	Voltage	inherited from: ACDCConverter
valveU0	0..1	Voltage	inherited from: ACDCConverter
maxP	0..1	ActivePower	inherited from: ACDCConverter
minP	0..1	ActivePower	inherited from: ACDCConverter
aggregate	0..1	Boolean	inherited from: Equipment
inService	0..1	Boolean	inherited from: Equipment
networkAnalysisEnabled	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 530 shows all association ends of VsConverter with other classes.

Table 530 – Association ends of DC::VsConverter with other classes

mult from	name	mult to	type	description
0..*	CapabilityCurve	0..1	VsCapabilityCurve	Capability curve of this converter.
1..1	VSCDynamics	0..1	VSCDynamics	Voltage source converter dynamics model used to describe dynamic behaviour of this converter.
0..*	PccTerminal	0..1	Terminal	inherited from: ACDCConverter
1..1	DCTerminals	0..*	ACDCConverterDCTerminal	inherited from: ACDCConverter
0..*	BaseVoltage	0..1	BaseVoltage	inherited from: ConductingEquipment
1..1	SvStatus	0..*	SvStatus	inherited from: ConductingEquipment
0..*	ProtectionEquipments	0..*	ProtectionEquipment	inherited from: ConductingEquipment
1..1	Terminals	0..*	Terminal	inherited from: ConductingEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	inherited from: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	inherited from: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment
0..*	Faults	0..*	Fault	inherited from: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	inherited from: Equipment
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

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6.7.30 VsPpccControlKind enumeration

Types applicable to the control of real power and/or DC voltage by voltage source converter.

Table 531 shows all literals of VsPpccControlKind.

Table 531 – Literals of DC::VsPpccControlKind

literal	value	description
pPcc		Control is real power at point of common coupling. The target value is provided by ACDCConverter.targetPpcc.
udc		Control is DC voltage with target value provided by ACDCConverter.targetUdc.
pPccAndUdcDroop		Control is active power at point of common coupling and local DC voltage, with the droop. Target values are provided by ACDCConverter.targetPpcc, ACDCConverter.targetUdc and VsConverter.droop.
pPccAndUdcDroopWithCompensation		Control is active power at point of common coupling and compensated DC voltage, with the droop. Compensation factor is the resistance, as an approximation of the DC voltage of a common (real or virtual) node in the DC network. Targets are provided by ACDCConverter.targetPpcc, ACDCConverter.targetUdc, VsConverter.droop and VsConverter.droopCompensation.
pPccAndUdcDroopPilot		Control is active power at point of common coupling and the pilot DC voltage, with the droop. The mode is used for Multi Terminal High Voltage DC (MTDC) systems where multiple HVDC Substations are connected to the HVDC transmission lines. The pilot voltage is then used to coordinate the control the DC voltage across the HVDC substations. Targets are provided by ACDCConverter.targetPpcc, ACDCConverter.targetUdc and VsConverter.droop.
phasePcc		Control is phase at point of common coupling. Target is provided by VsConverter.targetPhasePcc.

6.7.31 VsQpccControlKind enumeration

Kind of reactive power control at point of common coupling for a voltage source converter.

Table 532 shows all literals of VsQpccControlKind.

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Table 532 – Literals of DC::VsQpccControlKind

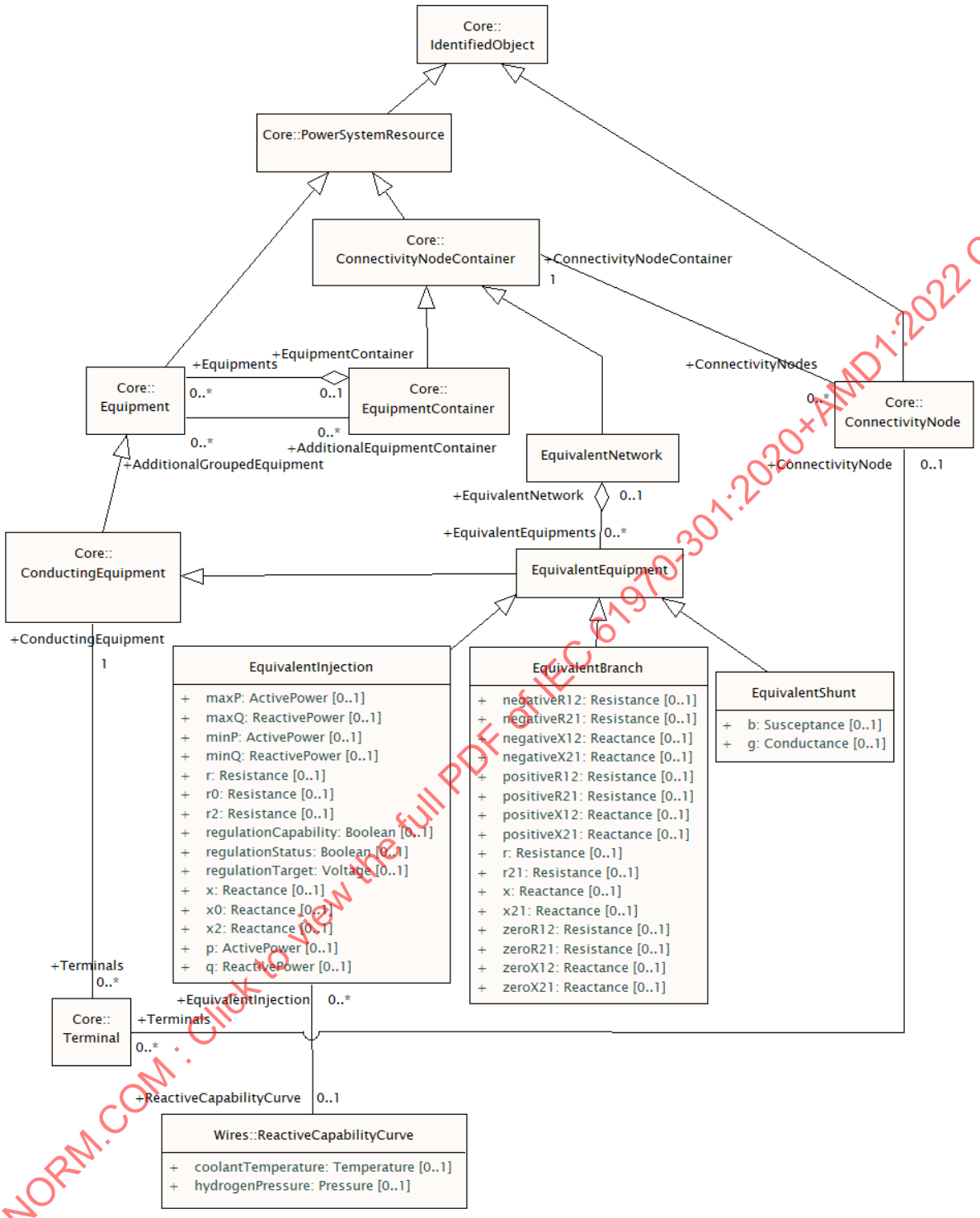
literal	value	description
reactivePcc		Control is reactive power at point of common coupling. Target is provided by VsConverter.targetQpcc.
voltagePcc		Control is voltage at point of common coupling. Target is provided by VsConverter.targetUpcc.
powerFactorPcc		Control is power factor at point of common coupling. Target is provided by VsConverter.targetPowerFactorPcc.
pulseWidthModulation		No explicit control. Pulse-modulation factor is directly set in magnitude (VsConverter.targetPWMfactor) and phase (VsConverter.targetPhasePcc).

6.8 Package Equivalents

6.8.1 General

The equivalents package models equivalent networks.

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Figure 117 – Class diagram Equivalents::Main

Figure 117: Shows model for equivalent networks.

6.8.2 EquivalentBranch

The class represents equivalent branches. In cases where a transformer phase shift is modelled and the EquivalentBranch is spanning the same nodes, the impedance quantities for the EquivalentBranch shall consider the needed phase shift.

Table 533 shows all attributes of EquivalentBranch.

Table 533 – Attributes of Equivalents::EquivalentBranch

name	mult	type	description
negativeR12	0..1	Resistance	Negative sequence series resistance from terminal sequence 1 to terminal sequence 2. Used for short circuit data exchange according to IEC 60909. EquivalentBranch is a result of network reduction prior to the data exchange.
negativeR21	0..1	Resistance	Negative sequence series resistance from terminal sequence 2 to terminal sequence 1. Used for short circuit data exchange according to IEC 60909. EquivalentBranch is a result of network reduction prior to the data exchange.
negativeX12	0..1	Reactance	Negative sequence series reactance from terminal sequence 1 to terminal sequence 2. Used for short circuit data exchange according to IEC 60909. Usage: EquivalentBranch is a result of network reduction prior to the data exchange.
negativeX21	0..1	Reactance	Negative sequence series reactance from terminal sequence 2 to terminal sequence 1. Used for short circuit data exchange according to IEC 60909. Usage: EquivalentBranch is a result of network reduction prior to the data exchange.
positiveR12	0..1	Resistance	Positive sequence series resistance from terminal sequence 1 to terminal sequence 2. Used for short circuit data exchange according to IEC 60909. EquivalentBranch is a result of network reduction prior to the data exchange.
positiveR21	0..1	Resistance	Positive sequence series resistance from terminal sequence 2 to terminal sequence 1. Used for short circuit data exchange according to IEC 60909. EquivalentBranch is a result of network reduction prior to the data exchange.
positiveX12	0..1	Reactance	Positive sequence series reactance from terminal sequence 1 to terminal sequence 2. Used for short circuit data exchange according to IEC 60909. Usage: EquivalentBranch is a result of network reduction prior to the data exchange.
positiveX21	0..1	Reactance	Positive sequence series reactance from terminal sequence 2 to terminal sequence 1. Used for short circuit data exchange according to IEC 60909. Usage: EquivalentBranch is a result of network reduction prior to the data exchange.
r	0..1	Resistance	Positive sequence series resistance of the reduced branch.

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name	mult	type	description
r21	0..1	Resistance	Resistance from terminal sequence 2 to terminal sequence 1. Used for steady state power flow. This attribute is optional and represent unbalanced network such as off-nominal phase shifter. If only EquivalentBranch.r is given, then EquivalentBranch.r21 is assumed equal to EquivalentBranch.r. Usage rule: EquivalentBranch is a result of network reduction prior to the data exchange.
x	0..1	Reactance	Positive sequence series reactance of the reduced branch.
x21	0..1	Reactance	Reactance from terminal sequence 2 to terminal sequence 1. Used for steady state power flow. This attribute is optional and represents an unbalanced network such as off-nominal phase shifter. If only EquivalentBranch.x is given, then EquivalentBranch.x21 is assumed equal to EquivalentBranch.x. Usage rule: EquivalentBranch is a result of network reduction prior to the data exchange.
zeroR12	0..1	Resistance	Zero sequence series resistance from terminal sequence 1 to terminal sequence 2. Used for short circuit data exchange according to IEC 60909. EquivalentBranch is a result of network reduction prior to the data exchange.
zeroR21	0..1	Resistance	Zero sequence series resistance from terminal sequence 2 to terminal sequence 1. Used for short circuit data exchange according to IEC 60909. Usage: EquivalentBranch is a result of network reduction prior to the data exchange.
zeroX12	0..1	Reactance	Zero sequence series reactance from terminal sequence 1 to terminal sequence 2. Used for short circuit data exchange according to IEC 60909. Usage: EquivalentBranch is a result of network reduction prior to the data exchange.
zeroX21	0..1	Reactance	Zero sequence series reactance from terminal sequence 2 to terminal sequence 1. Used for short circuit data exchange according to IEC 60909. Usage: EquivalentBranch is a result of network reduction prior to the data exchange.
aggregate	0..1	Boolean	inherited from: Equipment
inService	0..1	Boolean	inherited from: Equipment
networkAnalysisEnabled	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 534 shows all association ends of EquivalentBranch with other classes.

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Table 534 – Association ends of Equivalents::EquivalentBranch with other classes

mult from	name	mult to	type	description
0..*	EquivalentNetwork	0..1	EquivalentNetwork	inherited from: EquivalentEquipment
0..*	BaseVoltage	0..1	BaseVoltage	inherited from: ConductingEquipment
1..1	SvStatus	0..*	SvStatus	inherited from: ConductingEquipment
0..*	ProtectionEquipments	0..*	ProtectionEquipment	inherited from: ConductingEquipment
1..1	Terminals	0..*	Terminal	inherited from: ConductingEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	inherited from: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	inherited from: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment
0..1	Faults	0..*	Fault	inherited from: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	inherited from: Equipment
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.8.3 EquivalentEquipment

The class represents equivalent objects that are the result of a network reduction. The class is the base for equivalent objects of different types.

Table 535 shows all attributes of EquivalentEquipment.

Table 535 – Attributes of Equivalents::EquivalentEquipment

name	mult	type	description
aggregate	0..1	Boolean	inherited from: Equipment
inService	0..1	Boolean	inherited from: Equipment
networkAnalysisEnabled	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 536 shows all association ends of EquivalentEquipment with other classes.

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Table 536 – Association ends of Equivalents::EquivalentEquipment with other classes

mult from	name	mult to	type	description
0..*	EquivalentNetwork	0..1	EquivalentNetwork	The equivalent where the reduced model belongs.
0..*	BaseVoltage	0..1	BaseVoltage	inherited from: ConductingEquipment
1..1	SvStatus	0..*	SvStatus	inherited from: ConductingEquipment
0..*	ProtectionEquipments	0..*	ProtectionEquipment	inherited from: ConductingEquipment
1..1	Terminals	0..*	Terminal	inherited from: ConductingEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	inherited from: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	inherited from: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment
0..1	Faults	0..*	Fault	inherited from: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	inherited from: Equipment
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.8.4 EquivalentInjection

This class represents equivalent injections (generation or load). Voltage regulation is allowed only at the point of connection.

Table 537 shows all attributes of EquivalentInjection.

Table 537 – Attributes of Equivalents::EquivalentInjection

name	mult	type	description
maxP	0..1	ActivePower	Maximum active power of the injection.
maxQ	0..1	ReactivePower	Maximum reactive power of the injection. Used for modelling of infeed for load flow exchange. Not used for short circuit modelling. If maxQ and minQ are not used ReactiveCapabilityCurve can be used.
minP	0..1	ActivePower	Minimum active power of the injection.
minQ	0..1	ReactivePower	Minimum reactive power of the injection. Used for modelling of infeed for load flow exchange. Not used for short circuit modelling. If maxQ and minQ are not used ReactiveCapabilityCurve can be used.
r	0..1	Resistance	Positive sequence resistance. Used to represent Extended-Ward (IEC 60909). Usage: Extended-Ward is a result of network reduction prior to the data exchange.

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name	mult	type	description
r0	0..1	Resistance	Zero sequence resistance. Used to represent Extended-Ward (IEC 60909). Usage: Extended-Ward is a result of network reduction prior to the data exchange.
r2	0..1	Resistance	Negative sequence resistance. Used to represent Extended-Ward (IEC 60909). Usage: Extended-Ward is a result of network reduction prior to the data exchange.
regulationCapability	0..1	Boolean	Specifies whether or not the EquivalentInjection has the capability to regulate the local voltage. If true the EquivalentInjection can regulate. If false the EquivalentInjection cannot regulate. ReactiveCapabilityCurve can only be associated with EquivalentInjection if the flag is true.
regulationStatus	0..1	Boolean	Specifies the regulation status of the EquivalentInjection. True is regulating. False is not regulating.
regulationTarget	0..1	Voltage	The target voltage for voltage regulation. The attribute shall be a positive value.
x	0..1	Reactance	Positive sequence reactance. Used to represent Extended-Ward (IEC 60909). Usage: Extended-Ward is a result of network reduction prior to the data exchange.
x0	0..1	Reactance	Zero sequence reactance. Used to represent Extended-Ward (IEC 60909). Usage: Extended-Ward is a result of network reduction prior to the data exchange.
x2	0..1	Reactance	Negative sequence reactance. Used to represent Extended-Ward (IEC 60909). Usage: Extended-Ward is a result of network reduction prior to the data exchange.
p	0..1	ActivePower	Equivalent active power injection. Load sign convention is used, i.e. positive sign means flow out from a node. Starting value for steady state solutions.
q	0..1	ReactivePower	Equivalent reactive power injection. Load sign convention is used, i.e. positive sign means flow out from a node. Starting value for steady state solutions.
aggregate	0..1	Boolean	inherited from: Equipment
inService	0..1	Boolean	inherited from: Equipment
networkAnalysisEnabled	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 538 shows all association ends of EquivalentInjection with other classes.

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Table 538 – Association ends of Equivalents::EquivalentInjection with other classes

mult from	name	mult to	type	description
0..*	ReactiveCapabilityCurve	0..1	ReactiveCapabilityCurve	The reactive capability curve used by this equivalent injection.
0..*	EquivalentNetwork	0..1	EquivalentNetwork	inherited from: EquivalentEquipment
0..*	BaseVoltage	0..1	BaseVoltage	inherited from: ConductingEquipment
1..1	SvStatus	0..*	SvStatus	inherited from: ConductingEquipment
0..*	ProtectionEquipments	0..*	ProtectionEquipment	inherited from: ConductingEquipment
1..1	Terminals	0..*	Terminal	inherited from: ConductingEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	inherited from: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	inherited from: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment
0..1	Faults	0..*	Fault	inherited from: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	inherited from: Equipment
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.8.5 EquivalentNetwork

A class that groups electrical equivalents, including internal nodes, of a network that has been reduced. The ConnectivityNodes contained in the equivalent are intended to reflect internal nodes of the equivalent. The boundary Connectivity nodes where the equivalent connects outside itself are not contained by the equivalent.

Table 539 shows all attributes of EquivalentNetwork.

Table 539 – Attributes of Equivalents::EquivalentNetwork

name	mult	type	description
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 540 shows all association ends of EquivalentNetwork with other classes.

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Table 540 – Association ends of Equivalents::EquivalentNetwork with other classes

mult from	name	mult to	type	description
0..1	EquivalentEquipments	0..*	EquivalentEquipment	The associated reduced equivalents.
1..1	ConnectivityNodes	0..*	ConnectivityNode	inherited from: ConnectivityNodeContainer
0..1	TopologicalNode	0..*	TopologicalNode	inherited from: ConnectivityNodeContainer
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.8.6 EquivalentShunt

The class represents equivalent shunts.

Table 541 shows all attributes of EquivalentShunt.

Table 541 – Attributes of Equivalents::EquivalentShunt

name	mult	type	description
b	0..1	Susceptance	Positive sequence shunt susceptance.
g	0..1	Conductance	Positive sequence shunt conductance.
aggregate	0..1	Boolean	inherited from: Equipment
inService	0..1	Boolean	inherited from: Equipment
networkAnalysisEnabled	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 542 shows all association ends of EquivalentShunt with other classes.

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Table 542 – Association ends of Equivalents::EquivalentShunt with other classes

mult from	name	mult to	type	description
0..*	EquivalentNetwork	0..1	EquivalentNetwork	inherited from: EquivalentEquipment
0..*	BaseVoltage	0..1	BaseVoltage	inherited from: ConductingEquipment
1..1	SvStatus	0..*	SvStatus	inherited from: ConductingEquipment
0..*	ProtectionEquipments	0..*	ProtectionEquipment	inherited from: ConductingEquipment
1..1	Terminals	0..*	Terminal	inherited from: ConductingEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	inherited from: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	inherited from: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment
0..1	Faults	0..*	Fault	inherited from: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	inherited from: Equipment
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.9 Package AuxiliaryEquipment

6.9.1 General

Contains equipment which is not normal conducting equipment such as sensors, fault locators, and surge protectors. These devices do not define power carrying topological connections as conducting equipment, but are associated to terminals of other conducting equipment.

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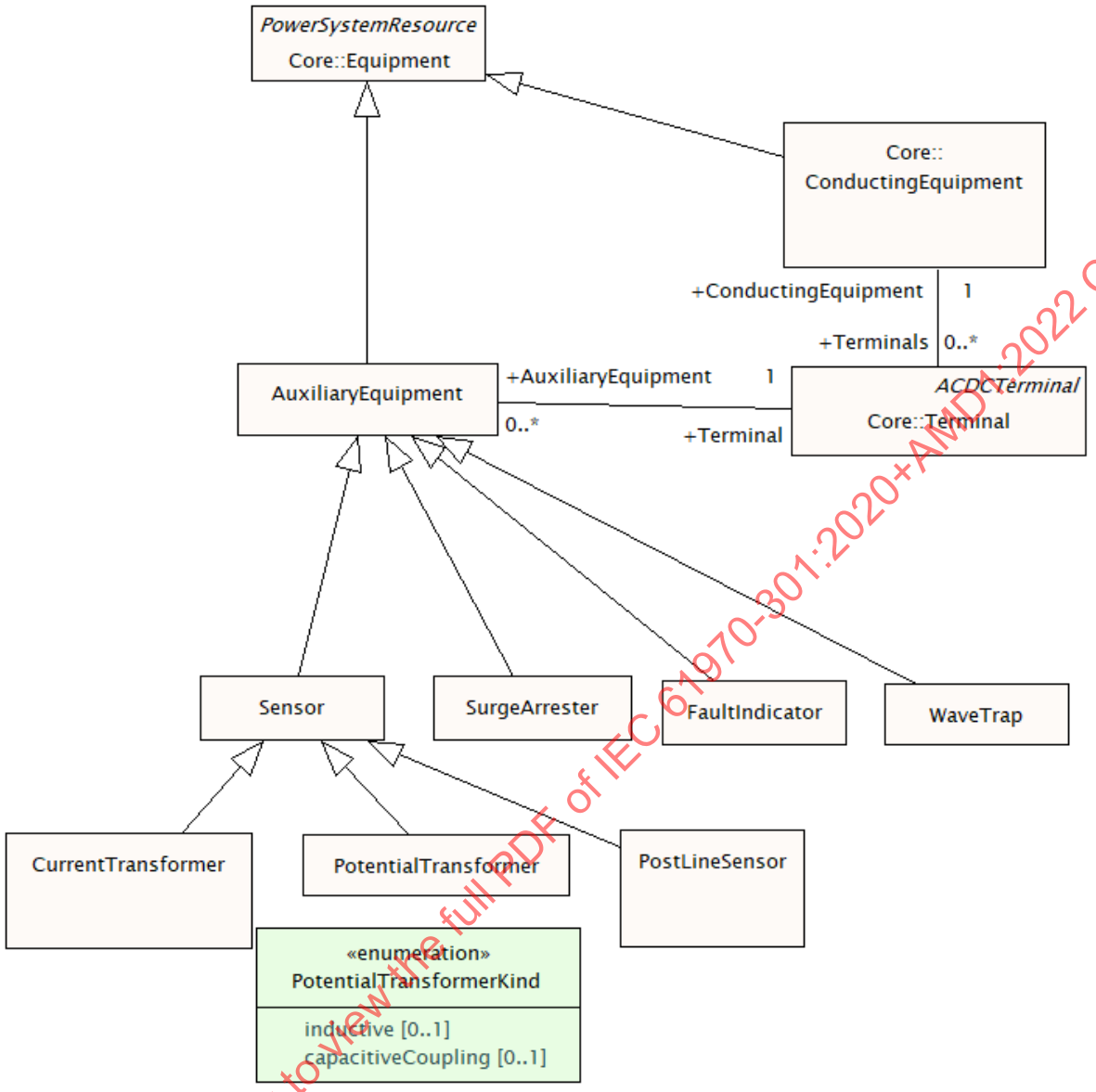


Figure 118 – Class diagram AuxiliaryEquipment::AuxiliaryEquipment

Figure 118: Inheritance and associations for auxiliary equipment.

6.9.2 AuxiliaryEquipment

AuxiliaryEquipment describe equipment that is not performing any primary functions but support for the equipment performing the primary function.

AuxiliaryEquipment is attached to primary equipment via an association with Terminal.

Table 543 shows all attributes of AuxiliaryEquipment.

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Table 543 – Attributes of AuxiliaryEquipment::AuxiliaryEquipment

name	mult	type	description
aggregate	0..1	Boolean	inherited from: Equipment
inService	0..1	Boolean	inherited from: Equipment
networkAnalysisEnabled	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 544 shows all association ends of AuxiliaryEquipment with other classes.

Table 544 – Association ends of AuxiliaryEquipment::AuxiliaryEquipment with other classes

mult from	name	mult to	type	description
0..*	Terminal	1..1	Terminal	The Terminal at the equipment where the AuxiliaryEquipment is attached.
0..1	OperationalLimitSet	0..*	OperationalLimitSet	inherited from: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	inherited from: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment
0..1	Faults	0..*	Fault	inherited from: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	inherited from: Equipment
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.9.3 CurrentTransformer

Instrument transformer used to measure electrical qualities of the circuit that is being protected and/or monitored. Typically used as current transducer for the purpose of metering or protection. A typical secondary current rating would be 5A.

Table 545 shows all attributes of CurrentTransformer.

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Table 545 – Attributes of AuxiliaryEquipment::CurrentTransformer

name	mult	type	description
accuracyClass	0..1	String	CT accuracy classification.
accuracyLimit	0..1	PerCent	Percent of rated current for which the CT remains accurate within specified limits.
ctClass	0..1	String	CT classification; i.e. class 10P.
usage	0..1	String	Intended usage of the CT; i.e. metering, protection.
coreBurden	0..1	ActivePower	Power burden of the CT core.
aggregate	0..1	Boolean	inherited from: Equipment
inService	0..1	Boolean	inherited from: Equipment
networkAnalysisEnabled	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 546 shows all association ends of CurrentTransformer with other classes.

Table 546 – Association ends of AuxiliaryEquipment::CurrentTransformer with other classes

mult from	name	mult to	type	description
0..*	Terminal	1..1	Terminal	inherited from: AuxiliaryEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	inherited from: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	inherited from: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment
0..1	Faults	0..*	Fault	inherited from: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	inherited from: Equipment
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

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6.9.4 FaultIndicator

A FaultIndicator is typically only an indicator (which may or may not be remotely monitored), and not a piece of equipment that actually initiates a protection event. It is used for FLISR (Fault Location, Isolation and Restoration) purposes, assisting with the dispatch of crews to "most likely" part of the network (i.e. assists with determining circuit section where the fault most likely happened).

Table 547 shows all attributes of FaultIndicator.

Table 547 – Attributes of AuxiliaryEquipment::FaultIndicator

name	mult	type	description
aggregate	0..1	Boolean	inherited from: Equipment
inService	0..1	Boolean	inherited from: Equipment
networkAnalysisEnabled	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 548 shows all association ends of FaultIndicator with other classes.

Table 548 – Association ends of AuxiliaryEquipment::FaultIndicator with other classes

mult from	name	mult to	type	description
0..*	Terminal	1..1	Terminal	inherited from: AuxiliaryEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	inherited from: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	inherited from: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment
0..1	Faults	0..*	Fault	inherited from: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	inherited from: Equipment
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.9.5 PostLineSensor

A sensor used mainly in overhead distribution networks as the source of both current and voltage measurements.

Table 549 shows all attributes of PostLineSensor.

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Table 549 – Attributes of AuxiliaryEquipment::PostLineSensor

name	mult	type	description
aggregate	0..1	Boolean	inherited from: Equipment
inService	0..1	Boolean	inherited from: Equipment
networkAnalysisEnabled	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 550 shows all association ends of PostLineSensor with other classes.

Table 550 – Association ends of AuxiliaryEquipment::PostLineSensor with other classes

mult from	name	mult to	type	description
0..*	Terminal	1..1	Terminal	inherited from: AuxiliaryEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	inherited from: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	inherited from: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment
0..1	Faults	0..*	Fault	inherited from: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	inherited from: Equipment
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.9.6 PotentialTransformer

Instrument transformer (also known as Voltage Transformer) used to measure electrical qualities of the circuit that is being protected and/or monitored. Typically used as voltage transducer for the purpose of metering, protection, or sometimes auxiliary substation supply. A typical secondary voltage rating would be 120V.

Table 551 shows all attributes of PotentialTransformer.

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Table 551 – Attributes of AuxiliaryEquipment::PotentialTransformer

name	mult	type	description
accuracyClass	0..1	String	PT accuracy classification.
nominalRatio	0..1	Float	Nominal ratio between the primary and secondary voltage.
ptClass	0..1	String	Potential transformer (PT) classification covering burden.
type	0..1	PotentialTransformerKind	Potential transformer construction type.
aggregate	0..1	Boolean	inherited from: Equipment
inService	0..1	Boolean	inherited from: Equipment
networkAnalysisEnabled	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 552 shows all association ends of PotentialTransformer with other classes.

Table 552 – Association ends of AuxiliaryEquipment::PotentialTransformer with other classes

mult from	name	mult to	type	description
0..*	Terminal	1..1	Terminal	inherited from: AuxiliaryEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	inherited from: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	inherited from: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment
0..1	Faults	0..*	Fault	inherited from: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	inherited from: Equipment
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

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6.9.7 PotentialTransformerKind enumeration

The construction kind of the potential transformer.

Table 553 shows all literals of PotentialTransformerKind.

Table 553 – Literals of AuxiliaryEquipment::PotentialTransformerKind

literal	value	description
inductive		The potential transformer is using induction coils to create secondary voltage.
capacitiveCoupling		The potential transformer is using capacitive coupling to create secondary voltage.

6.9.8 Sensor

This class describe devices that transform a measured quantity into signals that can be presented at displays, used in control or be recorded.

Table 554 shows all attributes of Sensor.

Table 554 – Attributes of AuxiliaryEquipment::Sensor

name	mult	type	description
aggregate	0..1	Boolean	inherited from: Equipment
inService	0..1	Boolean	inherited from: Equipment
networkAnalysisEnabled	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 555 shows all association ends of Sensor with other classes.

Table 555 – Association ends of AuxiliaryEquipment::Sensor with other classes

mult from	name	mult to	type	description
0..*	Terminal	1..1	Terminal	inherited from: AuxiliaryEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	inherited from: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	inherited from: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment
0..1	Faults	0..*	Fault	inherited from: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	inherited from: Equipment
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

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6.9.9 SurgeArrester

Shunt device, installed on the network, usually in the proximity of electrical equipment in order to protect the said equipment against transient voltage transients caused by lightning or switching activity.

Table 556 shows all attributes of SurgeArrester.

Table 556 – Attributes of AuxiliaryEquipment::SurgeArrester

name	mult	type	description
aggregate	0..1	Boolean	inherited from: Equipment
inService	0..1	Boolean	inherited from: Equipment
networkAnalysisEnabled	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 557 shows all association ends of SurgeArrester with other classes.

Table 557 – Association ends of AuxiliaryEquipment::SurgeArrester with other classes

mult from	name	mult to	type	description
0..*	Terminal	1..1	Terminal	inherited from: AuxiliaryEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	inherited from: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	inherited from: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment
0..1	Faults	0..*	Fault	inherited from: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	inherited from: Equipment
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

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6.9.10 WaveTrap

Line traps are devices that impede high frequency power line carrier signals yet present a negligible impedance at the main power frequency.

Table 558 shows all attributes of WaveTrap.

Table 558 – Attributes of AuxiliaryEquipment::WaveTrap

name	mult	type	description
aggregate	0..1	Boolean	inherited from: Equipment
inService	0..1	Boolean	inherited from: Equipment
networkAnalysisEnabled	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 559 shows all association ends of WaveTrap with other classes.

Table 559 – Association ends of AuxiliaryEquipment::WaveTrap with other classes

mult from	name	mult to	type	description
0..*	Terminal	1..1	Terminal	inherited from: AuxiliaryEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	inherited from: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	inherited from: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment
0..1	Faults	0..*	Fault	inherited from: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	inherited from: Equipment
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.10 Package Meas

6.10.1 General

Contains entities that describe dynamic measurement data exchanged between applications.

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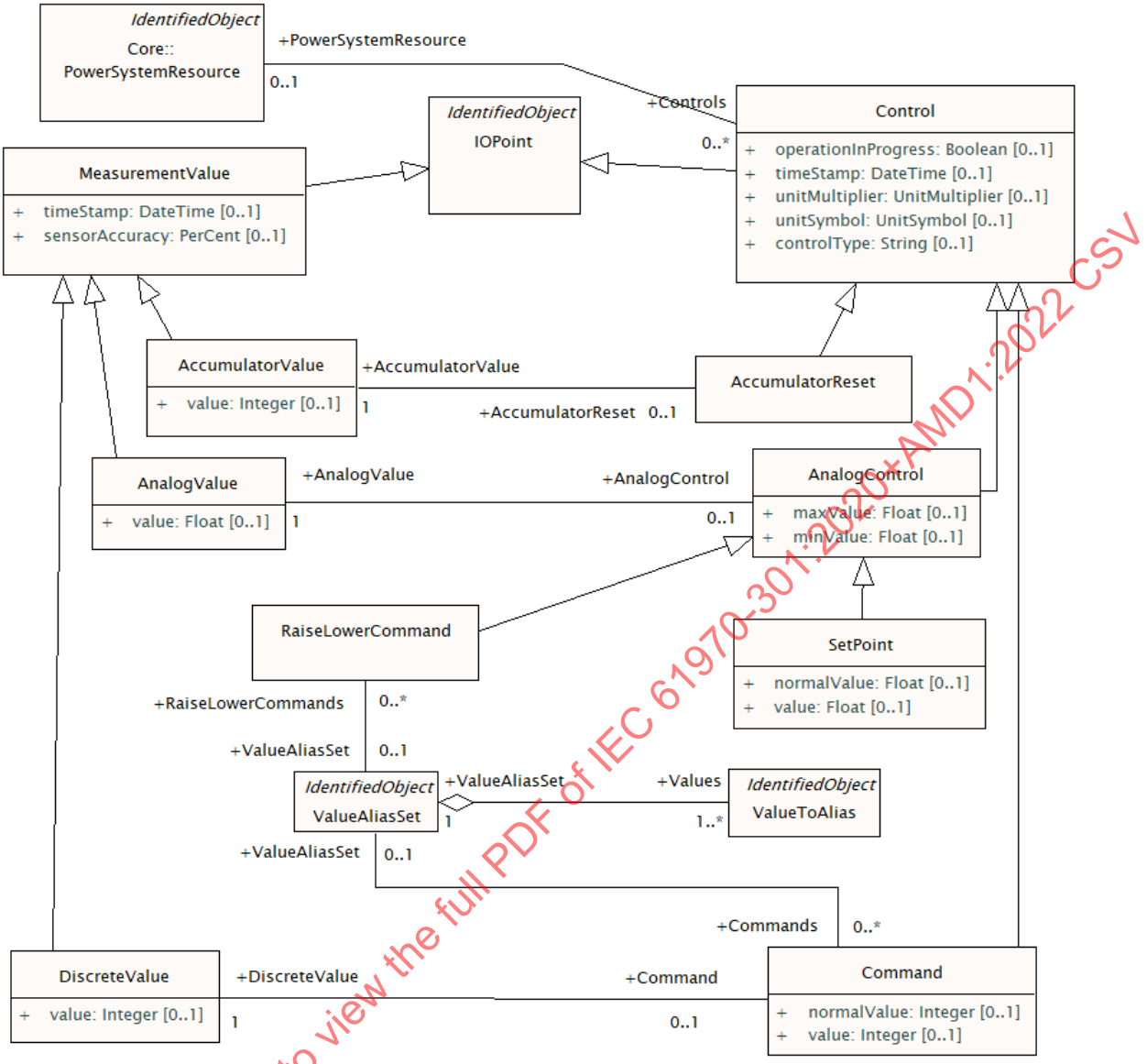


Figure 119 – Class diagram Meas::Control

Figure 119: This diagram shows all classes included in the Meas package.

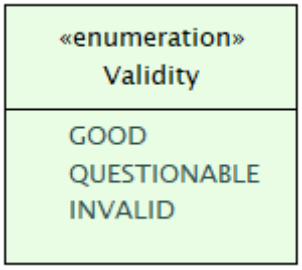


Figure 120 – Class diagram Meas::Datatypes

Figure 120: Shows datatypes for measurements.

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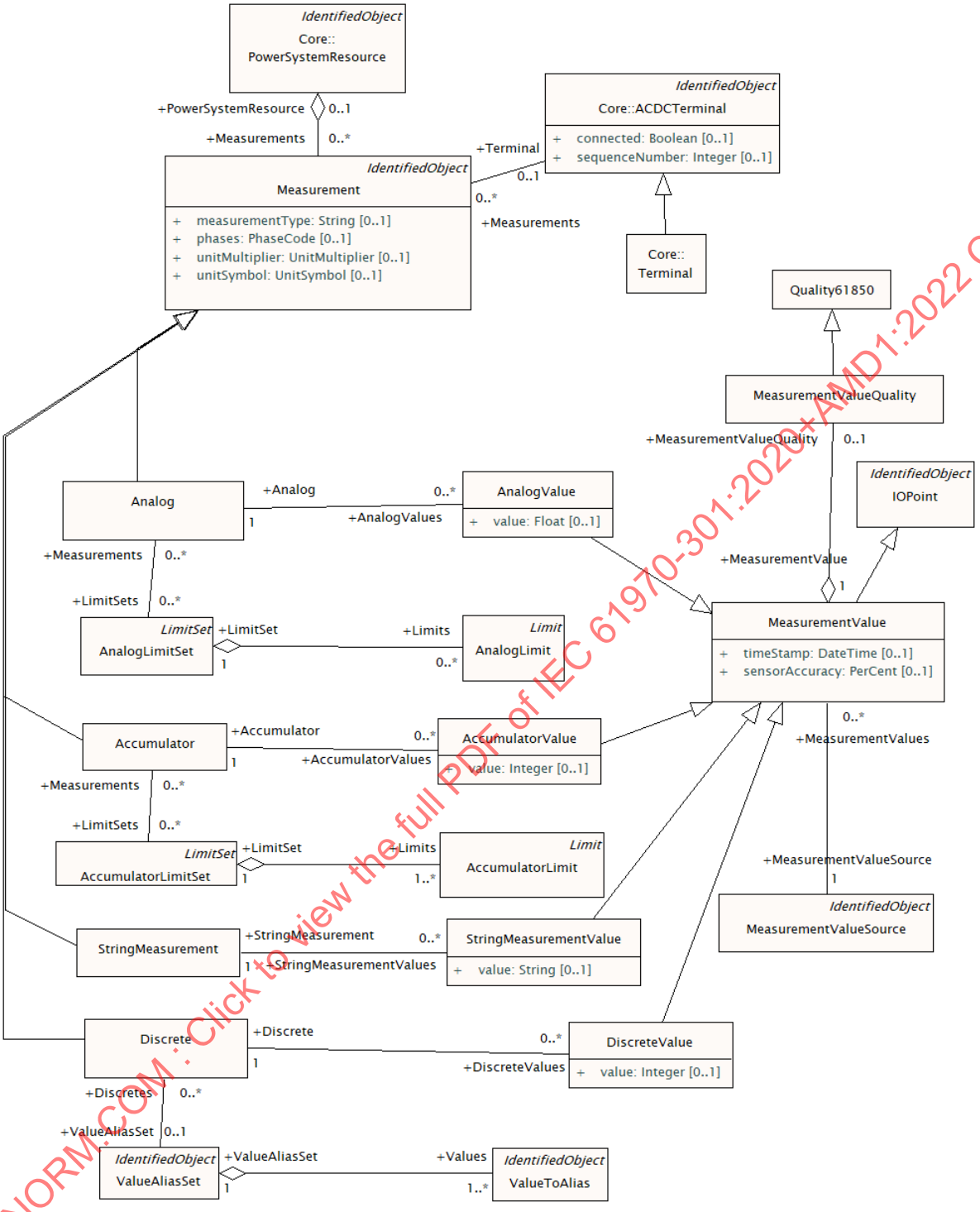


Figure 121 – Class diagram Meas::Measurement

Figure 121: This diagram shows classes central to the Measurement package and connections to some external classes.

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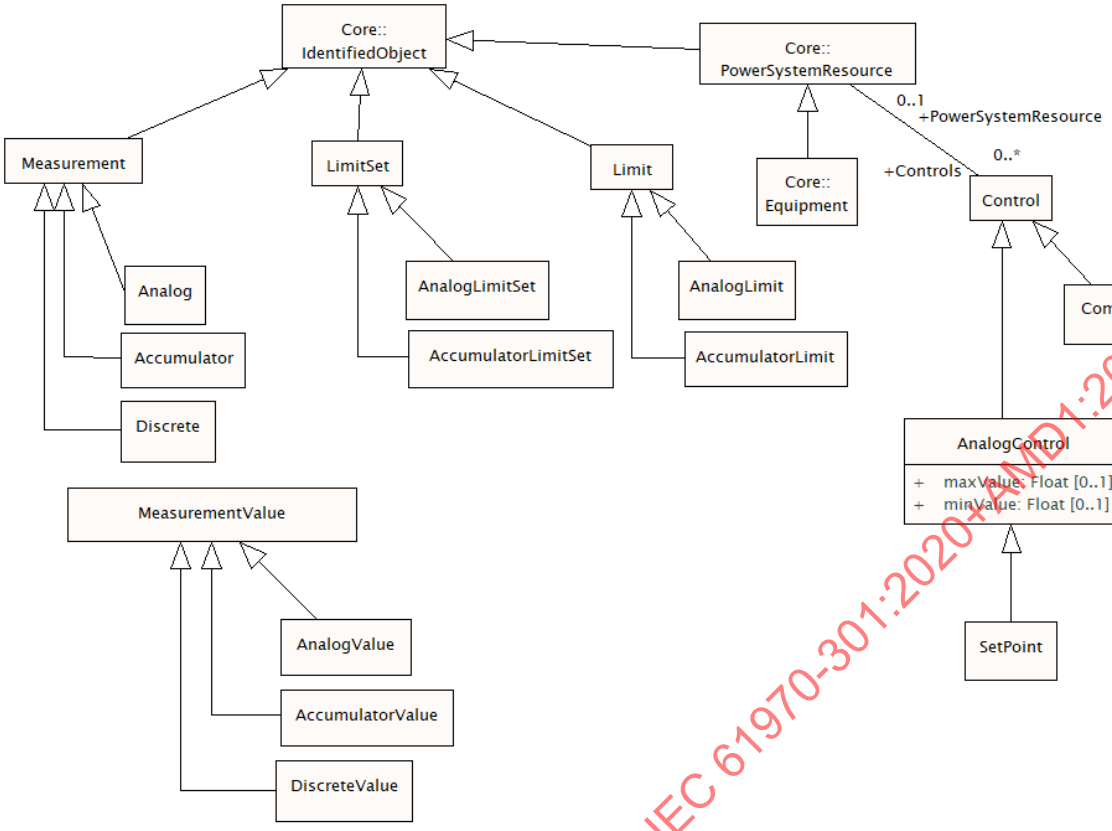


Figure 122 – Class diagram Meas::MeasurementInheritance

Figure 122: This diagram shows the measurement classes inheritance.

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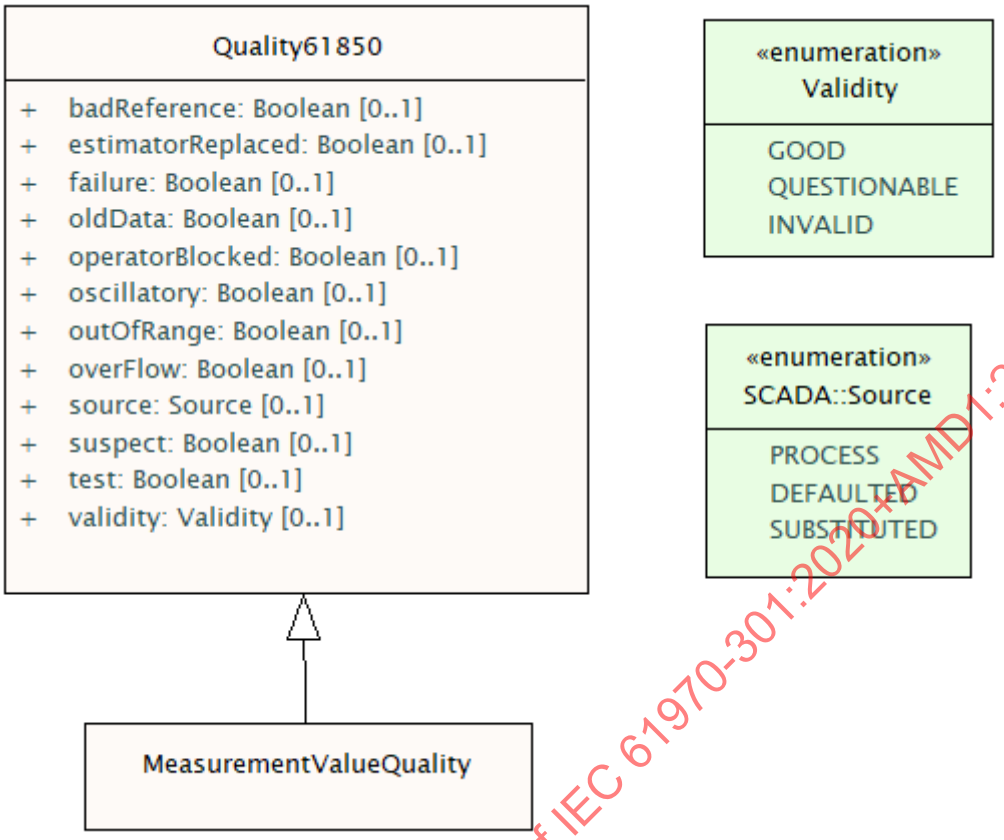


Figure 123 – Class diagram Meas::Quality

Figure 123: This diagram shows the details of the quality codes. The quality flags can be used also in other packages not only specific to MeasurementValues. A generalized Quality class is added and inherited into MeasurementValueQuality.

6.10.2 Accumulator

Accumulator represents an accumulated (counted) Measurement, e.g. an energy value.

Table 560 shows all attributes of Accumulator.

Table 560 – Attributes of Meas::Accumulator

name	mult	type	description
maxValue	0..1	Integer	Normal value range maximum for any of the MeasurementValue.values. Used for scaling, e.g. in bar graphs or of telemetered raw values.
measurementType	0..1	String	inherited from: Measurement
phases	0..1	PhaseCode	inherited from: Measurement
unitMultiplier	0..1	UnitMultiplier	inherited from: Measurement
unitSymbol	0..1	UnitSymbol	inherited from: Measurement
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

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Table 561 shows all association ends of Accumulator with other classes.

Table 561 – Association ends of Meas::Accumulator with other classes

mult from	name	mult to	type	description
1..1	AccumulatorValues	0..*	AccumulatorValue	The values connected to this measurement.
0..*	LimitSets	0..*	AccumulatorLimitSet	A measurement may have zero or more limit ranges defined for it.
0..*	Terminal	0..1	ACDCTerminal	inherited from: Measurement
0..*	PowerSystemResource	0..1	PowerSystemResource	inherited from: Measurement
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.10.3 AccumulatorLimit

Limit values for Accumulator measurements.

Table 562 shows all attributes of AccumulatorLimit.

Table 562 – Attributes of Meas::AccumulatorLimit

name	mult	type	description
value	0..1	Integer	The value to supervise against. The value is positive.
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 563 shows all association ends of AccumulatorLimit with other classes.

Table 563 – Association ends of Meas::AccumulatorLimit with other classes

mult from	name	mult to	type	description
1..*	LimitSet	1..1	AccumulatorLimitSet	The set of limits.
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.10.4 AccumulatorLimitSet

An AccumulatorLimitSet specifies a set of Limits that are associated with an Accumulator measurement.

Table 564 shows all attributes of AccumulatorLimitSet.

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Table 564 – Attributes of Meas::AccumulatorLimitSet

name	mult	type	description
isPercentageLimits	0..1	Boolean	inherited from: LimitSet
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 565 shows all association ends of AccumulatorLimitSet with other classes.

Table 565 – Association ends of Meas::AccumulatorLimitSet with other classes

mult from	name	mult to	type	description
1..1	Limits	1..*	AccumulatorLimit	The limit values used for supervision of Measurements.
0..*	Measurements	0..*	Accumulator	The Measurements using the LimitSet.
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.10.5 AccumulatorReset

This command resets the counter value to zero.

Table 566 shows all attributes of AccumulatorReset.

Table 566 – Attributes of Meas::AccumulatorReset

name	mult	type	description
operationInProgress	0..1	Boolean	inherited from: Control
timeStamp	0..1	DateTime	inherited from: Control
unitMultiplier	0..1	UnitMultiplier	inherited from: Control
unitSymbol	0..1	UnitSymbol	inherited from: Control
controlType	0..1	String	inherited from: Control
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 567 shows all association ends of AccumulatorReset with other classes.

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Table 567 – Association ends of Meas::AccumulatorReset with other classes

mult from	name	mult to	type	description
0..1	AccumulatorValue	1..1	AccumulatorValue	The accumulator value that is reset by the command.
0..*	PowerSystemResource	0..1	PowerSystemResource	inherited from: Control
1..1	RemoteControl	0..1	RemoteControl	inherited from: Control
0..1	BilateralToIOPoint	0..*	ProvidedBilateralPoint	inherited from: IOPoint
0..*	IOPointSource	0..1	IOPointSource	inherited from: IOPoint
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.10.6 AccumulatorValue

AccumulatorValue represents an accumulated (counted) MeasurementValue.

Table 568 shows all attributes of AccumulatorValue.

Table 568 – Attributes of Meas::AccumulatorValue

name	mult	type	description
value	0..1	Integer	The value to supervise. The value is positive.
timeStamp	0..1	DateTime	inherited from: MeasurementValue
sensorAccuracy	0..1	PerCent	inherited from: MeasurementValue
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 569 shows all association ends of AccumulatorValue with other classes.

Table 569 – Association ends of Meas::AccumulatorValue with other classes

mult from	name	mult to	type	description
0..*	Accumulator	1..1	Accumulator	Measurement to which this value is connected.
1..1	AccumulatorReset	0..1	AccumulatorReset	The command that resets the accumulator value.
1..1	RemoteSource	0..1	RemoteSource	inherited from: MeasurementValue
1..1	MeasurementValueQuality	0..1	MeasurementValueQuality	inherited from: MeasurementValue
0..*	MeasurementValueSource	1..1	MeasurementValueSource	inherited from: MeasurementValue
0..1	BilateralToIOPoint	0..*	ProvidedBilateralPoint	inherited from: IOPoint
0..*	IOPointSource	0..1	IOPointSource	inherited from: IOPoint
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

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6.10.7 Analog

Analog represents an analog Measurement.

Table 570 shows all attributes of Analog.

Table 570 – Attributes of Meas::Analog

name	mult	type	description
maxValue	0..1	Float	Normal value range maximum for any of the MeasurementValue.values. Used for scaling, e.g. in bar graphs or of telemetered raw values.
minValue	0..1	Float	Normal value range minimum for any of the MeasurementValue.values. Used for scaling, e.g. in bar graphs or of telemetered raw values.
normalValue	0..1	Float	Normal measurement value, e.g., used for percentage calculations.
positiveFlowIn	0..1	Boolean	If true then this measurement is an active power, reactive power or current with the convention that a positive value measured at the Terminal means power is flowing into the related PowerSystemResource.
measurementType	0..1	String	inherited from: Measurement
phases	0..1	PhaseCode	inherited from: Measurement
unitMultiplier	0..1	UnitMultiplier	inherited from: Measurement
unitSymbol	0..1	UnitSymbol	inherited from: Measurement
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 571 shows all association ends of Analog with other classes.

Table 571 – Association ends of Meas::Analog with other classes

mult from	name	mult to	type	description
1..1	AnalogValues	0..*	AnalogValue	The values connected to this measurement.
0..*	LimitSets	0..*	AnalogLimitSet	A measurement may have zero or more limit ranges defined for it.
0..*	Terminal	0..1	ACDCTerminal	inherited from: Measurement
0..*	PowerSystemResource	0..1	PowerSystemResource	inherited from: Measurement
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.10.8 AnalogControl

An analog control used for supervisory control.

Table 572 shows all attributes of AnalogControl.

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Table 572 – Attributes of Meas::AnalogControl

name	mult	type	description
maxValue	0..1	Float	Normal value range maximum for any of the Control.value. Used for scaling, e.g. in bar graphs.
minValue	0..1	Float	Normal value range minimum for any of the Control.value. Used for scaling, e.g. in bar graphs.
operationInProgress	0..1	Boolean	inherited from: Control
timeStamp	0..1	DateTime	inherited from: Control
unitMultiplier	0..1	UnitMultiplier	inherited from: Control
unitSymbol	0..1	UnitSymbol	inherited from: Control
controlType	0..1	String	inherited from: Control
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 573 shows all association ends of AnalogControl with other classes.

Table 573 – Association ends of Meas::AnalogControl with other classes

mult from	name	mult to	type	description
0..1	AnalogValue	1..1	AnalogValue	The MeasurementValue that is controlled.
0..*	PowerSystemResource	0..1	PowerSystemResource	inherited from: Control
1..1	RemoteControl	0..1	RemoteControl	inherited from: Control
0..1	BilateralToIOPoint	0..*	ProvidedBilateralPoint	inherited from: IOPoint
0..*	IOPointSource	0..1	IOPointSource	inherited from: IOPoint
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.10.9 AnalogLimit

Limit values for Analog measurements.

Table 574 shows all attributes of AnalogLimit.

Table 574 – Attributes of Meas::AnalogLimit

name	mult	type	description
value	0..1	Float	The value to supervise against.
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

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Table 575 shows all association ends of AnalogLimit with other classes.

Table 575 – Association ends of Meas::AnalogLimit with other classes

mult from	name	mult to	type	description
0..*	LimitSet	1..1	AnalogLimitSet	The set of limits.
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.10.10 AnalogLimitSet

An AnalogLimitSet specifies a set of Limits that are associated with an Analog measurement.

Table 576 shows all attributes of AnalogLimitSet.

Table 576 – Attributes of Meas::AnalogLimitSet

name	mult	type	description
isPercentageLimits	0..1	Boolean	inherited from: LimitSet
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 577 shows all association ends of AnalogLimitSet with other classes.

Table 577 – Association ends of Meas::AnalogLimitSet with other classes

mult from	name	mult to	type	description
1..1	Limits	0..*	AnalogLimit	The limit values used for supervision of Measurements.
0..*	Measurements	0..*	Analog	The Measurements using the LimitSet.
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.10.11 AnalogValue

AnalogValue represents an analog MeasurementValue.

Table 578 shows all attributes of AnalogValue.

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Table 578 – Attributes of Meas::AnalogValue

name	mult	type	description
value	0..1	Float	The value to supervise.
timeStamp	0..1	DateTime	inherited from: MeasurementValue
sensorAccuracy	0..1	PerCent	inherited from: MeasurementValue
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

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Table 579 shows all association ends of AnalogValue with other classes.

Table 579 – Association ends of Meas::AnalogValue with other classes

mult from	name	mult to	type	description
1..1	AnalogControl	0..1	AnalogControl	The Control variable associated with the MeasurementValue.
0..*	Analog	1..1	Analog	Measurement to which this value is connected.
1..1	AltTieMeas	0..*	AltTieMeas	The usage of the measurement within the control area specification.
1..1	AltGeneratingUnit	0..*	AltGeneratingUnitMeas	The alternate generating unit for which this measurement value applies.
1..1	RemoteSource	0..1	RemoteSource	inherited from: MeasurementValue
1..1	MeasurementValueQuality	0..1	MeasurementValueQuality	inherited from: MeasurementValue
0..*	MeasurementValueSource	1..1	MeasurementValueSource	inherited from: MeasurementValue
0..1	BilateralToIOPoint	0..*	ProvidedBilateralPoint	inherited from: IOPoint
0..*	IOPointSource	0..1	IOPointSource	inherited from: IOPoint
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.10.12 Command

A Command is a discrete control used for supervisory control.

Table 580 shows all attributes of Command.

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Table 580 – Attributes of Meas::Command

name	mult	type	description
normalValue	0..1	Integer	Normal value for Control.value e.g. used for percentage scaling.
value	0..1	Integer	The value representing the actuator output.
operationInProgress	0..1	Boolean	inherited from: Control
timeStamp	0..1	DateTime	inherited from: Control
unitMultiplier	0..1	UnitMultiplier	inherited from: Control
unitSymbol	0..1	UnitSymbol	inherited from: Control
controlType	0..1	String	inherited from: Control
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 581 shows all association ends of Command with other classes.

Table 581 – Association ends of Meas::Command with other classes

mult from	name	mult to	type	description
0..*	ValueAliasSet	0..1	ValueAliasSet	The ValueAliasSet used for translation of a Control value to a name.
0..1	DiscreteValue	1..1	DiscreteValue	The MeasurementValue that is controlled.
0..*	PowerSystemResource	0..1	PowerSystemResource	inherited from: Control
1..1	RemoteControl	0..1	RemoteControl	inherited from: Control
0..1	BilateralToIOPoint	0..*	ProvidedBilateralPoint	inherited from: IOPoint
0..*	IOPointSource	0..1	IOPointSource	inherited from: IOPoint
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.10.13 Control

Control is used for supervisory/device control. It represents control outputs that are used to change the state in a process, e.g. close or open breaker, a set point value or a raise lower command.

Table 582 shows all attributes of Control.

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Table 582 – Attributes of Meas::Control

name	mult	type	description
operationInProgress	0..1	Boolean	Indicates that a client is currently sending control commands that has not completed.
timeStamp	0..1	DateTime	The last time a control output was sent.
unitMultiplier	0..1	UnitMultiplier	The unit multiplier of the controlled quantity.
unitSymbol	0..1	UnitSymbol	The unit of measure of the controlled quantity.
controlType	0..1	String	~~Specifies the type of Control, e.g. BreakerOn/Off, GeneratorVoltageSetPoint, TieLineFlow etc. The ControlType.name shall be unique among all specified types and describe the type.~~ Specifies the type of Control. For example, this specifies if the Control represents BreakerOpen, BreakerClose, GeneratorVoltageSetPoint, GeneratorRaise, GeneratorLower, etc.
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 583 shows all association ends of Control with other classes.

Table 583 – Association ends of Meas::Control with other classes

mult from	name	mult to	type	description
0..*	PowerSystemResource	0..1	PowerSystemResource	Regulating device governed by this control output.
1..1	RemoteControl	0..1	RemoteControl	The remote point controlling the physical actuator.
0..1	BilateralToIOPoint	0..*	ProvidedBilateralPoint	inherited from: IOPoint
0..*	IOPointSource	0..1	IOPointSource	inherited from: IOPoint
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.10.14 Discrete

Discrete represents a discrete Measurement, i.e. a Measurement representing discrete values, e.g. a Breaker position.

Table 584 shows all attributes of Discrete.

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Table 584 – Attributes of Meas::Discrete

name	mult	type	description
maxValue	0..1	Integer	Normal value range maximum for any of the MeasurementValue.values. Used for scaling, e.g. in bar graphs or of telemetered raw values.
minValue	0..1	Integer	Normal value range minimum for any of the MeasurementValue.values. Used for scaling, e.g. in bar graphs or of telemetered raw values.
normalValue	0..1	Integer	Normal measurement value, e.g., used for percentage calculations.
measurementType	0..1	String	inherited from: Measurement
phases	0..1	PhaseCode	inherited from: Measurement
unitMultiplier	0..1	UnitMultiplier	inherited from: Measurement
unitSymbol	0..1	UnitSymbol	inherited from: Measurement
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 585 shows all association ends of Discrete with other classes.

Table 585 – Association ends of Meas::Discrete with other classes

mult from	name	mult to	type	description
1..1	DiscreteValues	0..*	DiscreteValue	The values connected to this measurement.
0..*	ValueAliasSet	0..1	ValueAliasSet	The ValueAliasSet used for translation of a MeasurementValue.value to a name.
0..*	Terminal	0..1	ACDCTerminal	inherited from: Measurement
0..*	PowerSystemResource	0..1	PowerSystemResource	inherited from: Measurement
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.10.15 DiscreteValue

DiscreteValue represents a discrete MeasurementValue.

Table 586 shows all attributes of DiscreteValue.

Table 586 – Attributes of Meas::DiscreteValue

name	mult	type	description
value	0..1	Integer	The value to supervise.
timeStamp	0..1	DateTime	inherited from: MeasurementValue
sensorAccuracy	0..1	PerCent	inherited from: MeasurementValue
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

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Table 587 shows all association ends of DiscreteValue with other classes.

Table 587 – Association ends of Meas::DiscreteValue with other classes

mult from	name	mult to	type	description
1..1	Command	0..1	Command	The Control variable associated with the MeasurementValue.
0..*	Discrete	1..1	Discrete	Measurement to which this value is connected.
1..1	RemoteSource	0..1	RemoteSource	inherited from: MeasurementValue
1..1	MeasurementValueQuality	0..1	MeasurementValueQuality	inherited from: MeasurementValue
0..*	MeasurementValueSource	1..1	MeasurementValueSource	inherited from: MeasurementValue
0..1	BilateralToIOPoint	0..*	ProvidedBilateralPoint	inherited from: IOPoint
0..*	IOPointSource	0..1	IOPointSource	inherited from: IOPoint
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.10.16 IOPoint

The class describe a measurement or control value. The purpose is to enable having attributes and associations common for measurement and control.

Table 588 shows all attributes of IOPoint.

Table 588 – Attributes of Meas::IOPoint

name	mult	type	description
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 589 shows all association ends of IOPoint with other classes.

Table 589 – Association ends of Meas::IOPoint with other classes

mult from	name	mult to	type	description
0..1	BilateralToIOPoint	0..*	ProvidedBilateralPoint	Bilateral ICCP point for the measurement or control.
0..*	IOPointSource	0..1	IOPointSource	Local merasurement value source for an ICCP point.
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

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6.10.17 Limit

Specifies one limit value for a Measurement. A Measurement typically has several limits that are kept together by the LimitSet class. The actual meaning and use of a Limit instance (i.e., if it is an alarm or warning limit or if it is a high or low limit) is not captured in the Limit class. However the name of a Limit instance may indicate both meaning and use.

Table 590 shows all attributes of Limit.

Table 590 – Attributes of Meas::Limit

name	mult	type	description
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 591 shows all association ends of Limit with other classes.

Table 591 – Association ends of Meas::Limit with other classes

mult from	name	mult to	type	description
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.10.18 LimitSet

Specifies a set of Limits that are associated with a Measurement. A Measurement may have several LimitSets corresponding to seasonal or other changing conditions. The condition is captured in the name and description attributes. The same LimitSet may be used for several Measurements. In particular percentage limits are used this way.

Table 592 shows all attributes of LimitSet.

Table 592 – Attributes of Meas::LimitSet

name	mult	type	description
isPercentageLimits	0..1	Boolean	Tells if the limit values are in percentage of normalValue or the specified Unit for Measurements and Controls.
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 593 shows all association ends of LimitSet with other classes.

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Table 593 – Association ends of Meas::LimitSet with other classes

mult from	name	mult to	type	description
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.10.19 Measurement

A Measurement represents any measured, calculated or non-measured non-calculated quantity. Any piece of equipment may contain Measurements, e.g. a substation may have temperature measurements and door open indications, a transformer may have oil temperature and tank pressure measurements, a bay may contain a number of power flow measurements and a Breaker may contain a switch status measurement.

The PSR – Measurement association is intended to capture this use of Measurement and is included in the naming hierarchy based on EquipmentContainer. The naming hierarchy typically has Measurements as leaves, e.g. Substation-VoltageLevel-Bay-Switch-Measurement.

Some Measurements represent quantities related to a particular sensor location in the network, e.g. a voltage transformer (VT) or potential transformer (PT) at a busbar or a current transformer (CT) at the bar between a breaker and an isolator. The sensing position is not captured in the PSR – Measurement association. Instead it is captured by the Measurement – Terminal association that is used to define the sensing location in the network topology. The location is defined by the connection of the Terminal to ConductingEquipment.

If both a Terminal and PSR are associated, and the PSR is of type ConductingEquipment, the associated Terminal should belong to that ConductingEquipment instance.

When the sensor location is needed both Measurement-PSR and Measurement-Terminal are used. The Measurement-Terminal association is never used alone.

Table 594 shows all attributes of Measurement.

Table 594 – Attributes of Meas::Measurement

name	mult	type	description
measurementType	0..1	String	Specifies the type of measurement. For example, this specifies if the measurement represents an indoor temperature, outdoor temperature, bus voltage, line flow, etc. When the measurementType is set to "Specialization", the type of Measurement is defined in more detail by the specialized class which inherits from Measurement.
phases	0..1	PhaseCode	Indicates to which phases the measurement applies and avoids the need to use 'measurementType' to also encode phase information (which would explode the types). The phase information in Measurement, along with 'measurementType' and 'phases' uniquely defines a Measurement for a device, based on normal network phase. Their meaning will not change when the computed energizing phasing is changed due to jumpers or other reasons. If the attribute is missing three phases (ABC) shall be assumed.
unitMultiplier	0..1	UnitMultiplier	The unit multiplier of the measured quantity.
unitSymbol	0..1	UnitSymbol	The unit of measure of the measured quantity.

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name	mult	type	description
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 595 shows all association ends of Measurement with other classes.

Table 595 – Association ends of Meas::Measurement with other classes

mult from	name	mult to	type	description
0..*	Terminal	0..1	ACDCTerminal	One or more measurements may be associated with a terminal in the network.
0..*	PowerSystemResource	0..1	PowerSystemResource	The power system resource that contains the measurement.
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.10.20 MeasurementValue

The current state for a measurement. A state value is an instance of a measurement from a specific source. Measurements can be associated with many state values, each representing a different source for the measurement.

Table 596 shows all attributes of MeasurementValue.

Table 596 – Attributes of Meas::MeasurementValue

name	mult	type	description
timeStamp	0..1	DateTime	The time when the value was last updated.
sensorAccuracy	0..1	PerCent	The limit, expressed as a percentage of the sensor maximum, that errors will not exceed when the sensor is used under reference conditions.
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 597 shows all association ends of MeasurementValue with other classes.

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Table 597 – Association ends of Meas::MeasurementValue with other classes

mult from	name	mult to	type	description
1..1	RemoteSource	0..1	RemoteSource	Link to the physical telemetered point associated with this measurement.
1..1	MeasurementValueQuality	0..1	MeasurementValueQuality	A MeasurementValue has a MeasurementValueQuality associated with it.
0..*	MeasurementValueSource	1..1	MeasurementValueSource	A reference to the type of source that updates the MeasurementValue, e.g. SCADA, CCLink, manual, etc. User conventions for the names of sources are contained in the introduction to IEC 61970-301.
0..1	BilateralToIOPoint	0..*	ProvidedBilateralPoint	inherited from: IOPoint
0..*	IOPointSource	0..1	IOPointSource	inherited from: IOPoint
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.10.21 MeasurementValueQuality

Measurement quality flags. Bits 0-10 are defined for substation automation in IEC 61850-7-3. Bits 11-15 are reserved for future expansion by that document. Bits 16-31 are reserved for EMS applications.

Table 598 shows all attributes of MeasurementValueQuality.

Table 598 – Attributes of Meas::MeasurementValueQuality

name	mult	type	description
badReference	0..1	Boolean	inherited from: Quality61850
estimatorReplaced	0..1	Boolean	inherited from: Quality61850
failure	0..1	Boolean	inherited from: Quality61850
oldData	0..1	Boolean	inherited from: Quality61850
operatorBlocked	0..1	Boolean	inherited from: Quality61850
oscillatory	0..1	Boolean	inherited from: Quality61850
outOfRange	0..1	Boolean	inherited from: Quality61850
overFlow	0..1	Boolean	inherited from: Quality61850
source	0..1	Source	inherited from: Quality61850
suspect	0..1	Boolean	inherited from: Quality61850
test	0..1	Boolean	inherited from: Quality61850
validity	0..1	Validity	inherited from: Quality61850

Table 599 shows all association ends of MeasurementValueQuality with other classes.

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Table 599 – Association ends of Meas::MeasurementValueQuality with other classes

mult from	name	mult to	type	description
0..1	MeasurementValue	1..1	MeasurementValue	A MeasurementValue has a MeasurementValueQuality associated with it.

6.10.22 MeasurementValueSource

MeasurementValueSource describes the alternative sources updating a MeasurementValue. User conventions for how to use the MeasurementValueSource attributes are defined in IEC 61970-301.

Table 600 shows all attributes of MeasurementValueSource.

Table 600 – Attributes of Meas::MeasurementValueSource

name	mult	type	description
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 601 shows all association ends of MeasurementValueSource with other classes.

Table 601 – Association ends of Meas::MeasurementValueSource with other classes

mult from	name	mult to	type	description
1..1	MeasurementValues	0..*	MeasurementValue	The MeasurementValues updated by the source.
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.10.23 Quality61850 root class

Quality flags in this class are as defined in IEC 61850, except for estimatorReplaced, which has been included in this class for convenience.

Table 602 shows all attributes of Quality61850.

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Table 602 – Attributes of Meas::Quality61850

name	mult	type	description
badReference	0..1	Boolean	Measurement value may be incorrect due to a reference being out of calibration.
estimatorReplaced	0..1	Boolean	Value has been replaced by State Estimator. estimatorReplaced is not an IEC61850 quality bit but has been put in this class for convenience.
failure	0..1	Boolean	This identifier indicates that a supervision function has detected an internal or external failure, e.g. communication failure.
oldData	0..1	Boolean	Measurement value is old and possibly invalid, as it has not been successfully updated during a specified time interval.
operatorBlocked	0..1	Boolean	Measurement value is blocked and hence unavailable for transmission.
oscillatory	0..1	Boolean	To prevent some overload of the communication it is sensible to detect and suppress oscillating (fast changing) binary inputs. If a signal changes in a defined time twice in the same direction (from 0 to 1 or from 1 to 0) then oscillation is detected and the detail quality identifier "oscillatory" is set. If it is detected a configured numbers of transient changes could be passed by. In this time the validity status "questionable" is set. If after this defined numbers of changes the signal is still in the oscillating state the value shall be set either to the opposite state of the previous stable value or to a defined default value. In this case the validity status "questionable" is reset and "invalid" is set as long as the signal is oscillating. If it is configured such that no transient changes should be passed by then the validity status "invalid" is set immediately in addition to the detail quality identifier "oscillatory" (used for status information only).
outOfRange	0..1	Boolean	Measurement value is beyond a predefined range of value.
overFlow	0..1	Boolean	Measurement value is beyond the capability of being represented properly. For example, a counter value overflows from maximum count back to a value of zero.
source	0..1	Source	Source gives information related to the origin of a value. The value may be acquired from the process, defaulted or substituted.
suspect	0..1	Boolean	A correlation function has detected that the value is not consistent with other values. Typically set by a network State Estimator.
test	0..1	Boolean	Measurement value is transmitted for test purposes.
validity	0..1	Validity	Validity of the measurement value.

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6.10.24 RaiseLowerCommand

An analog control that increases or decreases a set point value with pulses. Unless otherwise specified, one pulse moves the set point by one.

Table 603 shows all attributes of RaiseLowerCommand.

Table 603 – Attributes of Meas::RaiseLowerCommand

name	mult	type	description
maxValue	0..1	Float	inherited from: AnalogControl
minValue	0..1	Float	inherited from: AnalogControl
operationInProgress	0..1	Boolean	inherited from: Control
timeStamp	0..1	DateTime	inherited from: Control
unitMultiplier	0..1	UnitMultiplier	inherited from: Control
unitSymbol	0..1	UnitSymbol	inherited from: Control
controlType	0..1	String	inherited from: Control
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 604 shows all association ends of RaiseLowerCommand with other classes.

Table 604 – Association ends of Meas::RaiseLowerCommand with other classes

mult from	name	mult to	type	description
0..*	ValueAliasSet	0..1	ValueAliasSet	The ValueAliasSet used for translation of a Control value to a name.
0..1	AnalogValue	1..1	AnalogValue	inherited from: AnalogControl
0..*	PowerSystemResource	0..1	PowerSystemResource	inherited from: Control
1..1	RemoteControl	0..1	RemoteControl	inherited from: Control
0..1	BilateralToIOPoint	0..*	ProvidedBilateralPoint	inherited from: IOPoint
0..*	IOPointSource	0..1	IOPointSource	inherited from: IOPoint
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.10.25 SetPoint

An analog control that issues a set point value.

Table 605 shows all attributes of SetPoint.

Table 605 – Attributes of Meas::SetPoint

name	mult	type	description
normalValue	0..1	Float	Normal value for Control.value e.g. used for percentage scaling.
value	0..1	Float	The value representing the actuator output.
maxValue	0..1	Float	inherited from: AnalogControl
minValue	0..1	Float	inherited from: AnalogControl
operationInProgress	0..1	Boolean	inherited from: Control
timeStamp	0..1	DateTime	inherited from: Control
unitMultiplier	0..1	UnitMultiplier	inherited from: Control
unitSymbol	0..1	UnitSymbol	inherited from: Control

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name	mult	type	description
controlType	0..1	String	inherited from: Control
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 606 shows all association ends of SetPoint with other classes.

Table 606 – Association ends of Meas::SetPoint with other classes

mult from	name	mult to	type	description
0..1	AnalogValue	1..1	AnalogValue	inherited from: AnalogControl
0..*	PowerSystemResource	0..1	PowerSystemResource	inherited from: Control
1..1	RemoteControl	0..1	RemoteControl	inherited from: Control
0..1	BilateralToIOPoint	0..*	ProvidedBilateralPoint	inherited from: IOPoint
0..*	IOPointSource	0..1	IOPointSource	inherited from: IOPoint
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.10.26 StringMeasurement

StringMeasurement represents a measurement with values of type string.

Table 607 shows all attributes of StringMeasurement.

Table 607 – Attributes of Meas::StringMeasurement

name	mult	type	description
measurementType	0..1	String	inherited from: Measurement
phases	0..1	PhaseCode	inherited from: Measurement
unitMultiplier	0..1	UnitMultiplier	inherited from: Measurement
unitSymbol	0..1	UnitSymbol	inherited from: Measurement
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 608 shows all association ends of StringMeasurement with other classes.

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Table 608 – Association ends of Meas::StringMeasurement with other classes

mult from	name	mult to	type	description
1..1	StringMeasurementValues	0..*	StringMeasurementValue	The values connected to this measurement.
0..*	Terminal	0..1	ACDCTerminal	inherited from: Measurement
0..*	PowerSystemResource	0..1	PowerSystemResource	inherited from: Measurement
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.10.27 StringMeasurementValue

StringMeasurementValue represents a measurement value of type string.

Table 609 shows all attributes of StringMeasurementValue.

Table 609 – Attributes of Meas::StringMeasurementValue

name	mult	type	description
value	0..1	String	The value to supervise.
timeStamp	0..1	DateTime	inherited from: MeasurementValue
sensorAccuracy	0..1	PerCent	inherited from: MeasurementValue
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 610 shows all association ends of StringMeasurementValue with other classes.

Table 610 – Association ends of Meas::StringMeasurementValue with other classes

mult from	name	mult to	type	description
0..*	StringMeasurement	1..1	StringMeasurement	Measurement to which this value is connected.
1..1	RemoteSource	0..1	RemoteSource	inherited from: MeasurementValue
1..1	MeasurementValueQuality	0..1	MeasurementValueQuality	inherited from: MeasurementValue
0..*	MeasurementValueSource	1..1	MeasurementValueSource	inherited from: MeasurementValue
0..1	BilateralToIOPoint	0..*	ProvidedBilateralPoint	inherited from: IOPoint
0..*	IOPointSource	0..1	IOPointSource	inherited from: IOPoint
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.10.28 Validity enumeration

Validity for MeasurementValue.

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Table 611 shows all literals of Validity.

Table 611 – Literals of Meas::Validity

literal	value	description
GOOD		The value is marked good if no abnormal condition of the acquisition function or the information source is detected.
QUESTIONABLE		The value is marked questionable if a supervision function detects an abnormal behaviour, however the value could still be valid. The client is responsible for determining whether or not values marked "questionable" should be used.
INVALID		The value is marked invalid when a supervision function recognises abnormal conditions of the acquisition function or the information source (missing or non-operating updating devices). The value is not defined under this condition. The mark invalid is used to indicate to the client that the value may be incorrect and shall not be used.

6.10.29 ValueAliasSet

Describes the translation of a set of values into a name and is intendend to facilitate custom translations. Each ValueAliasSet has a name, description etc. A specific Measurement may represent a discrete state like Open, Closed, Intermediate etc. This requires a translation from the MeasurementValue.value number to a string, e.g. 0->"Invalid", 1->"Open", 2->"Closed", 3->"Intermediate". Each ValueToAlias member in ValueAliasSet.Value describe a mapping for one particular value to a name.

Table 612 shows all attributes of ValueAliasSet.

Table 612 – Attributes of Meas::ValueAliasSet

name	mult	type	description
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 613 shows all association ends of ValueAliasSet with other classes.

Table 613 – Association ends of Meas::ValueAliasSet with other classes

mult from	name	mult to	type	description
0..1	Discretes	0..*	Discrete	The Measurements using the set for translation.
1..1	Values	1..*	ValueToAlias	The ValueToAlias mappings included in the set.
0..1	Commands	0..*	Command	The Commands using the set for translation.
0..1	RaiseLowerCommands	0..*	RaiseLowerCommand	The Commands using the set for translation.
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject

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mult from	name	mult to	type	description
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.10.30 ValueToAlias

Describes the translation of one particular value into a name, e.g. 1 as "Open".

Table 614 shows all attributes of ValueToAlias.

Table 614 – Attributes of Meas::ValueToAlias

name	mult	type	description
value	0..1	Integer	The value that is mapped.
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 615 shows all association ends of ValueToAlias with other classes.

Table 615 – Association ends of Meas::ValueToAlias with other classes

mult from	name	mult to	type	description
1..*	ValueAliasSet	1..1	ValueAliasSet	The ValueAliasSet having the ValueToAlias mappings.
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.11 Package Topology

6.11.1 General

An extension to the Core Package that, in association with the Terminal class, models Connectivity, that is the physical definition of how equipment is connected together. In addition it models Topology, that is the logical definition of how equipment is connected via closed switches. The Topology definition is independent of the other electrical characteristics.

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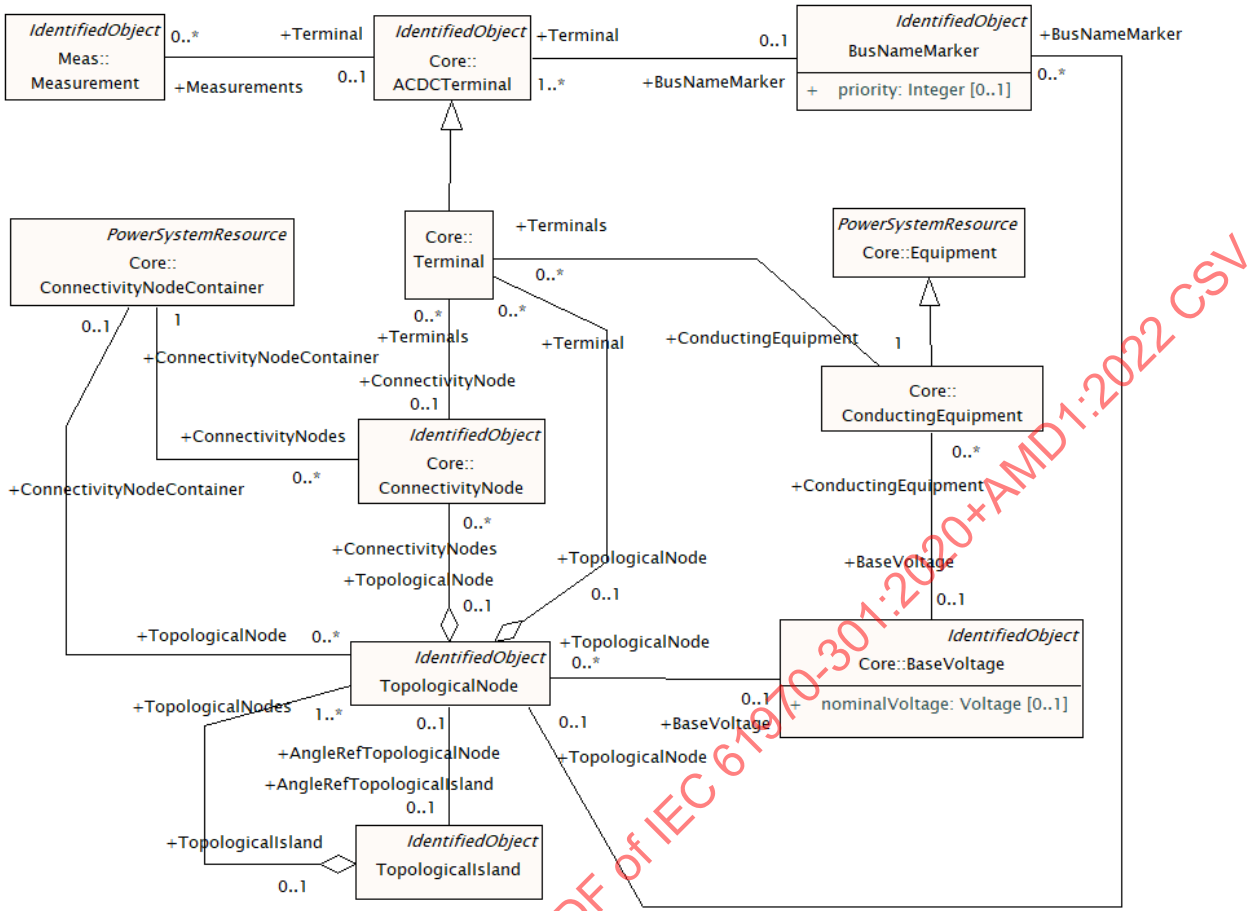


Figure 124 – Class diagram Topology::Main

Figure 124: This diagram shows all classes included in the Topology package as well as the key external classes that have associations with Topology classes.

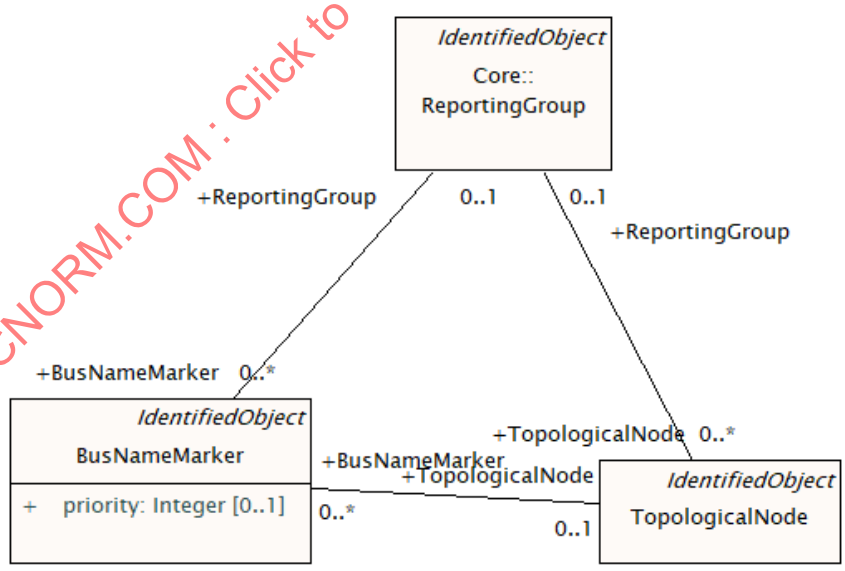


Figure 125 – Class diagram Topology::TopologyReporting

Figure 125: Shows topology reporting relationships.

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6.11.2 BusNameMarker

Used to apply user standard names to TopologicalNodes. Associated with one or more terminals that are normally connected with the bus name. The associated terminals are normally connected by non-retained switches. For a ring bus station configuration, all BusbarSection terminals in the ring are typically associated. For a breaker and a half scheme, both BusbarSections would normally be associated. For a ring bus, all BusbarSections would normally be associated. For a "straight" busbar configuration, normally only the main terminal at the BusbarSection would be associated.

Table 616 shows all attributes of BusNameMarker.

Table 616 – Attributes of Topology::BusNameMarker

name	mult	type	description
priority	0..1	Integer	Priority of bus name marker for use as topology bus name. Use 0 for do not care. Use 1 for highest priority. Use 2 as priority is less than 1 and so on.
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 617 shows all association ends of BusNameMarker with other classes.

Table 617 – Association ends of Topology::BusNameMarker with other classes

mult from	name	mult to	type	description
0..1	Terminal	1..*	ACDCTerminal	The terminals associated with this bus name marker.
0..*	ReportingGroup	0..1	ReportingGroup	The reporting group to which this bus name marker belongs.
0..*	TopologicalNode	0..1	TopologicalNode	A user defined topological node that was originally defined in a planning model not yet having topology described by ConnectivityNodes. Once ConnectivityNodes has been created they may linked to user defined ToplogicalNdes using BusNameMarkers.
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.11.3 TopologicalIsland

An electrically connected subset of the network. Topological islands can change as the current network state changes, e.g. due to:

– disconnect switches or breakers changing state in a SCADA/EMS.
– manual creation, change or deletion of topological nodes in a planning tool.

Only energised TopologicalNode-s shall be part of the topological island.

Table 618 shows all attributes of TopologicalIsland.

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Table 618 – Attributes of Topology::TopologicalIsland

name	mult	type	description
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 619 shows all association ends of TopologicalIsland with other classes.

Table 619 – Association ends of Topology::TopologicalIsland with other classes

mult from	name	mult to	type	description
0..1	AngleRefTopologicalNode	0..1	TopologicalNode	The angle reference for the island. Normally there is one TopologicalNode that is selected as the angle reference for each island. Other reference schemes exist, so the association is typically optional.
0..1	TopologicalNodes	1..*	TopologicalNode	A topological node belongs to a topological island.
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.11.4 TopologicalNode

For a detailed substation model a topological node is a set of connectivity nodes that, in the current network state, are connected together through any type of closed switches, including jumpers. Topological nodes change as the current network state changes (i.e., switches, breakers, etc. change state).

For a planning model, switch statuses are not used to form topological nodes. Instead they are manually created or deleted in a model builder tool. Topological nodes maintained this way are also called "busses".

Table 620 shows all attributes of TopologicalNode.

Table 620 – Attributes of Topology::TopologicalNode

name	mult	type	description
pInjection	0..1	ActivePower	The active power injected into the bus at this location in addition to injections from equipment. Positive sign means injection into the TopologicalNode (bus). Starting value for a steady state solution.
qInjection	0..1	ReactivePower	The reactive power injected into the bus at this location in addition to injections from equipment. Positive sign means injection into the TopologicalNode (bus). Starting value for a steady state solution.
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject

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name	mult	type	description
name	0..1	String	inherited from: IdentifiedObject

Table 621 shows all association ends of TopologicalNode with other classes.

Table 621 – Association ends of Topology::TopologicalNode with other classes

mult from	name	mult to	type	description
0..*	BaseVoltage	0..1	BaseVoltage	The base voltage of the topological node.
0..*	ConnectivityNodeContainer	0..1	ConnectivityNodeContainer	The connectivity node container to which the topological node belongs.
0..*	ReportingGroup	0..1	ReportingGroup	The reporting group to which the topological node belongs.
1..*	TopologicalIsland	0..1	TopologicalIsland	A topological node belongs to a topological island.
0..1	ConnectivityNodes	0..*	ConnectivityNode	The connectivity nodes combine together to form this topological node. May depend on the current state of switches in the network.
0..1	Terminal	0..*	Terminal	The terminals associated with the topological node. This can be used as an alternative to the connectivity node path to terminal, thus making it unnecessary to model connectivity nodes in some cases. Note that if connectivity nodes are in the model, this association would probably not be used as an input specification.
0..1	BusNameMarker	0..*	BusNameMarker	BusnameMarkers that may refer to a pre defined TopologicalNode.
0..1	AngleRefTopologicalIsland	0..1	TopologicalIsland	The island for which the node is an angle reference. Normally there is one angle reference node for each island.
1..1	SvInjection	0..*	SvInjection	The injection flows state variables associated with the topological node.
1..1	SvVoltage	0..*	SvVoltage	The state voltage associated with the topological node.
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.12 Package DiagramLayout

6.12.1 General

This package describes diagram layout. This describes how objects are arranged in a coordinate system rather than how they are rendered.

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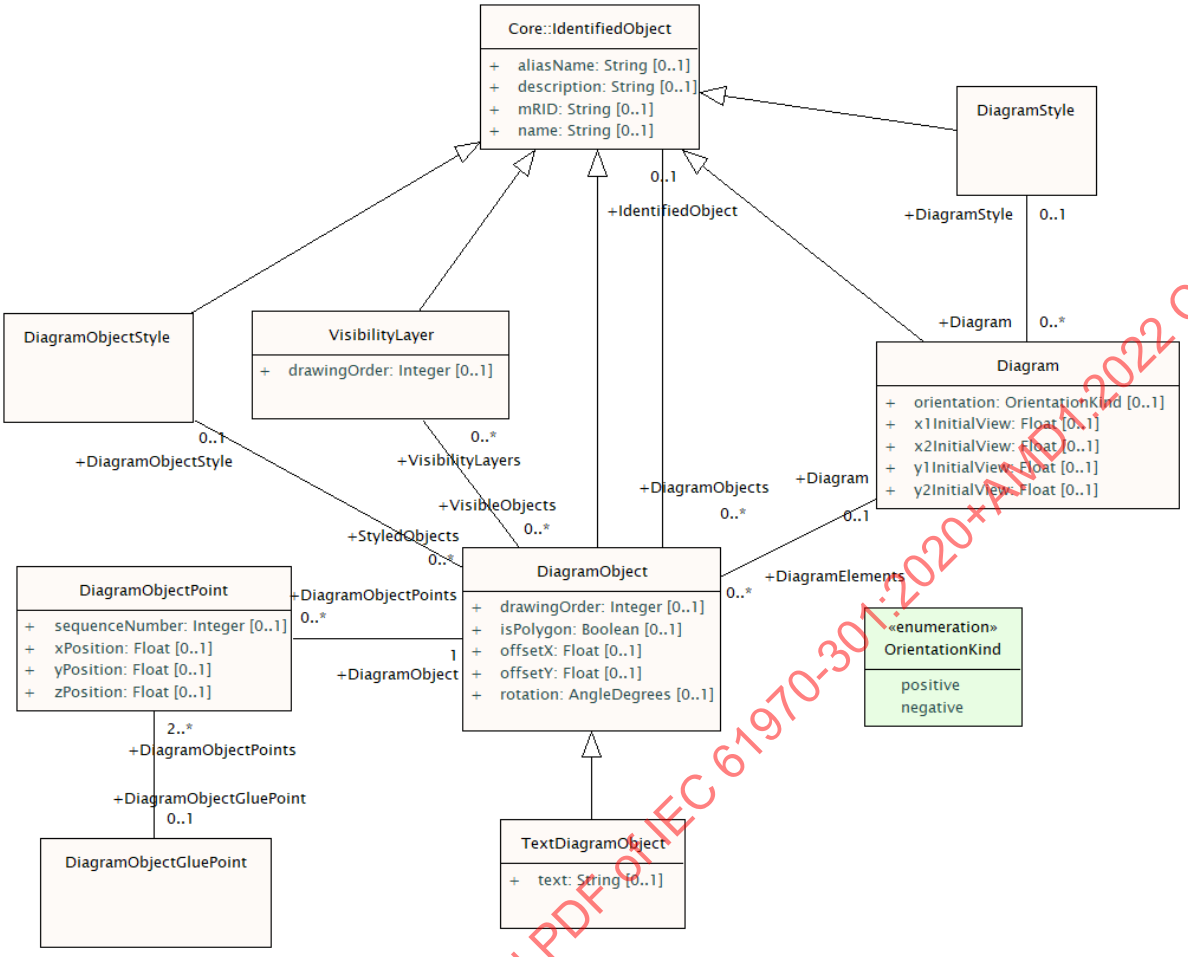


Figure 126 – Class diagram DiagramLayout::DiagramLayout

Figure 126: Shows model for diagram layout.

6.12.2 Diagram

The diagram being exchanged. The coordinate system is a standard Cartesian coordinate system and the orientation attribute defines the orientation. The initial view related attributes can be used to specify an initial view with the x,y coordinates of the diagonal points.

Table 622 shows all attributes of Diagram.

Table 622 – Attributes of DiagramLayout::Diagram

name	mult	type	description
orientation	0..1	OrientationKind	Coordinate system orientation of the diagram. A positive orientation gives standard “right-hand” orientation, with negative orientation indicating a “left-hand” orientation. For 2D diagrams, a positive orientation will result in X values increasing from left to right and Y values increasing from bottom to top. A negative orientation gives the “left-hand” orientation (favoured by computer graphics displays) with X values increasing from left to right and Y values increasing from top to bottom.
x1InitialView	0..1	Float	X coordinate of the first corner of the initial view.

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name	mult	type	description
x2InitialView	0..1	Float	X coordinate of the second corner of the initial view.
y1InitialView	0..1	Float	Y coordinate of the first corner of the initial view.
y2InitialView	0..1	Float	Y coordinate of the second corner of the initial view.
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 623 shows all association ends of Diagram with other classes.

Table 623 – Association ends of DiagramLayout::Diagram with other classes

mult from	name	mult to	type	description
0..1	DiagramElements	0..*	DiagramObject	A diagram is made up of multiple diagram objects.
0..*	DiagramStyle	0..1	DiagramStyle	A Diagram may have a DiagramStyle.
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.12.3 DiagramObject

An object that defines one or more points in a given space. This object can be associated with anything that specializes IdentifiedObject. For single line diagrams such objects typically include such items as analog values, breakers, disconnectors, power transformers, and transmission lines.

Table 624 shows all attributes of DiagramObject.

Table 624 – Attributes of DiagramLayout::DiagramObject

name	mult	type	description
drawingOrder	0..1	Integer	The drawing order of this element. The higher the number, the later the element is drawn in sequence. This is used to ensure that elements that overlap are rendered in the correct order.
isPolygon	0..1	Boolean	Defines whether or not the diagram objects points define the boundaries of a polygon or the routing of a polyline. If this value is true then a receiving application should consider the first and last points to be connected.
offsetX	0..1	Float	The offset in the X direction. This is used for defining the offset from centre for rendering an icon (the default is that a single point specifies the centre of the icon). The offset is in per-unit with 0 indicating there is no offset from the horizontal centre of the icon. -0.5 indicates it is offset by 50% to the left and 0.5 indicates an offset of 50% to the right.

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name	mult	type	description
offsetY	0..1	Float	The offset in the Y direction. This is used for defining the offset from centre for rendering an icon (the default is that a single point specifies the centre of the icon). The offset is in per-unit with 0 indicating there is no offset from the vertical centre of the icon. The offset direction is dependent on the orientation of the diagram, with -0.5 and 0.5 indicating an offset of +/- 50% on the vertical axis.
rotation	0..1	AngleDegrees	Sets the angle of rotation of the diagram object. Zero degrees is pointing to the top of the diagram. Rotation is clockwise. DiagramObject.rotation=0 has the following meaning: The connection point of an element which has one terminal is pointing to the top side of the diagram. The connection point "From side" of an element which has more than one terminal is pointing to the top side of the diagram. DiagramObject.rotation=90 has the following meaning: The connection point of an element which has one terminal is pointing to the right hand side of the diagram. The connection point "From side" of an element which has more than one terminal is pointing to the right hand side of the diagram.
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 625 shows all association ends of DiagramObject with other classes.

Table 625 – Association ends of DiagramLayout::DiagramObject with other classes

mult from	name	mult to	type	description
0..*	Diagram	0..1	Diagram	A diagram object is part of a diagram.
0..*	VisibilityLayers	0..*	VisibilityLayer	A diagram object can be part of multiple visibility layers.
1..1	DiagramObjectPoints	0..*	DiagramObjectPoint	A diagram object can have 0 or more points to reflect its layout position, routing (for polylines) or boundary (for polygons).
0..*	DiagramObjectStyle	0..1	DiagramObjectStyle	A diagram object has a style associated that provides a reference for the style used in the originating system.
0..*	IdentifiedObject	0..1	IdentifiedObject	The domain object to which this diagram object is associated.
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

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6.12.4 DiagramObjectGluePoint root class

This is used for grouping diagram object points from different diagram objects that are considered to be glued together in a diagram even if they are not at the exact same coordinates.

Table 626 shows all association ends of DiagramObjectGluePoint with other classes.

Table 626 – Association ends of DiagramLayout::DiagramObjectGluePoint with other classes

mult from	name	mult to	type	description
0..1	DiagramObjectPoints	2..*	DiagramObjectPoint	A diagram object glue point is associated with 2 or more object points that are considered to be 'glued' together.

6.12.5 DiagramObjectPoint root class

A point in a given space defined by 3 coordinates and associated to a diagram object. The coordinates may be positive or negative as the origin does not have to be in the corner of a diagram.

Table 627 shows all attributes of DiagramObjectPoint.

Table 627 – Attributes of DiagramLayout::DiagramObjectPoint

name	mult	type	description
sequenceNumber	0..1	Integer	The sequence position of the point, used for defining the order of points for diagram objects acting as a polyline or polygon with more than one point. The attribute shall be a positive value.
xPosition	0..1	Float	The X coordinate of this point.
yPosition	0..1	Float	The Y coordinate of this point.
zPosition	0..1	Float	The Z coordinate of this point.

Table 628 shows all association ends of DiagramObjectPoint with other classes.

Table 628 – Association ends of DiagramLayout::DiagramObjectPoint with other classes

mult from	name	mult to	type	description
2..*	DiagramObjectGluePoint	0..1	DiagramObjectGluePoint	The 'glue' point to which this point is associated.
0..*	DiagramObject	1..1	DiagramObject	The diagram object with which the points are associated.

6.12.6 DiagramObjectStyle

A reference to a style used by the originating system for a diagram object. A diagram object style describes information such as line thickness, shape such as circle or rectangle etc, and colour.

Table 629 shows all attributes of DiagramObjectStyle.

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Table 629 – Attributes of DiagramLayout::DiagramObjectStyle

name	mult	type	description
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 630 shows all association ends of DiagramObjectStyle with other classes.

Table 630 – Association ends of DiagramLayout::DiagramObjectStyle with other classes

mult from	name	mult to	type	description
0..1	StyledObjects	0..*	DiagramObject	A style can be assigned to multiple diagram objects.
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.12.7 DiagramStyle

The diagram style refers to a style used by the originating system for a diagram. A diagram style describes information such as schematic, geographic, etc.

Table 631 shows all attributes of DiagramStyle.

Table 631 – Attributes of DiagramLayout::DiagramStyle

name	mult	type	description
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 632 shows all association ends of DiagramStyle with other classes.

Table 632 – Association ends of DiagramLayout::DiagramStyle with other classes

mult from	name	mult to	type	description
0..1	Diagram	0..*	Diagram	A DiagramStyle can be used by many Diagrams.
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.12.8 OrientationKind enumeration

The orientation of the coordinate system with respect to top, left, and the coordinate number system.

Table 633 shows all literals of OrientationKind.

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Table 633 – Literals of DiagramLayout::OrientationKind

literal	value	description
positive		For 2D diagrams, a positive orientation will result in X values increasing from left to right and Y values increasing from bottom to top. This is also known as a right hand orientation.
negative		For 2D diagrams, a negative orientation gives the left-hand orientation (favoured by computer graphics displays) with X values increasing from left to right and Y values increasing from top to bottom. This is also known as a left hand orientation.

6.12.9 TextDiagramObject

A diagram object for placing free-text or text derived from an associated domain object.

Table 634 shows all attributes of TextDiagramObject.

Table 634 – Attributes of DiagramLayout::TextDiagramObject

name	mult	type	description
text	0..1	String	The text that is displayed by this text diagram object.
drawingOrder	0..1	Integer	inherited from: DiagramObject
isPolygon	0..1	Boolean	inherited from: DiagramObject
offsetX	0..1	Float	inherited from: DiagramObject
offsetY	0..1	Float	inherited from: DiagramObject
rotation	0..1	AngleDegrees	inherited from: DiagramObject
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 635 shows all association ends of TextDiagramObject with other classes.

Table 635 – Association ends of DiagramLayout::TextDiagramObject with other classes

mult from	name	mult to	type	description
0..*	Diagram	0..1	Diagram	inherited from: DiagramObject
0..*	VisibilityLayers	0..*	VisibilityLayer	inherited from: DiagramObject
1..1	DiagramObjectPoints	0..*	DiagramObjectPoint	inherited from: DiagramObject
0..*	DiagramObjectStyle	0..1	DiagramObjectStyle	inherited from: DiagramObject
0..*	IdentifiedObject	0..1	IdentifiedObject	inherited from: DiagramObject
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

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6.12.10 VisibilityLayer

Layers are typically used for grouping diagram objects according to themes and scales. Themes are used to display or hide certain information (e.g., lakes, borders), while scales are used for hiding or displaying information depending on the current zoom level (hide text when it is too small to be read, or when it exceeds the screen size). This is also called de-cluttering.

CIM based graphics exchange supports an m:n relationship between diagram objects and layers. The importing system shall convert an m:n case into an appropriate 1:n representation if the importing system does not support m:n.

Table 636 shows all attributes of VisibilityLayer.

Table 636 – Attributes of DiagramLayout::VisibilityLayer

name	mult	type	description
drawingOrder	0..1	Integer	The drawing order for this layer. The higher the number, the later the layer and the objects within it are rendered.
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 637 shows all association ends of VisibilityLayer with other classes.

Table 637 – Association ends of DiagramLayout::VisibilityLayer with other classes

mult from	name	mult to	type	description
0..*	VisibleObjects	0..*	DiagramObject	A visibility layer can contain one or more diagram objects.
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.13 Package OperationalLimits

6.13.1 General

This package models a specification of limits associated with equipment and other operational entities.

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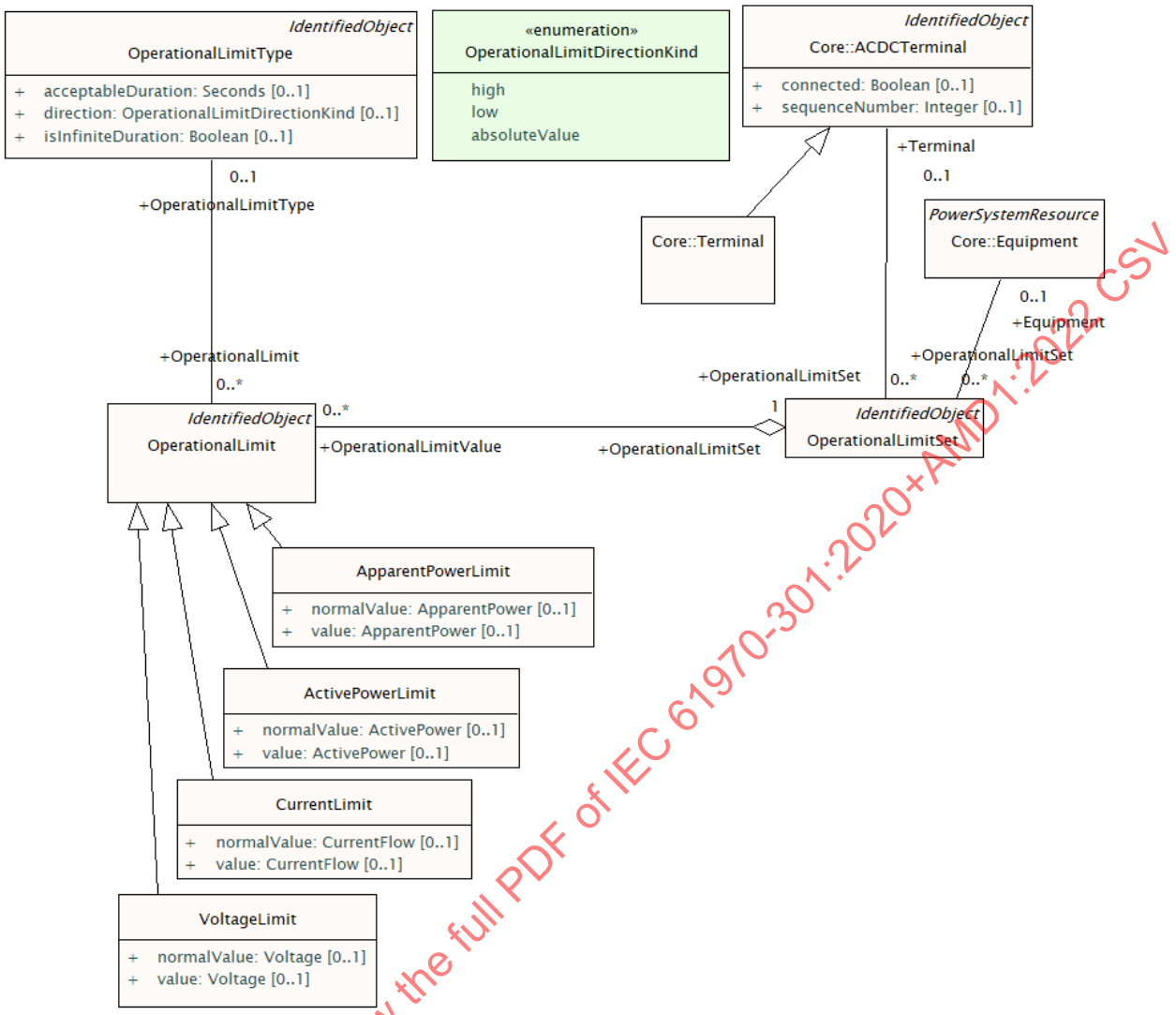


Figure 127 – Class diagram OperationalLimits::OperationalLimits

Figure 127: This diagram shows operational limits as they tie back into the core model.

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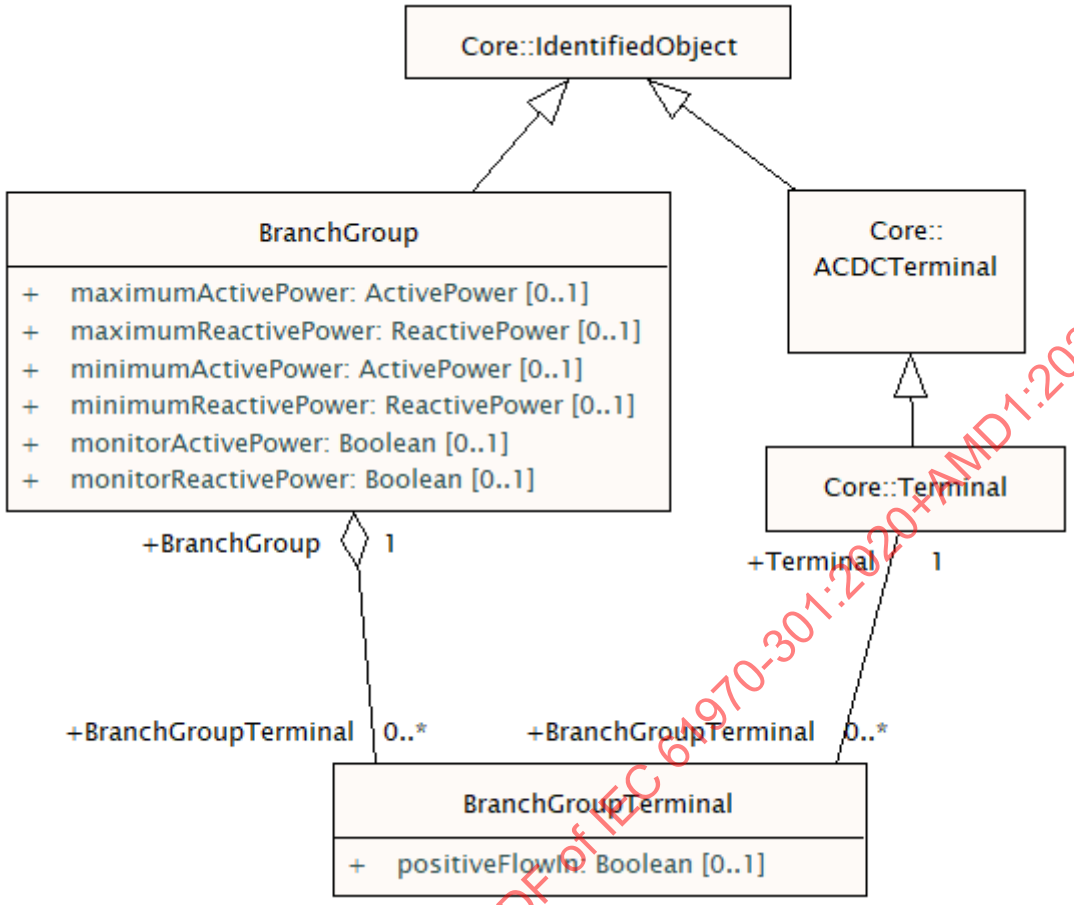


Figure 128 – Class diagram OperationalLimits::BranchGroup

Figure 128: This diagram shows the model for monitoring combined flows on groups of branches.

6.13.2 ActivePowerLimit

Limit on active power flow.

Table 638 shows all attributes of ActivePowerLimit.

Table 638 – Attributes of OperationalLimits::ActivePowerLimit

name	mult	type	description
normalValue	0..1	ActivePower	The normal value of active power limit. The attribute shall be a positive value or zero.
value	0..1	ActivePower	Value of active power limit. The attribute shall be a positive value or zero.
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 639 shows all association ends of ActivePowerLimit with other classes.

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Table 639 – Association ends of OperationalLimits::ActivePowerLimit with other classes

mult from	name	mult to	type	description
0..*	OperationalLimitSet	1..1	OperationalLimitSet	inherited from: OperationalLimit
0..*	OperationalLimitType	0..1	OperationalLimitType	inherited from: OperationalLimit
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.13.3 ApparentPowerLimit

Apparent power limit.

Table 640 shows all attributes of ApparentPowerLimit.

Table 640 – Attributes of OperationalLimits::ApparentPowerLimit

name	mult	type	description
normalValue	0..1	ApparentPower	The normal apparent power limit. The attribute shall be a positive value or zero.
value	0..1	ApparentPower	The apparent power limit. The attribute shall be a positive value or zero.
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 641 shows all association ends of ApparentPowerLimit with other classes.

Table 641 – Association ends of OperationalLimits::ApparentPowerLimit with other classes

mult from	name	mult to	type	description
0..*	OperationalLimitSet	1..1	OperationalLimitSet	inherited from: OperationalLimit
0..*	OperationalLimitType	0..1	OperationalLimitType	inherited from: OperationalLimit
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.13.4 BranchGroup

A group of branch terminals whose directed flow summation is to be monitored. A branch group need not form a cutset of the network.

Table 642 shows all attributes of BranchGroup.

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Table 642 – Attributes of OperationalLimits::BranchGroup

name	mult	type	description
maximumActivePower	0..1	ActivePower	The maximum active power flow.
maximumReactivePower	0..1	ReactivePower	The maximum reactive power flow.
minimumActivePower	0..1	ActivePower	The minimum active power flow.
minimumReactivePower	0..1	ReactivePower	The minimum reactive power flow.
monitorActivePower	0..1	Boolean	Monitor the active power flow.
monitorReactivePower	0..1	Boolean	Monitor the reactive power flow.
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 643 shows all association ends of BranchGroup with other classes.

Table 643 – Association ends of OperationalLimits::BranchGroup with other classes

mult from	name	mult to	type	description
1..1	BranchGroupTerminal	0..*	BranchGroupTerminal	The directed branch group terminals to be summed.
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.13.5 BranchGroupTerminal root class

A specific directed terminal flow for a branch group.

Table 644 shows all attributes of BranchGroupTerminal.

Table 644 – Attributes of OperationalLimits::BranchGroupTerminal

name	mult	type	description
positiveFlowIn	0..1	Boolean	The flow into the terminal is summed if set true. The flow out of the terminal is summed if set false.

Table 645 shows all association ends of BranchGroupTerminal with other classes.

Table 645 – Association ends of OperationalLimits::BranchGroupTerminal with other classes

mult from	name	mult to	type	description
0..*	Terminal	1..1	Terminal	The terminal to be summed.
0..*	BranchGroup	1..1	BranchGroup	The branch group to which the directed branch group terminals belong.

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6.13.6 CurrentLimit

Operational limit on current.

Table 646 shows all attributes of CurrentLimit.

Table 646 – Attributes of OperationalLimits::CurrentLimit

name	mult	type	description
normalValue	0..1	CurrentFlow	The normal value for limit on current flow. The attribute shall be a positive value or zero.
value	0..1	CurrentFlow	Limit on current flow. The attribute shall be a positive value or zero.
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 647 shows all association ends of CurrentLimit with other classes.

Table 647 – Association ends of OperationalLimits::CurrentLimit with other classes

mult from	name	mult to	type	description
0..*	OperationalLimitSet	1..1	OperationalLimitSet	inherited from: OperationalLimit
0..*	OperationalLimitType	0..1	OperationalLimitType	inherited from: OperationalLimit
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.13.7 OperationalLimit

A value and normal value associated with a specific kind of limit.

The sub class value and normalValue attributes vary inversely to the associated OperationalLimitType.acceptableDuration (acceptableDuration for short).

If a particular piece of equipment has multiple operational limits of the same kind (apparent power, current, etc.), the limit with the greatest acceptableDuration shall have the smallest limit value and the limit with the smallest acceptableDuration shall have the largest limit value. Note: A large current can only be allowed to flow through a piece of equipment for a short duration without causing damage, but a lesser current can be allowed to flow for a longer duration.

Table 648 shows all attributes of OperationalLimit.

Table 648 – Attributes of OperationalLimits::OperationalLimit

name	mult	type	description
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

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Table 649 shows all association ends of OperationalLimit with other classes.

Table 649 – Association ends of OperationalLimits::OperationalLimit with other classes

mult from	name	mult to	type	description
0..*	OperationalLimitSet	1..1	OperationalLimitSet	The limit set to which the limit values belong.
0..*	OperationalLimitType	0..1	OperationalLimitType	The limit type associated with this limit.
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.13.8 OperationalLimitDirectionKind enumeration

The direction attribute describes the side of a limit that is a violation.

Table 650 shows all literals of OperationalLimitDirectionKind.

Table 650 – Literals of OperationalLimits::OperationalLimitDirectionKind

literal	value	description
high		High means that a monitored value above the limit value is a violation. If applied to a terminal flow, the positive direction is into the terminal.
low		Low means a monitored value below the limit is a violation. If applied to a terminal flow, the positive direction is into the terminal.
absoluteValue		An absoluteValue limit means that a monitored absolute value above the limit value is a violation.

6.13.9 OperationalLimitSet

A set of limits associated with equipment. Sets of limits might apply to a specific temperature, or season for example. A set of limits may contain different severities of limit levels that would apply to the same equipment. The set may contain limits of different types such as apparent power and current limits or high and low voltage limits that are logically applied together as a set.

Table 651 shows all attributes of OperationalLimitSet.

Table 651 – Attributes of OperationalLimits::OperationalLimitSet

name	mult	type	description
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 652 shows all association ends of OperationalLimitSet with other classes.

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Table 652 – Association ends of OperationalLimits::OperationalLimitSet with other classes

mult from	name	mult to	type	description
0..*	Terminal	0..1	ACDCTerminal	The terminal where the operational limit set apply.
0..*	Equipment	0..1	Equipment	The equipment to which the limit set applies.
1..1	OperationalLimitValue	0..*	OperationalLimit	Values of equipment limits.
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.13.10 OperationalLimitType

The operational meaning of a category of limits.

Table 653 shows all attributes of OperationalLimitType.

Table 653 – Attributes of OperationalLimits::OperationalLimitType

name	mult	type	description
acceptableDuration	0..1	Seconds	The nominal acceptable duration of the limit. Limits are commonly expressed in terms of the time limit for which the limit is normally acceptable. The actual acceptable duration of a specific limit may depend on other local factors such as temperature or wind speed. The attribute has meaning only if the flag isInfiniteDuration is set to false, hence it shall not be exchanged when isInfiniteDuration is set to true.
direction	0..1	OperationalLimitDirectionKind	The direction of the limit.
isInfiniteDuration	0..1	Boolean	Defines if the operational limit type has infinite duration. If true, the limit has infinite duration. If false, the limit has definite duration which is defined by the attribute acceptableDuration.
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 654 shows all association ends of OperationalLimitType with other classes.

Table 654 – Association ends of OperationalLimits::OperationalLimitType with other classes

mult from	name	mult to	type	description
0..1	OperationalLimit	0..*	OperationalLimit	The operational limits associated with this type of limit.
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

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6.13.11 VoltageLimit

Operational limit applied to voltage.

The use of operational VoltageLimit is preferred instead of limits defined at VoltageLevel. The operational VoltageLimits are used, if present.

Table 655 shows all attributes of VoltageLimit.

Table 655 – Attributes of OperationalLimits::VoltageLimit

name	mult	type	description
normalValue	0..1	Voltage	The normal limit on voltage. High or low limit nature of the limit depends upon the properties of the operational limit type. The attribute shall be a positive value or zero.
value	0..1	Voltage	Limit on voltage. High or low limit nature of the limit depends upon the properties of the operational limit type. The attribute shall be a positive value or zero.
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 656 shows all association ends of VoltageLimit with other classes.

Table 656 – Association ends of OperationalLimits::VoltageLimit with other classes

mult from	name	mult to	type	description
0..*	OperationalLimitSet	1..1	OperationalLimitSet	inherited from: OperationalLimit
0..*	OperationalLimitType	0..1	OperationalLimitType	inherited from: OperationalLimit
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.14 Package ControlArea

6.14.1 General

The ControlArea package models area specifications which can be used for a variety of purposes. The package as a whole models potentially overlapping control area specifications for the purpose of actual generation control, load forecast area load capture, or powerflow based analysis.

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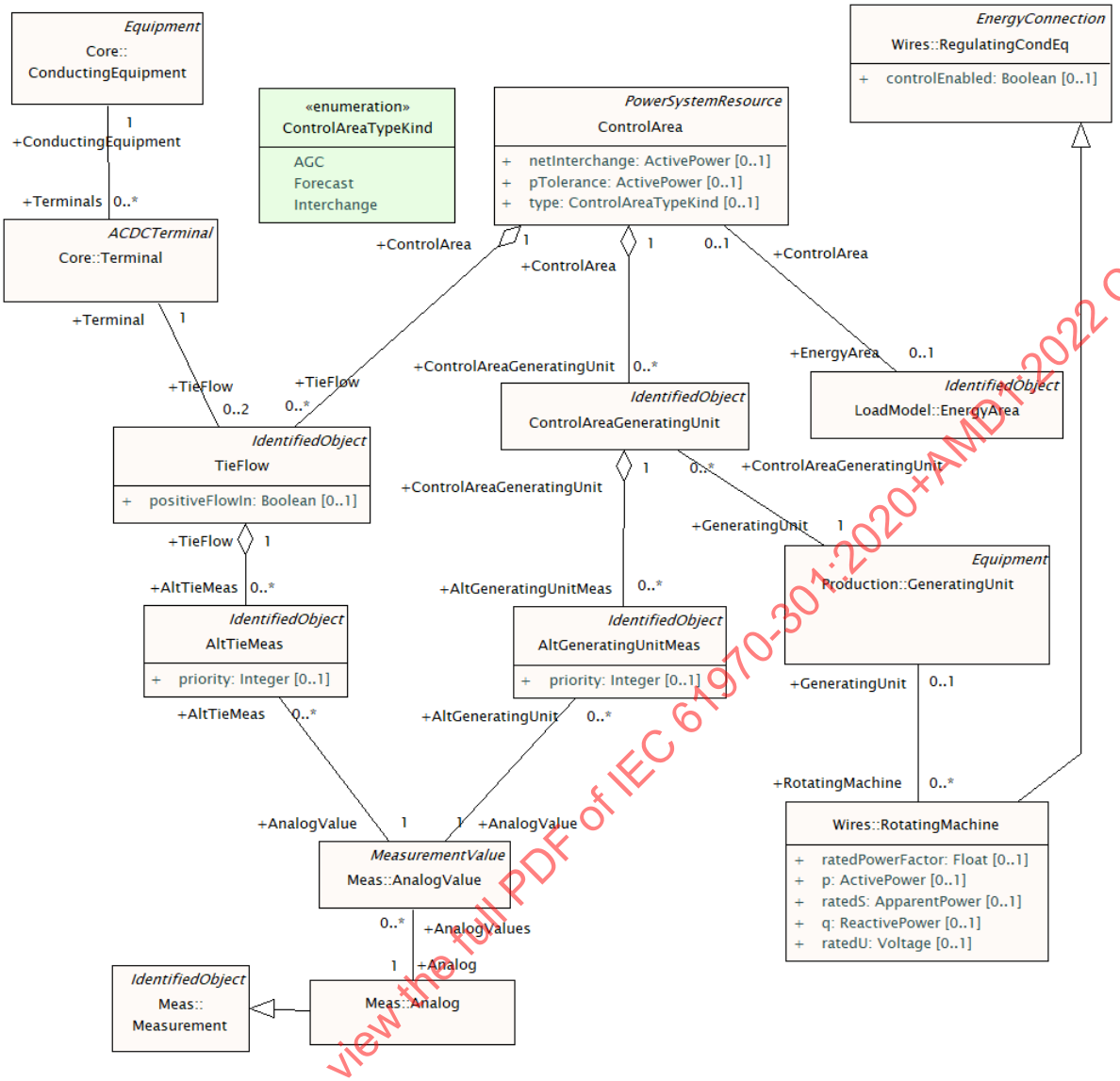


Figure 129 – Class diagram ControlArea::ControlArea

Figure 129: This diagram shows control area specification and some related classes. The Terminal to AnalogValue linkages are shown for clarity in understanding the control area specification. The GeneratingUnit to Terminal linkages are also shown to illustrate how generation flows are specifically tied to the network.

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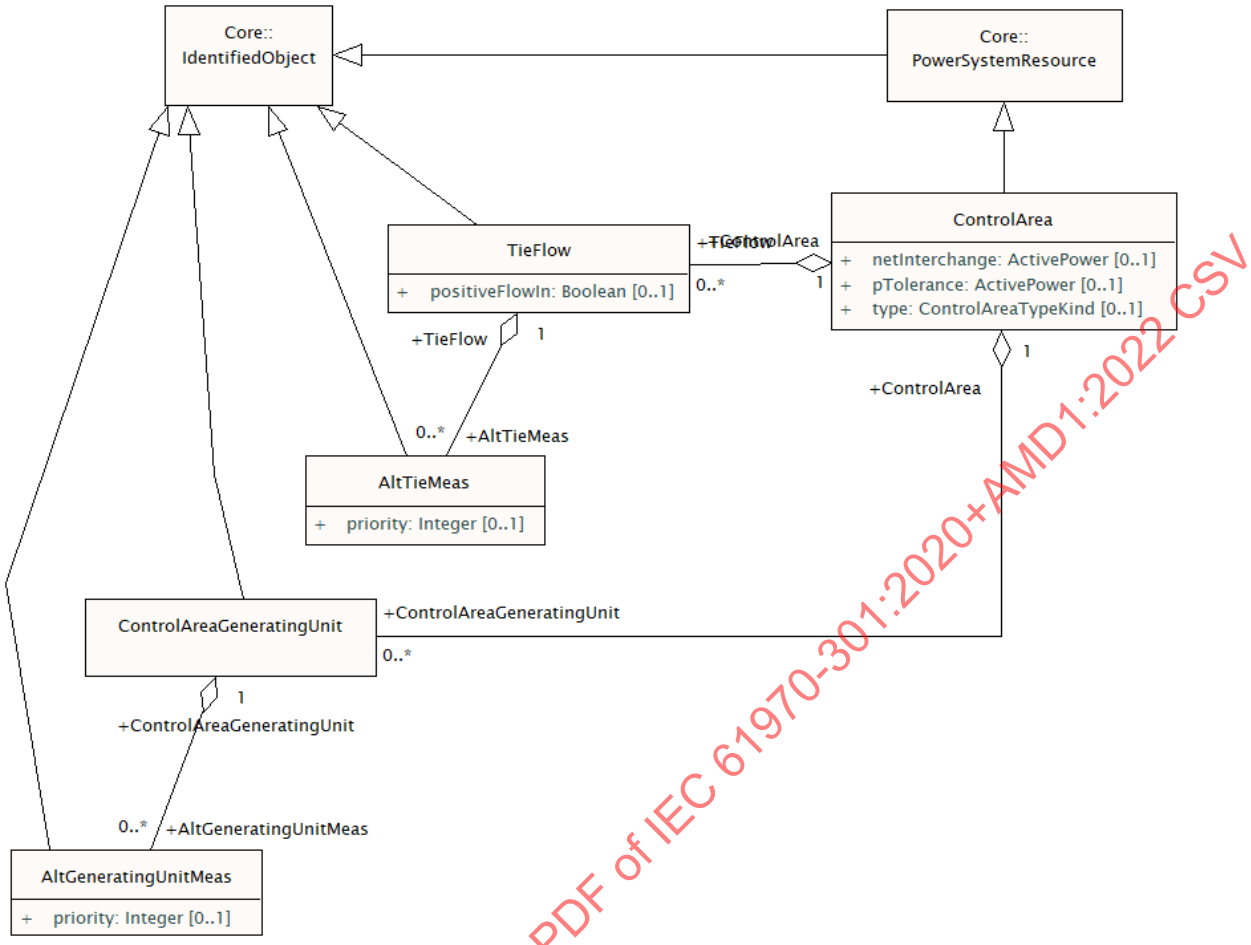


Figure 130 – Class diagram ControlArea::ControlAreaInheritance

Figure 130: Shows the inheritance of classes in this package.

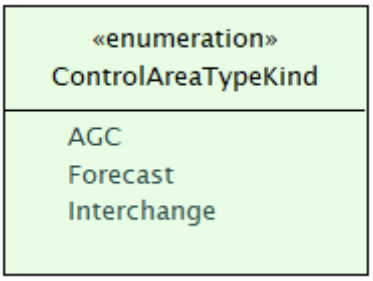


Figure 131 – Class diagram ControlArea::Datatypes

Figure 131: Shows datatypes for control areas.

6.14.2 AltGeneratingUnitMeas

A prioritized measurement to be used for the generating unit in the control area specification.

Table 657 shows all attributes of AltGeneratingUnitMeas.

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Table 657 – Attributes of ControlArea::AltGeneratingUnitMeas

name	mult	type	description
priority	0..1	Integer	Priority of a measurement usage. Lower numbers have first priority.
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 658 shows all association ends of AltGeneratingUnitMeas with other classes.

Table 658 – Association ends of ControlArea::AltGeneratingUnitMeas with other classes

mult from	name	mult to	type	description
0..*	AnalogValue	1..1	AnalogValue	The specific analog value used as a source.
0..*	ControlAreaGeneratingUnit	1..1	ControlAreaGeneratingUnit	The control area generating unit to which the prioritized measurement assignment is applied.
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.14.3 AltTieMeas

A prioritized measurement to be used for the tie flow as part of the control area specification.

Table 659 shows all attributes of AltTieMeas.

Table 659 – Attributes of ControlArea::AltTieMeas

name	mult	type	description
priority	0..1	Integer	Priority of a measurement usage. Lower numbers have first priority.
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 660 shows all association ends of AltTieMeas with other classes.

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Table 660 – Association ends of ControlArea::AltTieMeas with other classes

mult from	name	mult to	type	description
0..*	AnalogValue	1..1	AnalogValue	The specific analog value used as a source.
0..*	TieFlow	1..1	TieFlow	The tie flow of the alternate measurements.
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.14.4 ControlArea

A control area is a grouping of generating units and/or loads and a cutset of tie lines (as terminals) which may be used for a variety of purposes including automatic generation control, power flow solution area interchange control specification, and input to load forecasting. All generation and load within the area defined by the terminals on the border are considered in the area interchange control. Note that any number of overlapping control area specifications can be superimposed on the physical model. The following general principles apply to ControlArea:

1) The control area orientation for net interchange is positive for an import, negative for an export.
2) The control area net interchange is determined by summing flows in Terminals. The Terminals are identified by creating a set of TieFlow objects associated with a ControlArea object. Each TieFlow object identifies one Terminal.
3) In a single network model, a tie between two control areas must be modelled in both control area specifications, such that the two representations of the tie flow sum to zero.
4) The normal orientation of Terminal flow is positive for flow into the conducting equipment that owns the Terminal. (i.e. flow from a bus into a device is positive.) However, the orientation of each flow in the control area specification must align with the control area convention, i.e. import is positive. If the orientation of the Terminal flow referenced by a TieFlow is positive into the control area, then this is confirmed by setting TieFlow.positiveFlowIn flag TRUE. If not, the orientation must be reversed by setting the TieFlow.positiveFlowIn flag FALSE.

Table 661 shows all attributes of ControlArea.

Table 661 – Attributes of ControlArea::ControlArea

name	mult	type	description
netInterchange	0..1	ActivePower	The specified positive net interchange into the control area, i.e. positive sign means flow into the area.
pTolerance	0..1	ActivePower	Active power net interchange tolerance. The attribute shall be a positive value or zero.
type	0..1	ControlAreaTypeKind	The primary type of control area definition used to determine if this is used for automatic generation control, for planning interchange control, or other purposes. A control area specified with primary type of automatic generation control could still be forecast and used as an interchange area in power flow analysis.
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject

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name	mult	type	description
name	0..1	String	inherited from: IdentifiedObject

Table 662 shows all association ends of ControlArea with other classes.

Table 662 – Association ends of ControlArea::ControlArea with other classes

mult from	name	mult to	type	description
0..1	EnergyArea	0..1	EnergyArea	The energy area that is forecast from this control area specification.
1..1	ControlAreaGeneratingUnit	0..*	ControlAreaGeneratingUnit	The generating unit specifications for the control area.
1..1	TieFlow	0..*	TieFlow	The tie flows associated with the control area.
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.14.5 ControlAreaGeneratingUnit

A control area generating unit. This class is needed so that alternate control area definitions may include the same generating unit. It should be noted that only one instance within a control area should reference a specific generating unit.

Table 663 shows all attributes of ControlAreaGeneratingUnit.

Table 663 – Attributes of ControlArea::ControlAreaGeneratingUnit

name	mult	type	description
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 664 shows all association ends of ControlAreaGeneratingUnit with other classes.

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Table 664 – Association ends of ControlArea::ControlAreaGeneratingUnit with other classes

mult from	name	mult to	type	description
0..*	GeneratingUnit	1..1	GeneratingUnit	The generating unit specified for this control area. Note that a control area should include a GeneratingUnit only once.
0..*	ControlArea	1..1	ControlArea	The parent control area for the generating unit specifications.
1..1	AltGeneratingUnitMeas	0..*	AltGeneratingUnitMeas	The link to prioritized measurements for this GeneratingUnit.
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.14.6 ControlAreaTypeKind enumeration

The type of control area.

Table 665 shows all literals of ControlAreaTypeKind.

Table 665 – Literals of ControlArea::ControlAreaTypeKind

literal	value	description
AGC		Used for automatic generation control.
Forecast		Used for load forecast.
Interchange		Used for interchange specification or control.

6.14.7 TieFlow

Defines the structure (in terms of location and direction) of the net interchange constraint for a control area. This constraint may be used by either AGC or power flow.

Table 666 shows all attributes of TieFlow.

Table 666 – Attributes of ControlArea::TieFlow

name	mult	type	description
positiveFlowIn	0..1	Boolean	Specifies the sign of the tie flow associated with a control area. True if positive flow into the terminal (load convention) is also positive flow into the control area. See the description of ControlArea for further explanation of how TieFlow.positiveFlowIn is used.
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 667 shows all association ends of TieFlow with other classes.

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Table 667 – Association ends of ControlArea::TieFlow with other classes

mult from	name	mult to	type	description
0..2	Terminal	1..1	Terminal	The terminal to which this tie flow belongs.
0..*	ControlArea	1..1	ControlArea	The control area of the tie flows.
1..1	AltTieMeas	0..*	AltTieMeas	The primary and alternate tie flow measurements associated with the tie flow.
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.15 Package Contingency

6.15.1 General

Contingencies to be studied.

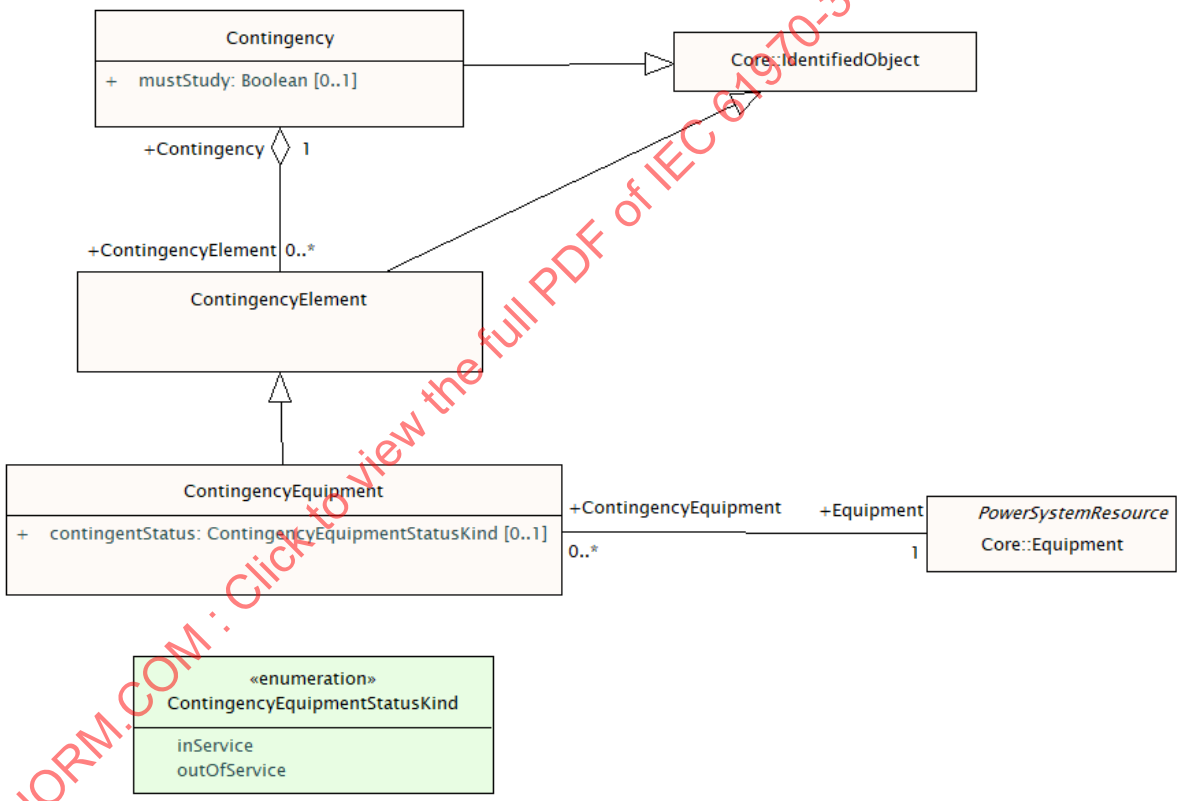


Figure 132 – Class diagram Contingency::Contingency

Figure 132: This diagram shows contingency model inheritance and associations.

6.15.2 Contingency

An event threatening system reliability, consisting of one or more contingency elements.

Table 668 shows all attributes of Contingency.

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Table 668 – Attributes of Contingency::Contingency

name	mult	type	description
mustStudy	0..1	Boolean	Set true if must study this contingency.
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 669 shows all association ends of Contingency with other classes.

Table 669 – Association ends of Contingency::Contingency with other classes

mult from	name	mult to	type	description
1..1	ContingencyElement	0..*	ContingencyElement	A contingency can have any number of contingency elements.
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.15.3 ContingencyElement

An element of a system event to be studied by contingency analysis, representing a change in status of a single piece of equipment.

Table 670 shows all attributes of ContingencyElement.

Table 670 – Attributes of Contingency::ContingencyElement

name	mult	type	description
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 671 shows all association ends of ContingencyElement with other classes.

Table 671 – Association ends of Contingency::ContingencyElement with other classes

mult from	name	mult to	type	description
0..*	Contingency	1..1	Contingency	A contingency element belongs to one contingency.
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.15.4 ContingencyEquipment

Equipment whose in service status is to change, such as a power transformer or AC line segment.

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Table 672 shows all attributes of ContingencyEquipment.

Table 672 – Attributes of Contingency::ContingencyEquipment

name	mult	type	description
contingentStatus	0..1	ContingencyEquipmentStatusKind	The status for the associated equipment when in the contingency state. This status is independent of the case to which the contingency is originally applied, but defines the equipment status when the contingency is applied.
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 673 shows all association ends of ContingencyEquipment with other classes.

Table 673 – Association ends of Contingency::ContingencyEquipment with other classes

mult from	name	mult to	type	description
0..*	Equipment	1..1	Equipment	The single piece of equipment to which to apply the contingency.
0..*	Contingency	1..1	Contingency	inherited from: ContingencyElement
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.15.5 ContingencyEquipmentStatusKind enumeration

Indicates the state which the contingency equipment is to be in when the contingency is applied.

Table 674 shows all literals of ContingencyEquipmentStatusKind.

Table 674 – Literals of Contingency::ContingencyEquipmentStatusKind

literal	value	description
inService		The equipment is to be put into service.
outOfService		The equipment is to be taken out of service.

6.16 Package StateVariables

6.16.1 General

State variables for analysis solutions such as powerflow.

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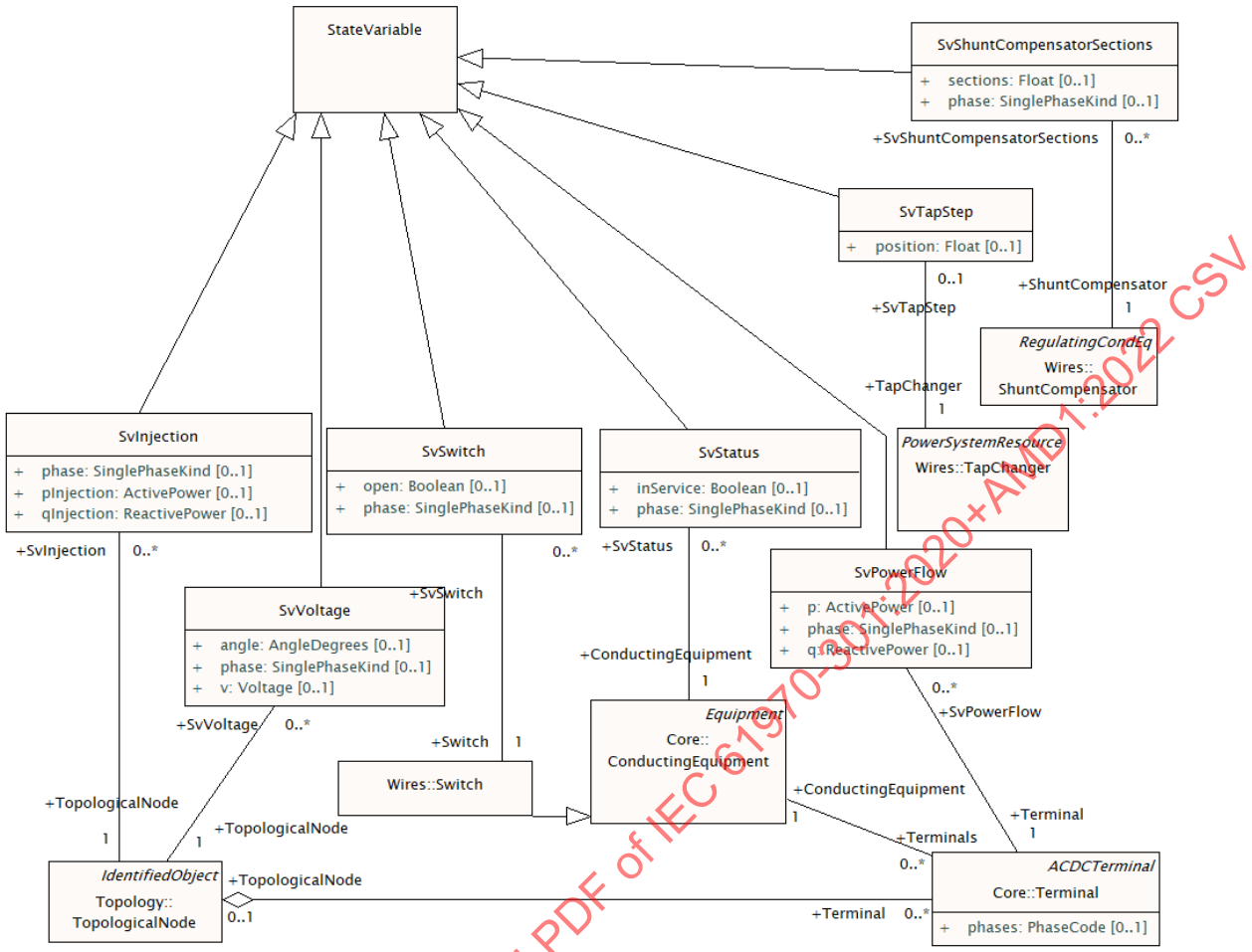


Figure 133 – Class diagram StateVariables::StateVariables

Figure 133: The state solution variables as derived from base StateVariable class. Note that specialized state variables are associated with objects derived from IdentifiedObject, but StateVariable does not derive from IdentifiedObject.

6.16.2 StateVariable root class

An abstract class for state variables.

6.16.3 SvInjection

The SvInjection reports the calculated bus injection minus the sum of the terminal flows. The terminal flow is positive out from the bus (load sign convention) and bus injection has positive flow into the bus. SvInjection may have the remainder after state estimation or slack after power flow calculation.

Table 675 shows all attributes of SvInjection.

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Table 675 – Attributes of StateVariables::SvInjection

name	mult	type	description
phase	0..1	SinglePhaseKind	The terminal phase at which the connection is applied. If missing, the injection is assumed to be balanced among non-neutral phases.
pInjection	0..1	ActivePower	The active power mismatch between calculated injection and initial injection. Positive sign means injection into the TopologicalNode (bus).
qInjection	0..1	ReactivePower	The reactive power mismatch between calculated injection and initial injection. Positive sign means injection into the TopologicalNode (bus).

Table 676 shows all association ends of SvInjection with other classes.

Table 676 – Association ends of StateVariables::SvInjection with other classes

mult from	name	mult to	type	description
0..*	TopologicalNode	1..1	TopologicalNode	The topological node associated with the flow injection state variable.

6.16.4 SvPowerFlow

State variable for power flow. Load convention is used for flow direction. This means flow out from the TopologicalNode into the equipment is positive.

Table 677 shows all attributes of SvPowerFlow.

Table 677 – Attributes of StateVariables::SvPowerFlow

name	mult	type	description
p	0..1	ActivePower	The active power flow. Load sign convention is used, i.e. positive sign means flow out from a TopologicalNode (bus) into the conducting equipment.
phase	0..1	SinglePhaseKind	The individual phase of the flow. If unspecified, then assumed to be balanced among phases.
q	0..1	ReactivePower	The reactive power flow. Load sign convention is used, i.e. positive sign means flow out from a TopologicalNode (bus) into the conducting equipment.

Table 678 shows all association ends of SvPowerFlow with other classes.

Table 678 – Association ends of StateVariables::SvPowerFlow with other classes

mult from	name	mult to	type	description
0..*	Terminal	1..1	Terminal	The terminal associated with the power flow state variable.

6.16.5 SvShuntCompensatorSections

State variable for the number of sections in service for a shunt compensator.

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Table 679 shows all attributes of SvShuntCompensatorSections.

Table 679 – Attributes of StateVariables::SvShuntCompensatorSections

name	mult	type	description
sections	0..1	Float	The number of sections in service as a continuous variable. The attribute shall be a positive value or zero. To get integer value scale with ShuntCompensator.bPerSection.
phase	0..1	SinglePhaseKind	The terminal phase at which the connection is applied. If missing, the injection is assumed to be balanced among non-neutral phases.

Table 680 shows all association ends of SvShuntCompensatorSections with other classes.

Table 680 – Association ends of StateVariables::SvShuntCompensatorSections with other classes

mult from	name	mult to	type	description
0..*	ShuntCompensator	1..1	ShuntCompensator	The shunt compensator for which the state applies.

6.16.6 SvStatus

State variable for status.

Table 681 shows all attributes of SvStatus.

Table 681 – Attributes of StateVariables::SvStatus

name	mult	type	description
inService	0..1	Boolean	The in service status as a result of topology processing. It indicates if the equipment is considered as energized by the power flow. It reflects if the equipment is connected within a solvable island. It does not necessarily reflect whether or not the island was solved by the power flow.
phase	0..1	SinglePhaseKind	The individual phase status. If the attribute is unspecified, then three phase model is assumed.

Table 682 shows all association ends of SvStatus with other classes.

Table 682 – Association ends of StateVariables::SvStatus with other classes

mult from	name	mult to	type	description
0..*	ConductingEquipment	1..1	ConductingEquipment	The conducting equipment associated with the status state variable.

6.16.7 SvSwitch

State variable for switch.

Table 683 shows all attributes of SvSwitch.

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Table 683 – Attributes of StateVariables::SvSwitch

name	mult	type	description
open	0..1	Boolean	The attribute tells if the computed state of the switch is considered open.
phase	0..1	SinglePhaseKind	The terminal phase at which the connection is applied. If missing, the injection is assumed to be balanced among non-neutral phases.

Table 684 shows all association ends of SvSwitch with other classes.

Table 684 – Association ends of StateVariables::SvSwitch with other classes

mult from	name	mult to	type	description
0..*	Switch	1..1	Switch	The switch associated with the switch state.

6.16.8 SvTapStep

State variable for transformer tap step.

Table 685 shows all attributes of SvTapStep.

Table 685 – Attributes of StateVariables::SvTapStep

name	mult	type	description
position	0..1	Float	The floating point tap position. This is not the tap ratio, but rather the tap step position as defined by the related tap changer model and normally is constrained to be within the range of minimum and maximum tap positions.

Table 686 shows all association ends of SvTapStep with other classes.

Table 686 – Association ends of StateVariables::SvTapStep with other classes

mult from	name	mult to	type	description
0..1	TapChanger	1..1	TapChanger	The tap changer associated with the tap step state.

6.16.9 SvVoltage

State variable for voltage.

Table 687 shows all attributes of SvVoltage.

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Table 687 – Attributes of StateVariables::SvVoltage

name	mult	type	description
angle	0..1	AngleDegrees	The voltage angle of the topological node complex voltage with respect to system reference.
phase	0..1	SinglePhaseKind	If specified the voltage is the line to ground voltage of the individual phase. If unspecified, then the voltage is assumed balanced.
v	0..1	Voltage	The voltage magnitude at the topological node. The attribute shall be a positive value.

Table 688 shows all association ends of SvVoltage with other classes.

Table 688 – Association ends of StateVariables::SvVoltage with other classes

mult from	name	mult to	type	description
0..*	TopologicalNode	1..1	TopologicalNode	The topological node associated with the voltage state.

6.17 Package Protection

6.17.1 General

An extension to the Core and Wires packages that models information for protection equipment such as relays. These entities are used within training simulators and distribution network fault location applications.

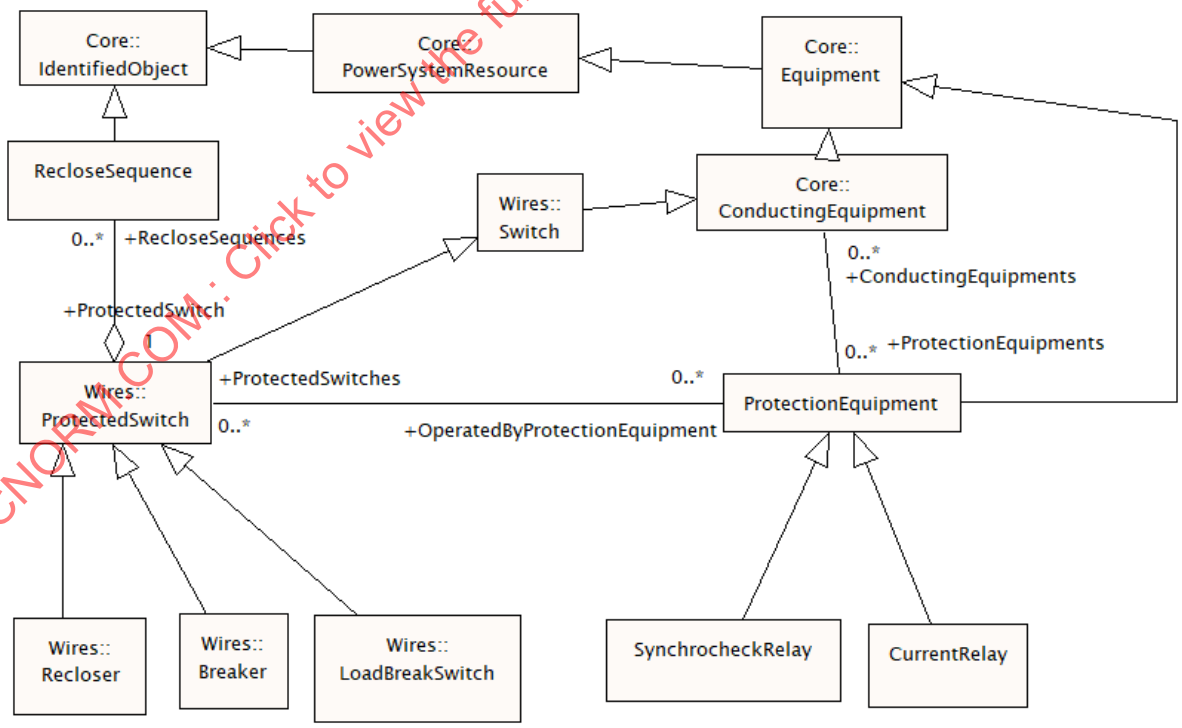


Figure 134 – Class diagram Protection::Main

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Figure 134: This diagram shows all classes included in the Protection package as well as the key external classes that have associations with Protection classes.

6.17.2 CurrentRelay

A device that checks current flow values in any direction or designated direction.

Table 689 shows all attributes of CurrentRelay.

Table 689 – Attributes of Protection::CurrentRelay

name	mult	type	description
currentLimit1	0..1	CurrentFlow	Current limit number one 1 for inverse time pickup.
currentLimit2	0..1	CurrentFlow	Current limit number 2 for inverse time pickup.
currentLimit3	0..1	CurrentFlow	Current limit number 3 for inverse time pickup.
inverseTimeFlag	0..1	Boolean	Set true if the current relay has inverse time characteristic.
timeDelay1	0..1	Seconds	Inverse time delay number 1 for current limit number 1.
timeDelay2	0..1	Seconds	Inverse time delay number 2 for current limit number 2.
timeDelay3	0..1	Seconds	Inverse time delay number 3 for current limit number 3.
relayDelayTime	0..1	Seconds	inherited from: ProtectionEquipment
highLimit	0..1	Float	inherited from: ProtectionEquipment
lowLimit	0..1	Float	inherited from: ProtectionEquipment
powerDirectionFlag	0..1	Boolean	inherited from: ProtectionEquipment
unitSymbol	0..1	UnitSymbol	inherited from: ProtectionEquipment
unitMultiplier	0..1	UnitMultiplier	inherited from: ProtectionEquipment
aggregate	0..1	Boolean	inherited from: Equipment
inService	0..1	Boolean	inherited from: Equipment
networkAnalysisEnabled	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 690 shows all association ends of CurrentRelay with other classes.

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Table 690 – Association ends of Protection::CurrentRelay with other classes

mult from	name	mult to	type	description
0..*	ConductingEquipments	0..*	ConductingEquipment	inherited from: ProtectionEquipment
0..*	ProtectedSwitches	0..*	ProtectedSwitch	inherited from: ProtectionEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	inherited from: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	inherited from: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment
0..1	Faults	0..*	Fault	inherited from: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	inherited from: Equipment
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.17.3 ProtectionEquipment

An electrical device designed to respond to input conditions in a prescribed manner and after specified conditions are met to cause contact operation or similar abrupt change in associated electric control circuits, or simply to display the detected condition. Protection equipment is associated with conducting equipment and usually operate circuit breakers.

Table 691 shows all attributes of ProtectionEquipment.

Table 691 – Attributes of Protection::ProtectionEquipment

name	mult	type	description
relayDelayTime	0..1	Seconds	The time delay from detection of abnormal conditions to relay operation.
highLimit	0..1	Float	The maximum allowable value.
lowLimit	0..1	Float	The minimum allowable value.
powerDirectionFlag	0..1	Boolean	Direction same as positive active power flow value.
unitSymbol	0..1	UnitSymbol	The unit of measure of the value.
unitMultiplier	0..1	UnitMultiplier	The unit multiplier of the value.
aggregate	0..1	Boolean	inherited from: Equipment
inService	0..1	Boolean	inherited from: Equipment
networkAnalysisEnabled	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

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Table 692 shows all association ends of ProtectionEquipment with other classes.

Table 692 – Association ends of Protection::ProtectionEquipment with other classes

mult from	name	mult to	type	description
0..*	ConductingEquipments	0..*	ConductingEquipment	Protection equipment may be used to protect specific conducting equipment.
0..*	ProtectedSwitches	0..*	ProtectedSwitch	Protected switches operated by this ProtectionEquipment.
0..1	OperationalLimitSet	0..*	OperationalLimitSet	inherited from: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	inherited from: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment
0..1	Faults	0..*	Fault	inherited from: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	inherited from: Equipment
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.17.4 RecloseSequence

A reclose sequence (open and close) is defined for each possible reclosure of a breaker.

Table 693 shows all attributes of RecloseSequence.

Table 693 – Attributes of Protection::RecloseSequence

name	mult	type	description
recloseDelay	0..1	Seconds	Indicates the time lapse before the reclose step will execute a reclose.
recloseStep	0..1	Integer	Indicates the ordinal position of the reclose step relative to other steps in the sequence.
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 694 shows all association ends of RecloseSequence with other classes.

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Table 694 – Association ends of Protection::RecloseSequence with other classes

mult from	name	mult to	type	description
0..*	ProtectedSwitch	1..1	ProtectedSwitch	A breaker may have zero or more automatic reclosures after a trip occurs.
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.17.5 SynchrocheckRelay

A device that operates when two AC circuits are within the desired limits of frequency, phase angle, and voltage, to permit or to cause the paralleling of these two circuits. Used to prevent the paralleling of non-synchronous topological islands.

Table 695 shows all attributes of SynchrocheckRelay.

Table 695 – Attributes of Protection::SynchrocheckRelay

name	mult	type	description
maxAngleDiff	0..1	AngleRadians	The maximum allowable voltage vector phase angle difference across the open device.
maxFreqDiff	0..1	Frequency	The maximum allowable frequency difference across the open device.
maxVoltDiff	0..1	Voltage	The maximum allowable difference voltage across the open device.
relayDelayTime	0..1	Seconds	inherited from: ProtectionEquipment
highLimit	0..1	Float	inherited from: ProtectionEquipment
lowLimit	0..1	Float	inherited from: ProtectionEquipment
powerDirectionFlag	0..1	Boolean	inherited from: ProtectionEquipment
unitSymbol	0..1	UnitSymbol	inherited from: ProtectionEquipment
unitMultiplier	0..1	UnitMultiplier	inherited from: ProtectionEquipment
aggregate	0..1	Boolean	inherited from: Equipment
inService	0..1	Boolean	inherited from: Equipment
networkAnalysisEnabled	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 696 shows all association ends of SynchrocheckRelay with other classes.

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Table 696 – Association ends of Protection::SynchrocheckRelay with other classes

mult from	name	mult to	type	description
0..*	ConductingEquipments	0..*	ConductingEquipment	inherited from: ProtectionEquipment
0..*	ProtectedSwitches	0..*	ProtectedSwitch	inherited from: ProtectionEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	inherited from: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	inherited from: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment
0..1	Faults	0..*	Fault	inherited from: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	inherited from: Equipment
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.18 Package Faults

6.18.1 General

The package describes faults that may happen to conducting equipment, e.g. tree falling on a power line.

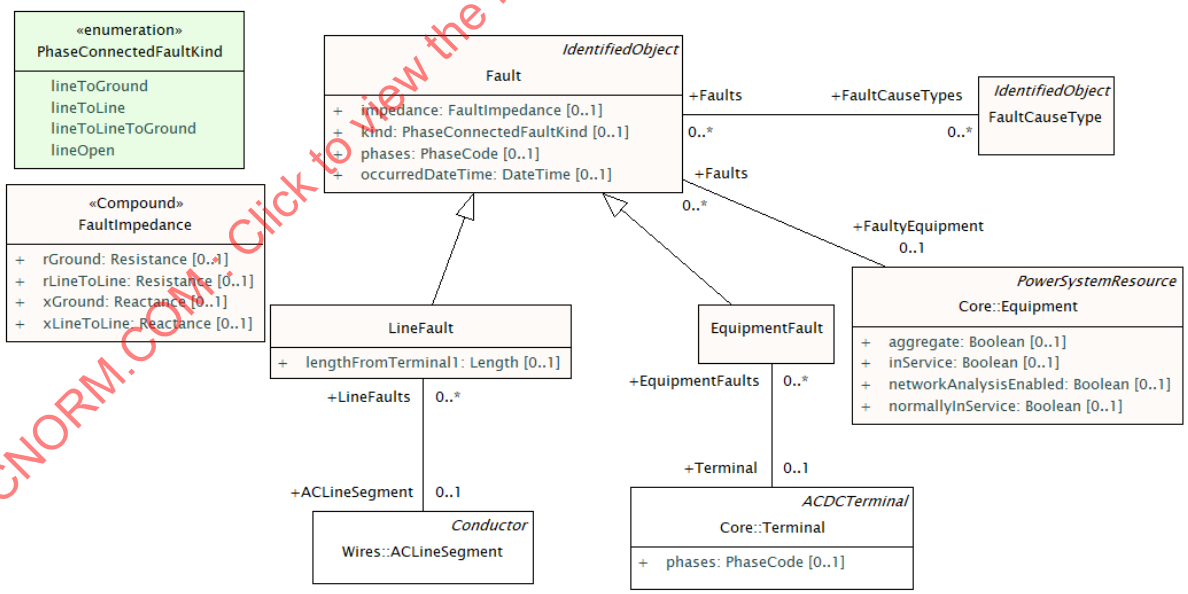


Figure 135 – Class diagram Faults::Faults

Figure 135: Classes used to model faults.

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6.18.2 EquipmentFault

A fault applied at the terminal, external to the equipment. This class is not used to specify faults internal to the equipment.

Table 697 shows all attributes of EquipmentFault.

Table 697 – Attributes of Faults::EquipmentFault

name	mult	type	description
impedance	0..1	FaultImpedance	inherited from: Fault
kind	0..1	PhaseConnectedFaultKind	inherited from: Fault
phases	0..1	PhaseCode	inherited from: Fault
occurredDateTime	0..1	DateTime	inherited from: Fault
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 698 shows all association ends of EquipmentFault with other classes.

Table 698 – Association ends of Faults::EquipmentFault with other classes

mult from	name	mult to	type	description
0..*	Terminal	0..1	Terminal	The terminal connecting to the bus to which the fault is applied.
0..*	FaultyEquipment	0..1	Equipment	inherited from: Fault
0..*	FaultCauseTypes	0..*	FaultCauseType	inherited from: Fault
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.18.3 Fault

Abnormal condition causing current flow through conducting equipment, such as caused by equipment failure or short circuits from objects not typically modelled (for example, a tree falling on a line).

Table 699 shows all attributes of Fault.

Table 699 – Attributes of Faults::Fault

name	mult	type	description
impedance	0..1	FaultImpedance	Fault impedance. Its usage is described by 'kind'.
kind	0..1	PhaseConnectedFaultKind	The kind of phase fault.
phases	0..1	PhaseCode	The phases participating in the fault. The fault connections into these phases are further specified by the type of fault.
occurredDateTime	0..1	DateTime	The date and time at which the fault occurred.

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name	mult	type	description
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 700 shows all association ends of Fault with other classes.

Table 700 – Association ends of Faults::Fault with other classes

mult from	name	mult to	type	description
0..*	FaultyEquipment	0..1	Equipment	Equipment carrying this fault.
0..*	FaultCauseTypes	0..*	FaultCauseType	All types of fault cause.
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.18.4 FaultCauseType

Type of cause of the fault.

Table 701 shows all attributes of FaultCauseType.

Table 701 – Attributes of Faults::FaultCauseType

name	mult	type	description
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 702 shows all association ends of FaultCauseType with other classes.

Table 702 – Association ends of Faults::FaultCauseType with other classes

mult from	name	mult to	type	description
0..*	Faults	0..*	Fault	All faults with this cause type.
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.18.5 FaultImpedance compound

Impedance description for the fault.

Table 703 shows all attributes of FaultImpedance.

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Table 703 – Attributes of Faults::FaultImpedance

name	mult	type	description
rGround	0..1	Resistance	The resistance of the fault between phases and ground.
rLineToLine	0..1	Resistance	The resistance of the fault between phases.
xGround	0..1	Reactance	The reactance of the fault between phases and ground.
xLineToLine	0..1	Reactance	The reactance of the fault between phases.

6.18.6 LineFault

A fault that occurs on an AC line segment at some point along the length.

Table 704 shows all attributes of LineFault.

Table 704 – Attributes of Faults::LineFault

name	mult	type	description
lengthFromTerminal1	0..1	Length	The length to the place where the fault is located starting from terminal with sequence number 1 of the faulted line segment.
impedance	0..1	FaultImpedance	inherited from: Fault
kind	0..1	PhaseConnectedFaultKind	inherited from: Fault
phases	0..1	PhaseCode	inherited from: Fault
occurredDateTime	0..1	DateTime	inherited from: Fault
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 705 shows all association ends of LineFault with other classes.

Table 705 – Association ends of Faults::LineFault with other classes

mult from	name	mult to	type	description
0..*	ACLineSegment	0..1	ACLineSegment	The line segment of this line fault.
0..*	FaultyEquipment	0..1	Equipment	inherited from: Fault
0..*	FaultCauseTypes	0..*	FaultCauseType	inherited from: Fault
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.18.7 PhaseConnectedFaultKind enumeration

The type of fault connection among phases.

Table 706 shows all literals of PhaseConnectedFaultKind.

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Table 706 – Literals of Faults::PhaseConnectedFaultKind

literal	value	description
lineToGround		The fault connects the indicated phases to ground. The line to line fault impedance is not used and assumed infinite. The full ground impedance is connected between each phase specified in the fault and ground, but not between the phases.
lineToLine		The fault connects the specified phases together without a connection to ground. The ground impedance of this fault is ignored. The line to line impedance is connected between each of the phases specified in the fault. For example three times for a three phase fault, one time for a two phase fault. A single phase fault should not be specified.
lineToLineToGround		The fault connects the indicated phases to ground and to each other. The line to line impedance is connected between each of the phases specified in the fault in a full mesh. For example three times for a three phase fault, one time for a two phase fault. A single phase fault should not be specified. The full ground impedance is connected between each phase specified in the fault and ground.
lineOpen		The fault is when the conductor path is broken between two terminals. Additional coexisting faults may be required if the broken conductor also causes connections to grounds or other lines or phases.

6.19 Package SCADA

6.19.1 General

Contains entities to model information used by Supervisory Control and Data Acquisition (SCADA) applications. Supervisory control supports operator control of equipment, such as opening or closing a breaker. Data acquisition gathers telemetered data from various sources. The subtypes of the Telemetry entity deliberately match the UCA and IEC 61850 definitions.

This package also supports alarm presentation but it is not expected to be used by other applications.

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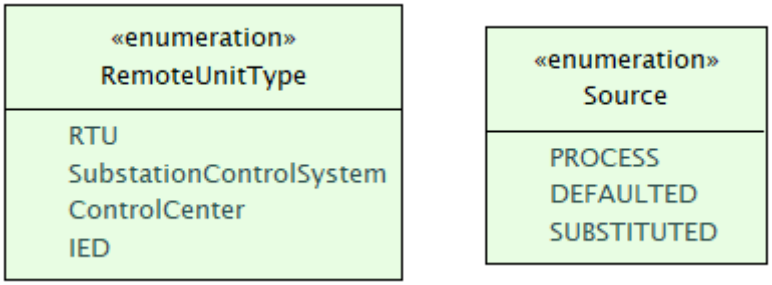


Figure 136 – Class diagram SCADA::Datatypes

Figure 136: Shows datatypes for SCADA model.

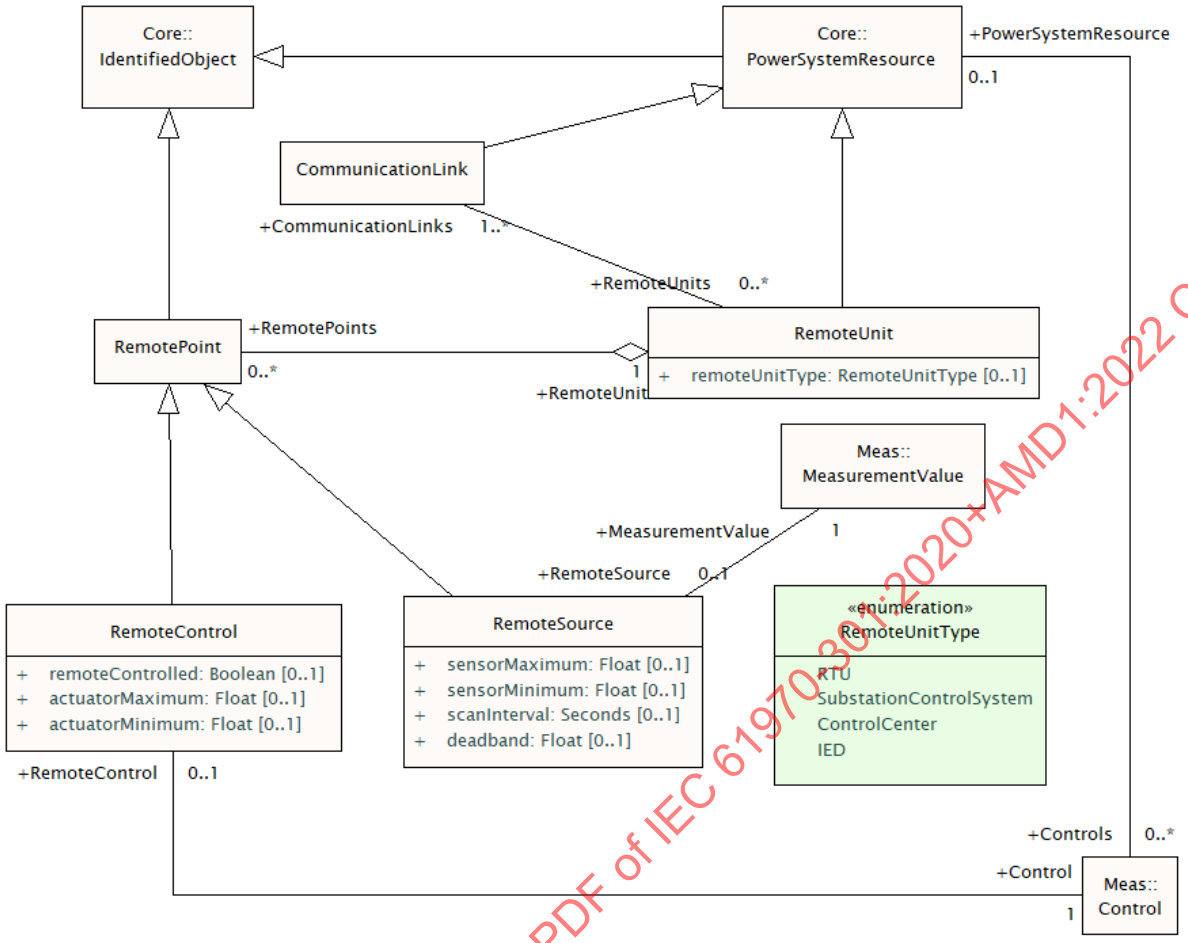


Figure 137 – Class diagram SCADA::Main

Figure 137: This diagram shows all classes included in the SCADA package as well as the key external classes that have associations with SCADA classes.

6.19.2 CommunicationLink

The connection to remote units is through one or more communication links. Reduntant links may exist. The CommunicationLink class inherits PowerSystemResource. The intention is to allow CommunicationLinks to have Measurements. These Measurements can be used to model link status as operational, out of service, unit failure etc.

Table 707 shows all attributes of CommunicationLink.

Table 707 – Attributes of SCADA::CommunicationLink

name	mult	type	description
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 708 shows all association ends of CommunicationLink with other classes.

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Table 708 – Association ends of SCADA::CommunicationLink with other classes

mult from	name	mult to	type	description
1..*	RemoteUnits	0..*	RemoteUnit	RTUs may be attached to communication links.
0..n	BilateralExchangeActor	0..1	BilateralExchangeActor	ICCP data provider or consumer using communication addressing for a Bilateral table.
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.19.3 RemoteControl

Remote controls are outputs that are sent by the remote unit to actuators in the process.

Table 709 shows all attributes of RemoteControl.

Table 709 – Attributes of SCADA::RemoteControl

name	mult	type	description
remoteControlled	0..1	Boolean	Set to true if the actuator is remotely controlled.
actuatorMaximum	0..1	Float	The maximum set point value accepted by the remote control point.
actuatorMinimum	0..1	Float	The minimum set point value accepted by the remote control point.
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 710 shows all association ends of RemoteControl with other classes.

Table 710 – Association ends of SCADA::RemoteControl with other classes

mult from	name	mult to	type	description
0..1	Control	1..1	Control	The Control for the RemoteControl point.
0..*	RemoteUnit	1..1	RemoteUnit	inherited from: RemotePoint
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.19.4 RemotePoint

For an RTU, remote points correspond to telemetered values or control outputs. Other units (e.g. control centres) usually also contain calculated values.

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Table 711 shows all attributes of RemotePoint.

Table 711 – Attributes of SCADA::RemotePoint

name	mult	type	description
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 712 shows all association ends of RemotePoint with other classes.

Table 712 – Association ends of SCADA::RemotePoint with other classes

mult from	name	mult to	type	description
0..*	RemoteUnit	1..1	RemoteUnit	Remote unit this point belongs to.
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.19.5 RemoteSource

Remote sources are state variables that are telemetered or calculated within the remote unit.

Table 713 shows all attributes of RemoteSource.

Table 713 – Attributes of SCADA::RemoteSource

name	mult	type	description
sensorMaximum	0..1	Float	The maximum value the telemetry item can return.
sensorMinimum	0..1	Float	The minimum value the telemetry item can return.
scanInterval	0..1	Seconds	The time interval between scans.
deadband	0..1	Float	The smallest change in value to be reported.
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 714 shows all association ends of RemoteSource with other classes.

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Table 714 – Association ends of SCADA::RemoteSource with other classes

mult from	name	mult to	type	description
0..1	MeasurementValue	1..1	MeasurementValue	Link to the physical telemetered point associated with this measurement.
0..*	RemoteUnit	1..1	RemoteUnit	inherited from: RemotePoint
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.19.6 RemoteUnit

A remote unit can be an RTU, IED, substation control system, control centre, etc. The communication with the remote unit can be through various standard protocols (e.g. IEC 61870, IEC 61850) or non standard protocols (e.g. DNP, RP570, etc.). A remote unit contains remote data points that might be telemetered, collected or calculated. The RemoteUnit class inherits PowerSystemResource. The intention is to allow RemoteUnits to have Measurements. These Measurements can be used to model unit status as operational, out of service, unit failure, etc.

Table 715 shows all attributes of RemoteUnit.

Table 715 – Attributes of SCADA::RemoteUnit

name	mult	type	description
remoteUnitType	0..1	RemoteUnitType	Type of remote unit.
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 716 shows all association ends of RemoteUnit with other classes.

Table 716 – Association ends of SCADA::RemoteUnit with other classes

mult from	name	mult to	type	description
0..*	CommunicationLinks	1..*	CommunicationLink	RTUs may be attached to communication links.
1..1	RemotePoints	0..*	RemotePoint	Remote points this Remote unit contains.
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.19.7 RemoteUnitType enumeration

Type of remote unit.

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Table 717 shows all literals of RemoteUnitType.

Table 717 – Literals of SCADA::RemoteUnitType

literal	value	description
RTU		Remote terminal unit.
SubstationControlSystem		Substation control system.
ControlCenter		Control centre.
IED		Intelligent electronic device (IED).

6.19.8 Source enumeration

Source gives information related to the origin of a value.

Table 718 shows all literals of Source.

Table 718 – Literals of SCADA::Source

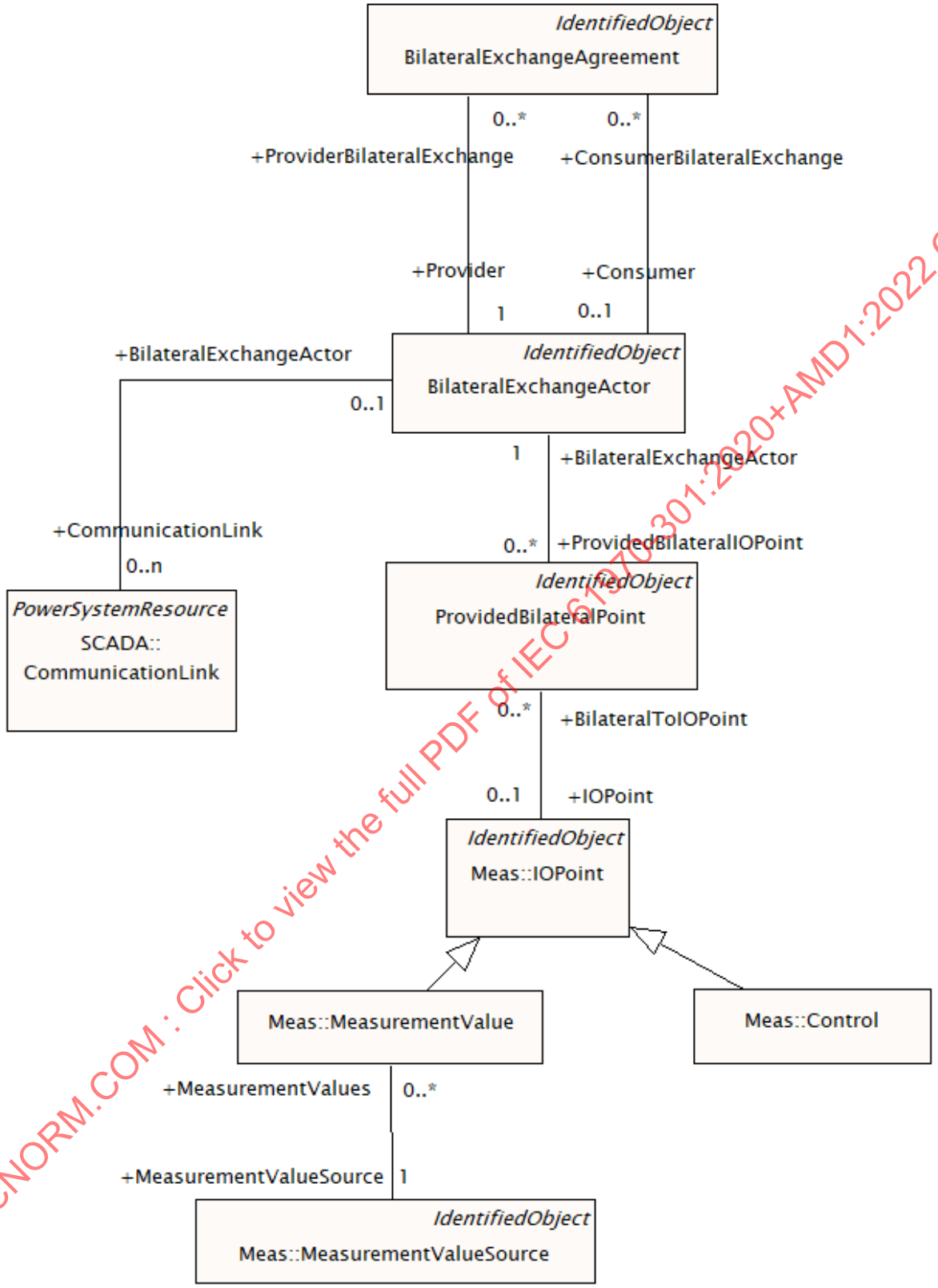
literal	value	description
PROCESS		The value is provided by input from the process I/O or being calculated from some function.
DEFAULTED		The value contains a default value.
SUBSTITUTED		The value is provided by input of an operator or by an automatic source.

6.20 Package ICCPConfiguration

6.20.1 General

This package models configuration of ICCP required for bilateral exchanges.

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Figure 138 – Class diagram ICCPConfiguration::GenericBilateralExchange

Figure 138: Classes used to model bilateral ICCP exchange.

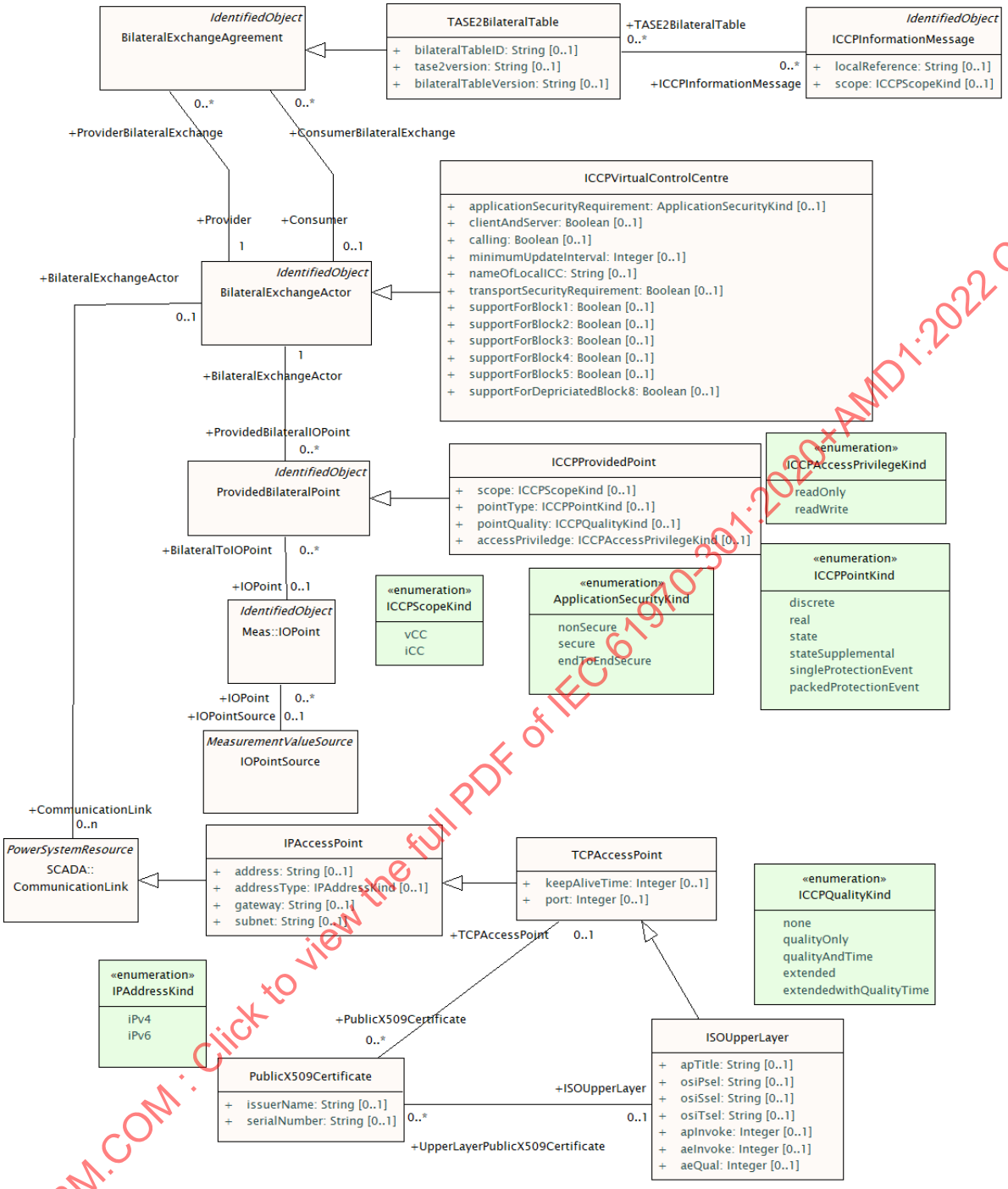


Figure 139 – Class diagram ICCPConfiguration::ICCP

Figure 139: Classes used to model ICCP configuration.

6.20.2 ApplicationSecurityKind enumeration

Specifies the expected security mechanism, per IEC 62351-4, to be utilized.

Table 719 shows all literals of ApplicationSecurityKind.

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Table 719 – Literals of ICCPConfiguration::ApplicationSecurityKind

literal	value	description
nonSecure		Indicates that an application security shall not be used in order to allow establishment of an MSS association.
secure		Indicates that the A-security-profile as specified in Clause 11 (or IEC TS 62351-4:2007) shall be used in order to allow establishment of an MMS association.
endToEndSecure		Indicates that E2E-security shall be used in order to allow establishment of an MMS association.

6.20.3 BilateralExchangeActor

BilateralExchangeActor describes an actor that provides ICCP data, consumes ICCP data or both. The ICCP data provider lists the data it makes available to an ICCP data consumer. This data is described by ProvidedBilateralPoints. The relation between an ICCP data provider and a consumer is established by a BilateralExchangeAgreement. It is up to the ICCP data consumer to select what ProvidedBilateralPoints to use. The selection made is not described in this information model.

Table 720 shows all attributes of BilateralExchangeActor.

Table 720 – Attributes of ICCPConfiguration::BilateralExchangeActor

name	mult	type	description
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 721 shows all association ends of BilateralExchangeActor with other classes.

Table 721 – Association ends of ICCPConfiguration::BilateralExchangeActor with other classes

mult from	name	mult to	type	description
1..1	ProviderBilateralExchange	0..*	BilateralExchangeAgreement	Agreement to information provider.
0..1	CommunicationLink	0..n	CommunicationLink	Communication addressing for a Bilateral Table used by a ICCP data provider or consumer.
0..1	ConsumerBilateralExchange	0..*	BilateralExchangeAgreement	Agreement to information subscriber.
1..1	ProvidedBilateralIOPoint	0..*	ProvidedBilateralPoint	ICCP information in a Bilateral table that will be exposed to a remote peer.
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.20.4 BilateralExchangeAgreement

This is the representation of the information exchange agreement between peers.

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Table 722 shows all attributes of BilateralExchangeAgreement.

Table 722 – Attributes of ICCPConfiguration::BilateralExchangeAgreement

name	mult	type	description
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 723 shows all association ends of BilateralExchangeAgreement with other classes.

Table 723 – Association ends of ICCPConfiguration::BilateralExchangeAgreement with other classes

mult from	name	mult to	type	description
0..*	Consumer	0..1	BilateralExchangeActor	Subscriber of information from a remote peer.
0..*	Provider	1..1	BilateralExchangeActor	Provider of information to a remote peer.
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.20.5 ICCPAccessPrivilegeKind enumeration

Provides access privilege information regarding an ICCP point.

Table 724 shows all literals of ICCPAccessPrivilegeKind.

Table 724 – Literals of ICCPConfiguration::ICCPAccessPrivilegeKind

literal	value	description
readOnly		Indicates that the remote is not allowed to change the value of the ICCPPoint.
readWrite		Indicates that the remote can not only get the value, but may also change the value of the ICCP Point.

6.20.6 ICCPInformationMessage

This class represents the TASE.2 Information Message Object. The IdentifiedObject.name attribute must be non-null. The value of the attribute shall be used as the TASE.2 Information Reference, as specified by 60870-6-503.

Table 725 shows all attributes of ICCPInformationMessage.

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Table 725 – Attributes of ICCPConfiguration::ICCPInformationMessage

name	mult	type	description
localReference	0..1	String	The Local Reference attribute specifies a value agreed upon between sender and receiver of the Information Message. It further identifies the Information Message.
scope	0..1	ICCPScopeKind	Indicates if the Point is global scoped (e.g. VCC) or accessible only to the Bilateral table peer (e.g. ICC).
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 726 shows all association ends of ICCPInformationMessage with other classes.

Table 726 – Association ends of ICCPConfiguration::ICCPInformationMessage with other classes

mult from	name	mult to	type	description
0..*	TASE2BilateralTable	0..*	TASE2BilateralTable	Bilateral table agreement that includes the informational message.
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.20.7 ICCPPointKind enumeration

The kind of ICCP point that is to be conveyed.

Table 727 shows all literals of ICCPPointKind.

Table 727 – Literals of ICCPConfiguration::ICCPPointKind

literal	value	description
discrete		Indicates that an ICCP discrete type is to be conveyed.
real		Indicates that an ICCP real type is to be conveyed.
state		Indicates that an ICCP state type is to be conveyed.
stateSupplemental		Indicates that an ICCP state supplemental type is to be conveyed.
singleProtectionEvent		Indicates that an ICCP single Protection Event type is to be conveyed.
packedProtectionEvent		Indicates that an ICCP packed Protection Event is to be conveyed.

6.20.8 ICCPProvidedPoint

The IdentifiedObject.name attribute must have a value. The name attribute shall be used as the DataValue name used for the exchange.

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Table 728 shows all attributes of ICCPProvidedPoint.

Table 728 – Attributes of ICCPConfiguration::ICCPProvidedPoint

name	mult	type	description
scope	0..1	ICCPScopeKind	Indicates if the Point is global scoped (e.g. VCC) or accessible only to the Bilateral table peer (e.g. ICC).
pointType	0..1	ICCPPointKind	Indicates the ICCP Point type that is to be conveyed. A CIM AccumlatorValue shall be mapped to an ICCP real. A CIM AnalogValue shall be mapped to an ICCP real. A CIM DiscreteValue shall be mapped to either an ICCP real, state, stateSupplemental, or either protection event type. A CIM StringMeasurementValue does not have a standardized mapping.
pointQuality	0..1	ICCPQualityKind	Specifies the type of ICCP quality that will be conveyed as part of the ICCP Point.
accessPriviledge	0..1	ICCPAccessPrivilegeKind	Provides information regarding the access privileges allowed to the ICCP Point.
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 729 shows all association ends of ICCPProvidedPoint with other classes.

Table 729 – Association ends of ICCPConfiguration::ICCPProvidedPoint with other classes

mult from	name	mult to	type	description
0..*	BilateralExchangeActor	1..1	BilateralExchangeActor	inherited from: ProvidedBilateralPoint
0..*	IOPoint	0..1	IOPoint	inherited from: ProvidedBilateralPoint
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.20.9 ICCPQualityKind enumeration

Indicates the type of quality information that is to be exchanged. For protection events the value shall be "none".

Table 730 shows all literals of ICCPQualityKind.

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Table 730 – Literals of ICCPConfiguration::ICCPQualityKind

literal	value	description
none		Indicates that no quality is conveyed with the ICCP point.
qualityOnly		Indicates that only quality is to be provided.
qualityAndTime		Indicates that quality and a timestamp are to be provided.
extended		Indicates that only extended information is to be provided.
extendedwithQualityTime		Provides quality, timestamp, and extended information.

6.20.10 ICCPScopeKind enumeration

Specifies the control centre scope.

Table 731 shows all literals of ICCPScopeKind.

Table 731 – Literals of ICCPConfiguration::ICCPScopeKind

literal	value	description
vCC		Virtual Control Centre Scope – globally available.
iCC		Inter-Control Centre scope – available for exchange between the control centres in the bilateral table.

6.20.11 ICCPVCC

Indicates that the ICCP information is global in nature and normally is available to all authorized peers.

Table 732 shows all attributes of ICCPVCC.

Table 732 – Attributes of ICCPConfiguration::ICCPVCC

name	mult	type	description
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 733 shows all association ends of ICCPVCC with other classes.

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Table 733 – Association ends of ICCPConfiguration::ICCPVCC with other classes

mult from	name	mult to	type	description
1..1	ProviderBilateralExchange	0..*	BilateralExchangeAgreement	inherited from: BilateralExchangeActor
0..1	CommunicationLink	0..n	CommunicationLink	inherited from: BilateralExchangeActor
0..1	ConsumerBilateralExchange	0..*	BilateralExchangeAgreement	inherited from: BilateralExchangeActor
1..1	ProvidedBilateralIOPoint	0..*	ProvidedBilateralPoint	inherited from: BilateralExchangeActor
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.20.12 ICCPVirtualControlCentre

This contains the information that a particular actor exposes for a particular agreed upon ICCP Bilateral Table.

Table 734 shows all attributes of ICCPVirtualControlCentre.

Table 734 – Attributes of ICCPConfiguration::ICCPVirtualControlCentre

name	mult	type	description
applicationSecurityRequirement	0..1	ApplicationSecurityKind	Specifies the expected security mechanism, per IEC 62351-4, to be utilized.
clientAndServer	0..1	Boolean	If True the value indicates that the entity represented by the bilateral table is capable of issuing requests and responding to request (e.g. bidirectional support of ICCP requests). If False, this indicates that a calling entity (e.g. calling = True) will not be able to respond to ICCP requests. If False, and calling=False, this indicates that the entity will only respond to ICCP requests and not issue ICCP requests.
calling	0..1	Boolean	Used to indicate if the Provider is responsible for initiating the TASE.2 connection. If the value is TRUE, the provider is responsible for establishing the association. If the value is FALSE, the peer provider of the Bilateral Table will need to establish the association.
minimumUpdateInterval	0..1	Integer	Specifies the fastest update interval that can be provided for integrity information and Transfer Set creation. The value is in seconds.
nameOfLocalICC	0..1	String	Specifies the ICC scope name that the remote can use to access the information in the Bilateral Table if the information is not VCC scoped. This value may not be null.
transportSecurityRequirement	0..1	Boolean	If true, then transport level security as specified by IEC 62351-6 is required.
supportForBlock1	0..1	Boolean	Per IEC 60870-6-702: If true indicates support for basic services. Must always be true.
supportForBlock2	0..1	Boolean	Per IEC 60870-6-702: If true indicates support for extended conditions.
supportForBlock3	0..1	Boolean	Per IEC 60870-6-702: If true indicates support for blocked transfers.
supportForBlock4	0..1	Boolean	Per IEC 60870-6-702: If true indicates support for information messages.

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name	mult	type	description
supportForBlock5	0..1	Boolean	Per IEC 60870-6-702: If true indicates support for device control.
supportForDepriciatedBlock8	0..1	Boolean	Per IEC 60870-6-702: If true indicates support for accounts. The use of this block was deprecated in Edition 3.
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 735 shows all association ends of ICCPVirtualControlCentre with other classes.

Table 735 – Association ends of ICCPConfiguration::ICCPVirtualControlCentre with other classes

mult from	name	mult to	type	description
1..1	ProviderBilateralExchange	0..*	BilateralExchangeAgreement	inherited from: BilateralExchangeActor
0..1	CommunicationLink	0..n	CommunicationLink	inherited from: BilateralExchangeActor
0..1	ConsumerBilateralExchange	0..*	BilateralExchangeAgreement	inherited from: BilateralExchangeActor
1..1	ProvidedBilateralIOPoint	0..*	ProvidedBilateralPoint	inherited from: BilateralExchangeActor
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.20.13 IOPointSource

Indicates the point source for an IO Point.

Table 736 shows all attributes of IOPointSource.

Table 736 – Attributes of ICCPConfiguration::IOPointSource

name	mult	type	description
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 737 shows all association ends of IOPointSource with other classes.

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Table 737 – Association ends of ICCPConfiguration::IOPointSource with other classes

mult from	name	mult to	type	description
0..1	IOPoint	0..*	IOPoint	ICCP point for a local measurement value source.
1..1	MeasurementValues	0..*	MeasurementValue	inherited from: MeasurementValueSource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.20.14 IPAccessPoint

Internet Protocol Access Point – used to represent an addressing structure is based upon an Internet Protocol (IP) address.

Table 738 shows all attributes of IPAccessPoint.

Table 738 – Attributes of ICCPConfiguration::IPAccessPoint

name	mult	type	description
address	0..1	String	Is the dotted decimal IP Address resolve the IP address. The format is controlled by the value of the addressType.
addressType	0..1	IPAddressKind	IP address type.
gateway	0..1	String	Is the dotted decimal IPAddress of the first hop router. Format is controlled by the addressType.
subnet	0..1	String	This is the IP subnet mask which controls the local vs non-local routing.
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 739 shows all association ends of IPAccessPoint with other classes.

Table 739 – Association ends of ICCPConfiguration::IPAccessPoint with other classes

mult from	name	mult to	type	description
1..*	RemoteUnits	0..*	RemoteUnit	inherited from: CommunicationLink
0..n	BilateralExchangeActor	0..1	BilateralExchangeActor	inherited from: CommunicationLink
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

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6.20.15 IPAddressKind enumeration

Indicates if the addressing of the IPAccessPoint, gateway, and subnet are per IPv4 or IPv6.

Table 740 shows all literals of IPAddressKind.

Table 740 – Literals of ICCPConfiguration::IPAddressKind

literal	value	description
iPv4		Indicates that IPv4 dotted decimal notation is in use.
iPv6		Indicates that an IPv6 dotted decimal is in use.

6.20.16 ISOUpperLayer

Is a set of configure addressing information that is required since ICCP utilizes addressing other than a TCP port.

Table 741 shows all attributes of ISOUpperLayer.

Table 741 – Attributes of ICCPConfiguration::ISOUpperLayer

name	mult	type	description
apTitle	0..1	String	Is a sequence of integer strings separated by ".". The value, in conjunction with other application addressing attributes (e.g. other APs) are used to select a specific application (e.g. the ICCP application entity) per the OSI reference model. The sequence, and its values, represent a namespace whose values are governed by ISO/IEC 7498-3.
osiPsel	0..1	String	Is the addressing selector for OSI presentation addressing.
osiSsel	0..1	String	Is the OSI session layer addressing information.
osiTsel	0..1	String	Is the OSI Transport Layer addressing information.
apInvoke	0..1	Integer	Is a further application level OSI addressing parameter.
aeInvoke	0..1	Integer	Is part of the Application Entity addressing as specified by ISO Addressing.
aeQual	0..1	Integer	Is the AE qualifier and represents further application level addressing information.
keepAliveTime	0..1	Integer	inherited from: TCPAccessPoint
port	0..1	Integer	inherited from: TCPAccessPoint
address	0..1	String	inherited from: IPAccessPoint
addressType	0..1	IPAddressKind	inherited from: IPAccessPoint
gateway	0..1	String	inherited from: IPAccessPoint
subnet	0..1	String	inherited from: IPAccessPoint
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 742 shows all association ends of ISOUpperLayer with other classes.

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Table 742 – Association ends of ICCPConfiguration::ISOUpperLayer with other classes

mult from	name	mult to	type	description
0..1	UpperLayerPublicX509Certificate	0..*	PublicX509Certificate	Certificate to be bound for use for Application layer mutual authentication.
0..1	PublicX509Certificate	0..*	PublicX509Certificate	inherited from: TCPAccessPoint
1..*	RemoteUnits	0..*	RemoteUnit	inherited from: CommunicationLink
0..n	BilateralExchangeActor	0..1	BilateralExchangeActor	inherited from: CommunicationLink
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.20.17 ProvidedBilateralPoint

Allows declaration of ICCP points to be provided through a Bilateral Table agreement.

Table 743 shows all attributes of ProvidedBilateralPoint.

Table 743 – Attributes of ICCPConfiguration::ProvidedBilateralPoint

name	mult	type	description
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 744 shows all association ends of ProvidedBilateralPoint with other classes.

Table 744 – Association ends of ICCPConfiguration::ProvidedBilateralPoint with other classes

mult from	name	mult to	type	description
0..*	BilateralExchangeActor	1..1	BilateralExchangeActor	Remote peer that will receive ICCP information in a Bilateral table.
0..*	IOPoint	0..1	IOPoint	Measurement or control for the bilateral ICCP point.
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.20.18 PublicX509Certificate root class

Used to convey information that will allow matching in order to determine which certificate to use. Actual certificates are exchanged externally to the CIM exchange.

Table 745 shows all attributes of PublicX509Certificate.

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Table 745 – Attributes of ICCPConfiguration::PublicX509Certificate

name	mult	type	description
issuerName	0..1	String	Represents the CA that issued the certificate. Defined to be per X.509.
serialNumber	0..1	String	Is the serial number of the certificate per X.509 definition.

Table 746 shows all association ends of PublicX509Certificate with other classes.

Table 746 – Association ends of ICCPConfiguration::PublicX509Certificate with other classes

mult from	name	mult to	type	description
0..*	ISOUpperLayer	0..1	ISOUpperLayer	Application layer used with the certificate for mutual authentication.
0..*	TCPAccessPoint	0..1	TCPAccessPoint	The association allows a certificate to be bound for use by TLS.

6.20.19 TASE2BilateralTable

This class describe the sending (providing) side in a bilateral ICCP data exchange. Hence the ICCP bilateral (table) descriptions are created by exchanging ICCP Provider data between the parties.

Table 747 shows all attributes of TASE2BilateralTable.

Table 747 – Attributes of ICCPConfiguration::TASE2BilateralTable

name	mult	type	description
bilateralTableID	0..1	String	Specifies the version of the Bilateral Table configuration that is being exchanged.
tase2version	0..1	String	Specifies the version of the TASE.2 that is needed to access the Bilateral Table information via TASE.2. In order for a link to be established, both sides must have the same value.
bilateralTableVersion	0..1	String	The Version attribute identifies a unique version of the Bilateral Table. If any changes are made to a Bilateral Table, then a new unique value for this attribute shall be generated.
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 748 shows all association ends of TASE2BilateralTable with other classes.

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Table 748 – Association ends of ICCPConfiguration::TASE2BilateralTable with other classes

mult from	name	mult to	type	description
0..*	ICCPInformationMessage	0..*	ICCPInformationMessage	Informational message to be included in a Bilateral Table agreement.
0..*	Consumer	0..1	BilateralExchangeActor	inherited from: BilateralExchangeAgreement
0..*	Provider	1..1	BilateralExchangeActor	inherited from: BilateralExchangeAgreement
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.20.20 TCPAccessPoint

Allows addressing and behavioural information regarding the use of TCP by ICCP links.

Table 749 shows all attributes of TCPAccessPoint.

Table 749 – Attributes of ICCPConfiguration::TCPAccessPoint

name	mult	type	description
keepAliveTime	0..1	Integer	Indicates the default interval at which TCP will check if the TCP connection is still valid.
port	0..1	Integer	This value is only needed to be specified for called nodes (e.g. those that respond to a TCP.Open request). This value specifies the TCP port to be used. Well known and "registered" ports are preferred and can be found at: http://www.iana.org/assignments/service-names-port-numbers/service-names-port-numbers.xhtml For IEC 60870-6 TASE.2 (e.g. ICCP) and IEC 61850, the value used shall be 102 for non-TLS protected exchanges. The value shall be 3782 for TLS transported ICCP and 61850 exchanges.
address	0..1	String	inherited from: IPAccessPoint
addressType	0..1	IPAddressKind	inherited from: IPAccessPoint
gateway	0..1	String	inherited from: IPAccessPoint
subnet	0..1	String	inherited from: IPAccessPoint
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 750 shows all association ends of TCPAccessPoint with other classes.

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Table 750 – Association ends of ICCPConfiguration::TCPAccessPoint with other classes

mult from	name	mult to	type	description
0..1	PublicX509Certificate	0..*	PublicX509Certificate	Is the Public Certificate used for mutual authentication between peers.
1..*	RemoteUnits	0..*	RemoteUnit	inherited from: CommunicationLink
0..n	BilateralExchangeActor	0..1	BilateralExchangeActor	inherited from: CommunicationLink
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

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Annex A
(normative)

Custom extensions

A.1 Overview

Annex A is normative and contains custom extensions with wide spread use that may be useful to more than the organizations that created them.

A.2 European extensions

A.2.1 General

~~[nsuri = http://iec.ch/TC57/CIM100-EuropeanExtension/1/0#, nsprefix = eu]~~

[nsuri = http://iec.ch/TC57/CIM100-European#, nsprefix = eu]

This package contains the European extensions to Base package of the canonical CIM model.

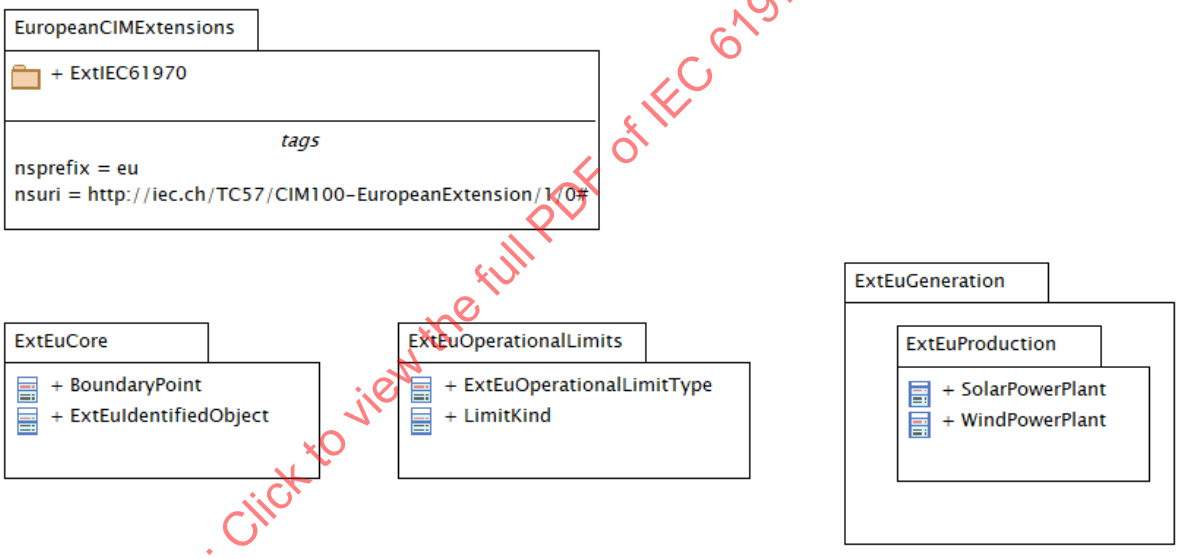


Figure A.1 – Class diagram ExtEuBase::ExtEuBase

Figure A.1: The diagram shows the overview of European extension packages.

A.2.2 Package ExtEuCore

A.2.2.1 General

European extensions to Core package.

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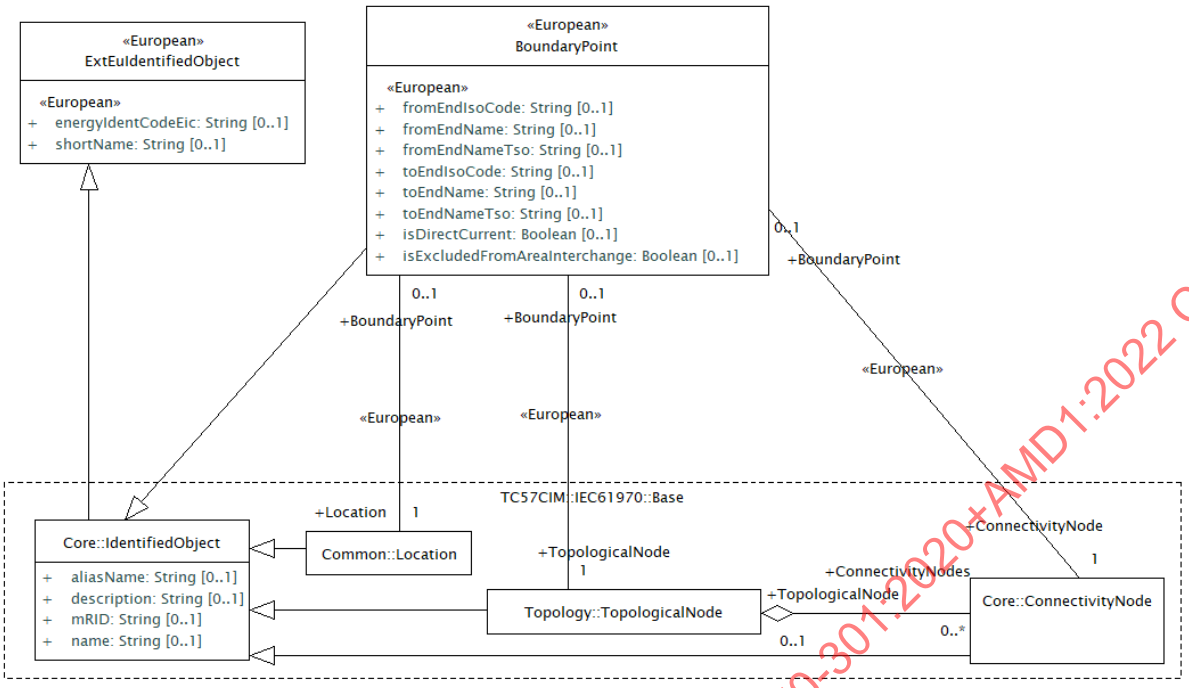


Figure A.2 – Class diagram ExtEuCore::ExtEuCore

Figure A.2: The diagram shows European extensions related to boundary definitions and naming.

A.2.2.2 (European) BoundaryPoint

Designates a connection point at which one or more model authority sets shall connect to. The location of the connection point as well as other properties are agreed between organisations responsible for the interconnection, hence all attributes of the class represent this agreement. It is primarily used in a boundary model authority set which can contain one or many BoundaryPoint-s among other Equipment-s and their connections.

Table A.1 shows all attributes of BoundaryPoint.

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Table A.1 – Attributes of ExtEuCore::BoundaryPoint

name	mult	type	description
fromEndIsoCode	0..1	String	(European) The ISO code of the region which the "From" side of the Boundary point belongs to or it is connected to. The ISO code is a two-character country code as defined by ISO 3166 (http://www.iso.org/iso/country_codes). The length of the string is 2 characters maximum.
fromEndName	0..1	String	(European) A human readable name with length of the string 64 characters maximum. It covers the following two cases: – if the Boundary point is placed on a tie-line, it is the name (IdentifiedObject.name) of the substation at which the ~~"From"~~ "To"side of the tie-line is connected to. – if the Boundary point is placed in a substation, it is the name (IdentifiedObject.name) of the element (e.g. PowerTransformer, ACLineSegment, Switch, etc.) at which the ~~"From"~~ "To" side of the Boundary point is connected to.
fromEndNameTso	0..1	String	(European) Identifies the name of the transmission system operator, distribution system operator or other entity at which the "From" side of the interconnection is connected to. The length of the string is 64 characters maximum.
toEndIsoCode	0..1	String	(European) The ISO code of the region which the "To" side of the Boundary point belongs to or is connected to. The ISO code is a two-character country code as defined by ISO 3166 (http://www.iso.org/iso/country_codes). The length of the string is 2 characters maximum.
toEndName	0..1	String	(European) A human readable name with length of the string 32 characters maximum. It covers the following two cases: – if the Boundary point is placed on a tie-line, it is the name (IdentifiedObject.name) of the substation at which the "To" side of the tie-line is connected to. – if the Boundary point is placed in a substation, it is the name (IdentifiedObject.name) of the element (e.g. PowerTransformer, ACLineSegment, Switch, etc.) at which the "To" side of the Boundary point is connected to.
toEndNameTso	0..1	String	(European) Identifies the name of the transmission system operator, distribution system operator or other entity at which the "To" side of the interconnection is connected to. The length of the string is 64 characters maximum.
isDirectCurrent	0..1	Boolean	(European) If true, this boundary point is a point of common coupling (PCC) of a direct current (DC) interconnection, otherwise the interconnection is AC (default).

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name	mult	type	description
isExcludedFromAreaInterchange	0..1	Boolean	(European) If true, this boundary point is on the interconnection that is excluded from control area interchange calculation and consequently has no related tie flows. Otherwise, the interconnection is included in control area interchange and a TieFlow is required at all sides of the boundary point (default).
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject
energyIdentCodeEic	0..1	String	(European) inherited from: ExtEuIdentifiedObject
shortName	0..1	String	(European) inherited from: ExtEuIdentifiedObject

Table A.2 shows all association ends of BoundaryPoint with other classes.

Table A.2 – Association ends of ExtEuCore::BoundaryPoint with other classes

mult from	name	mult to	type	description
0..1	ConnectivityNode	1..1	ConnectivityNode	(European) The connectivity node that is designated as a boundary point.
~~0..1~~	~~TopologicalNode~~	~~1..1~~	~~TopologicalNode~~	~~(European) The topological node that is designated as a boundary point.~~
~~0..1~~	~~Location~~	~~1..1~~	~~Location~~	~~(European) The location of the associated boundary point.~~
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource

A.2.2.3 (European) ExtEuIdentifiedObject root class

Contains attributes to allow for mappings between different European identification schemes.

Table A.3 shows all attributes of ExtEuIdentifiedObject.

Table A.3 – Attributes of ExtEuCore::ExtEuIdentifiedObject

name	mult	type	description
energyIdentCodeEic	0..1	String	(European) The attribute is used for an exchange of the EIC code (Energy identification Code). The length of the string is 16 characters as defined by the EIC code. For details on EIC scheme please refer to ENTSO-E web site.
shortName	0..1	String	(European) The attribute is used for an exchange of a human readable short name with length of the string 12 characters maximum.

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A.2.3 Package ExtEuOperationalLimits

A.2.3.1 General

European extensions to OperationalLimits package.

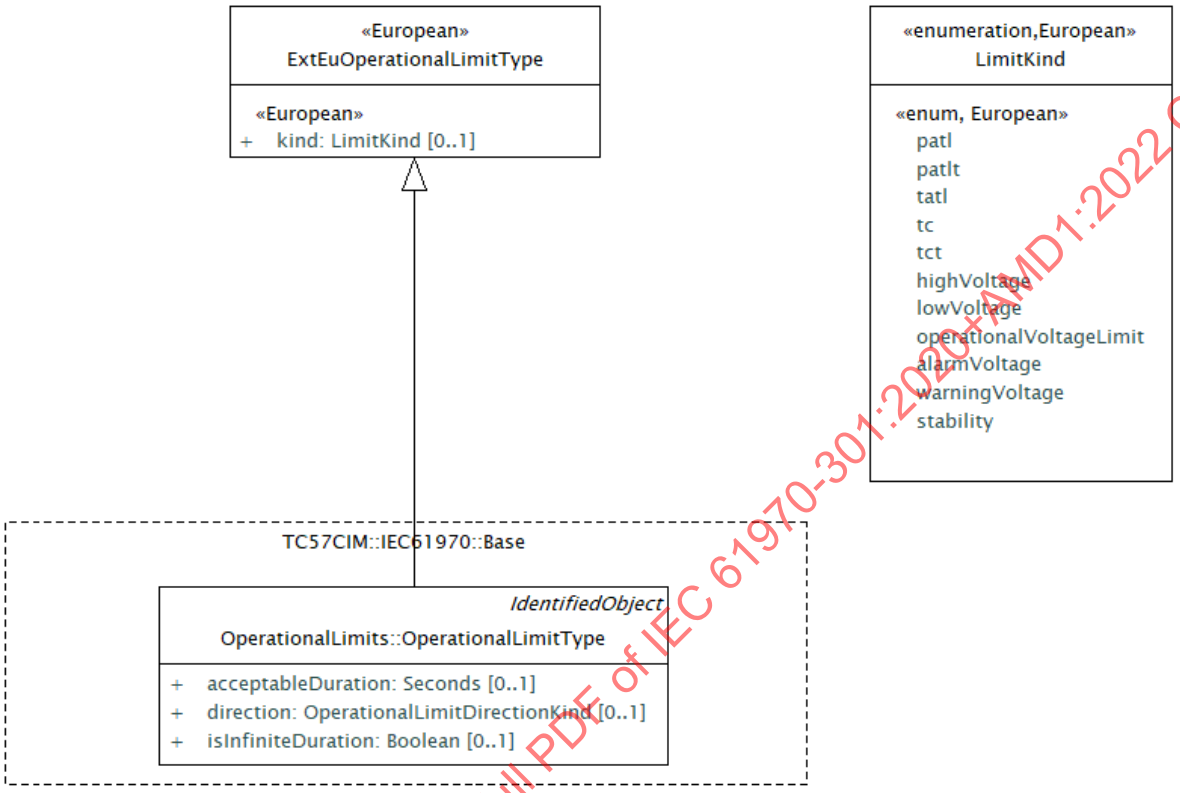


Figure A.3 – Class diagram ExtEuOperationalLimits::ExtEuOperationalLimits

Figure A.3: The diagram shows European extensions to OperationalLimits package.

A.2.3.2 (European) ExtEuOperationalLimitType root class

Contains an attribute that extends the OperationalLimit by assigning it a specific type.

Table A.4 shows all attributes of ExtEuOperationalLimitType.

Table A.4 – Attributes of ExtEuOperationalLimits::ExtEuOperationalLimitType

name	mult	type	description
kind	0..1	LimitKind	(European) Types of limits defined in the ENTSO-E Operational Handbook Policy 3.

A.2.3.3 (European) LimitKind enumeration

Limit kinds.

Table A.5 shows all literals of LimitKind.

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Table A.5 – Literals of ExtEuOperationalLimits::LimitKind

literal	value	description
patl		(European) The Permanent Admissible Transmission Loading (PATL) is the loading in amperes, MVA or MW that can be accepted by a network branch for an unlimited duration without any risk for the material. The OperationnalLimitType.isInfiniteDuration is set to true. There shall be only one OperationalLimitType of kind PATL per OperationalLimitSet if the PATL is ApparentPowerLimit, ActivePowerLimit, or CurrentLimit for a given Terminal or Equipment.
patlt		(European) Permanent Admissible Transmission Loading Threshold (PATLT) is a value in engineering units defined for PATL and calculated using a percentage less than 100 % of the PATL type intended to alert operators of an arising condition. The percentage should be given in the name of the OperationalLimitSet. The aceptableDuration is another way to express the severity of the limit.
tatl		(European) Temporarily Admissible Transmission Loading (TATL) which is the loading in amperes, MVA or MW that can be accepted by a branch for a certain limited duration. The TATL can be defined in different ways: – as a fixed percentage of the PATL for a given time (for example, 115% of the PATL that can be accepted during 15 minutes), – pairs of TATL type and Duration calculated for each line taking into account its particular configuration and conditions of functioning (for example, it can define a TATL acceptable during 20 minutes and another one acceptable during 10 minutes). Such a definition of TATL can depend on the initial operating conditions of the network element (sag situation of a line). The duration attribute can be used to define several TATL limit types. Hence multiple TATL limit values may exist having different durations.
tc		(European) Tripping Current (TC) is the ultimate intensity without any delay. It is defined as the threshold the line will trip without any possible remedial actions. The tripping of the network element is ordered by protections against short circuits or by overload protections, but in any case, the activation delay of these protections is not compatible with the reaction delay of an operator (less than one minute). The duration is always zero if the OperationalLimitType.acceptableDuration is exchanged. Only one limit value exists for the TC type.

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literal	value	description
tct		(European) Tripping Current Threshold (TCT) is a value in engineering units defined for TC and calculated using a percentage less than 100 % of the TC type intended to alert operators of an arising condition. The percentage should be given in the name of the OperationalLimitSet. The aceptableDuration is another way to express the severity of the limit.
highVoltage		(European) Referring to the rating of the equipments, a voltage too high can lead to accelerated ageing or the destruction of the equipment. This limit type may or may not have duration.
lowVoltage		(European) A too low voltage can disturb the normal operation of some protections and transformer equipped with on-load tap changers, electronic power devices or can affect the behaviour of the auxiliaries of generation units. This limit type may or may not have duration.
operationalVoltageLimit		(European) Operational voltage limit.
alarmVoltage		(European) Voltage alarm.
warningVoltage		(European) Voltage warning.
stability		(European) Stability.

A.2.4 Package ExtEuGeneration

A.2.4.1 General

European extensions to Generation package.

A.2.4.2 Package ExtEuProduction

A.2.4.2.1 General

European extensions to Production package.

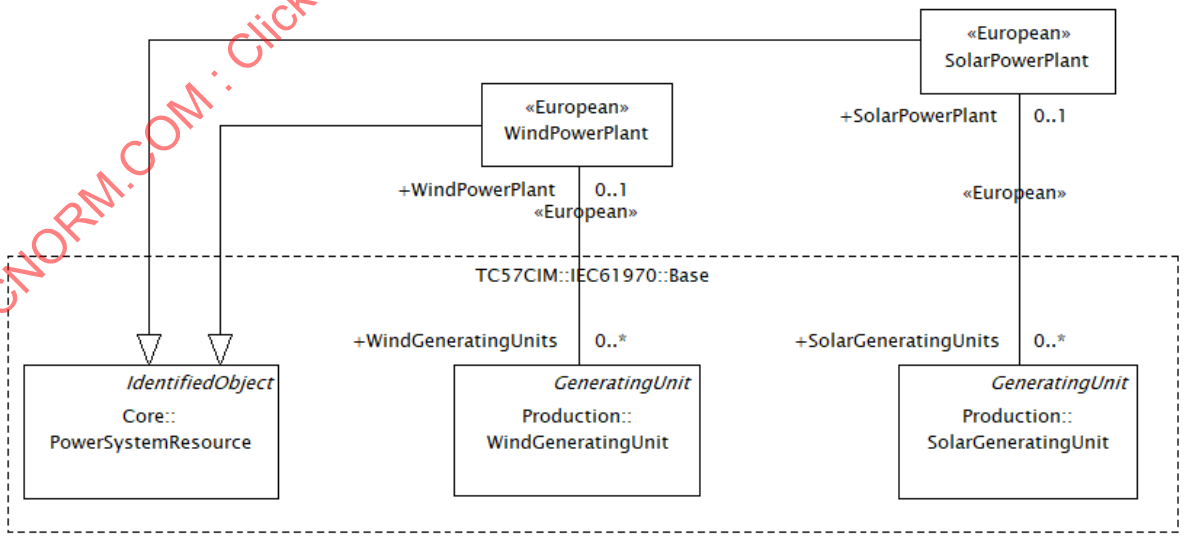


Figure A.4 – Class diagram ExtEuProduction::ExtEuProduction

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Figure A.4: The diagram shows European extensions to Production package.

A.2.4.2.2 (European) SolarPowerPlant

Solar power plant.

Table A.6 shows all attributes of SolarPowerPlant.

Table A.6 – Attributes of ExtEuProduction::SolarPowerPlant

name	mult	type	description
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject
energyIdentCodeEic	0..1	String	(European) inherited from: ExtEuIdentifiedObject
shortName	0..1	String	(European) inherited from: ExtEuIdentifiedObject

Table A.7 shows all association ends of SolarPowerPlant with other classes.

Table A.7 – Association ends of ExtEuProduction::SolarPowerPlant with other classes

mult from	name	mult to	type	description
0..1	SolarGeneratingUnits	0..*	SolarGeneratingUnit	(European) A solar generating unit or units may be a member of a solar power plant.
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

A.2.4.2.3 (European) WindPowerPlant

Wind power plant.

Table A.8 shows all attributes of WindPowerPlant.

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Table A.8 – Attributes of ExtEuProduction::WindPowerPlant

name	mult	type	description
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject
energyIdentCodeEic	0..1	String	(European) inherited from: ExtEuIdentifiedObject
shortName	0..1	String	(European) inherited from: ExtEuIdentifiedObject

Table A.9 shows all association ends of WindPowerPlant with other classes.

Table A.9 – Association ends of ExtEuProduction::WindPowerPlant with other classes

mult from	name	mult to	type	description
0..1	WindGeneratingUnits	0..*	WindGeneratingUnit	(European) A wind generating unit or units may be a member of a wind power plant.
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

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Annex B
(Informative)

Examples of PST transformer modelling

B.1 General

This annex provides examples of Phase-Shifting Transformer (PST) modelling according to the type and technology of the equipment as described in 4.5.7.

B.2 Detailed calculations and examples

B.2.1 Symmetrical phase shifters with two cores

Figure B.1 shows symmetrical phase shifters with two cores.

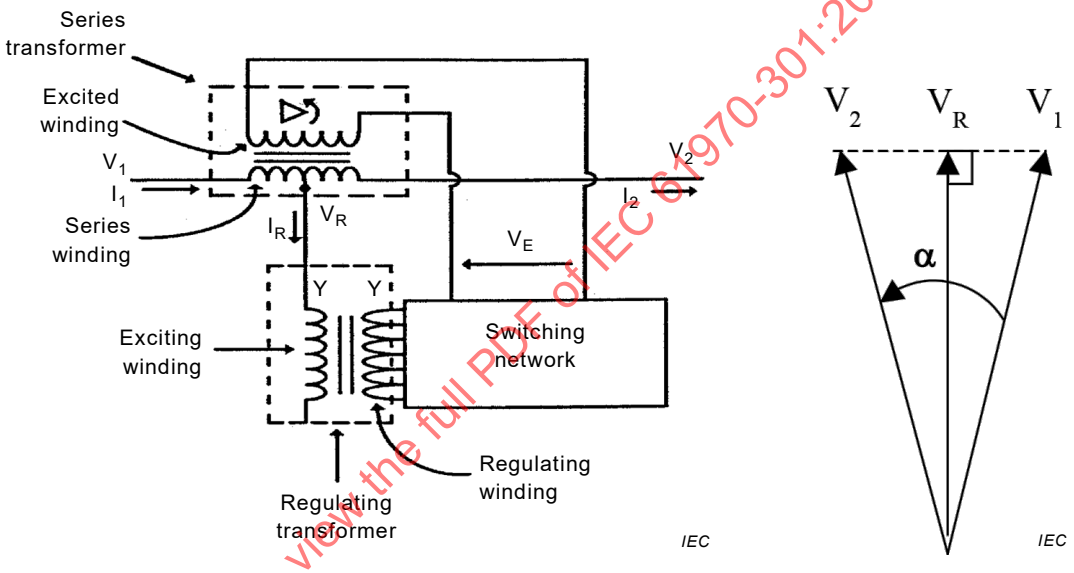


Figure B.1 – Symmetrical phase shifters with two cores

Figure B.2 shows a detailed three phase diagram.

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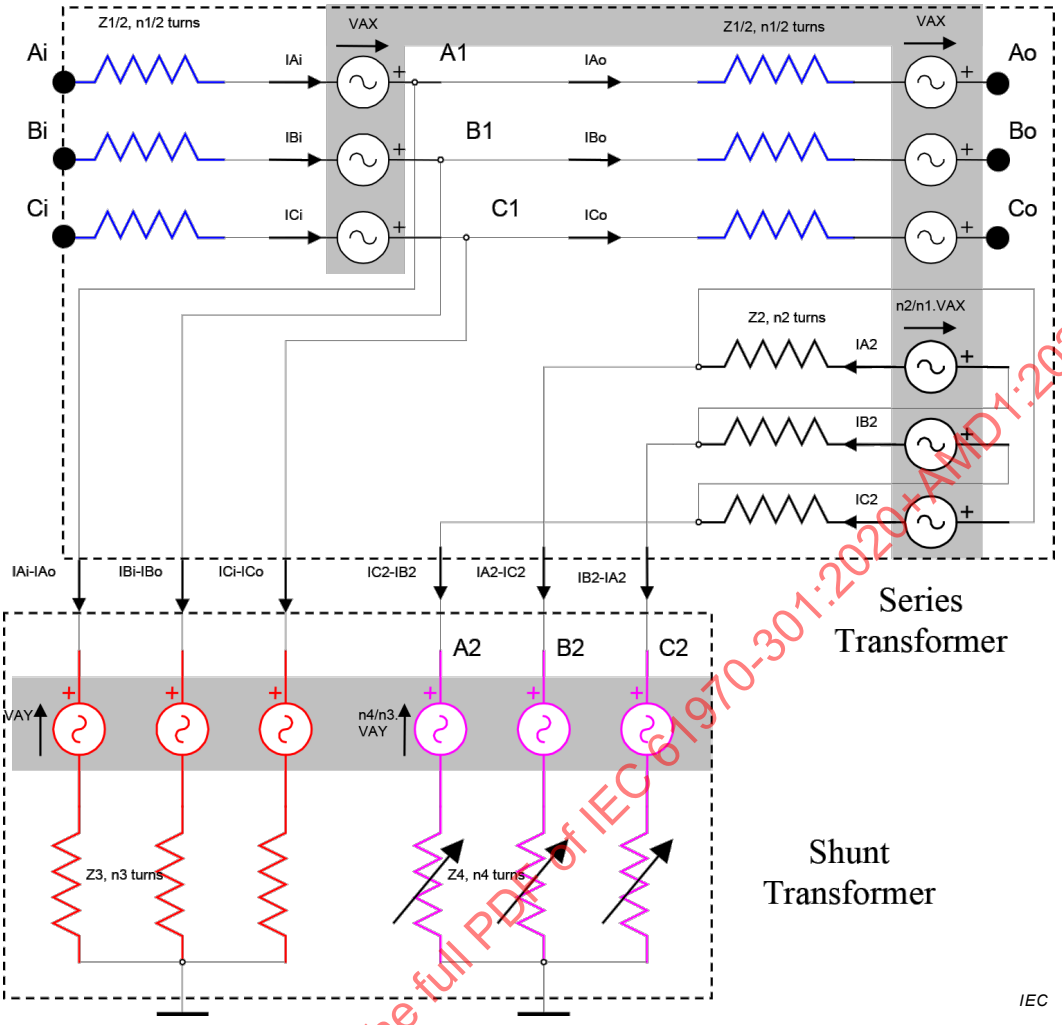


Figure B.2 – Detailed three phase diagram

Only n4 varies.

Example of numerical values:

n1 = 120

n2 = 318

n3 =680

$n4_{max}$ = 182

X1 = 1,23 Ω

X2 = 8,64 Ω

X3 = 101 Ω

Expression of the output current Io and the shunt current I3 = Ii-Io:

When considering an ideal phase shifter, the conservation of the electric power is written: $Si = 3ViIi^* = 3VoIo^*$

As the voltage angle is shifted by alpha: $Vo = e^{j\alpha}Vi$

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The current angle must also be shifted by alpha as well: $Io = e^{j\alpha} Ii$

Then, the shunt current $I3 = Ii - Io = (1 - e^{j\alpha})Ii$

Expression of the shunt equivalent reactance

The shunt reactance Xshunt(α) is defined as the equivalent reactance which crossed by the series input current (*Ii*) would produce the reactive losses of the shunt transformer:

$$Qshunt = 3.Xshunt(\alpha).|Ii|^2$$

with:

$$Qshunt = 3.X3.|I3|^2 + 3.X4.|I4|^2$$

$$|I3|^2 = |Ii|^2 |1 - e^{j\alpha}|^2 = 2(1 - \cos\alpha)|Ii|^2 = 4(\sin(\alpha/2))^2$$

$$|I4|^2 = \frac{n3^2}{n4^2}|I3|^2$$

$$Xshunt(\alpha) = 4(\sin(\alpha/2))^2 \left(X3 + X4 \left(\frac{n3}{n4} \right)^2 \right)$$

Hypothesis: $X4 = X4_{\max} \left(\frac{n4}{n4_{\max}} \right)^2$

Then $Xshunt(\alpha) = 4(\sin(\alpha/2))^2 \left(X3 + X4_{\max} \frac{n3^2}{n4^2_{\max}} \right)$

Expression of the equivalent series reactance

The series reactance Xseries(α) is defined as the equivalent reactance which crossed by the series input current (*Ii*) would produce the reactive losses of the series transformer:

$$Qseries = 3.Xseries(\alpha).|Ii|^2$$

with:

$$Qseries = 3.\frac{X1}{2}.|Ii|^2 + 3.\frac{X1}{2}.|Io|^2 + 3.X2.|I2|^2$$

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as seen previously: $Io = e^{j\alpha} Ii$

series transformer current relationship: $\frac{n1}{2}.Ii + \frac{n1}{2}.Io = +n2.I2$

then

$$I2 = \frac{n1}{2n2}\left(1 + e^{j\alpha}\right)Ii \text{ and } \left|I2\right|^2 = \left(\frac{n1}{2n2}\right)^2 \left|Ii\right|^2 \left|1 + e^{j\alpha}\right|^2 = \frac{1}{2}\frac{n1^2}{n2^2}(1 + \cos\alpha)\left|Ii\right|^2$$

then

$$Xseries(\alpha) = X1 + \frac{1}{2}\left(\frac{n1}{n2}\right)^2 (1 + \cos\alpha)X2 = X1 + \left(\frac{n1}{n2}\right)^2 (1 - \sin(\alpha/2))X2$$

$$Xseries(\alpha) = \left(X1 + \left(\frac{n1}{n2}\right)^2 X2\right) - \left(\frac{n1}{n2}\right)^2 X2(\sin(\alpha/2))^2$$

Expression of the total equivalent reactance X

$$X(\alpha) = \left(X1 + \left(\frac{n1}{n2}\right)^2 X2\right) + 4(\sin(\alpha/2))^2 \left(X3 + X4_{\max}\frac{n3^2}{n4_{\max}^2} - \left(\frac{n1}{2n2}\right)^2 X2\right)$$

or

$$X(\alpha) = X(0) + \left(X(\alpha_{\max}) - X(0)\right)\left(\frac{\sin(\alpha/2)}{\sin(\alpha_{\max}/2)}\right)^2$$

with:

$$X(0) = \left(X1 + \left(\frac{n1}{n2}\right)^2 X2\right)$$

$$X(\alpha_{\max}) - X(0) = 4(\sin(\alpha_{\max}/2))^2 \left(X3 + X4_{\max}\frac{n3^2}{n4_{\max}^2} - \left(\frac{n1}{2n2}\right)^2 X2\right)$$

Remark: only α varies.

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B.2.2 Quadrature boosters

B.2.2.1 Quadrature booster with two cores

Figure B.3 shows a detailed three phase diagram. The single phase diagram is shown in Figure B.4.

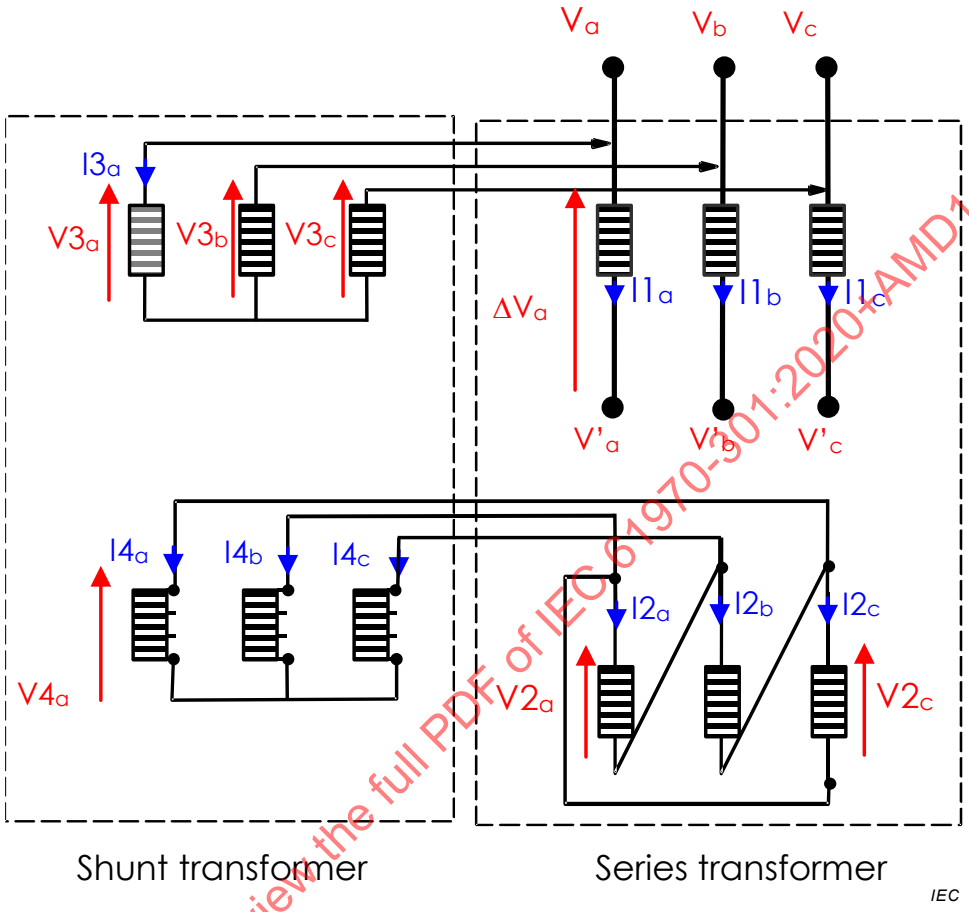


Figure B.3 – Detailed three phase diagram

For each physical value X (X = V or I) $X = X_a = aX_b = a^2X_c$ with $a = e^{j\frac{2\pi}{3}}$

shunt transformer with variable ratio n4/n3 with X3 reactance on the primary winding and X4 on the secondary winding:

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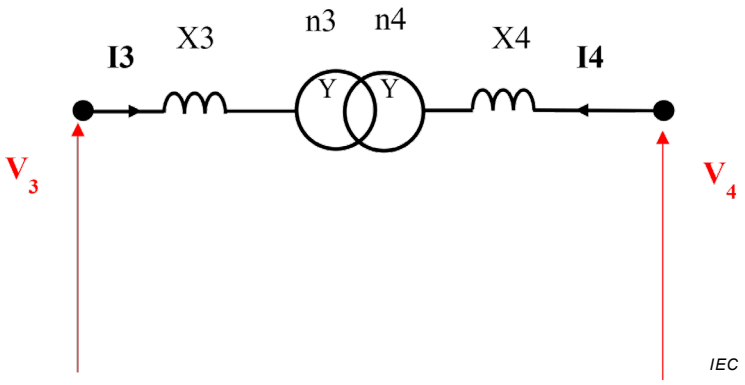


Figure B.4 – Single phase diagram

$$V4 - jX4.I4 = \frac{n4}{n3}(V3 - jX3.I3) \qquad I3 = -\frac{n4}{n3}I4$$

$$V4 = \frac{n4}{n3}V3 + j\left(X_4 + X_3\left(\frac{n4}{n3}\right)^2\right)I4$$

Hypothesis: the X4 reactance varies like the square of the number of turns n4:

$$X_4 = X_4^{\max}\left(\frac{n4}{n4_{\max}}\right)^2$$

Series transformer of fixed ratio n1/n2 with X1 reactance on the primary winding and X2 on the secondary winding:

$$\Delta V = \frac{n1}{n2}V2 + j\left(X1 + \left(\frac{n1}{n2}\right)^2 X2\right)I1$$

$$I2 = -\frac{n1}{n2}I1$$

Link between series and shunt transformers:

- Primary windings:

$$V3 = V$$

- Secondary windings:

$$I4 = I4_a = I2_b - I2_c = (a^2 - a)I2_a = -j\sqrt{3}I2$$

$$V2 = V2_a = V4_b - V4_c = (a^2 - a)V4 = -j\sqrt{3}V4$$

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Calculation:

$$\Delta V = -j\frac{n4.n1}{n3.n2}\sqrt{3}V + j\left(X1+\left(\frac{n1}{n2}\right)^2 X2 + 3\left(\frac{n1}{n2}\right)^2 n4^2\left(\frac{X4^{\max}}{n4_{\max}^2}+\frac{X3}{n3^2}\right)\right)I1$$

$$I3 = -j\frac{n4.n1}{n3.n2}\sqrt{3}I1$$

At no load conditions (I = 0):

$$\Delta V = -j\frac{n4.n1}{n3.n2}\sqrt{3}V$$

And geometrically, shown in Figure B.5:

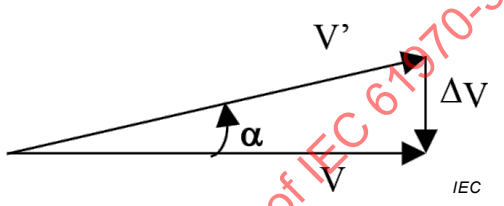


Figure B.5 – Phasor diagram

$$\Delta V = -jV\tan\alpha$$

Hence $\dfrac{n4}{n4^{\max}} = \dfrac{\tan\alpha}{\tan\alpha_{\max}}$

And $\Delta V = -j\dfrac{n4.n1}{n3.n2}\sqrt{3}V + j\left(X1+\left(\dfrac{n1}{n2}\right)^2 X2 + 3n4_{\max}^2\left(\dfrac{n1}{n2}\right)^2\left(\dfrac{X4^{\max}}{n4_{\max}^2}+\dfrac{X3}{n3^2}\right)\left(\dfrac{\tan\alpha}{\tan\alpha_{\max}}\right)^2\right)I1$

comes:

$$\Delta V = -j\frac{n4.n1}{n3.n2}\sqrt{3}V + jXI \text{ with } X(\alpha) = X(0) + \left(X(\alpha_{\max}) - X(0)\right)\left(\frac{\tan(\alpha)}{\tan(\alpha_{\max})}\right)^2$$

B.2.2.2 Quadrature booster with a single core

Figure B.6 shows a detailed three phase diagram.

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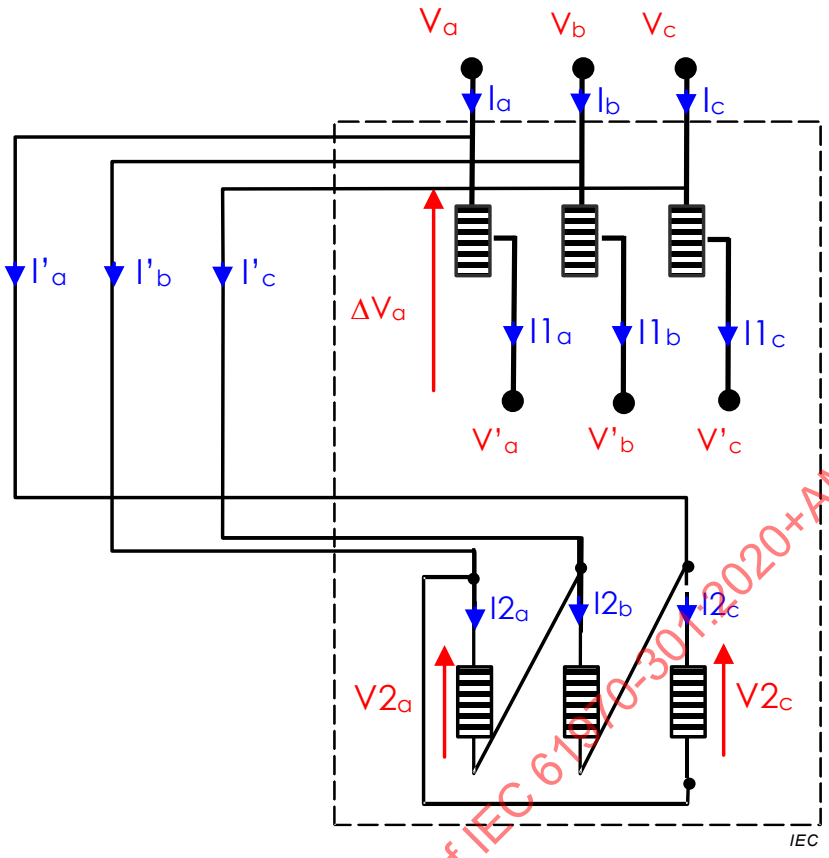


Figure B.6 – Detailed three phase diagram

n1 varies.

$$I' = j\sqrt{3}I2$$

$$V2 = -j\sqrt{3}V$$

$$\Delta V = \frac{n1}{n2}V2 + j\left(X1 + \left(\frac{n1}{n2}\right)^2 X2\right)I1$$

$$\Delta V = -j\sqrt{3}\frac{n1}{n2}V + j\left(X1 + \left(\frac{n1}{n2}\right)^2 X2\right)I1$$

Assuming $X1 = X1_{\max}\left(\frac{n1}{n1_{\max}}\right)^2$

$$\Delta V = -j\sqrt{3}\frac{n1}{n2}V + j\left(\frac{X1_{\max}}{n1_{\max}} + \frac{X2}{n2^2}\right)n1^2 I1$$

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At no-load: $\Delta V = -j\sqrt{3}\frac{n1}{n2}V$

And geometrically, shown in Figure B.7:

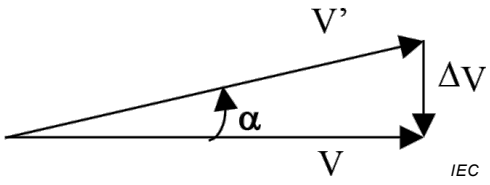


Figure B.7 – Phasor diagram

$$\Delta V = -jV\tan\alpha$$

hence $$\frac{n1}{n1^{\max}} = \frac{\tan\alpha}{\tan\alpha_{\max}}$$

$$X(\alpha) = \left(X1_{\max} + X2\frac{n1_{\max}^2}{n2^2}\right)\left(\frac{\tan\alpha}{\tan\alpha_{\max}}\right)^2$$

$$X(\alpha) = X(\alpha_{\max})\left(\frac{\tan\alpha}{\tan\alpha_{\max}}\right)^2$$

B.2.3 Asymmetrical phase shifter

B.2.3.1 Asymmetrical phase shifter with two cores

Figure B.8 shows an asymmetrical phase shifter with two cores.

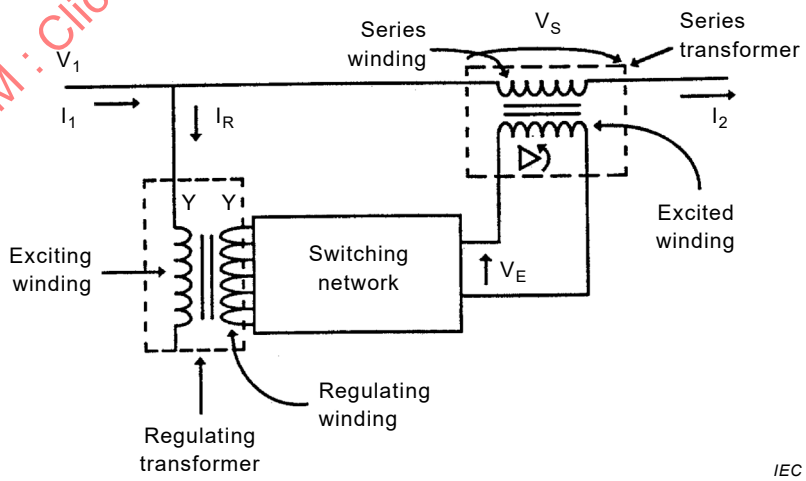


Figure B.8 – Asymmetrical phase shifter with two cores

Figure B.9 shows a detailed three phase diagram:

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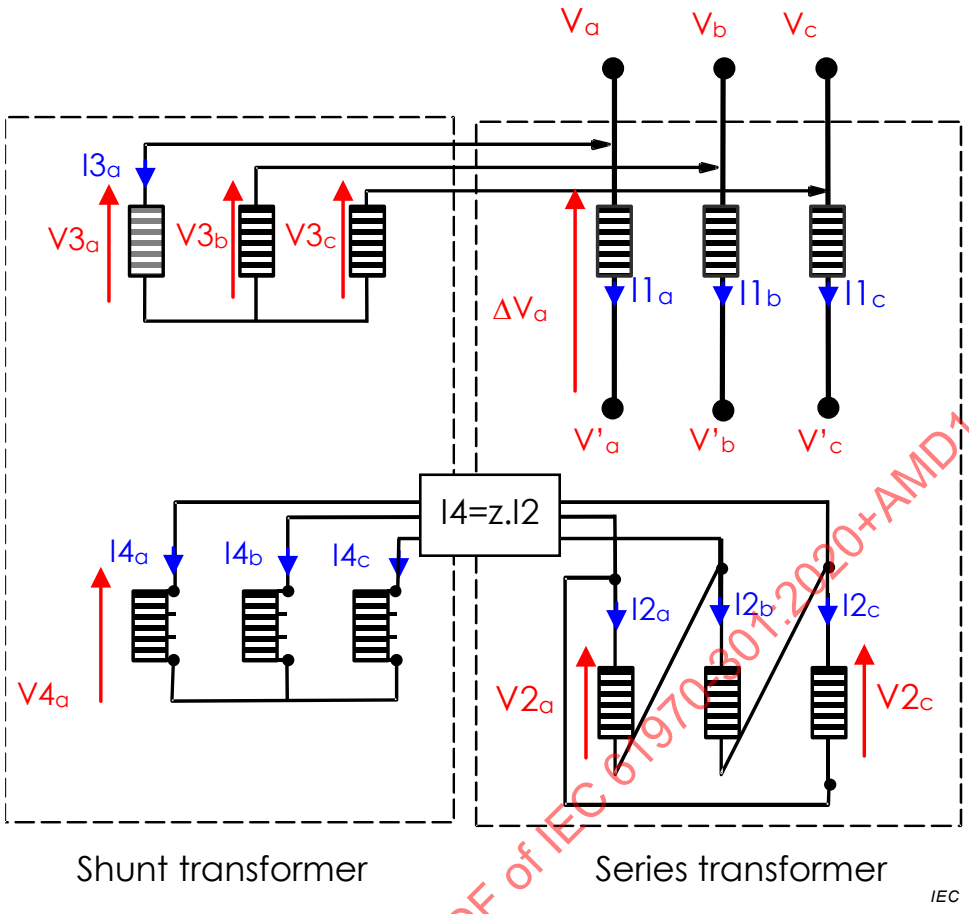


Figure B.9 – Detailed three phase diagram

For each physical value X (X = V or I) $X = X_a = aX_b = a^2X_c$ with $a = e^{j\frac{2\pi}{3}}$

shunt transformer equations:

$$V4 = \frac{n4}{n3}V3 + j\left(X_4 + X_3\left(\frac{n4}{n3}\right)^2\right)I4$$

$$I3 = -\frac{n4}{n3}I4$$

Hypothesis: the X2 reactance varies like the square of the k1 ratio:

$$X_4 = X_4^{\max}\left(\frac{n4}{n4_{\max}}\right)^2$$

Series transformer of fixed ratio k_2 with X_{series} reactance on the primary winding:

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$$\Delta V = \frac{n1}{n2} V2 + j\left(X1 + \left(\frac{n1}{n2} \right)^2 X2 \right) I1$$

$$I2 = -\frac{n1}{n2} I1$$

Link between series and shunt transformers:

- Primary windings:

  $V3 = V$

- "z", a complex number, determines the coupling between the series and shunt transformer secondary windings:

  $I4 = I4_a = z.I2$

  $V2 = z.V4$

  for a quadrature booster $z = -j\sqrt{3}$

Calculation:

$$\Delta V = \frac{n4.n1}{n3.n2}.z.V + j\left(X1 + \left(\frac{n1}{n2} \right)^2 X2 - z^2 \left(\frac{n1}{n2} \right)^2 n4^2 \left(\frac{X4^{\max}}{n4^2_{\max}} + \frac{X3}{n3^2} \right) \right) I1$$

$$I3 = \frac{n4.n1}{n3.n2}.z.I1$$

At no load conditions (I = 0):

$$\Delta V = \frac{n4.n1}{n3.n2}.z.V$$

And geometrically, shown in Figure B.10:

$$\Delta V = -e^{j\theta}.V \frac{\tan\alpha}{\sin\theta - \tan\alpha\cos\theta}$$

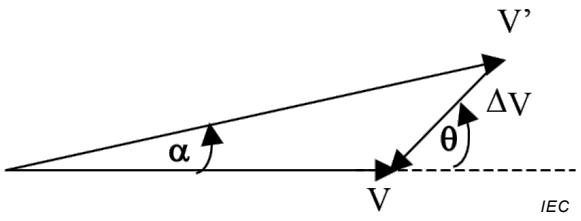


Figure B.10 – Phasor diagram

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hence $\frac{n4}{n4^{\max}} = \frac{\tan\alpha}{\tan\alpha_{\max}} \frac{\sin\theta - \tan\alpha_{\max}\cos\theta}{\sin\theta - \tan\alpha\cos\theta}$

And

$$\Delta V = -j\frac{n4.n1}{n3.n2}\sqrt{3}V + j\left(X1 + \left(\frac{n1}{n2}\right)^2 X2 - z^2 n4_{\max}^2 \left(\frac{n1}{n2}\right)^2 \left(\frac{X4^{\max}}{n4_{\max}^2} + \frac{X3}{n3^2}\right)\left(\frac{\tan\alpha}{\tan\alpha_{\max}} \frac{\sin\theta - \tan\alpha_{\max}\cos\theta}{\sin\theta - \tan\alpha\cos\theta}\right)^2\right) I1$$

comes:

$$\Delta V = z\frac{n4.n1}{n3.n2}V + jXI \text{ with } X(\alpha) = X(0) + \left(X(\alpha_{\max}) - X(0)\right)\left(\frac{\tan\alpha}{\tan\alpha_{\max}} \frac{\sin\theta - \tan\alpha_{\max}\cos\theta}{\sin\theta - \tan\alpha\cos\theta}\right)^2$$

B.2.3.2 Asymmetrical phase shifter with a single core

Figure B.11 shows an asymmetrical phase shifter with a single core.

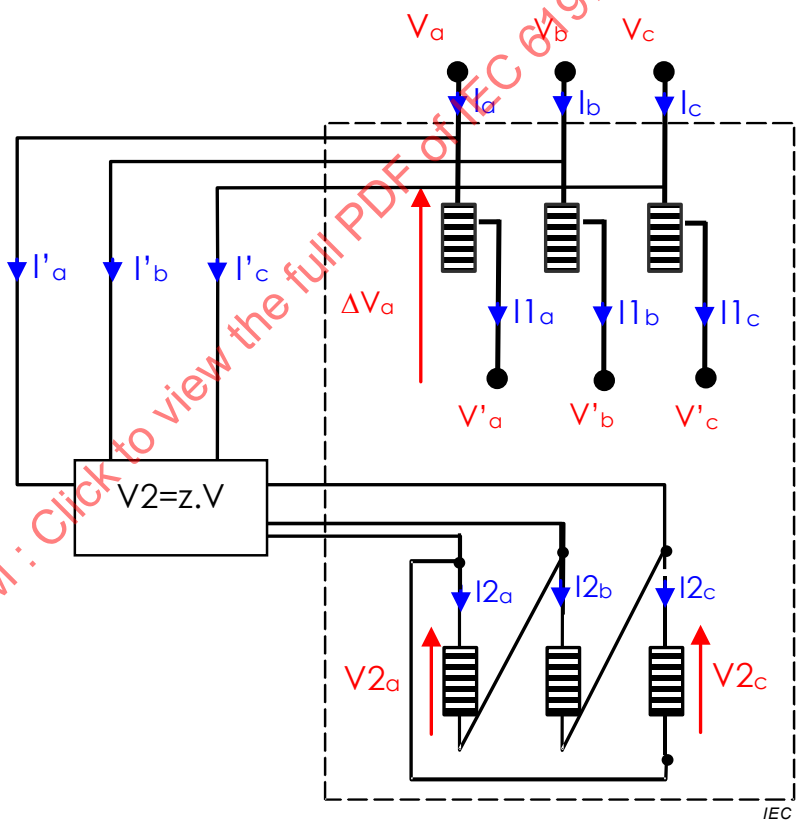


Figure B.11 – Asymmetrical phase shifter with a single core

Only n1 varies.

$$I' = -z.I2$$

$$V2 = z.V$$

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$$\Delta V = \frac{n1}{n2}V2 + j\left(X1 + \left(\frac{n1}{n2}\right)^2 X2\right)I1$$

$$\Delta V = z.\frac{n1}{n2}V + j\left(X1 + \left(\frac{n1}{n2}\right)^2 X2\right)I1$$

Assuming $X1 = X1_{max}\left(\frac{n1}{n1_{max}}\right)^2$

$$\Delta V = z.\frac{n1}{n2}V + j\left(\frac{X1_{max}}{n1_{max}} + \frac{X2}{n2^2}\right)n1^2 I1$$

At no-load: $\Delta V = z.\frac{n1}{n2}V$

And geometrically, shown in Figure B.12:

$$\Delta V = -e^{j\theta}.V\frac{\tan\alpha}{\sin\theta - \tan\alpha\cos\theta}$$

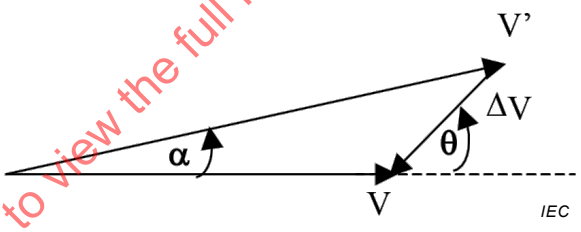


Figure B.12 – Phasor diagram

hence $\frac{n1}{n1_{max}} = \frac{\tan\alpha}{\tan\alpha_{max}}\frac{\sin\theta - \tan\alpha_{max}\cos\theta}{\sin\theta - \tan\alpha\cos\theta}$

$$X(\alpha) = \left(X1_{max} + X2\frac{n1_{max}^2}{n2^2}\right)\left(\frac{\tan\alpha}{\tan\alpha_{max}}\frac{\sin\theta - \tan\alpha_{max}\cos\theta}{\sin\theta - \tan\alpha\cos\theta}\right)^2$$

$$X(\alpha) = X(\alpha_{max})\left(\frac{\tan\alpha}{\tan\alpha_{max}}\frac{\sin\theta - \tan\alpha_{max}\cos\theta}{\sin\theta - \tan\alpha\cos\theta}\right)^2$$

B.2.3.3 In-phase transformer and asymmetrical phase shifter

Figure B.13 and Figure B.14 give examples of detailed three-phase diagrams of voltage regulating auto-transformer and quadrature booster.

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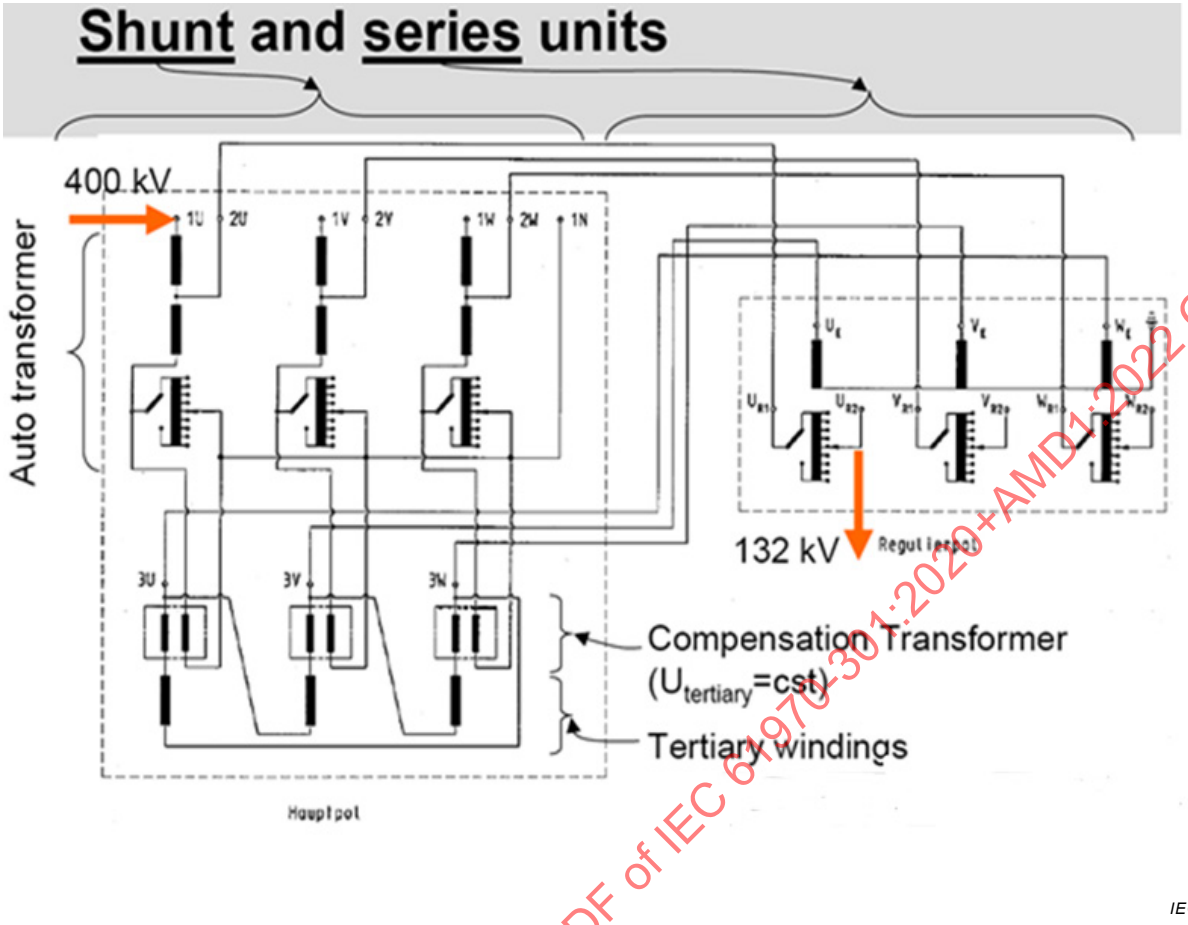
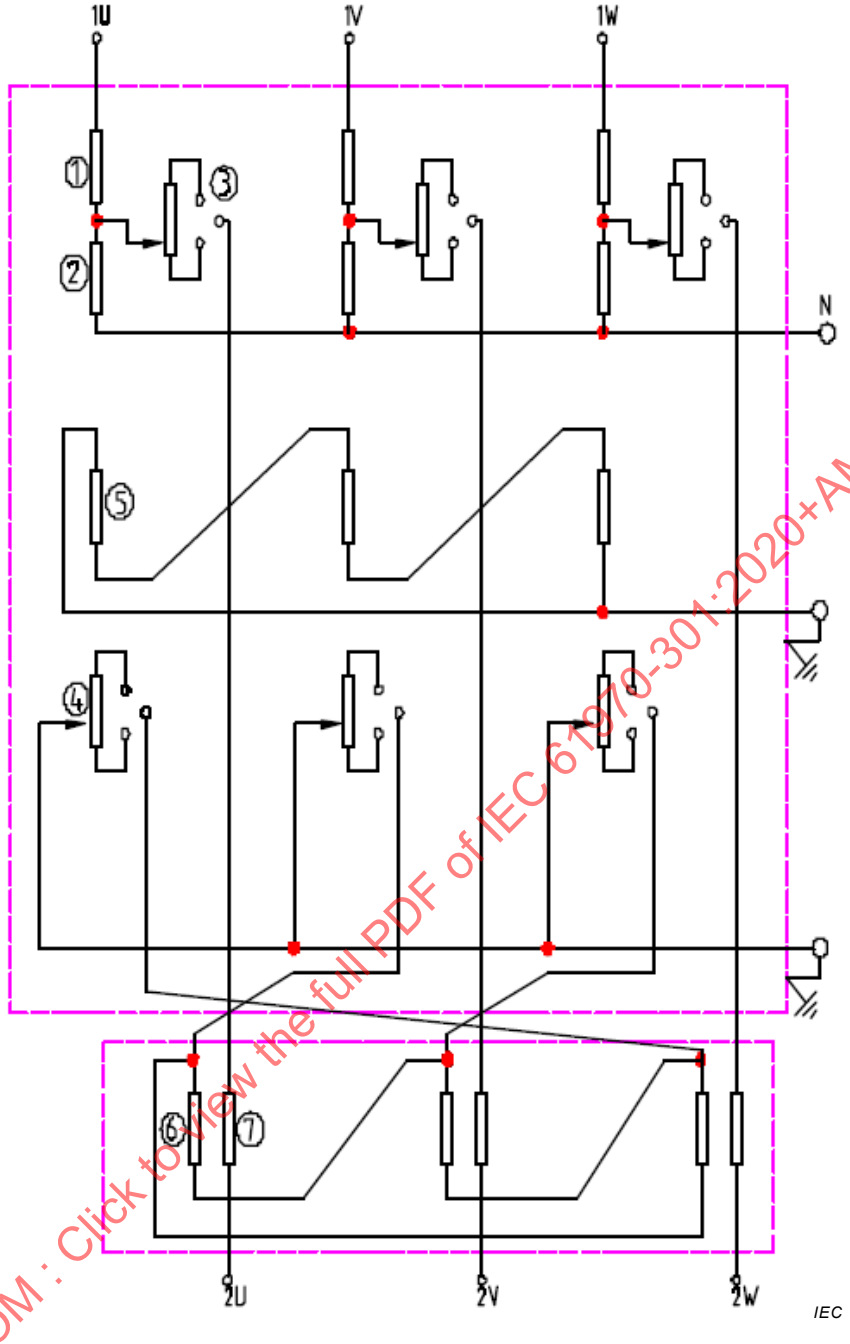


Figure B.13 – Example of detailed three-phase diagram of voltage regulating auto-transformer and quadrature booster

Voltage regulating auto-transformer and quadrature booster:

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1) EHV winding
2) HV winding
3) EV voltage regulating winding
4) Phase shift regulating winding
5) Tertiary winding
6) Primary winding of the series transformer
7) Secondary winding of the series transformer

Figure B.14 – Example of detailed winding diagram of voltage regulating auto-transformer and quadrature booster

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Annex C
(informative)

Use cases HVDC representation

C.1 Overview

Annex C is informative and contains information about the use cases related to the HVDC representation.

C.2 Back-to-back installations

The expression back-to-back indicates that the rectifier and inverter are located in the same station. Back-to-back converters are mainly used for power transmission between adjacent AC grids which cannot be synchronized. They can also be used within a meshed grid in order to achieve a defined power flow.

The DC filter and smoothing reactor is not modelled explicitly in this example, although they should when calculating special types of short circuit and/or dynamic response. The DC components are marked red, the candidates for boundary points are marked green. If the back-to-back installation is exchanged in a separate MAS, both boundary points are used.

The point of common coupling terminal associated with the boundary point also features as TieFlow.Terminal if the flow counts in the net position of the ControlArea. Figure C.1 represents a 12-p back-to-back installation.

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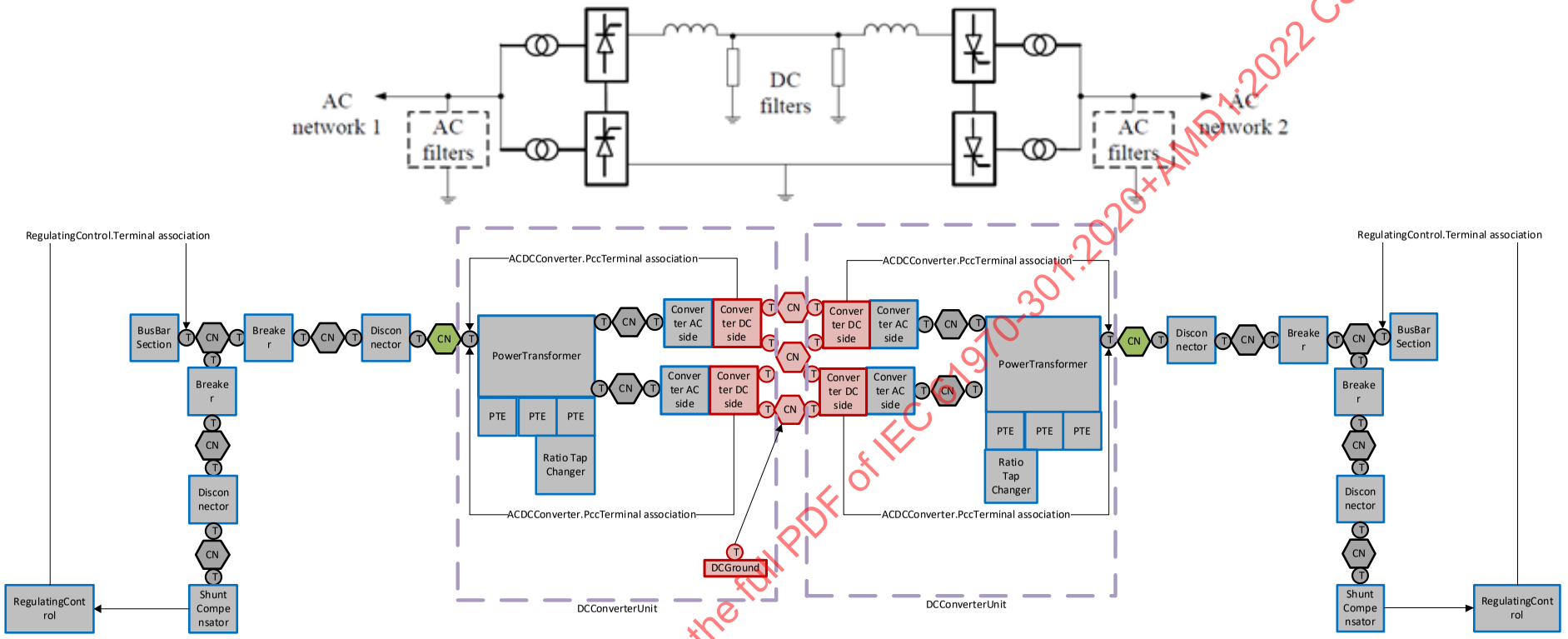


Figure C.1 – Representation of a 12-p back-to-back installation

C.3 Monopole with ground return

Figure C.2 shows an example for modelling and serializing a 12 pulse monopole installation with ground return.

The DC filter is not modelled explicitly in this example, although they should when calculating special types of short circuit and/or dynamic response. The DC components are marked red, the candidates for boundary points are marked green. If the installation is exchanged in a separate MAS, both boundary points are used.

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The point of Common Coupling terminal associated with the boundary point also features as TieFlow.Terminal if the flow counts in the net position of the ControlArea.

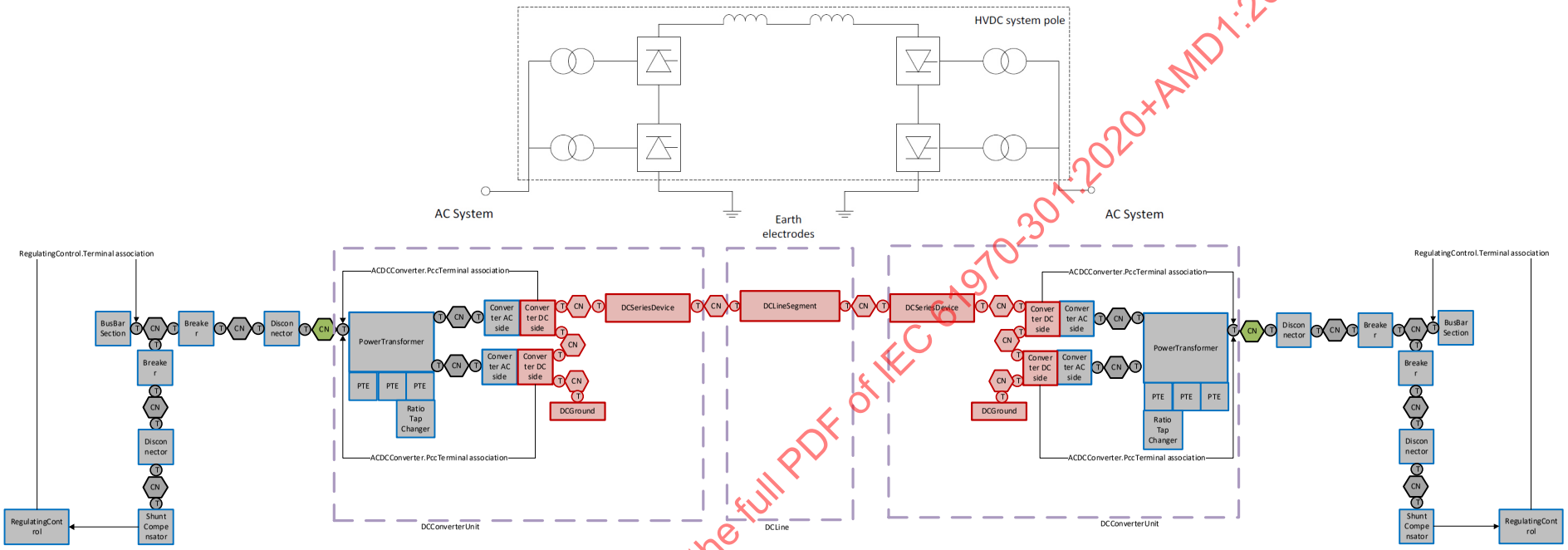


Figure C.2 – Representation of a 12-p monopole installation with ground return

C.4 Monopole with metallic return

Figure C.3 shows an example for modelling and serializing a 12 pulse monopole installation with metallic return.

The DC filter is not modelled explicitly in this example, although they should when calculating special types of short circuit and/or dynamic response. The DC components are marked red, the candidates for boundary points are marked green. If the installation is exchanged in a separate MAS, both boundary points are used.

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The point of Common Coupling terminal associated with the boundary point also features as TieFlow.Terminal if the flow counts in the net position of the ControlArea.

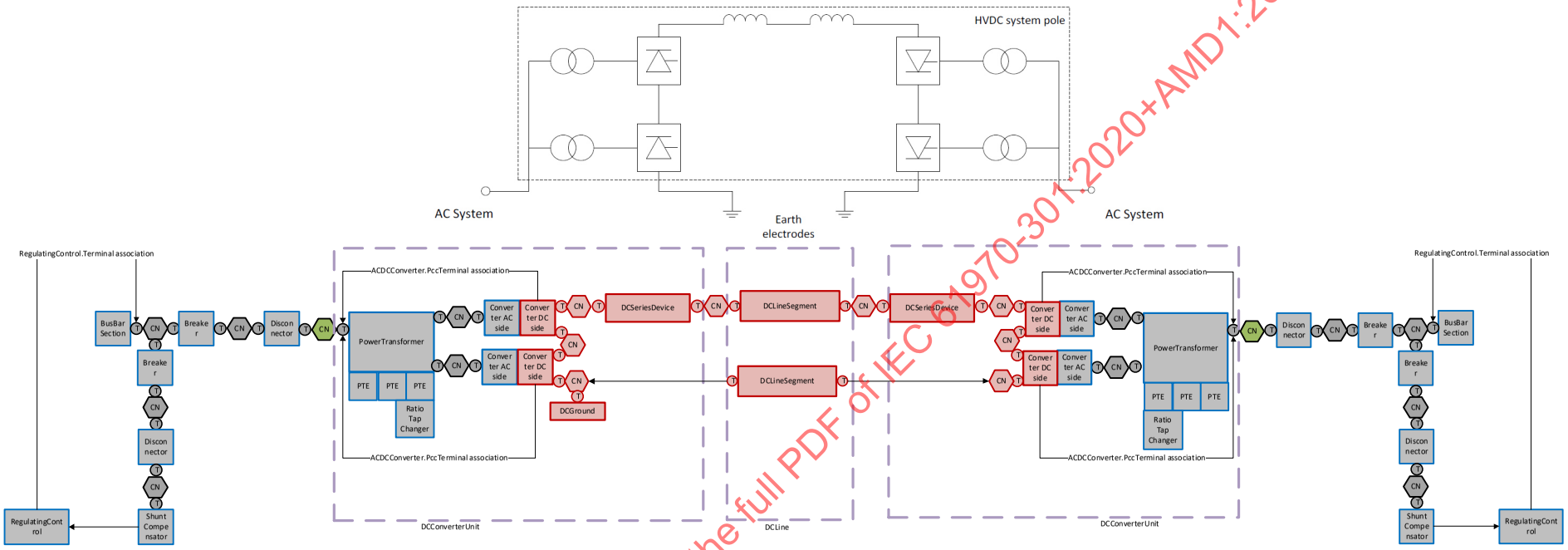


Figure C.3 – Representation of a 12-p monopole installation with metallic return

C.5 Voltage source converter

Figure C.4 shows an example for modelling and serializing a voltage source converter (VSC).

The DC filter is not modelled explicitly in this example, although they should when calculating special types of short circuit and/or dynamic response. The DC components are marked red, the candidates for boundary points are marked green. If the installation is exchanged in a separate MAS, both boundary points are used.

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The point of Common Coupling terminal associated with the boundary point also features as TieFlow.Terminal if the flow counts in the net position of the ControlArea.

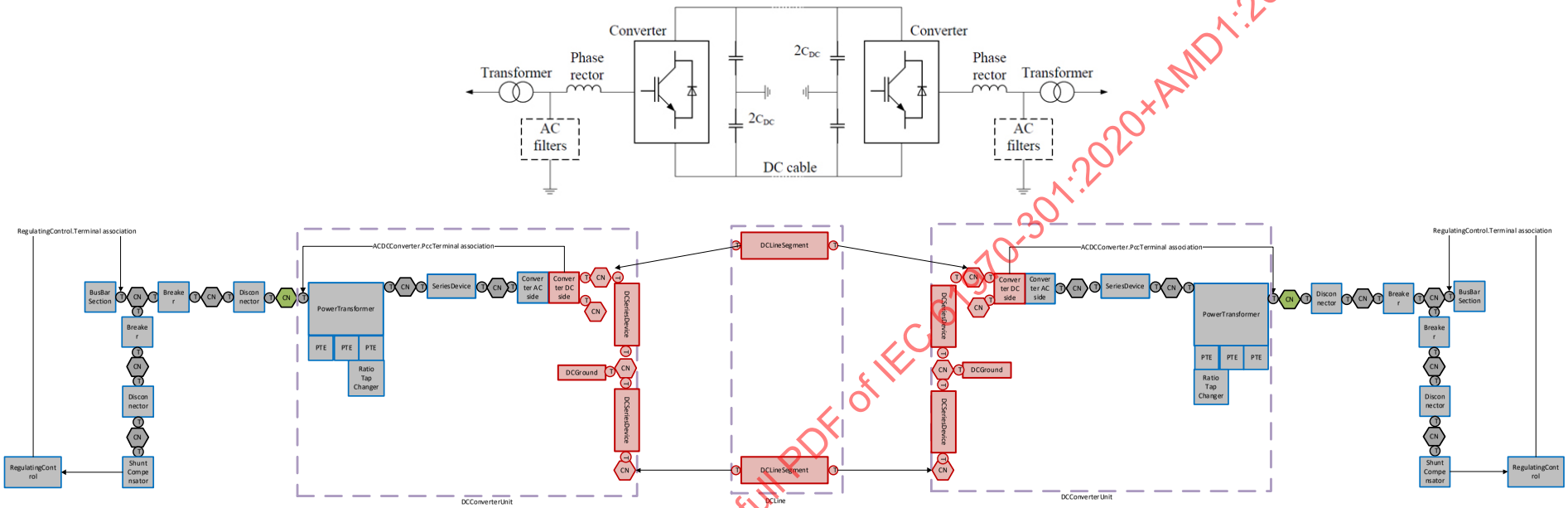


Figure C.4 – Representation of a voltage source converter

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SOMMAIRE

AVANT-PROPOS 594
INTRODUCTION 596
1 Domaine d'application 598
2 Références normatives 598
3 Termes et définitions 599
4 Spécification du CIM 600
4.1 Vue d'ensemble 600
4.2 Notation de modélisation du CIM 600
4.3 Paquetages CIM 600
4.4 Classes CIM et relations 602
4.4.1 Classes 602
4.4.2 Generalization 603
4.4.3 Simple association (Association simple) 604
4.4.4 Aggregation 605
4.5 Concepts et exemples de modèles CIM 606
4.5.1 Concepts 606
4.5.2 Hiérarchies d'emboîtement, d'équipements et dénomination 606
4.5.3 Modèle de Names 608
4.5.4 Modèle de connectivité 608
4.5.5 Hiérarchie des héritages 611
4.5.6 Modèle de Transformer 613
4.5.7 Modélisation de prise du transformateur 617
4.5.8 Modélisation des phases 632
4.5.9 Modélisation des appareils de mise à la terre 635
4.5.10 Modèle de cuts, de clamps (serre-fils) et de jumpers (cavaliers) 638
4.5.11 Mesures et commandes 642
4.5.12 Modèles de commande de régulation 647
4.5.13 Modèle en courant continu pour le CIM 649
4.5.14 Régulation de la tension du compensateur de Var statique 673
4.5.15 Modèle de configuration ICCP 675
4.5.16 Modèle Feeder 682
4.5.17 Modélisation de la zone de commande 683
4.6 Lignes directrices de modélisation 684
4.6.1 Modélisation pour modifications 684
4.6.2 Processus pour les amendements au CIM 685
4.6.3 Modifications apportées au modèle UML du CIM 685
4.6.4 Modifications apportées aux documents normatifs du CIM 685
4.6.5 Éléments déconseillés 686
4.6.6 Profils CIM 686
4.7 Outils de modélisation 686
4.8 Conventions de mise en œuvre pour les utilisateurs 687
4.8.1 Conventions au-delà de l'UML 687
4.8.2 Nombre de bornes pour les objets ConductingEquipment 687
4.8.3 Grandeurs nominales 687
4.8.4 Datatypes 687
4.9 Exemples de modélisation CIM 688

IECNORM.COM : Click to view the full PDF of IEC 61970-301:2020+AMD1:2022 CSV

5 Modèle détaillé 688
5.1 Vue d'ensemble 688
5.2 Contexte 688
6 Paquetage Base 690
6.1 Généralités 690
6.2 Paquetage Domain 691
6.2.1 Généralités 691
6.2.2 Type de données ActivePower 697
6.2.3 Type de données ActivePowerChangeRate 698
6.2.4 Type de données ActivePowerPerCurrentFlow 698
6.2.5 Type de données ActivePowerPerFrequency 698
6.2.6 Type de données Admittance 698
6.2.7 Type de données AngleDegrees 699
6.2.8 Type de données AngleRadians 699
6.2.9 Type de données ApparentPower 699
6.2.10 Type de données Area 699
6.2.11 Type primitif de données Boolean 700
6.2.12 Type de données Capacitance 700
6.2.13 Type de données CapacitancePerLength 700
6.2.14 Type de données Classification 700
6.2.15 Type de données Conductance 701
6.2.16 Type de données ConductancePerLength 701
6.2.17 Type de données CostPerEnergyUnit 701
6.2.18 Type de données CostPerHeatUnit 701
6.2.19 Type de données CostPerVolume 702
6.2.20 Type de données CostRate 702
6.2.21 Enumération Currency 702
6.2.22 Type de données CurrentFlow 706
6.2.23 Type de données Damping 706
6.2.24 Type primitif de données Date 707
6.2.25 Compound DateInterval 707
6.2.26 Type primitif de données DateTime 707
6.2.27 Compound DateTimeInterval 707
6.2.28 Type primitif de données Decimal 707
6.2.29 Compound DecimalQuantity 708
6.2.30 Type de données Displacement 708
6.2.31 Type primitif de données Duration 708
6.2.32 Type de données Emission 708
6.2.33 Type primitif de données Float 708
6.2.34 Compound FloatQuantity 709
6.2.35 Type de données Frequency 709
6.2.36 Type de données HeatRate 709
6.2.37 Type de données Hours 709
6.2.38 Type de données Impedance 710
6.2.39 Type de données Inductance 710
6.2.40 Type de données InductancePerLength 710
6.2.41 Type primitif de données Integer 710
6.2.42 Compound IntegerQuantity 711
6.2.43 Type de données KiloActivePower 711

IECNORM.COM : Click to view the full PDF of IEC 61970-301:2020+AMD1:2022 CSV

6.2.44 Type de données Length 711
6.2.45 Type de données Mass 711
6.2.46 Type de données Minutes 712
6.2.47 Type de données Money 712
6.2.48 Type primitif de données MonthDay 712
6.2.49 Compound MonthDayInterval 712
6.2.50 Type de données PU 712
6.2.51 Type de données PerCent 713
6.2.52 Type de données Pressure 713
6.2.53 Type de données Reactance 713
6.2.54 Type de données ReactancePerLength 713
6.2.55 Type de données ReactivePower 714
6.2.56 Type de données RealEnergy 714
6.2.57 Type de données Resistance 714
6.2.58 Type de données ResistancePerLength 715
6.2.59 Type de données RotationSpeed 715
6.2.60 Type de données Seconds 715
6.2.61 Type de données Speed 715
6.2.62 Type primitif de données String 716
6.2.63 Compound StringQuantity 716
6.2.64 Type de données Susceptance 716
6.2.65 Type de données SusceptancePerLength 716
6.2.66 Type de données Temperature 717
6.2.67 Type primitif de données Time 717
6.2.68 Compound TimeInterval 717
6.2.69 Enumération UnitMultiplier 717
6.2.70 Enumération UnitSymbol 718
6.2.71 Type de données Voltage 724
6.2.72 Type de données VoltagePerReactivePower 724
6.2.73 Type de données Volume 724
6.2.74 Type de données VolumeFlowRate 725
6.2.75 Type de données WaterLevel 725
6.3 Paquetage Core 725
6.3.1 Généralités 725
6.3.2 ACDCTerminal 730
6.3.3 BaseFrequency 731
6.3.4 BasePower 732
6.3.5 BaseVoltage 732
6.3.6 BasicIntervalSchedule 733
6.3.7 Bay 734
6.3.8 Enumération BreakerConfiguration 734
6.3.9 Enumération BusbarConfiguration 735
6.3.10 ConductingEquipment 735
6.3.11 ConnectivityNode 736
6.3.12 ConnectivityNodeContainer 737
6.3.13 Curve 738
6.3.14 Classe racine CurveData 738
6.3.15 Enumération CurveStyle 739
6.3.16 Equipment 739

IECNORM.COM : Click to view the full PDF of IEC 61970-301:2020+AMD1:2022 CSV

6.3.17 EquipmentContainer 741
6.3.18 Feeder 742
6.3.19 GeographicalRegion 743
6.3.20 Classe racine IdentifiedObject 743
6.3.21 IrregularIntervalSchedule 744
6.3.22 Classe racine IrregularTimePoint 745
6.3.23 Classe racine Name 745
6.3.24 Classe racine NameType 746
6.3.25 Classe racine NameTypeAuthority 746
6.3.26 OperatingParticipant 747
6.3.27 Classe racine OperatingShare 748
6.3.28 PSRType 748
6.3.29 Enumération PhaseCode 749
6.3.30 PowerSystemResource 750
6.3.31 RegularIntervalSchedule 751
6.3.32 Classe racine RegularTimePoint 751
6.3.33 ReportingGroup 752
6.3.34 ReportingSuperGroup 753
6.3.35 SubGeographicalRegion 753
6.3.36 Substation 754
6.3.37 Terminal 755
6.3.38 VoltageLevel 757
6.4 Paquetage Wires 758
6.4.1 Généralités 758
6.4.2 Enumération AsynchronousMachineKind 773
6.4.3 ACLineSegment 774
6.4.4 ACLineSegmentPhase 775
6.4.5 AsynchronousMachine 776
6.4.6 Breaker 779
6.4.7 BusbarSection 780
6.4.8 Clamp 781
6.4.9 CompositeSwitch 782
6.4.10 Conductor 783
6.4.11 Connector 784
6.4.12 Enumération CoolantType 785
6.4.13 Cut 786
6.4.14 Disconnector 787
6.4.15 DisconnectingCircuitBreaker 788
6.4.16 EarthFaultCompensator 790
6.4.17 EnergyConnection 791
6.4.18 EnergyConsumer 792
6.4.19 EnergyConsumerPhase 794
6.4.20 EnergySchedulingType 796
6.4.21 EnergySource 796
6.4.22 EnergySourcePhase 798
6.4.23 ExternalNetworkInjection 799
6.4.24 FrequencyConverter 801
6.4.25 Fuse 803
6.4.26 Ground 804

IECNORM.COM : Click to view the full PDF of IEC 61970-301:2020+AMD1:2022 CSV

6.4.27 GroundingImpedance 805
6.4.28 GroundDisconnector 806
6.4.29 Jumper 807
6.4.30 Junction 809
6.4.31 Line 809
6.4.32 LinearShuntCompensator 810
6.4.33 LinearShuntCompensatorPhase 812
6.4.34 LoadBreakSwitch 813
6.4.35 MutualCoupling 815
6.4.36 NonlinearShuntCompensator 816
6.4.37 NonlinearShuntCompensatorPhase 817
6.4.38 NonlinearShuntCompensatorPhasePoint root class 818
6.4.39 Classe racine NonlinearShuntCompensatorPoint 819
6.4.40 PerLengthImpedance 819
6.4.41 PerLengthLineParameter 820
6.4.42 PerLengthPhaseImpedance 820
6.4.43 PerLengthSequenceImpedance 821
6.4.44 PetersenCoil 822
6.4.45 Enumération PetersenCoilModeKind 823
6.4.46 Classe racine PhaseImpedanceData 824
6.4.47 Enumération PhaseShuntConnectionKind 825
6.4.48 PhaseTapChanger 825
6.4.49 PhaseTapChangerAsymmetrical 826
6.4.50 PhaseTapChangerLinear 827
6.4.51 PhaseTapChangerNonLinear 829
6.4.52 PhaseTapChangerSymmetrical 830
6.4.53 PhaseTapChangerTable 831
6.4.54 PhaseTapChangerTablePoint 832
6.4.55 PhaseTapChangerTabular 833
6.4.56 Plant 834
6.4.57 PowerElectronicsConnection 834
6.4.58 PowerElectronicsConnectionPhase 836
6.4.59 PowerTransformer 837
6.4.60 PowerTransformerEnd 840
6.4.61 ProtectedSwitch 842
6.4.62 RatioTapChanger 844
6.4.63 RatioTapChangerTable 845
6.4.64 RatioTapChangerTablePoint 846
6.4.65 ReactiveCapabilityCurve 846
6.4.66 Recloser 847
6.4.67 RegulatingCondEq 849
6.4.68 RegulatingControl 850
6.4.69 Enumération RegulatingControlModeKind 852
6.4.70 RegulationSchedule 852
6.4.71 RotatingMachine 853
6.4.72 Sectionaliser 855
6.4.73 SeriesCompensator 857
6.4.74 Enumération ShortCircuitRotorKind 858
6.4.75 ShuntCompensator 858

IECNORM.COM : Click to view the full PDF of IEC 61970-301:2020+AMD1:2022 CSV

6.4.76 ShunkCompensatorPhase 860
6.4.77 Enumération SinglePhaseKind 862
6.4.78 StaticVarCompensator 862
6.4.79 Enumération SVCControlMode 864
6.4.80 Switch 864
6.4.81 SwitchPhase 866
6.4.82 SwitchSchedule 867
6.4.83 SynchronousMachine 868
6.4.84 Enumération SynchronousMachineOperatingMode 871
6.4.85 Enumération SynchronousMachineKind 872
6.4.86 TapChanger 872
6.4.87 TapChangerControl 874
6.4.88 Classe racine TapChangerTablePoint 876
6.4.89 TapSchedule 877
6.4.90 Enumération TransformerControlMode 878
6.4.91 TransformerCoreAdmittance 878
6.4.92 TransformerEnd 879
6.4.93 TransformerMeshImpedance 880
6.4.94 TransformerStarImpedance 881
6.4.95 TransformerTank 882
6.4.96 TransformerTankEnd 883
6.4.97 VoltageControlZone 884
6.4.98 WireSegment 885
6.4.99 WireSegmentPhase 886
6.4.100 Enumération WindingConnection 887
6.5 Paquetage LoadModel 887
6.5.1 Généralités 887
6.5.2 ConformLoad 888
6.5.3 ConformLoadGroup 890
6.5.4 ConformLoadSchedule 890
6.5.5 DayType 891
6.5.6 EnergyArea 892
6.5.7 LoadArea 892
6.5.8 LoadGroup 893
6.5.9 LoadResponseCharacteristic 894
6.5.10 NonConformLoad 896
6.5.11 NonConformLoadGroup 897
6.5.12 NonConformLoadSchedule 898
6.5.13 PowerCutZone 899
6.5.14 Season 900
6.5.15 SeasonDayTypeSchedule 900
6.5.16 StationSupply 901
6.5.17 SubLoadArea 902
6.6 Paquetage Generation 903
6.6.1 Généralités 903
6.6.2 Paquetage GenerationTrainingSimulation 903
6.6.3 Paquetage Production 921
6.7 Paquetage DC 978
6.7.1 Généralités 978

IECNORM.COM : Click to view the full PDF of IEC 61970-301:2020+AMD1:2022 CSV

6.7.2 ACDCConverter 983
6.7.3 ACDCConverterDCTerminal 986
6.7.4 CsConverter 988
6.7.5 DCTopologicalNode 991
6.7.6 Enumération CsOperatingModeKind 991
6.7.7 Enumération CsPpccControlKind 992
6.7.8 DCBaseTerminal 992
6.7.9 DCBreaker 993
6.7.10 DCBusbar 994
6.7.11 DCChopper 995
6.7.12 DCConductingEquipment 996
6.7.13 Enumération DCConverterOperatingModeKind 997
6.7.14 DCConverterUnit 997
6.7.15 DCDisconnector 998
6.7.16 DCEquipmentContainer 999
6.7.17 DCGround 1000
6.7.18 DCLine 1001
6.7.19 DCLineSegment 1002
6.7.20 DCNode 1004
6.7.21 Enumération DCPolarityKind 1004
6.7.22 DCSeriesDevice 1005
6.7.23 DCShunt 1006
6.7.24 DCSwitch 1006
6.7.25 DCTerminal 1007
6.7.26 DCTopologicalIsland 1008
6.7.27 PerLengthDCLineParameter 1009
6.7.28 VsCapabilityCurve 1010
6.7.29 VsConverter 1010
6.7.30 Enumération VsPpccControlKind 1013
6.7.31 Enumération VsQpccControlKind 1014
6.8 Paquetage Equivalents 1014
6.8.1 Généralités 1014
6.8.2 EquivalentBranch 1015
6.8.3 EquivalentEquipment 1018
6.8.4 EquivalentInjection 1019
6.8.5 EquivalentNetwork 1021
6.8.6 EquivalentShunt 1022
6.9 Paquetage AuxiliaryEquipment 1023
6.9.1 Généralités 1023
6.9.2 AuxiliaryEquipment 1024
6.9.3 CurrentTransformer 1025
6.9.4 FaultIndicator 1027
6.9.5 PostLineSensor 1028
6.9.6 PotentialTransformer 1028
6.9.7 Enumération PotentialTransformerKind 1029
6.9.8 Sensor 1030
6.9.9 SurgeArrester 1031
6.9.10 WaveTrap 1032
6.10 Paquetage Meas 1033

IECNORM.COM : Click to view the full PDF of IEC 61970-301:2020+AMD1:2022 CSV

6.10.1 Généralités 1033
6.10.2 Accumulator 1037
6.10.3 AccumulatorLimit 1038
6.10.4 AccumulatorLimitSet 1039
6.10.5 AccumulatorReset 1039
6.10.6 AccumulatorValue 1040
6.10.7 Analog 1041
6.10.8 AnalogControl 1042
6.10.9 AnalogLimit 1043
6.10.10 AnalogLimitSet 1043
6.10.11 AnalogValue 1044
6.10.12 Command 1045
6.10.13 Control 1046
6.10.14 Discrete 1047
6.10.15 DiscreteValue 1048
6.10.16 IOPoint 1049
6.10.17 Limit 1049
6.10.18 LimitSet 1050
6.10.19 Measurement 1051
6.10.20 MeasurementValue 1052
6.10.21 MeasurementValueQuality 1053
6.10.22 MeasurementValueSource 1054
6.10.23 Classe racine Quality61850 1054
6.10.24 RaiseLowerCommand 1055
6.10.25 SetPoint 1056
6.10.26 StringMeasurement 1057
6.10.27 StringMeasurementValue 1058
6.10.28 Enumération Validity 1059
6.10.29 ValueAliasSet 1059
6.10.30 ValueToAlias 1060
6.11 Paquetage Topology 1061
6.11.1 Généralités 1061
6.11.2 BusNameMarker 1062
6.11.3 TopologicalIsland 1063
6.11.4 TopologicalNode 1064
6.12 Package DiagramLayout 1065
6.12.1 Généralités 1065
6.12.2 Diagram 1066
6.12.3 DiagramObject 1067
6.12.4 Classe racine DiagramObjectGluePoint 1069
6.12.5 Classe racine DiagramObjectPoint 1069
6.12.6 DiagramObjectStyle 1070
6.12.7 DiagramStyle 1071
6.12.8 Enumération OrientationKind 1071
6.12.9 TextDiagramObject 1072
6.12.10 VisibilityLayer 1073
6.13 Paquetage OperationalLimits 1074
6.13.1 Généralités 1074
6.13.2 ActivePowerLimit 1075

IECNORM.COM: Click to view the full PDF of IEC 61970-301:2020+AMD1:2022 CSV

6.13.3 ApparentPowerLimit 1076
6.13.4 BranchGroup 1076
6.13.5 Classe racine BranchGroupTerminal 1077
6.13.6 CurrentLimit 1078
6.13.7 OperationalLimit 1078
6.13.8 Enumération OperationalLimitDirectionKind 1079
6.13.9 OperationalLimitSet 1080
6.13.10 OperationalLimitType 1080
6.13.11 VoltageLimit 1081
6.14 Paquetage ControlArea 1082
6.14.1 Généralités 1082
6.14.2 AltGeneratingUnitMeas 1084
6.14.3 AltTieMeas 1085
6.14.4 ControlArea 1086
6.14.5 ControlAreaGeneratingUnit 1087
6.14.6 Enumération ControlAreaTypeKind 1088
6.14.7 TieFlow 1088
6.15 Paquetage Contingency 1089
6.15.1 Généralités 1089
6.15.2 Contingency 1090
6.15.3 ContingencyElement 1091
6.15.4 ContingencyEquipment 1091
6.15.5 Enumération ContingencyEquipmentStatusKind 1092
6.16 Paquetage StateVariables 1092
6.16.1 Généralités 1092
6.16.2 Classe racine StateVariable 1093
6.16.3 SvInjection 1093
6.16.4 SvPowerFlow 1094
6.16.5 SvShuntCompensatorSections 1095
6.16.6 SvStatus 1095
6.16.7 SvSwitch 1096
6.16.8 SvTapStep 1096
6.16.9 SvVoltage 1097
6.17 Paquetage Protection 1097
6.17.1 Généralités 1097
6.17.2 CurrentRelay 1098
6.17.3 ProtectionEquipment 1099
6.17.4 RecloseSequence 1101
6.17.5 SynchrocheckRelay 1101
6.18 Paquetage Faults 1103
6.18.1 Généralités 1103
6.18.2 EquipmentFault 1103
6.18.3 Fault 1104
6.18.4 FaultCauseType 1105
6.18.5 Compound FaultImpedance 1105
6.18.6 LineFault 1105
6.18.7 Enumération PhaseConnectedFaultKind 1106
6.19 Paquetage SCADA 1107
6.19.1 Généralités 1107

IECNORM.COM : Click to view the full PDF of IEC 61970-301:2020+AMD1:2022 CSV

6.19.2 CommunicationLink 1108
6.19.3 RemoteControl 1109
6.19.4 RemotePoint 1110
6.19.5 RemoteSource 1110
6.19.6 RemoteUnit 1111
6.19.7 Enumération RemoteUnitType 1112
6.19.8 Enumération Source 1112
6.20 Paquetage ICCPConfiguration 1113
6.20.1 Généralités 1113
6.20.2 Enumération ApplicationSecurityKind 1114
6.20.3 BilateralExchangeActor 1115
6.20.4 BilateralExchangeAgreement 1116
6.20.5 Enumération ICCPAccessPrivilegeKind 1116
6.20.6 ICCPInformationMessage 1116
6.20.7 Enumération ICCPPointKind 1117
6.20.8 ICCPProvidedPoint 1118
6.20.9 Enumération ICCPQualityKind 1118
6.20.10 Enumération ICCPScopeKind 1119
6.20.11 ICCPVCC 1119
6.20.12 ICCPVirtualControlCentre 1120
6.20.13 IOPointSource 1121
6.20.14 IPAccessPoint 1122
6.20.15 Enumération IPAddressKind 1123
6.20.16 ISOUpperLayer 1123
6.20.17 ProvidedBilateralPoint 1124
6.20.18 Classe racine PublicX509Certificate 1125
6.20.19 TASE2BilateralTable 1125
6.20.20 TCPAccessPoint 1126
Annexe A (normative) Extensions personnalisées 1128
A.1 Vue d'ensemble 1128
A.2 Extensions européennes 1128
A.2.1 Généralités 1128
A.2.2 Paquetage ExtEuCore 1128
A.2.3 Paquetage ExtEuOperationalLimits 1131
A.2.4 Paquetage ExtEuGeneration 1134
Annexe B (informative) Exemples de modélisation de transformateur PST 1138
B.1 Généralités 1138
B.2 Calculs et exemples détaillés 1138
B.2.1 Déphaseurs symétriques avec deux noyaux 1138
B.2.2 Transformateurs déphaseurs en quadrature 1142
B.2.3 Déphaseur asymétrique 1146
Annexe C (informative) Représentation des cas d'utilisation CCHT 1154
C.1 Aperçu 1154
C.2 Installations dos à dos 1154
C.3 Monopole avec retour par la terre 1156
C.4 Monopole avec retour métallique 1158
C.5 Convertisseur de source de tension 1160
Bibliographie 1162

IECNORM.COM : Click to view the full PDF of IEC 61970-301:2020+AMD1:2022 CSV

Figure 1 – Dépendances définies entre les paquetages du CIM et les informations de versions de paquetages 601
Figure 2 – Diagramme du paquetage CIM IEC 61970-301 602
Figure 3 – Exemple de généralisation 604
Figure 4 – Exemple d'association simple 605
Figure 5 – Exemple d'agrégation 605
Figure 6 – EquipmentContainers 607
Figure 7 – Names 608
Figure 8 – Modèle de connectivité 609
Figure 9 – Exemple de réseau simple 610
Figure 10 – Connectivité d'un réseau simple modélisé avec la topologie du CIM 611
Figure 11 – Hiérarchie des héritages de Equipment 612
Figure 12 – Modèle de Transformer et Tank 614
Figure 13 – Modèle de Transformer 616
Figure 14 – Modèle de prise de transformateur 618
Figure 15 – Schéma et équations du phaseur 622
Figure 16 – Variation d'impédance de déphaseur symétrique 623
Figure 17 – Organisation du noyau 624
Figure 18 – Schéma et équations du phaseur 624
Figure 19 – Organisation du noyau 626
Figure 20 – Schéma et équations du phaseur 627
Figure 21 – Organisation du noyau 628
Figure 22 – Schéma et équations du phaseur 628
Figure 23 – Schémas et équations du phaseur 630
Figure 24 – Organisation du noyau 631
Figure 25 – Modèle de données des phases 633
Figure 26 – Connectivité de phase 634
Figure 27 – Modèle de données de l'appareil de mise à la terre 636
Figure 28 – Exemple de représentation de poste comprenant des bobines Petersen 637
Figure 29 – Objets de diagramme d'instance avec une bobine à bornes 638
Figure 30 – Modèle UML de cuts, de clamps (serre-fils) et de jumpers (cavaliers) 639
Figure 31 – Exemple avant application des cuts et des jumpers (cavaliers) 640
Figure 32 – Exemple après application des cuts et des jumpers (cavaliers) 641
Figure 33 – Exemple de cavalier sans cut ni serre-fil 642
Figure 34 – Navigation de PSR à MeasurementValue 644
Figure 35 – Placement de Measurement 647
Figure 36 – Modèles de commande de régulation 649
Figure 37 – Exemple simplifié de représentation d'un modèle CCHT 651
Figure 38 – Exemple détaillé de représentation de modèle CCHT avec postes CCHT fictifs 652
Figure 39 – Exemple détaillé de représentation de modèle CCHT sans postes CCHT fictifs 653
Figure 40 – Liaison CCHT bipolaire issue de l'IEC 60633 654
Figure 41 – Schéma de transport point à point par un VSC 654

IECNORM.COM : Click to view the full PDF of IEC 61970-301:2020+AMD1:2022 CSV

Figure 42 – Modèle de flux de puissance CCHT 655
Figure 43 – Modèle détaillé de flux de puissance CCHT 656
Figure 44 – Flux de puissance d'un convertisseur de source de courant 657
Figure 45 – Flux de puissance d'un convertisseur de source de tension 658
Figure 46 – Cas de flux de puissance 659
Figure 47 – Transport par VSC à monopole symétrique représenté avec mise à la terre capacitive côté courant continu (IEC 62747) 660
Figure 48 – Courbe de capacité P-Q du VSC 660
Figure 49 – Transport par VSC bipolaire avec retour par la terre (IEC 62747) 661
Figure 50 – Instances d'objets d'une ligne CCHT de source bipolaire de courant 662
Figure 51 – Instances d'objets d'un modèle de données CCHT d'un VSC à monopole symétrique 663
Figure 52 – Structure d'emboîtement d'une ligne CCHT bipolaire 665
Figure 53 – Structure d'emboîtement d'un poste CCHT bipolaire dos à dos 666
Figure 54 – Topologie de base (Basic) dans le paquetage Core 667
Figure 55 – Topologie en courant continu et en courant alternatif 668
Figure 56 – Modèle d'Equipment 669
Figure 57 – Modèle de ligne CCHT 670
Figure 58 – Légende 671
Figure 59 – Monopole simple et mesures 672
Figure 60 – Bipolaire simple 672
Figure 61 – Côté de monopole avec modèle détaillé 673
Figure 62 – Caractéristique V-I du SVC 674
Figure 63 – Mesures ICCP et modèles de réseau 676
Figure 64 – Configuration et démarrage d'ICCP 677
Figure 65 – Exemple de fournisseur et d'utilisateur de valeur de mesure 678
Figure 66 – Modèle de données d'échange bilatéral généralisé 679
Figure 67 – Modèle de données d'échange bilatéral ICCP 681
Figure 68 – Modèle de données Feeder 682
Figure 69 – Orientation du flux de la Terminal 683
Figure 70 – Différentes manières de décrire les interconnexions de la zone de commande 684
Figure 71 – Paquetages de haut niveau du CIM 689
Figure 72 – Diagramme de classe Domain::CombinedElectricalDatatypes 691
Figure 73 – Diagramme de classe Domain::BasicDatatypes 691
Figure 74 – Diagramme de classe Domain::ElectricityDatatypes 693
Figure 75 – Diagramme de classe Domain::EnumeratedUnitDatatypes 694
Figure 76 – Diagramme de classe Domain::GeneralDatatypes 695
Figure 77 – Diagramme de classe Domain::MonetaryDatatypes 696
Figure 78 – Diagramme de classe Domain::TimeDatatypes 697
Figure 79 – Diagramme de classe Core::Main 726
Figure 80 – Diagramme de classe Core::Names 727
Figure 81 – Diagramme de classe Core::CurveSchedule 727
Figure 82 – Diagramme de classe Core::Datatypes 728
IECNORM.COM : Click to view the full PDF of IEC 61970-301:2020+AMD1:2022 CSV

Figure 83 – Diagramme de classe Core::FeederContainment 729
Figure 84 – Diagramme de classe Core::Reporting 729
Figure 85 – Diagramme de classe Core::OperatingShare 730
Figure 86 – Diagramme de classe Wires::CutsAndJumpers 759
Figure 87 – Diagramme de classe Wires::Datatypes 760
Figure 88 – Diagramme de classe Wires::EarthFaultCompensator 761
Figure 89 – Diagramme de classe Wires::InheritanceHierarchy 762
Figure 90 – Diagramme de classe Wires::LineModel 763
Figure 91 – Diagramme de classe Wires::MutualCoupling 764
Figure 92 – Diagramme de classe Wires::NamingHierarchyPart1 765
Figure 93 – Diagramme de classe Wires::NamingHierarchyPart2 766
Figure 94 – Diagramme de classe Wires::RegulatingEquipment 767
Figure 95 – Diagramme de classe Wires::Schedules 768
Figure 96 – Diagramme de classe Wires::ShuntCompensator 768
Figure 97 – Diagramme de classe Wires::SwitchingEquipment 769
Figure 98 – Diagramme de classe Wires::TapChanger 770
Figure 99 – Diagramme de classe Wires::VoltageControl 771
Figure 100 – Diagramme de classe Wires::WiresPhaseModel 772
Figure 101 – Diagramme de classe Wires::Transformer 773
Figure 102 – Diagramme de classe LoadModel::Main 888
Figure 103 – Diagramme de classe Generation::Main 903
Figure 104 – Diagramme de classe GenerationTrainingSimulation::Main 904
Figure 105 – Diagramme de classe GenerationTrainingSimulation::Datatypes 904
Figure 106 – Diagramme de classe Production::PowerElectronics 921
Figure 107 – Diagramme de classe Production::Nuclear 922
Figure 108 – Diagramme de classe Production::Main 923
Figure 109 – Diagramme de classe Production::Datatypes 924
Figure 110 – Diagramme de classe Production::Hydro 925
Figure 111 – Diagramme de classe Production::Thermal 926
Figure 112 – Diagramme de classe DC::DCContainment 979
Figure 113 – Diagramme de classe DC::DCEquipment 980
Figure 114 – Diagramme de classe DC::DCLineModel 981
Figure 115 – Diagramme de classe DC::ACDCConverter 982
Figure 116 – Diagramme de classe DC::ACDCConnectivityModel 983
Figure 117 – Diagramme de classe Equivalents::Main 1015
Figure 118 – Diagramme de classe AuxiliaryEquipment::AuxiliaryEquipment 1024
Figure 119 – Diagramme de classe Meas::Control 1033
Figure 120 – Diagramme de classe Meas::Datatypes 1034
Figure 121 – Diagramme de classe Meas::Measurement 1035
Figure 122 – Diagramme de classe Meas::MeasurementInheritance 1036
Figure 123 – Diagramme de classe Meas::Quality 1037
Figure 124 – Diagramme de classe Topology::Main 1061
Figure 125 – Diagramme de classe Topology::TopologyReporting 1062
IECNORM.COM : Click to view the full PDF of IEC 61970-301:2020+AMD1:2022 CSV

Figure 126 – Diagramme de classe DiagramLayout::DiagramLayout 1066
Figure 127 – Diagramme de classe OperationalLimits::OperationalLimits 1074
Figure 128 – Diagramme de classe OperationalLimits::BranchGroup 1075
Figure 129 – Diagramme de classe ControlArea::ControlArea 1083
Figure 130 – Diagramme de classe ControlArea::ControlAreaInheritance 1084
Figure 131 – Diagramme de classe ControlArea::Datatypes 1084
Figure 132 – Diagramme de classe Contingency::Contingency 1090
Figure 133 – Diagramme de classe StateVariables::StateVariables 1093
Figure 134 – Diagramme de classe Protection::Main 1098
Figure 135 – Diagramme de classe Faults::Faults 1103
Figure 136 – Diagramme de classe SCADA::Datatypes 1107
Figure 137 – Diagramme de classe SCADA::Main 1108
Figure 138 – Diagramme de classe ICCPConfiguration::GenericBilateralExchange 1113
Figure 139 – Diagramme de classe ICCPConfiguration::ICCP 1114
Figure A.1 – Diagramme de classe ExtEuBase::ExtEuBase 1128
Figure A.2 – Diagramme de classe ExtEuCore::ExtEuCore 1129
Figure A.3 – Diagramme de classe ExtEuOperationalLimits::ExtEuOperationalLimits 1132
Figure A.4 – Diagramme de classe ExtEuProduction::ExtEuProduction 1135
Figure B.1 – Déphaseurs symétriques avec deux noyaux 1138
Figure B.2 – Schéma triphasé détaillé 1139
Figure B.3 – Schéma triphasé détaillé 1142
Figure B.4 – Schéma monophasé 1143
Figure B.5 – Schéma du phaseur 1144
Figure B.6 – Schéma triphasé détaillé 1145
Figure B.7 – Schéma du phaseur 1146
Figure B.8 – Déphaseur asymétrique avec deux noyaux 1146
Figure B.9 – Schéma triphasé détaillé 1147
Figure B.10 – Schéma du phaseur 1149
Figure B.11 – Déphaseur asymétrique avec un seul noyau 1150
Figure B.12 – Schéma du phaseur 1151
Figure B.13 – Exemple de schéma triphasé détaillé d'un autotransformateur et d'un transformateur déphaseur en quadrature à régulation de tension 1152
Figure B.14 – Exemple de schéma d'enroulement détaillé d'un autotransformateur et d'un transformateur déphaseur en quadrature à régulation de tension 1153
Figure C.1 – Représentation d'une installation à 12 impulsions dos à dos 1155
Figure C.2 – Représentation d'une installation monopolaire à 12 impulsions avec retour par la terre 1157
Figure C.3 – Représentation d'une installation monopolaire à 12 impulsions avec retour métallique 1159
Figure C.4 – Représentation d'un convertisseur de source de courant 1161

Tableau 1 – Mise en correspondance des transformateurs déphaseurs avec les classes CIM 620
Tableau 2 – Mise en correspondance des symboles utilisés dans les formules avec les attributs CIM 620

IECNORM.COM : Click to view the full PDF of IEC 61970-301:2020+AMD1:2022 CSV

Tableau 3 – Variations d'impédance dans un transformateur déphaseur 621
Tableau 4 – Description des variables 621
Tableau 5 – Options de commande du changeur de prises 632
Tableau 6 – Conventions de dénomination de measurementType 645
Tableau 7 – Conventions de dénomination de MeasurementValueSource (source de valeur de mesure) 646
Tableau 8 – Attributs de Package1::Class1 689
Tableau 9 – Extrémités d'association de Package1::Class1 avec d'autres classes 690
Tableau 10 – Libellés de Package1::Enumeration1 690
Tableau 11 – Attributs de Domain::ActivePower 697
Tableau 12 – Attributs de Domain::ActivePowerChangeRate 698
Tableau 13 – Attributs de Domain::ActivePowerPerCurrentFlow 698
Tableau 14 – Attributs de Domain::ActivePowerPerFrequency 698
Tableau 15 – Attributs de Domain::Admittance 698
Tableau 16 – Attributs de Domain::AngleDegrees 699
Tableau 17 – Attributs de Domain::AngleRadians 699
Tableau 18 – Attributs de Domain::ApparentPower 699
Tableau 19 – Attributs de Domain::Area 700
Tableau 20 – Attributs de Domain::Capacitance 700
Tableau 21 – Attributs de Domain::CapacitancePerLength 700
Tableau 22 – Attributs de Domain::Classification 700
Tableau 23 – Attributs de Domain::Conductance 701
Tableau 24 – Attributs de Domain::ConductancePerLength 701
Tableau 25 – Attributs de Domain::CostPerEnergyUnit 701
Tableau 26 – Attributs de Domain::CostPerHeatUnit 702
Tableau 27 – Attributs de Domain::CostPerVolume 702
Tableau 28 – Attributs de Domain::CostRate 702
Tableau 29 – Libellés de Domain::Currency 702
Tableau 30 – Attributs de Domain::CurrentFlow 706
Tableau 31 – Attributs de Domain::Damping 707
Tableau 32 – Attributs de Domain::DateInterval 707
Tableau 33 – Attributs de Domain::DateTimeInterval 707
Tableau 34 – Attributs de Domain::DecimalQuantity 708
Tableau 35 – Attributs de Domain::Displacement 708
Tableau 36 – Attributs de Domain::Emission 708
Tableau 37 – Attributs de Domain::FloatQuantity 709
Tableau 38 – Attributs de Domain::Frequency 709
Tableau 39 – Attributs de Domain::HeatRate 709
Tableau 40 – Attributs de Domain::Hours 710
Tableau 41 – Attributs de Domain::Impedance 710
Tableau 42 – Attributs de Domain::Inductance 710
Tableau 43 – Attributs de Domain::InductancePerLength 710
Tableau 44 – Attributs de Domain::IntegerQuantity 711

IECNORM.COM : Click to view the full PDF of IEC 61970-301:2020+AMD1:2022 CSV

Tableau 45 – Attributs de Domain::KiloActivePower 711
Tableau 46 – Attributs de Domain::Length 711
Tableau 47 – Attributs de Domain::Mass 711
Tableau 48 – Attributs de Domain::Minutes 712
Tableau 49 – Attributs de Domain::Money 712
Tableau 50 – Attributs de Domain::MonthDayInterval 712
Tableau 51 – Attributs de Domain::PU 713
Tableau 52 – Attributs de Domain::PerCent 713
Tableau 53 – Attributs de Domain::Pressure 713
Tableau 54 – Attributs de Domain::Reactance 713
Tableau 55 – Attributs de Domain::ReactancePerLength 714
Tableau 56 – Attributs de Domain::ReactivePower 714
Tableau 57 – Attributs de Domain::RealEnergy 714
Tableau 58 – Attributs de Domain::Resistance 714
Tableau 59 – Attributs de Domain::ResistancePerLength 715
Tableau 60 – Attributs de Domain::RotationSpeed 715
Tableau 61 – Attributs de Domain::Seconds 715
Tableau 62 – Attributs de Domain::Speed 716
Tableau 63 – Attributs de Domain::StringQuantity 716
Tableau 64 – Attributs de Domain::Susceptance 716
Tableau 65 – Attributs de Domain::SusceptancePerLength 716
Tableau 66 – Attributs de Domain::Temperature 717
Tableau 67 – Attributs de Domain::TimeInterval 717
Tableau 68 – Libellés de Domain::UnitMultiplier 718
Tableau 69 – Libellés de Domain::UnitSymbol 719
Tableau 70 – Attributs de Domain::Voltage 724
Tableau 71 – Attributs de Domain::VoltagePerReactivePower 724
Tableau 72 – Attributs de Domain::Volume 725
Tableau 73 – Attributs de Domain::VolumeFlowRate 725
Tableau 74 – Attributs de Domain::WaterLevel 725
Tableau 75 – Attributs de Core::ACDCTerminal 730
Tableau 76 – Extrémités d'association de Core::ACDCTerminal avec d'autres classes 731
Tableau 77 – Attributs de Core::BaseFrequency 731
Tableau 78 – Extrémités d'association de Core::BaseFrequency avec d'autres classes 732
Tableau 79 – Attributs de Core::BasePower 732
Tableau 80 – Extrémités d'association de Core::BasePower avec d'autres classes 732
Tableau 81 – Attributs de Core::BaseVoltage 732
Tableau 82 – Extrémités d'association de Core::BaseVoltage avec d'autres classes 733
Tableau 83 – Attributs de Core::BasicIntervalSchedule 733
Tableau 84 – Extrémités d'association de Core::BasicIntervalSchedule avec d'autres classes 733
Tableau 85 – Attributs de Core::Bay 734
Tableau 86 – Extrémités d'association de Core::Bay avec d'autres classes 734
IECNORM.COM : Click to view the full PDF of IEC 61970-301:2020+AMD1:2022 CSV

Tableau 87 – Libellés de Core::BreakerConfiguration 735
Tableau 88 – Libellés de Core::BusbarConfiguration 735
Tableau 89 – Attributs de Core::ConductingEquipment 735
Tableau 90 – Extrémités d'association de Core::ConductingEquipment avec d'autres classes 736
Tableau 91 – Attributs de Core::ConnectivityNode 736
Tableau 92 – Extrémités d'association de Core::ConnectivityNode avec d'autres classes 737
Tableau 93 – Attributs de Core::ConnectivityNodeContainer 737
Tableau 94 – Extrémités d'association de Core::ConnectivityNodeContainer avec d'autres classes 737
Tableau 95 – Attributs de Core::Curve 738
Tableau 96 – Extrémités d'association de Core::Curve avec d'autres classes 738
Tableau 97 – Attributs de Core::CurveData 739
Tableau 98 – Extrémités d'association de Core::CurveData avec d'autres classes 739
Tableau 99 – Libellés de Core::CurveStyle 739
Tableau 100 – Attributs de Core::Equipment 740
Tableau 101 – Extrémités d'association de Core::Equipment avec d'autres classes 740
Tableau 102 – Attributs de Core::EquipmentContainer 741
Tableau 103 – Extrémités d'association de Core::EquipmentContainer avec d'autres classes 741
Tableau 104 – Attributs de Core::Feeder 742
Tableau 105 – Extrémités d'association de Core::Feeder avec d'autres classes 742
Tableau 106 – Attributs de Core::GeographicalRegion 743
Tableau 107 – Extrémités d'association de Core::GeographicalRegion avec d'autres classes 743
Tableau 108 – Attributs de Core::IdentifiedObject 744
Tableau 109 – Extrémités d'association de Core::IdentifiedObject avec d'autres classes 744
Tableau 110 – Attributs de Core::IrregularIntervalSchedule 744
Tableau 111 – Extrémités d'association de Core::IrregularIntervalSchedule avec d'autres classes 745
Tableau 112 – Attributs de Core::IrregularTimePoint 745
Tableau 113 – Extrémités d'association de Core::IrregularTimePoint avec d'autres classes 745
Tableau 114 – Attributs de Core::Name 746
Tableau 115 – Extrémités d'association de Core::Name avec d'autres classes 746
Tableau 116 – Attributs de Core::NameType 746
Tableau 117 – Extrémités d'association de Core::NameType avec d'autres classes 746
Tableau 118 – Attributs de Core::NameTypeAuthority 747
Tableau 119 – Extrémités d'association de Core::NameTypeAuthority avec d'autres classes 747
Tableau 120 – Attributs de Core::OperatingParticipant 747
Tableau 121 – Extrémités d'association de Core::OperatingParticipant avec d'autres classes 747
Tableau 122 – Attributs de Core::OperatingShare 748

IECNORM.COM : Click to view the full PDF of IEC 61970-301:2020+AMD1:2022 CSV

Tableau 123 – Extrémités d'association de Core::OperatingShare avec d'autres classes 748
Tableau 124 – Attributs de Core::PSRType 748
Tableau 125 – Extrémités d'association de Core::PSRType avec d'autres classes 749
Tableau 126 – Libellés de Core::PhaseCode 749
Tableau 127 – Attributs de Core::PowerSystemResource 750
Tableau 128 – Extrémités d'association de Core::PowerSystemResource avec d'autres classes 750
Tableau 129 – Attributs de Core::RegularIntervalSchedule 751
Tableau 130 – Extrémités d'association de Core::RegularIntervalSchedule avec d'autres classes 751
Tableau 131 – Attributs de Core::RegularTimePoint 752
Tableau 132 – Extrémités d'association de Core::RegularTimePoint avec d'autres classes 752
Tableau 133 – Attributs de Core::ReportingGroup 752
Tableau 134 – Extrémités d'association de Core::ReportingGroup avec d'autres classes 753
Tableau 135 – Attributs de Core::ReportingSuperGroup 753
Tableau 136 – Extrémités d'association de Core::ReportingSuperGroup avec d'autres classes 753
Tableau 137 – Attributs de Core::SubGeographicalRegion 754
Tableau 138 – Extrémités d'association de Core::SubGeographicalRegion avec d'autres classes 754
Tableau 139 – Attributs de Core::Substation 754
Tableau 140 – Extrémités d'association de Core::Substation avec d'autres classes 755
Tableau 141 – Attributs de Core::Terminal 756
Tableau 142 – Extrémités d'association de Core::Terminal avec d'autres classes 756
Tableau 143 – Attributs de Core::VoltageLevel 757
Tableau 144 – Extrémités d'association de Core::VoltageLevel avec d'autres classes 758
Tableau 145 – Libellés de Wires::AsynchronousMachineKind 774
Tableau 146 – Attributs de Wires::ACLineSegment 774
Tableau 147 – Extrémités d'association de Wires::ACLineSegment avec d'autres classes 775
Tableau 148 – Attributs de Wires::ACLineSegmentPhase 776
Tableau 149 – Extrémités d'association de Wires::ACLineSegmentPhase avec d'autres classes 776
Tableau 150 – Attributs de Wires::AsynchronousMachine 777
Tableau 151 – Extrémités d'association de Wires::AsynchronousMachine avec d'autres classes 778
Tableau 152 – Attributs de Wires::Breaker 779
Tableau 153 – Extrémités d'association de Wires::Breaker avec d'autres classes 779
Tableau 154 – Attributs de Wires::BusbarSection 780
Tableau 155 – Extrémités d'association de Wires::BusbarSection avec d'autres classes 781
Tableau 156 – Attributs de Wires::Clamp 781
Tableau 157 – Extrémités d'association de Wires::Clamp avec d'autres classes 782
Tableau 158 – Attributs de Wires::CompositeSwitch 783
IECNORM.COM : Click to view the full PDF of IEC 61970-301:2020+AMD1:2022 CSV

Tableau 159 – Extrémités d'association de Wires::CompositeSwitch avec d'autres classes 783
Tableau 160 – Attributs de Wires::Conductor 784
Tableau 161 – Extrémités d'association de Wires::Conductor avec d'autres classes 784
Tableau 162 – Attributs de Wires::Connector 785
Tableau 163 – Extrémités d'association de Wires::Connector avec d'autres classes 785
Tableau 164 – Libellés de Wires::CoolantType 786
Tableau 165 – Attributs de Wires::Cut 786
Tableau 166 – Extrémités d'association de Wires::Cut avec d'autres classes 787
Tableau 167 – Attributs de Wires::Disconnector 787
Tableau 168 – Extrémités d'association de Wires::Disconnector avec d'autres classes 788
Tableau 169 – Attributs de Wires::DisconnectingCircuitBreaker 789
Tableau 170 – Extrémités d'association de ExtEuWires::DisconnectingCircuitBreaker avec d'autres classes 789
Tableau 171 – Attributs de Wires::EarthFaultCompensator 790
Tableau 172 – Extrémités d'association de Wires::EarthFaultCompensator avec d'autres classes 791
Tableau 173 – Attributs de Wires::EnergyConnection 791
Tableau 174 – Extrémités d'association de Wires::EnergyConnection avec d'autres classes 792
Tableau 175 – Attributs de Wires::EnergyConsumer 793
Tableau 176 – Extrémités d'association de Wires::EnergyConsumer avec d'autres classes 794
Tableau 177 – Attributs de Wires::EnergyConsumerPhase 795
Tableau 178 – Extrémités d'association de Wires::EnergyConsumerPhase avec d'autres classes 796
Tableau 179 – Attributs de Wires::EnergySchedulingType 796
Tableau 180 – Extrémités d'association de Wires::EnergySchedulingType avec d'autres classes 796
Tableau 181 – Attributs de Wires::EnergySource 797
Tableau 182 – Extrémités d'association de Wires::EnergySource avec d'autres classes 798
Tableau 183 – Attributs de Wires::EnergySourcePhase 798
Tableau 184 – Extrémités d'association de Wires::EnergySourcePhase avec d'autres classes 799
Tableau 185 – Attributs de Wires::ExternalNetworkInjection 799
Tableau 186 – Extrémités d'association de Wires::ExternalNetworkInjection avec d'autres classes 801
Tableau 187 – Attributs de Wires::FrequencyConverter 802
Tableau 188 – Extrémités d'association de Wires::FrequencyConverter avec d'autres classes 802
Tableau 189 – Attributs de Wires::Fuse 803
Tableau 190 – Extrémités d'association de Wires::Fuse avec d'autres classes 803
Tableau 191 – Attributs de Wires::Ground 804
Tableau 192 – Extrémités d'association de Wires::Ground avec d'autres classes 805
Tableau 193 – Attributs de Wires::GroundingImpedance 805

IECNORM.COM : Click to view the full PDF of IEC 61970-301:2020+AMD1:2022 CSV

Tableau 194 – Extrémités d'association de Wires::GroundingImpedance avec d'autres classes 806
Tableau 195 – Attributs de Wires::GroundDisconnector 806
Tableau 196 – Extrémités d'association de Wires::GroundDisconnector avec d'autres classes 807
Tableau 197 – Attributs de Wires::Jumper 808
Tableau 198 – Extrémités d'association de Wires::Jumper avec d'autres classes 808
Tableau 199 – Attributs de Wires::Junction 809
Tableau 200 – Extrémités d'association de Wires::Junction avec d'autres classes 809
Tableau 201 – Attributs de Wires::Line 810
Tableau 202 – Extrémités d'association de Wires::Line avec d'autres classes 810
Tableau 203 – Attributs de Wires::LinearShuntCompensator 811
Tableau 204 – Extrémités d'association de Wires::LinearShuntCompensator avec d'autres classes 812
Tableau 205 – Attributs de Wires::LinearShuntCompensatorPhase 813
Tableau 206 – Extrémités d'association de Wires::LinearShuntCompensatorPhase avec d'autres classes 813
Tableau 207 – Attributs de Wires::LoadBreakSwitch 814
Tableau 208 – Extrémités d'association de Wires::LoadBreakSwitch avec d'autres classes 814
Tableau 209 – Attributs de Wires::MutualCoupling 815
Tableau 210 – Extrémités d'association de Wires::MutualCoupling avec d'autres classes 816
Tableau 211 – Attributs de Wires::NonlinearShuntCompensator 816
Tableau 212 – Extrémités d'association de Wires::NonlinearShuntCompensator avec d'autres classes 817
Tableau 213 – Attributs de Wires::NonlinearShuntCompensatorPhase 818
Tableau 214 – Extrémités d'association de Wires::NonlinearShuntCompensatorPhase avec d'autres classes 818
Tableau 215 – Attributs de Wires::NonlinearShuntCompensatorPhasePoint 818
Tableau 216 – Extrémités d'association de Wires::NonlinearShuntCompensatorPhasePoint avec d'autres classes 819
Tableau 217 – Attributs de Wires::NonlinearShuntCompensatorPoint 819
Tableau 218 – Extrémités d'association de Wires::NonlinearShuntCompensatorPoint avec d'autres classes 819
Tableau 219 – Attributs de Wires::PerLengthImpedance 820
Tableau 220 – Extrémités d'association de Wires::PerLengthImpedance avec d'autres classes 820
Tableau 221 – Attributs de Wires::PerLengthLineParameter 820
Tableau 222 – Extrémités d'association de Wires::PerLengthLineParameter avec d'autres classes 820
Tableau 223 – Attributs de Wires::PerLengthPhaseImpedance 821
Tableau 224 – Extrémités d'association de Wires::PerLengthPhaseImpedance avec d'autres classes 821
Tableau 225 – Attributs de Wires::PerLengthSequenceImpedance 821
Tableau 226 – Extrémités d'association de Wires::PerLengthSequenceImpedance avec d'autres classes 822
IECNORM.COM : Click to view the full PDF of IEC 61970-301:2020+AMD1:2022 CSV

Tableau 227 – Attributs de Wires::PetersenCoil 822
Tableau 228 – Extrémités d'association de Wires::PetersenCoil avec d'autres classes 823
Tableau 229 – Libellés de Wires::PetersenCoilModeKind 824
Tableau 230 – Attributs de Wires::PhaseImpedanceData 824
Tableau 231 – Extrémités d'association de Wires::PhaseImpedanceData avec d'autres classes 824
Tableau 232 – Libellés de Wires::PhaseShuntConnectionKind 825
Tableau 233 – Attributs de Wires::PhaseTapChanger 825
Tableau 234 – Extrémités d'association de Wires::PhaseTapChanger avec d'autres classes 826
Tableau 235 – Attributs de Wires::PhaseTapChangerAsymmetrical 826
Tableau 236 – Extrémités d'association de Wires::PhaseTapChangerAsymmetrical avec d'autres classes 827
Tableau 237 – Attributs de Wires::PhaseTapChangerLinear 828
Tableau 238 – Extrémités d'association de Wires::PhaseTapChangerLinear avec d'autres classes 829
Tableau 239 – Attributs de Wires::PhaseTapChangerNonLinear 829
Tableau 240 – Extrémités d'association de Wires::PhaseTapChangerNonLinear avec d'autres classes 830
Tableau 241 – Attributs de Wires::PhaseTapChangerSymmetrical 831
Tableau 242 – Extrémités d'association de Wires::PhaseTapChangerSymmetrical avec d'autres classes 831
Tableau 243 – Attributs de Wires::PhaseTapChangerTable 832
Tableau 244 – Extrémités d'association de Wires::PhaseTapChangerTable avec d'autres classes 832
Tableau 245 – Attributs de Wires::PhaseTapChangerTablePoint 832
Tableau 246 – Extrémités d'association de Wires::PhaseTapChangerTablePoint avec d'autres classes 833
Tableau 247 – Attributs de Wires::PhaseTapChangerTabular 833
Tableau 248 – Extrémités d'association de Wires::PhaseTapChangerTabular avec d'autres classes 833
Tableau 249 – Attributs de Wires::Plant 834
Tableau 250 – Extrémités d'association de Wires::Plant avec d'autres classes 834
Tableau 251 – Attributs de Wires::PowerElectronicsConnection 835
Tableau 252 – Extrémités d'association de Wires::PowerElectronicsConnection avec d'autres classes 836
Tableau 253 – Attributs de Wires::PowerElectronicsConnectionPhase 837
Tableau 254 – Extrémités d'association de Wires::PowerElectronicsConnectionPhase avec d'autres classes 837
Tableau 255 – Attributs de Wires::PowerTransformer 838
Tableau 256 – Extrémités d'association de Wires::PowerTransformer avec d'autres classes 840
Tableau 257 – Attributs de Wires::PowerTransformerEnd 841
Tableau 258 – Extrémités d'association de Wires::PowerTransformerEnd avec d'autres classes 842
Tableau 259 – Attributs de Wires::ProtectedSwitch 843

IECNORM.COM : Click to view the full PDF of IEC 61970-301:2020+AMD1:2022 CSV

Tableau 260 – Extrémités d'association de Wires::ProtectedSwitch avec d'autres classes 843
Tableau 261 – Attributs de Wires::RatioTapChanger 844
Tableau 262 – Extrémités d'association de Wires::RatioTapChanger avec d'autres classes 845
Tableau 263 – Attributs de Wires::RatioTapChangerTable 845
Tableau 264 – Extrémités d'association de Wires::RatioTapChangerTable avec d'autres classes 846
Tableau 265 – Attributs de Wires::RatioTapChangerTablePoint 846
Tableau 266 – Extrémités d'association de Wires::RatioTapChangerTablePoint avec d'autres classes 846
Tableau 267 – Attributs de Wires::ReactiveCapabilityCurve 847
Tableau 268 – Extrémités d'association de Wires::ReactiveCapabilityCurve avec d'autres classes 847
Tableau 269 – Attributs de Wires::Recloser 848
Tableau 270 – Extrémités d'association de Wires::Recloser avec d'autres classes 848
Tableau 271 – Attributs de Wires::RegulatingCondEq 849
Tableau 272 – Extrémités d'association de Wires::RegulatingCondEq avec d'autres classes 849
Tableau 273 – Attributs de Wires::RegulatingControl 851
Tableau 274 – Extrémités d'association de Wires::RegulatingControl avec d'autres classes 852
Tableau 275 – Libellés de Wires::RegulatingControlModeKind 852
Tableau 276 – Attributs de Wires::RegulationSchedule 853
Tableau 277 – Extrémités d'association de Wires::RegulationSchedule avec d'autres classes 853
Tableau 278 – Attributs de Wires::RotatingMachine 854
Tableau 279 – Extrémités d'association de Wires::RotatingMachine avec d'autres classes 855
Tableau 280 – Attributs de Wires::Sectionaliser 856
Tableau 281 – Extrémités d'association de Wires::Sectionaliser avec d'autres classes 856
Tableau 282 – Attributs de Wires::SeriesCompensator 857
Tableau 283 – Extrémités d'association de Wires::SeriesCompensator avec d'autres classes 858
Tableau 284 – Libellés de Wires::ShortCircuitRotorKind 858
Tableau 285 – Attributs de Wires::ShuntCompensator 859
Tableau 286 – Extrémités d'association de Wires::ShuntCompensator avec d'autres classes 860
Tableau 287 – Attributs de Wires::ShuntCompensatorPhase 861
Tableau 288 – Extrémités d'association de Wires::ShuntCompensatorPhase avec d'autres classes 862
Tableau 289 – Libellés de Wires::SinglePhaseKind 862
Tableau 290 – Attributs de Wires::StaticVarCompensator 863
Tableau 291 – Extrémités d'association de Wires::StaticVarCompensator avec d'autres classes 864
Tableau 292 – Libellés de Wires::SVCControlMode 864
Tableau 293 – Attributs de Wires::Switch 865
IECNORM.COM : Click to view the full PDF of IEC 61970-301:2020+AMD1:2022 CSV

Tableau 294 – Extrémités d'association de Wires::Switch avec d'autres classes 866
Tableau 295 – Attributs de Wires::SwitchPhase 867
Tableau 296 – Extrémités d'association de Wires::SwitchPhase avec d'autres classes 867
Tableau 297 – Attributs de Wires::SwitchSchedule 868
Tableau 298 – Extrémités d'association de Wires::SwitchSchedule avec d'autres classes 868
Tableau 299 – Attributs de Wires::SynchronousMachine 869
Tableau 300 – Extrémités d'association de Wires::SynchronousMachine avec d'autres classes 871
Tableau 301 – Libellés de Wires::SynchronousMachineOperatingMode 872
Tableau 302 – Libellés de Wires::SynchronousMachineKind 872
Tableau 303 – Attributs de Wires::TapChanger 873
Tableau 304 – Extrémités d'association de Wires::TapChanger avec d'autres classes 874
Tableau 305 – Attributs de Wires::TapChangerControl 875
Tableau 306 – Extrémités d'association de Wires::TapChangerControl avec d'autres classes 876
Tableau 307 – Attributs de Wires::TapChangerTablePoint 876
Tableau 308 – Attributs de Wires::TapSchedule 877
Tableau 309 – Extrémités d'association de Wires::TapSchedule avec d'autres classes 878
Tableau 310 – Libellés de Wires::TransformerControlMode 878
Tableau 311 – Attributs de Wires::TransformerCoreAdmittance 878
Tableau 312 – Extrémités d'association de Wires::TransformerCoreAdmittance avec d'autres classes 879
Tableau 313 – Attributs de Wires::TransformerEnd 879
Tableau 314 – Extrémités d'association de Wires::TransformerEnd avec d'autres classes 880
Tableau 315 – Attributs de Wires::TransformerMeshImpedance 881
Tableau 316 – Extrémités d'association de Wires::TransformerMeshImpedance avec d'autres classes 881
Tableau 317 – Attributs de Wires::TransformerStarImpedance 882
Tableau 318 – Extrémités d'association de Wires::TransformerStarImpedance avec d'autres classes 882
Tableau 319 – Attributs de Wires::TransformerTank 882
Tableau 320 – Extrémités d'association de Wires::TransformerTank avec d'autres classes 883
Tableau 321 – Attributs de Wires::TransformerTankEnd 883
Tableau 322 – Extrémités d'association de Wires::TransformerTankEnd avec d'autres classes 884
Tableau 323 – Attributs de Wires::VoltageControlZone 884
Tableau 324 – Extrémités d'association de Wires::VoltageControlZone avec d'autres classes 885
Tableau 325 – Attributs de Wires::WireSegment 885
Tableau 326 – Extrémités d'association de Wires::WireSegment avec d'autres classes 886
Tableau 327 – Attributs de Wires::WireSegmentPhase 886
Tableau 328 – Extrémités d'association de Wires::WireSegmentPhase avec d'autres classes 887

IECNORM.COM : Click to view the full PDF of IEC 61970-301:2020+AMD1:2022 CSV

Tableau 329 – Libellés de Wires::WindingConnection 887
Tableau 330 – Attributs de LoadModel::ConformLoad 889
Tableau 331 – Extrémités d'association de LoadModel::ConformLoad avec d'autres classes 889
Tableau 332 – Attributs de LoadModel::ConformLoadGroup 890
Tableau 333 – Extrémités d'association de LoadModel::ConformLoadGroup avec d'autres classes 890
Tableau 334 – Attributs de LoadModel::ConformLoadSchedule 891
Tableau 335 – Extrémités d'association de LoadModel::ConformLoadSchedule avec d'autres classes 891
Tableau 336 – Attributs de LoadModel::DayType 891
Tableau 337 – Extrémités d'association de LoadModel::DayType avec d'autres classes 892
Tableau 338 – Attributs de LoadModel::EnergyArea 892
Tableau 339 – Extrémités d'association de LoadModel::EnergyArea avec d'autres classes 892
Tableau 340 – Attributs de LoadModel::LoadArea 893
Tableau 341 – Extrémités d'association de LoadModel::LoadArea avec d'autres classes 893
Tableau 342 – Attributs de LoadModel::LoadGroup 893
Tableau 343 – Extrémités d'association de LoadModel::LoadGroup avec d'autres classes 893
Tableau 344 – Attributs de LoadModel::LoadResponseCharacteristic 895
Tableau 345 – Extrémités d'association de LoadModel::LoadResponseCharacteristic avec d'autres classes 896
Tableau 346 – Attributs de LoadModel::NonConformLoad 896
Tableau 347 – Extrémités d'association de LoadModel::NonConformLoad avec d'autres classes 897
Tableau 348 – Attributs de LoadModel::NonConformLoadGroup 897
Tableau 349 – Extrémités d'association de LoadModel::NonConformLoadGroup avec d'autres classes 898
Tableau 350 – Attributs de LoadModel::NonConformLoadSchedule 898
Tableau 351 – Extrémités d'association de LoadModel::NonConformLoadSchedule avec d'autres classes 899
Tableau 352 – Attributs de LoadModel::PowerCutZone 899
Tableau 353 – Extrémités d'association de LoadModel::PowerCutZone avec d'autres classes 899
Tableau 354 – Attributs de LoadModel::Season 900
Tableau 355 – Extrémités d'association de LoadModel::Season avec d'autres classes 900
Tableau 356 – Attributs de LoadModel::SeasonDayTypeSchedule 900
Tableau 357 – Extrémités d'association de LoadModel::SeasonDayTypeSchedule avec d'autres classes 901
Tableau 358 – Attributs de LoadModel::StationSupply 901
Tableau 359 – Extrémités d'association de LoadModel::StationSupply avec d'autres classes 902
Tableau 360 – Attributs de LoadModel::SubLoadArea 902
Tableau 361 – Extrémités d'association de LoadModel::SubLoadArea avec d'autres classes 903
IECNORM.COM : Click to view the full PDF of IEC 61970-301:2020+AMD1:2022 CSV

Tableau 362 – Attributs de GenerationTrainingSimulation::BWRSteamSupply 905
Tableau 363 – Extrémités d'association de GenerationTrainingSimulation::BWRSteamSupply avec d'autres classes 906
Tableau 364 – Libellés de GenerationTrainingSimulation::BoilerControlMode 906
Tableau 365 – Attributs de GenerationTrainingSimulation::CTTempActivePowerCurve 906
Tableau 366 – Extrémités d'association de GenerationTrainingSimulation::CTTempActivePowerCurve avec d'autres classes 907
Tableau 367 – Attributs de GenerationTrainingSimulation::CombustionTurbine 907
Tableau 368 – Extrémités d'association de GenerationTrainingSimulation::CombustionTurbine avec d'autres classes 908
Tableau 369 – Attributs de GenerationTrainingSimulation::DrumBoiler 909
Tableau 370 – Extrémités d'association de GenerationTrainingSimulation::DrumBoiler avec d'autres classes 910
Tableau 371 – Attributs de GenerationTrainingSimulation::FossilSteamSupply 910
Tableau 372 – Extrémités d'association de GenerationTrainingSimulation::FossilSteamSupply avec d'autres classes 911
Tableau 373 – Attributs de GenerationTrainingSimulation::HeatRecoveryBoiler 912
Tableau 374 – Extrémités d'association de GenerationTrainingSimulation::HeatRecoveryBoiler avec d'autres classes 913
Tableau 375 – Attributs de GenerationTrainingSimulation::HydroTurbine 913
Tableau 376 – Extrémités d'association de GenerationTrainingSimulation::HydroTurbine avec d'autres classes 914
Tableau 377 – Attributs de GenerationTrainingSimulation::PWRSteamSupply 914
Tableau 378 – Extrémités d'association de GenerationTrainingSimulation:: PWRSteamSupply avec d'autres classes 915
Tableau 379 – Attributs de GenerationTrainingSimulation::PrimeMover 915
Tableau 380 – Extrémités d'association de GenerationTrainingSimulation::PrimeMover avec d'autres classes 916
Tableau 381 – Attributs de GenerationTrainingSimulation::SteamSupply 916
Tableau 382 – Extrémités d'association de GenerationTrainingSimulation::SteamSupply avec d'autres classes 916
Tableau 383 – Attributs de GenerationTrainingSimulation::SteamTurbine 917
Tableau 384 – Extrémités d'association de GenerationTrainingSimulation::SteamTurbine avec d'autres classes 918
Tableau 385 – Attributs de GenerationTrainingSimulation::Subcritical 918
Tableau 386 – Extrémités d'association de GenerationTrainingSimulation::Subcritical avec d'autres classes 919
Tableau 387 – Attributs de GenerationTrainingSimulation::Supercritical 919
Tableau 388 – Extrémités d'association de GenerationTrainingSimulation:: Supercritical avec d'autres classes 920
Tableau 389 – Libellés de GenerationTrainingSimulation::HydroTurbineKind 921
Tableau 390 – Attributs de Production::AirCompressor 926
Tableau 391 – Extrémités d'association de Production::AirCompressor avec d'autres classes 927
Tableau 392 – Libellés de Production::BatteryStateKind 927
Tableau 393 – Attributs de Production::BatteryUnit 927
Tableau 394 – Extrémités d'association de Production:: BatteryUnit avec d'autres classes 928

IECNORM.COM : Click to view the full PDF of IEC 61970-301:2020+AMD1:2022 CSV

Tableau 395 – Attributs de Production::CAESPlant 929
Tableau 396 – Extrémités d'association de Production::CAESPlant avec d'autres classes 929
Tableau 397 – Attributs de Production::CogenerationPlant 930
Tableau 398 – Extrémités d'association de Production::CogenerationPlant avec d'autres classes 930
Tableau 399 – Attributs de Production::CombinedCyclePlant 931
Tableau 400 – Extrémités d'association de Production::CombinedCyclePlant avec d'autres classes 931
Tableau 401 – Attributs de Production::EmissionAccount 931
Tableau 402 – Extrémités d'association de Production::EmissionAccount avec d'autres classes 932
Tableau 403 – Attributs de Production::EmissionCurve 932
Tableau 404 – Extrémités d'association de Production::EmissionCurve avec d'autres classes 933
Tableau 405 – Libellés de Production::EmissionType 933
Tableau 406 – Libellés de Production::WindGenUnitKind 934
Tableau 407 – Libellés de Production::EmissionValueSource 934
Tableau 408 – Attributs de Production::FossilFuel 934
Tableau 409 – Extrémités d'association de Production::FossilFuel avec d'autres classes 935
Tableau 410 – Attributs de Production::FuelAllocationSchedule 935
Tableau 411 – Extrémités d'association de Production::FuelAllocationSchedule avec d'autres classes 936
Tableau 412 – Libellés de Production::FuelType 936
Tableau 413 – Attributs de Production::GenUnitOpCostCurve 937
Tableau 414 – Extrémités d'association de Production::GenUnitOpCostCurve avec d'autres classes 937
Tableau 415 – Attributs de Production::GenUnitOpSchedule 938
Tableau 416 – Extrémités d'association de Production::GenUnitOpSchedule avec d'autres classes 938
Tableau 417 – Attributs de Production::GeneratingUnit 939
Tableau 418 – Extrémités d'association de Production::GeneratingUnit avec d'autres classes 942
Tableau 419 – Libellés de Production::GeneratorControlMode 942
Tableau 420 – Libellés de Production::GeneratorControlSource 943
Tableau 421 – Attributs de Production::GrossToNetActivePowerCurve 943
Tableau 422 – Extrémités d'association de Production::GrossToNetActivePowerCurve avec d'autres classes 944
Tableau 423 – Attributs de Production::HeatInputCurve 944
Tableau 424 – Extrémités d'association de Production::HeatInputCurve avec d'autres classes 945
Tableau 425 – Attributs de Production::HeatRateCurve 945
Tableau 426 – Extrémités d'association de Production::HeatRateCurve avec d'autres classes 946
Tableau 427 – Libellés de Production::HydroEnergyConversionKind 946
Tableau 428 – Attributs de Production::HydroGeneratingEfficiencyCurve 947

IECNORM.COM : Click to view the full PDF of IEC 61970-301:2020+AMD1:2022 CSV

Tableau 429 – Extrémités d'association de Production::HydroGeneratingEfficiencyCurve avec d'autres classes 947
Tableau 430 – Attributs de Production::HydroGeneratingUnit 948
Tableau 431 – Extrémités d'association de Production::HydroGeneratingUnit avec d'autres classes 949
Tableau 432 – Libellés de Production::HydroPlantStorageKind 950
Tableau 433 – Attributs de Production::HydroPowerPlant 950
Tableau 434 – Extrémités d'association de Production::HydroPowerPlant avec d'autres classes 951
Tableau 435 – Attributs de Production::HydroPump 951
Tableau 436 – Extrémités d'association de Production::HydroPump avec d'autres classes 952
Tableau 437 – Attributs de Production::HydroPumpOpSchedule 953
Tableau 438 – Extrémités d'association de Production::HydroPumpOpSchedule avec d'autres classes 953
Tableau 439 – Attributs de Production::IncrementalHeatRateCurve 954
Tableau 440 – Extrémités d'association de Production::IncrementalHeatRateCurve avec d'autres classes 954
Tableau 441 – Attributs de Production::InflowForecast 955
Tableau 442 – Extrémités d'association de Production::InflowForecast avec d'autres classes 955
Tableau 443 – Attributs de Production::LevelVsVolumeCurve 955
Tableau 444 – Extrémités d'association de Production::LevelVsVolumeCurve avec d'autres classes 956
Tableau 445 – Attributs de Production::NuclearGeneratingUnit 956
Tableau 446 – Extrémités d'association de Production::NuclearGeneratingUnit avec d'autres classes 958
Tableau 447 – Attributs de Production::PenstockLossCurve 958
Tableau 448 – Extrémités d'association de Production::PenstockLossCurve avec d'autres classes 959
Tableau 449 – Attributs de Production::PhotoVoltaicUnit 959
Tableau 450 – Extrémités d'association de Production::PhotoVoltaicUnit avec d'autres noms 960
Tableau 451 – Attributs de Production::PowerElectronicsUnit 960
Tableau 452 – Extrémités d'association de Production::PowerElectronicsUnit avec d'autres classes 961
Tableau 453 – Attributs de Production::PowerElectronicsWindUnit 961
Tableau 454 – Extrémités d'association de Production::PowerElectronicsWindUnit avec d'autres classes 962
Tableau 455 – Attributs de Production::Reservoir 962
Tableau 456 – Extrémités d'association de Production::Reservoir avec d'autres classes 963
Tableau 457 – Attributs de Production::ShutdownCurve 964
Tableau 458 – Extrémités d'association de Production::ShutdownCurve avec d'autres classes 964
Tableau 459 – Attributs de Production::SolarGeneratingUnit 965
Tableau 460 – Extrémités d'association de Production::SolarGeneratingUnit avec d'autres classes 966
Tableau 461 – Attributs de Production::StartIgnFuelCurve 967

IECNORM.COM : Click to view the full PDF of IEC 61970-301:2020+AMD1:2022 CSV

Tableau 462 – Extrémités d'association de Production::StartIgnFuelCurve avec d'autres classes 967
Tableau 463 – Attributs de Production::StartMainFuelCurve 968
Tableau 464 – Extrémités d'association de Production::StartMainFuelCurve avec d'autres classes 968
Tableau 465 – Attributs de Production::StartRampCurve 969
Tableau 466 – Extrémités d'association de Production::StartRampCurve avec d'autres classes 969
Tableau 467 – Attributs de Production::StartupModel 970
Tableau 468 – Extrémités d'association de Production::StartupModel avec d'autres classes 970
Tableau 469 – Attributs de Production::SteamSendoutSchedule 971
Tableau 470 – Extrémités d'association de Production::SteamSendoutSchedule avec d'autres classes 971
Tableau 471 – Attributs de Production::TailbayLossCurve 972
Tableau 472 – Extrémités d'association de Production::TailbayLossCurve avec d'autres classes 972
Tableau 473 – Attributs de Production::TargetLevelSchedule 973
Tableau 474 – Extrémités d'association de Production::TargetLevelSchedule avec d'autres classes 973
Tableau 475 – Attributs de Production::ThermalGeneratingUnit 974
Tableau 476 – Extrémités d'association de Production::ThermalGeneratingUnit avec d'autres classes 975
Tableau 477 – Attributs de Production::WindGeneratingUnit 976
Tableau 478 – Extrémités d'association de Production::WindGeneratingUnit avec d'autres classes 978
Tableau 479 – Attributs de DC::ACDCConverter 984
Tableau 480 – Extrémités d'association de DC::ACDCConverter avec d'autres classes 986
Tableau 481 – Attributs de DC::ACDCConverterDCTerminal 987
Tableau 482 – Extrémités d'association de DC::ACDCConverterDCTerminal avec d'autres classes 987
Tableau 483 – Attributs de DC::CsConverter 988
Tableau 484 – Extrémités d'association de DC::CsConverter avec d'autres classes 990
Tableau 485 – Attributs de DC::DCTopologicalNode 991
Tableau 486 – Extrémités d'association de DC::DCTopologicalNode avec d'autres classes 991
Tableau 487 – Libellés de DC::CsOperatingModeKind 991
Tableau 488 – Libellés de DC::CsPpccControlKind 992
Tableau 489 – Attributs de DC::DCBaseTerminal 992
Tableau 490 – Extrémités d'association de DC::DCBaseTerminal avec d'autres classes 993
Tableau 491 – Attributs de DC::DCBreaker 993
Tableau 492 – Extrémités d'association de DC::DCBreaker avec d'autres classes 994
Tableau 493 – Attributs de DC::DCBusbar 994
Tableau 494 – Extrémités d'association de DC::DCBusbar avec d'autres classes 995
Tableau 495 – Attributs de DC::DCChopper 995
Tableau 496 – Extrémités d'association de DC::DCChopper avec d'autres classes 996

IECNORM.COM : Click to view the full PDF of IEC 61970-301:2020+AMD1:2022 CSV

Tableau 497 – Attributs de DC::DCConductingEquipment 996
Tableau 498 – Extrémités d'association de DC::DCConductingEquipment avec d'autres classes 997
Tableau 499 – Libellés de DC::DCConverterOperatingModeKind 997
Tableau 500 – Attributs de DC::DCConverterUnit 998
Tableau 501 – Extrémités d'association de DC::DCConverterUnit avec d'autres classes 998
Tableau 502 – Attributs de DC::DCDisconnector 999
Tableau 503 – Extrémités d'association de DC::DCDisconnector avec d'autres classes 999
Tableau 504 – Attributs de DC::DCEquipmentContainer 1000
Tableau 505 – Extrémités d'association de DC::DCEquipmentContainer avec d'autres classes 1000
Tableau 506 – Attributs de DC::DCGround 1001
Tableau 507 – Extrémités d'association de DC::DCGround avec d'autres classes 1001
Tableau 508 – Attributs de DC::DCLine 1002
Tableau 509 – Extrémités d'association de DC::DCLine avec d'autres classes 1002
Tableau 510 – Attributs de DC::DCLineSegment 1003
Tableau 511 – Extrémités d'association de DC::DCLineSegment avec d'autres classes 1003
Tableau 512 – Attributs de DC::DCNode 1004
Tableau 513 – Extrémités d'association de DC::DCNode avec d'autres classes 1004
Tableau 514 – Libellés de DC::DCPolarityKind 1004
Tableau 515 – Attributs de DC::DCSeriesDevice 1005
Tableau 516 – Extrémités d'association de DC::DCSeriesDevice avec d'autres classes 1005
Tableau 517 – Attributs de DC::DCShunt 1006
Tableau 518 – Extrémités d'association de DC::DCShunt avec d'autres classes 1006
Tableau 519 – Attributs de DC::DCSwitch 1007
Tableau 520 – Extrémités d'association de DC::DCSwitch avec d'autres classes 1007
Tableau 521 – Attributs de DC::DCTerminal 1008
Tableau 522 – Extrémités d'association de DC::DCTerminal avec d'autres classes 1008
Tableau 523 – Attributs de DC::DCTopologicalIsland 1008
Tableau 524 – Extrémités d'association de DC::DCTopologicalIsland avec d'autres classes 1009
Tableau 525 – Attributs de DC::PerLengthDCLineParameter 1009
Tableau 526 – Extrémités d'association de DC::PerLengthDCLineParameter avec d'autres classes 1009
Tableau 527 – Attributs de DC::VsCapabilityCurve 1010
Tableau 528 – Extrémités d'association de DC::VsCapabilityCurve avec d'autres classes 1010
Tableau 529 – Attributs de DC::VsConverter 1011
Tableau 530 – Extrémités d'association de DC::VsConverter avec d'autres classes 1012
Tableau 531 – Libellés de DC::VsPpccControlKind 1013
Tableau 532 – Libellés de DC::VsQpccControlKind 1014
Tableau 533 – Attributs de Equivalents::EquivalentBranch 1016
Tableau 534 – Extrémités d'association de Equivalents::EquivalentBranch avec d'autres classes 1018
Tableau 535 – Attributs de Equivalents::EquivalentEquipment 1018

IECNORM.COM : Click to view the full PDF of IEC 61970-301:2020+AMD1:2022 CSV

Tableau 536 – Extrémités d'association de Equivalents::EquivalentEquipment avec d'autres classes 1019
Tableau 537 – Attributs de Equivalents::EquivalentInjection 1019
Tableau 538 – Extrémités d'association de Equivalents::EquivalentInjection avec d'autres classes 1021
Tableau 539 – Attributs de Equivalents::EquivalentNetwork 1021
Tableau 540 – Extrémités d'association de Equivalents::EquivalentNetwork avec d'autres classes 1022
Tableau 541 – Attributs de Equivalents::EquivalentShunt 1022
Tableau 542 – Extrémités d'association de Equivalents::EquivalentShunt avec d'autres classes 1023
Tableau 543 – Attributs de AuxiliaryEquipment::AuxiliaryEquipment 1025
Tableau 544 – Extrémités d'association de AuxiliaryEquipment::AuxiliaryEquipment avec d'autres classes 1025
Tableau 545 – Attributs de AuxiliaryEquipment::CurrentTransformer 1026
Tableau 546 – Extrémités d'association de AuxiliaryEquipment::CurrentTransformer avec d'autres classes 1026
Tableau 547 – Attributs de AuxiliaryEquipment::FaultIndicator 1027
Tableau 548 – Extrémités d'association de AuxiliaryEquipment::FaultIndicator avec d'autres classes 1027
Tableau 549 – Attributs de AuxiliaryEquipment::PostLineSensor 1028
Tableau 550 – Extrémités d'association de AuxiliaryEquipment::PostLineSensor avec d'autres classes 1028
Tableau 551 – Attributs de AuxiliaryEquipment::PotentialTransformer 1029
Tableau 552 – Extrémités d'association de AuxiliaryEquipment::PotentialTransformer avec d'autres classes 1029
Tableau 553 – Libellés de AuxiliaryEquipment::PotentialTransformerKind 1030
Tableau 554 – Attributs de AuxiliaryEquipment::Sensor 1030
Tableau 555 – Extrémités d'association de AuxiliaryEquipment::Sensor avec d'autres classes 1030
Tableau 556 – Attributs de AuxiliaryEquipment::SurgeArrester 1031
Tableau 557 – Extrémités d'association de AuxiliaryEquipment::SurgeArrester avec d'autres classes 1031
Tableau 558 – Attributs de AuxiliaryEquipment::WaveTrap 1032
Tableau 559 – Extrémités d'association de AuxiliaryEquipment::WaveTrap avec d'autres classes 1032
Tableau 560 – Attributs de Meas::Accumulator 1037
Tableau 561 – Extrémités d'association de Meas::Accumulator avec d'autres classes 1038
Tableau 562 – Attributs de Meas::AccumulatorLimit 1038
Tableau 563 – Extrémités d'association de Meas::AccumulatorLimit avec d'autres classes 1038
Tableau 564 – Attributs de Meas::AccumulatorLimitSet 1039
Tableau 565 – Extrémités d'association de Meas::AccumulatorLimitSet avec d'autres classes 1039
Tableau 566 – Attributs de Meas::AccumulatorReset 1039
Tableau 567 – Extrémités d'association de Meas::AccumulatorReset avec d'autres classes 1040
Tableau 568 – Attributs de Meas::AccumulatorValue 1040

IECNORM.COM : Click to view the full PDF of IEC 61970-301:2020+AMD1:2022 CSV

Tableau 569 – Extrémités d'association de Meas::AccumulatorValue avec d'autres classes 1041
Tableau 570 – Attributs de Meas::Analog 1041
Tableau 571 – Extrémités d'association de Meas::Analog avec d'autres classes 1042
Tableau 572 – Attributs de Meas::AnalogControl 1042
Tableau 573 – Extrémités d'association de Meas::AnalogControl avec d'autres classes 1043
Tableau 574 – Attributs de Meas::AnalogLimit 1043
Tableau 575 – Extrémités d'association de Meas::AnalogLimit avec d'autres classes 1043
Tableau 576 – Attributs de Meas::AnalogLimitSet 1044
Tableau 577 – Extrémités d'association de Meas::AnalogLimitSet avec d'autres classes 1044
Tableau 578 – Attributs de Meas::AnalogValue 1044
Tableau 579 – Extrémités d'association de Meas::AnalogValue avec d'autres classes 1045
Tableau 580 – Attributs de Meas::Command 1045
Tableau 581 – Extrémités d'association de Meas::Command avec d'autres classes 1046
Tableau 582 – Attributs de Meas::Control 1046
Tableau 583 – Extrémités d'association de Meas::Control avec d'autres classes 1047
Tableau 584 – Attributs de Meas::Discrete 1047
Tableau 585 – Extrémités d'association de Meas::Discrete avec d'autres classes 1048
Tableau 586 – Attributs de Meas::DiscreteValue 1048
Tableau 587 – Extrémités d'association de Meas::DiscreteValue avec d'autres classes 1048
Tableau 588 – Attributs de Meas::IOPoint 1049
Tableau 589 – Extrémités d'association de Meas::IOPoint avec d'autres classes 1049
Tableau 590 – Attributs de Meas::Limit 1050
Tableau 591 – Extrémités d'association de Meas::Limit avec d'autres classes 1050
Tableau 592 – Attributs de Meas::LimitSet 1050
Tableau 593 – Extrémités d'association de Meas::LimitSet avec d'autres classes 1050
Tableau 594 – Attributs de Meas::Measurement 1051
Tableau 595 – Extrémités d'association de Meas::Measurement avec d'autres classes 1052
Tableau 596 – Attributs de Meas::MeasurementValue 1052
Tableau 597 – Extrémités d'association de Meas::MeasurementValue avec d'autres classes 1053
Tableau 598 – Attributs de Meas::MeasurementValueQuality 1053
Tableau 599 – Extrémités d'association de Meas::MeasurementValueQuality avec d'autres classes 1054
Tableau 600 – Attributs de Meas::MeasurementValueSource 1054
Tableau 601 – Extrémités d'association de Meas::MeasurementValueSource avec d'autres classes 1054
Tableau 602 – Attributs de Meas::Quality61850 1055
Tableau 603 – Attributs de Meas::RaiseLowerCommand 1056
Tableau 604 – Extrémités d'association de Meas::RaiseLowerCommand avec d'autres classes 1056
Tableau 605 – Attributs de Meas::SetPoint 1057
Tableau 606 – Extrémités d'association de Meas::SetPoint avec d'autres classes 1057
Tableau 607 – Attributs de Meas::StringMeasurement 1058

IECNORM.COM : Click to view the full PDF of IEC 61970-301:2020+AMD1:2022 CSV

Tableau 608 – Extrémités d'association de Meas::StringMeasurement avec d'autres classes 1058
Tableau 609 – Attributs de Meas::StringMeasurementValue 1058
Tableau 610 – Extrémités d'association de Meas::StringMeasurementValue avec d'autres classes 1059
Tableau 611 – Libellés de Meas::Validity 1059
Tableau 612 – Attributs de Meas::ValueAliasSet 1060
Tableau 613 – Extrémités d'association de Meas::ValueAliasSet avec d'autres classes 1060
Tableau 614 – Attributs de Meas::ValueToAlias 1060
Tableau 615 – Extrémités d'association de Meas::ValueToAlias avec d'autres classes 1061
Tableau 616 – Attributs de Topology::BusNameMarker 1062
Tableau 617 – Extrémités d'association de Topology::BusNameMarker avec d'autres classes 1063
Tableau 618 – Attributs de Topology::TopologicalIsland 1063
Tableau 619 – Extrémités d'association de Topology::TopologicalIsland avec d'autres classes 1064
Tableau 620 – Attributs de Topology::TopologicalNode 1064
Tableau 621 – Extrémités d'association de Topology::TopologicalNode avec d'autres classes 1065
Tableau 622 – Attributs de DiagramLayout::Diagram 1067
Tableau 623 – Extrémités d'association de DiagramLayout::Diagram avec d'autres classes 1067
Tableau 624 – Attributs de DiagramLayout::DiagramObject 1068
Tableau 625 – Extrémités d'association de DiagramLayout::DiagramObject avec d'autres classes 1069
Tableau 626 – Extrémités d'association de DiagramLayout::DiagramObjectGluePoint avec d'autres classes 1069
Tableau 627 – Attributs de DiagramLayout::DiagramObjectPoint 1070
Tableau 628 – Extrémités d'association de DiagramLayout::DiagramObjectPoint avec d'autres classes 1070
Tableau 629 – Attributs de DiagramLayout::DiagramObjectStyle 1070
Tableau 630 – Extrémités d'association de DiagramLayout::DiagramObjectStyle avec d'autres classes 1071
Tableau 631 – Attributs de DiagramLayout::DiagramStyle 1071
Tableau 632 – Extrémités d'association de DiagramLayout::DiagramStyle avec d'autres classes 1071
Tableau 633 – Libellés de DiagramLayout::OrientationKind 1072
Tableau 634 – Attributs de DiagramLayout::TextDiagramObject 1072
Tableau 635 – Extrémités d'association de DiagramLayout::TextDiagramObject avec d'autres classes 1073
Tableau 636 – Attributs de DiagramLayout::VisibilityLayer 1073
Tableau 637 – Extrémités d'association de DiagramLayout::VisibilityLayer avec d'autres classes 1074
Tableau 638 – Attributs de OperationalLimits::ActivePowerLimit 1075
Tableau 639 – Extrémités d'association de OperationalLimits::ActivePowerLimit avec d'autres classes 1076
Tableau 640 – Attributs de OperationalLimits::ApparentPowerLimit 1076
IECNORM.COM : Click to view the full PDF of IEC 61970-301:2020+AMD1:2022 CSV

Tableau 641 – Extrémités d'association de OperationalLimits::ApparentPowerLimit avec d'autres classes 1076
Tableau 642 – Attributs de OperationalLimits::BranchGroup 1077
Tableau 643 – Extrémités d'association de OperationalLimits::BranchGroup avec d'autres classes 1077
Tableau 644 – Attributs de OperationalLimits::BranchGroupTerminal 1077
Tableau 645 – Extrémités d'association de OperationalLimits::BranchGroupTerminal avec d'autres classes 1078
Tableau 646 – Attributs de OperationalLimits::CurrentLimit 1078
Tableau 647 – Extrémités d'association de OperationalLimits::CurrentLimit avec d'autres classes 1078
Tableau 648 – Attributs de OperationalLimits::OperationalLimit 1079
Tableau 649 – Extrémités d'association de OperationalLimits::OperationalLimit avec d'autres classes 1079
Tableau 650 – Libellés de OperationalLimits::OperationalLimitDirectionKind 1079
Tableau 651 – Attributs de OperationalLimits::OperationalLimitSet 1080
Tableau 652 – Extrémités d'association de OperationalLimits::OperationalLimitSet avec d'autres classes 1080
Tableau 653 – Attributs de OperationalLimits::OperationalLimitType 1081
Tableau 654 – Extrémités d'association de OperationalLimits::OperationalLimitType avec d'autres classes 1081
Tableau 655 – Attributs de OperationalLimits::VoltageLimit 1082
Tableau 656 – Extrémités d'association de OperationalLimits::VoltageLimit avec d'autres classes 1082
Tableau 657 – Attributs de ControlArea::AltGeneratingUnitMeas 1085
Tableau 658 – Extrémités d'association de ControlArea::AltGeneratingUnitMeas avec d'autres classes 1085
Tableau 659 – Attributs de ControlArea::AltTieMeas 1085
Tableau 660 – Extrémités d'association de ControlArea::AltTieMeas avec d'autres classes 1086
Tableau 661 – Attributs de ControlArea::ControlArea 1087
Tableau 662 – Extrémités d'association de ControlArea::ControlArea avec d'autres classes 1087
Tableau 663 – Attributs de ControlArea::ControlAreaGeneratingUnit 1088
Tableau 664 – Extrémités d'association de ControlArea::ControlAreaGeneratingUnit avec d'autres classes 1088
Tableau 665 – Libellés de ControlArea::ControlAreaTypeKind 1088
Tableau 666 – Attributs de ControlArea::TieFlow 1089
Tableau 667 – Extrémités d'association de ControlArea::TieFlow avec d'autres classes 1089
Tableau 668 – Attributs de Contingency::Contingency 1090
Tableau 669 – Extrémités d'association de Contingency::Contingency avec d'autres classes 1091
Tableau 670 – Attributs de Contingency::ContingencyElement 1091
Tableau 671 – Extrémités d'association de Contingency::ContingencyElement avec d'autres classes 1091
Tableau 672 – Attributs de Contingency::ContingencyEquipment 1092
Tableau 673 – Extrémités d'association de Contingency::ContingencyEquipment avec d'autres classes 1092

IECNORM.COM : Click to view the full PDF of IEC 61970-301:2020+AMD1:2022 CSV

Tableau 674 – Libellés de Contingency::ContingencyEquipmentStatusKind 1092
Tableau 675 – Attributs de StateVariables::SvInjection 1094
Tableau 676 – Extrémités d'association de StateVariables::SvInjection avec d'autres classes 1094
Tableau 677 – Attributs de StateVariables::SvPowerFlow 1094
Tableau 678 – Extrémités d'association de StateVariables::SvPowerFlow avec d'autres classes 1095
Tableau 679 – Attributs de StateVariables::SvShuntCompensatorSections 1095
Tableau 680 – Extrémités d'association de StateVariables::SvShuntCompensatorSections avec d'autres classes 1095
Tableau 681 – Attributs de StateVariables::SvStatus 1095
Tableau 682 – Extrémités d'association de StateVariables::SvStatus avec d'autres classes 1096
Tableau 683 – Attributs de StateVariables::SvSwitch 1096
Tableau 684 – Extrémités d'association de StateVariables::SvSwitch avec d'autres classes 1096
Tableau 685 – Attributs de StateVariables::SvTapStep 1096
Tableau 686 – Extrémités d'association de StateVariables::SvTapStep avec d'autres classes 1097
Tableau 687 – Attributs de StateVariables::SvVoltage 1097
Tableau 688 – Extrémités d'association de StateVariables::SvVoltage avec d'autres classes 1097
Tableau 689 – Attributs de Protection::CurrentRelay 1098
Tableau 690 – Extrémités d'association de Protection::CurrentRelay avec d'autres classes 1099
Tableau 691 – Attributs de Protection::ProtectionEquipment 1100
Tableau 692 – Extrémités d'association de Protection::ProtectionEquipment avec d'autres classes 1100
Tableau 693 – Attributs de Protection::RecloseSequence 1101
Tableau 694 – Extrémités d'association de Protection::RecloseSequence avec d'autres classes 1101
Tableau 695 – Attributs de Protection::SynchrocheckRelay 1102
Tableau 696 – Extrémités d'association de Protection::SynchrocheckRelay avec d'autres classes 1102
Tableau 697 – Attributs de Faults::EquipmentFault 1103
Tableau 698 – Extrémités d'association de Faults::EquipmentFault avec d'autres classes 1104
Tableau 699 – Attributs de Faults::Fault 1104
Tableau 700 – Extrémités d'association de Faults::Fault avec d'autres classes 1104
Tableau 701 – Attributs de Faults::FaultCauseType 1105
Tableau 702 – Extrémités d'association de Faults::FaultCauseType avec d'autres classes 1105
Tableau 703 – Attributs de Faults::FaultImpedance 1105
Tableau 704 – Attributs de Faults::LineFault 1106
Tableau 705 – Extrémités d'association de Faults::LineFault avec d'autres classes 1106
Tableau 706 – Libellés de Faults::PhaseConnectedFaultKind 1106
Tableau 707 – Attributs de SCADA::CommunicationLink 1108
IECNORM.COM : Click to view the full PDF of IEC 61970-301:2020+AMD1:2022 CSV

Tableau 708 – Extrémités d'association de SCADA::CommunicationLink avec d'autres classes 1109
Tableau 709 – Attributs de SCADA::RemoteControl 1109
Tableau 710 – Extrémités d'association de SCADA::RemoteControl avec d'autres classes 1110
Tableau 711 – Attributs de SCADA::RemotePoint 1110
Tableau 712 – Extrémités d'association de SCADA::RemotePoint avec d'autres classes 1110
Tableau 713 – Attributs de SCADA::RemoteSource 1111
Tableau 714 – Extrémités d'association de SCADA::RemoteSource avec d'autres classes 1111
Tableau 715 – Attributs de SCADA::RemoteUnit 1111
Tableau 716 – Extrémités d'association de SCADA::RemoteUnit avec d'autres classes 1112
Tableau 717 – Libellés de SCADA::RemoteUnitType 1112
Tableau 718 – Libellés de SCADA::Source 1112
Tableau 719 – Libellés de ICCPConfiguration::ApplicationSecurityKind 1115
Tableau 720 – Attributs de ICCPConfiguration::BilateralExchangeActor 1115
Tableau 721 – Extrémités d'association de ICCPConfiguration::BilateralExchangeActor avec d'autres classes 1115
Tableau 722 – Attributs de ICCPConfiguration::BilateralExchangeAgreement 1116
Tableau 723 – Extrémités d'association de ICCPConfiguration::BilateralExchangeAgreement avec d'autres classes 1116
Tableau 724 – Libellés de ICCPConfiguration::ICCPAccessPrivilegeKind 1116
Tableau 725 – Attributs de ICCPConfiguration::ICCPInformationMessage 1117
Tableau 726 – Extrémités d'association de ICCPConfiguration::ICCPInformationMessage avec d'autres classes 1117
Tableau 727 – Libellés de ICCPConfiguration::ICCPPointKind 1117
Tableau 728 – Attributs de ICCPConfiguration::ICCPProvidedPoint 1118
Tableau 729 – Extrémités d'association de ICCPConfiguration::ICCPProvidedPoint avec d'autres classes 1118
Tableau 730 – Libellés de ICCPConfiguration::ICCPQualityKind 1119
Tableau 731 – Libellés de ICCPConfiguration::ICCPScopeKind 1119
Tableau 732 – Attributs de ICCPConfiguration::ICCPVCC 1119
Tableau 733 – Extrémités d'association de ICCPConfiguration::ICCPVCC avec d'autres classes 1120
Tableau 734 – Attributs de ICCPConfiguration::ICCPVirtualControlCentre 1120
Tableau 735 – Extrémités d'association de ICCPConfiguration::ICCPVirtualControlCentre avec d'autres classes 1121
Tableau 736 – Attributs de ICCPConfiguration::IOPointSource 1121
Tableau 737 – Extrémités d'association de ICCPConfiguration::IOPointSource avec d'autres classes 1122
Tableau 738 – Attributs de ICCPConfiguration::IPAccessPoint 1122
Tableau 739 – Extrémités d'association de ICCPConfiguration::IPAccessPoint avec d'autres classes 1122
Tableau 740 – Libellés de ICCPConfiguration::IPAddressKind 1123
Tableau 741 – Attributs de ICCPConfiguration::ISOUpperLayer 1123
Tableau 742 – Extrémités d'association de ICCPConfiguration::ISOUpperLayer avec d'autres classes 1124

IECNORM.COM : Click to view the full PDF of IEC 61970-301:2020+AMD1:2022 CSV

Tableau 743 – Attributs de ICCPConfiguration::ProvidedBilateralPoint 1124
Tableau 744 – Extrémités d'association de ICCPConfiguration::ProvidedBilateralPoint avec d'autres classes 1125
Tableau 745 – Attributs de ICCPConfiguration::PublicX509Certificate 1125
Tableau 746 – Extrémités d'association de ICCPConfiguration::PublicX509Certificate avec d'autres classes 1125
Tableau 747 – Attributs de ICCPConfiguration::TASE2BilateralTable 1126
Tableau 748 – Extrémités d'association de ICCPConfiguration::TASE2BilateralTable avec d'autres classes 1126
Tableau 749 – Attributs de ICCPConfiguration::TCPAccessPoint 1127
Tableau 750 – Extrémités d'association de ICCPConfiguration::TCPAccessPoint avec d'autres classes 1127
Tableau A.1 – Attributs de ExtEuCore::BoundaryPoint 1130
Tableau A.2 – Extrémités d'association de ExtEuCore::BoundaryPoint avec d'autres classes 1131
Tableau A.3 – Attributs de ExtEuCore::ExtEuIdentifiedObject 1131
Tableau A.4 – Attributs de ExtEuOperationalLimits::ExtEuOperationalLimitType 1132
Tableau A.5 – Libellés de ExtEuOperationalLimits::LimitKind 1133
Tableau A.6 – Attributs de ExtEuProduction::SolarPowerPlant 1135
Tableau A.7 – Extrémités d'association de ExtEuProduction::SolarPowerPlant avec d'autres classes 1136
Tableau A.8 – Attributs de ExtEuProduction::WindPowerPlant 1136
Tableau A.9 – Extrémités d'association de ExtEuProduction::WindPowerPlant avec d'autres classes 1137

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COMMISSION ÉLECTROTECHNIQUE INTERNATIONALE

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INTERFACE DE PROGRAMMATION D'APPLICATION POUR SYSTÈME DE GESTION D'ÉNERGIE (EMS-API) –

Partie 301: Base de modèle d'information commun (CIM)

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L'IEC 61970-301 édition 7.1 contient la septième édition (2020-06) [documents 57/2210/FDIS and 57/2224/RVD] et son amendement 1 (2022-02) [documents 57/2439/FDIS et 57/2450/RVD].

Dans cette version Redline, une ligne verticale dans la marge indique où le contenu technique est modifié par l'amendement 1. Les ajouts sont en vert, les suppressions sont en rouge, barrées. Une version Finale avec toutes les modifications acceptées est disponible dans cette publication.

La Norme internationale IEC 61970-301 a été établie par le comité d'études 57 de l'IEC: Gestion des systèmes de puissance et échanges d'informations associés

Cette septième édition constitue une révision technique.

Cette édition reflète la version du contenu du modèle "IEC61970CIM17v38", datée de "2020-01-21", et inclut les modifications techniques majeures suivantes par rapport à l'édition précédente:

a) modélisation Feeder ajoutée;
b) modélisation de la configuration ICCP ajoutée;
c) correction de problèmes détectés dans les essais d'interopérabilité ou l'utilisation de la norme;
d) documentation améliorée;
e) Annexe A mise à jour avec des extensions personnalisées;
f) Annexe B ajoutée Exemples de modélisation de transformateur PST;
g) Annexe C ajoutée Cas d'utilisation CCHT.

Cette publication a été rédigée selon les Directives ISO/IEC, Partie 2

Une liste de toutes les parties de la série IEC 61970, sous le titre général: *Interface de programme d'application de système de gestion d'énergie (EMS-API)*, peut être consultée sur le site Web de l'IEC.

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INTRODUCTION

Le présent document fait partie de la série IEC 61970 qui définit une interface de programmation d'application (API – *Application program interface*) pour un système de gestion d'énergie (EMS – *Energy management system*). L'IEC 61970 a été initialement fondée sur les travaux réalisés dans le cadre du projet de recherche (RP-3654-1) sur les API de centres de conduite (CCAPI) de l'EPRI. Le projet CCAPI de l'EPRI avait principalement pour objet de:

- réduire les coûts et le temps nécessaires à l'ajout de nouvelles applications à un EMS;
- protéger l'investissement dans les applications ou systèmes existant(e)s qui fonctionnent efficacement dans un EMS.

Le principal objet de la série IEC 61970 est de produire des documents destinés à faciliter l'intégration d'applications EMS développées de façon indépendante par différents fournisseurs, entre des systèmes EMS complets développés de façon indépendante ou entre un système EMS et d'autres systèmes concernés par différents aspects de l'exploitation d'un système de puissance, tels que les systèmes de gestion de la distribution (DMS – *Distribution management systems*) ou de la production. Cela est réalisé en définissant des API pour permettre à ces applications ou systèmes d'accéder aux données publiques et d'échanger des informations indépendamment de la représentation interne de ces informations.

Le modèle d'information commun (CIM – *Common Information Model*) spécifie la sémantique de cette API. Les spécifications des composants d'interface (CIS – *Component Interface Specifications*), qui sont contenues dans d'autres parties de la série de normes IEC 61970, précisent le contenu des messages échangés.

Le CIM est un modèle abstrait contenant tous les objets principaux d'une entreprise de service public d'électricité habituellement nécessaires pour représenter les opérations d'une entreprise de service public d'électricité. Ce modèle inclut les classes et les attributs publics de ces objets, ainsi que les relations entre eux.

Le présent document définit la base du CIM constituée d'un ensemble de paquetages qui offrent une vue logique des aspects fonctionnels d'un EMS incluant SCADA (*Supervisory control and data acquisition* – système de supervision, contrôle et acquisition de données). D'autres domaines fonctionnels sont normalisés dans des documents IEC distincts qui complètent et référencent le présent document. Par exemple, l'IEC 61968-11 traite des modèles de distribution et référence le présent document. Alors qu'il existe plusieurs normes de l'IEC qui traitent des différentes parties du CIM, un seul modèle d'information unifié comprenant le CIM est sous-jacent à tous ces documents normatifs individuels.

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L'attention est d'autre part attirée sur le fait que certains des éléments du présent document peuvent faire l'objet de droits de propriété autres que ceux qui ont été mentionnés ci-dessus. L'IEC ne saurait être tenue pour responsable de l'identification de ces droits de propriété en tout ou partie.

ISO (www.iso.org/patents) et l'IEC (http://www.iec.ch/tctools/patent_decl.htm) tiennent à jour des bases de données, consultables en ligne, des droits de propriété liés à leurs normes. Les utilisateurs sont invités à consulter ces bases de données pour obtenir les informations les plus récentes concernant les droits de propriété.

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INTERFACE DE PROGRAMMATION D'APPLICATION POUR SYSTÈME DE GESTION D'ÉNERGIE (EMS-API) –

Partie 301: Base de modèle d'information commun (CIM)

1 Domaine d'application

Le modèle d'information commun (CIM – common information model) est un modèle abstrait qui représente tous les objets principaux d'une entreprise de service public d'électricité habituellement nécessaires aux opérations d'une entreprise de service public d'électricité. La représentation normalisée des ressources de systèmes de puissance comme classes et attributs d'objets ainsi que leurs relations que fournit le CIM facilite l'intégration et l'interopérabilité des applications réseau développées de façon indépendante par différents fournisseurs, entre des systèmes complets exploitant des applications réseau développés de façon indépendante ou entre un système exploitant des applications réseau et d'autres systèmes concernés par différents aspects des opérations d'un système de puissance tels que la gestion de la production ou de la distribution. Le système SCADA (système de supervision, contrôle et acquisition de données – *supervisory control and data acquisition*) est modélisé dans toute la mesure nécessaire pour prendre en charge la simulation des systèmes de puissance et la communication entre des centres de conduite. Le CIM facilite l'intégration en définissant un langage commun (c'est-à-dire une sémantique) fondé sur le modèle CIM pour permettre à ces applications ou systèmes d'accéder aux données publiques et d'échanger des informations indépendamment de la représentation interne de ces informations.

Les classes d'objets représentées dans le CIM sont de nature abstraite et peuvent être utilisées dans une large gamme d'applications. L'utilisation du CIM n'est pas limitée à son application dans un EMS. Il convient de considérer le présent document comme un outil permettant l'intégration dans tout domaine nécessitant d'appliquer un modèle commun de système de puissance pour faciliter l'interopérabilité et la compatibilité de connexion entre des applications et des systèmes indépendants de toute mise en œuvre particulière.

En raison de la taille du CIM complet, les classes d'objets qui le composent sont regroupées en plusieurs Paquetages logiques, qui représentent chacun une certaine partie du système de puissance global modélisé. Les ensembles de ces Paquetages sont fournis progressivement sous forme de Normes internationales distinctes. Le présent document spécifie un ensemble de Base de paquetages qui offrent une vue logique sur les aspects fonctionnels des informations relatives à un EMS et à la modélisation du système de puissance d'une entreprise de service public d'électricité qui sont partagées par toutes les applications. D'autres normes spécifient des aspects plus spécifiques du modèle qui ne sont nécessaires qu'à certaines applications. Le Paragraphe 4.3 du présent document définit le découpage actuel des paquetages dans les documents normatifs.

2 Références normatives

Les documents suivants sont cités dans le texte de sorte qu'ils constituent, pour tout ou partie de leur contenu, des exigences du présent document. Pour les références datées, seule l'édition citée s'applique. Pour les références non datées, la dernière édition du document de référence s'applique (y compris les éventuels amendements).

IEC 61850 (toutes les parties), *Réseaux et systèmes de communication pour l'automatisation des systèmes électriques*

IEC 61850-7-4:2010, *Réseaux et systèmes de communication pour l'automatisation des systèmes électriques – Partie 7-4: Structure de communication de base – Classes de nœud logique et classes de donnée objet compatibles*

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IEC 61968 (toutes les parties), *Intégration d'applications pour les services électriques – Interfaces système pour la gestion de distribution*

IEC TS 61970-2, *Energy management system application program interface (EMS-API) – Part 2: Glossary* (disponible en anglais seulement)

Object Management Group: UML 2.0 Specification – http://www.omg.org

3 Termes et définitions

Pour les besoins du présent document, les termes et les définitions de l'IEC TS 61970-2 ainsi que les suivants, s'appliquent.

L'ISO et l'IEC tiennent à jour des bases de données terminologiques destinées à être utilisées en normalisation, consultables aux adresses suivantes:

- IEC Electropedia: disponible à l'adresse http://www.electropedia.org/
- ISO Online browsing platform: disponible à l'adresse http://www.iso.org/obp

3.1
système de gestion d'énergie
EMS
système informatique comprenant une plate-forme logicielle offrant les services de support de base et un ensemble d'applications offrant les fonctionnalités requises pour le bon fonctionnement des installations de production et de transport d'électricité afin d'assurer la sécurité adéquate d'approvisionnement énergétique à un coût minimal

Note 1 à l'article: L'abréviation "EMS" est dérivée du terme anglais développé correspondant "energy management system".

3.2
interface de programmation d'application
API
ensemble des fonctions publiques qu'offre un composant exécutable d'application pour être utilisées par d'autres composants exécutables d'application

Note 1 à l'article: L'abréviation "API" est dérivée du terme anglais développé correspondant "application program interface".

3.3
langage de modélisation unifié
UML
langage descriptif formel et complet avec des techniques de présentation de diagrammes utilisées pour représenter des systèmes logiciels, depuis l'analyse des exigences, en passant par la conception et la mise en œuvre, jusqu'à la documentation

Note 1 à l'article: Le langage UML a évolué pour devenir une Norme internationale (ISO/IEC 19505, publiée en 2012) en passant d'un ensemble de méthodes apportées par différents pratiquants. Le CIM se réfère à l'UML pour définir le modèle, des outils automatiques génèrent directement à partir de l'UML la documentation, les schémas ainsi que d'autres artéfacts. Il est nécessaire d'avoir des notions d'UML pour comprendre le CIM.

Note 2 à l'article: L'abréviation "UML" est dérivée du terme anglais développé correspondant "unified modeling language".

3.4
profil
sous-ensemble des classes, associations et attributs du CIM nécessaires pour accomplir un type spécifique d'interface

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Note 1 à l'article: Cela peut être exprimé dans des fichiers XSD, RDF et/ou OWL. Un profil peut être soumis à l'essai entre des applications. Un profil est nécessaire pour "utiliser" le CIM. Plusieurs profils sont définis dans d'autres parties des séries IEC 61968 et IEC 62325.

4 Spécification du CIM

4.1 Vue d'ensemble

Le modèle CIM est décrit dans le langage de modélisation unifié (UML) qui est conservé comme un fichier UML géré par un outil d'édition UML. Le fichier UML existe dans deux différents formats:

- un format propriétaire d'outil;
- un format xmi normalisé.

Le modèle CIM est décrit à l'Article 6, qui présente un rapport généré à partir du fichier UML. Le nom du fichier UML utilisé pour la génération de l'Article 6 est:

- ~~iec61970cim17v38_iec61968cim13v12_iec62325cim03v17a.eap.~~
- iec61970cim17v40_iec61968cim13v13a_iec62325cim03v17a.eap

Ce fichier peut être obtenu auprès du groupe des utilisateurs du CIM.

4.2 Notation de modélisation du CIM

Le CIM est défini en utilisant des techniques de modélisation orientées objet. Plus précisément, la spécification du CIM utilise la notation UML qui définit le CIM comme un groupe de paquetages.

Chaque paquetage du CIM contient un ou plusieurs diagrammes de classe représentant sous forme graphique toutes les classes de ce paquetage et leurs relations. Chaque classe est ensuite définie de façon textuelle en mettant l'accent sur ses attributs et ses relations avec d'autres classes.

La notation UML est décrite dans les documents de l'Object Management Group (OMG) et dans plusieurs autres manuels.

4.3 Paquetages CIM

Un paquetage est un moyen général permettant de grouper des éléments liés à un modèle. Les paquetages ont été choisis pour simplifier la conception, la compréhension et la révision du modèle. Des entités peuvent avoir des associations dépassant les limites de plusieurs paquetages. Chaque application utilise des informations représentées dans plusieurs paquetages.

Différents groupes de paquetages sont attribués à différents groupes dans l'IEC afin de mieux les gérer et maintenir.

Les paquetages WG13 sont inclus dans le présent document et contenus dans le paquetage de l'IEC 61970. Les paquetages de l'IEC 61970 ne dépendent pas d'autres paquetages externes. Comme le représente la Figure 1, le paquetage de l'IEC 61970 et ses sous-paquetages servent de modèle central ou de modèle de base à d'autres paquetages du CIM. Les lignes tiretées indiquent des relations de dépendance, la flèche allant du paquetage dépendant vers le paquetage dont il dépend. Les paquetages WG14 de la série IEC 61968 décrivent des parties supplémentaires du CIM qui traitent d'autres vues logiques des opérations d'une entreprise de service public, y compris la gestion du patrimoine, des emplacements, des activités, des clients, de la documentation et des travaux et des comptages. Les paquetages WG16 de la série IEC 62325 décrivent les marchés de l'énergie électrique.

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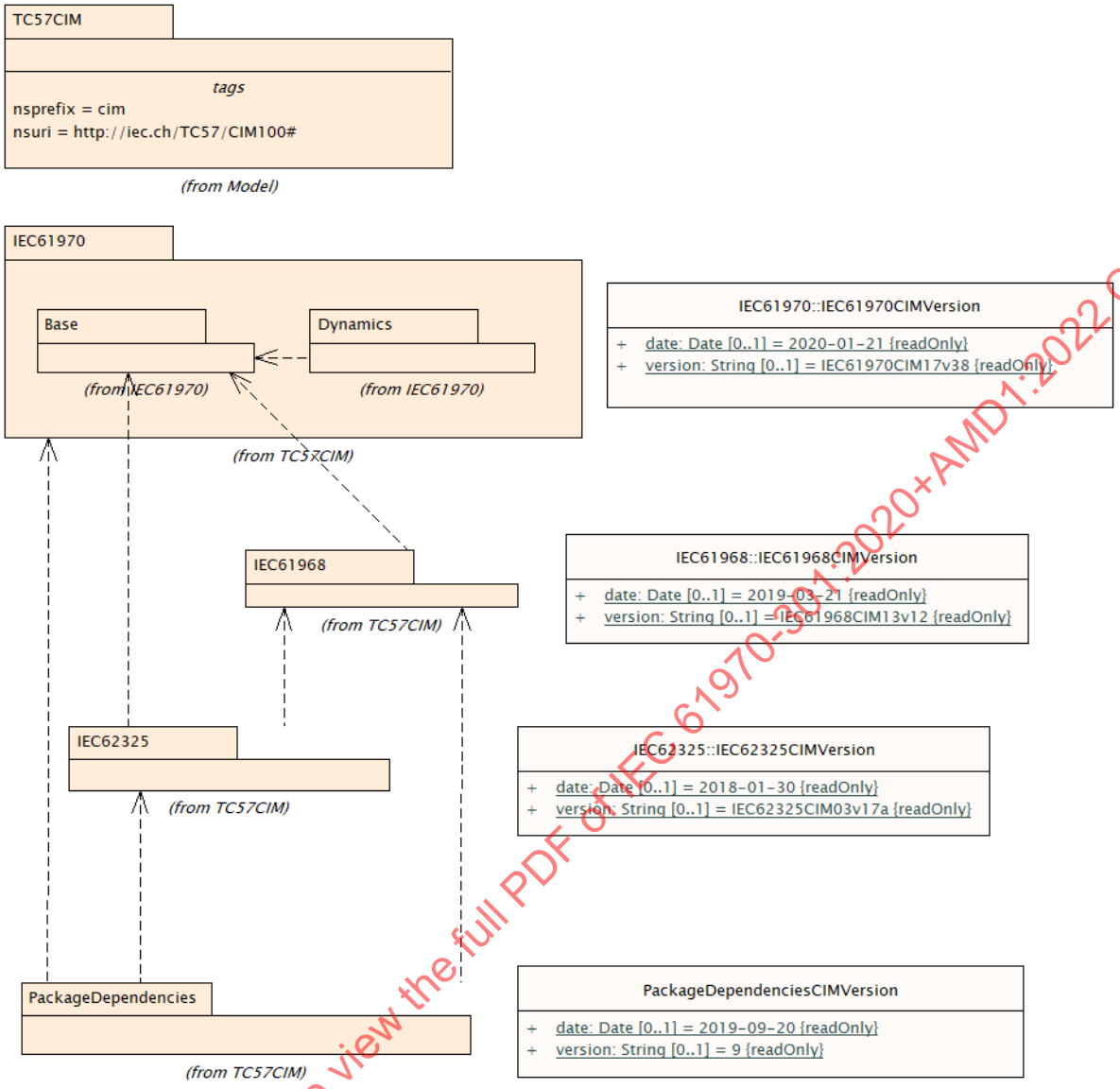


Figure 1 – Dépendances définies entre les paquetages du CIM et les informations de versions de paquetages

Noter que les limites du paquetage n'impliquent pas de limites pour une application. Une application peut utiliser des entités CIM provenant de différents paquetages. Il est également prévu que des paquetages du CIM en dehors de ceux décrits dans le présent document auront des dépendances avec certains des paquetages décrits dans le présent document, notamment les paquetages Domain et Core, même si d'autres dépendances existent aussi.

La Figure 2 représente les paquetages définis pour la Base de CIM de l'IEC 61970-301 et leurs relations de dépendance.

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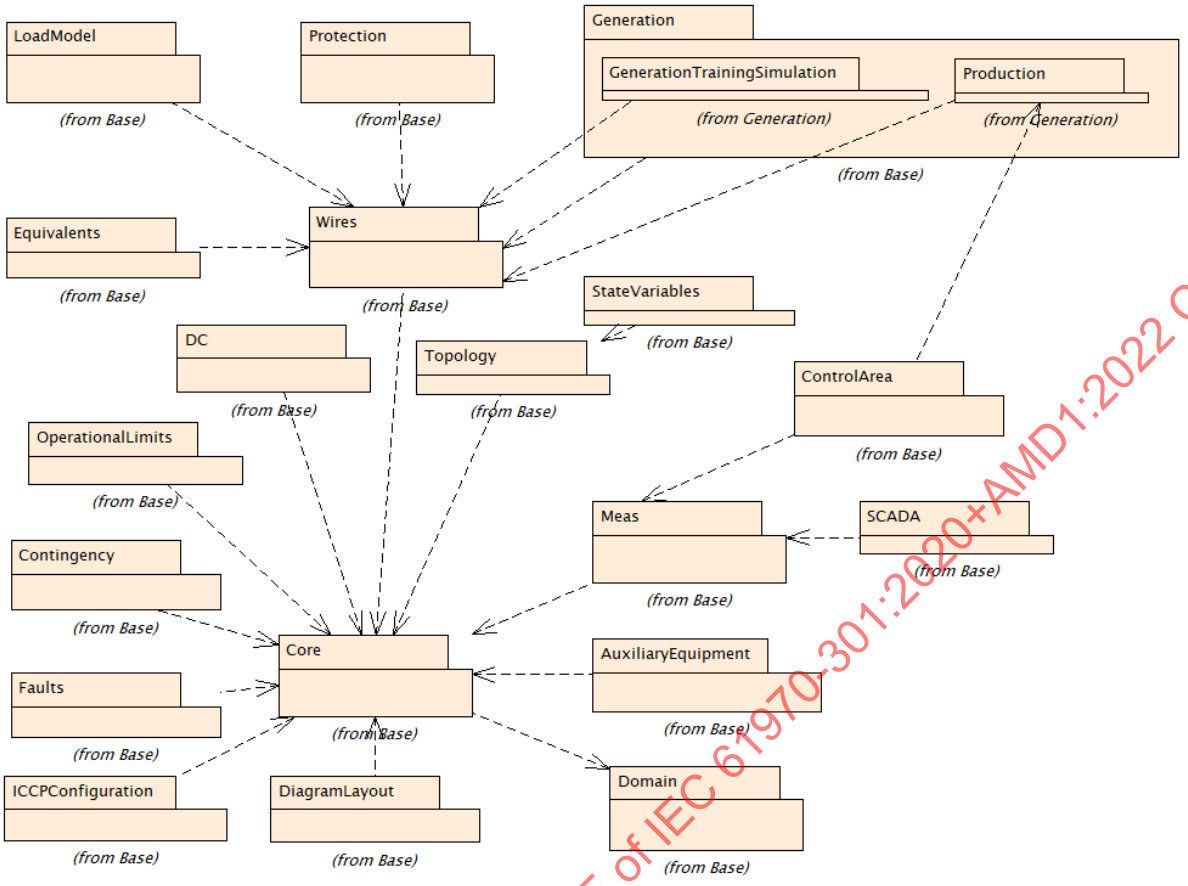


Figure 2 – Diagramme du paquetage CIM IEC 61970-301

4.4 Classes CIM et relations

4.4.1 Classes

Le ou les diagrammes de classe de chaque paquetage CIM représentent toutes les classes du paquetage et leurs relations. Lorsque des relations existent avec des classes dans d'autres paquetages, ces classes peuvent être également représentées.

Les classes et les objets modélisent ce qui se trouve dans un système de puissance et qu'il y a lieu de représenter de la même façon pour des applications de système de puissance. Une classe est une description d'un objet réel, tel qu'un transformateur électrique, un générateur ou une charge, qu'il y a lieu de représenter comme faisant partie du modèle global de système de puissance dans un EMS, par exemple. Parmi les autres types d'objets figurent des éléments tels que les programmes et les mesures qui nécessitent également d'être traités, analysés et enregistrés par des applications EMS. De tels objets nécessitent une représentation commune pour atteindre les objectifs de compatibilité de connexion et d'interopérabilité de la norme EMS-API. Un objet particulier dans un système de puissance ayant une identité unique est modélisé comme une instance de la classe à laquelle il appartient.

Il convient également de noter que le CIM est défini pour faciliter l'échange de données. Comme indiqué dans le présent document, les propriétés des entités CIM sont modélisées, mais pas leur comportement. Pour une interface spécifique, un profil est défini et comprend des sous-ensembles de classes, attributs et associations du CIM. Un profil définit la charge utile de message pour une interface.

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Les classes comportent des attributs qui décrivent les caractéristiques des objets. Chaque classe du CIM contient les attributs décrivant et identifiant une instance spécifique de la classe. Seuls les attributs importants pour l'intégration et l'interopérabilité des applications de système de puissance sont inclus dans les descriptions de classe.

Chaque attribut a un type qui identifie le type d'attribut dont il s'agit. Les attributs typiques sont de type Integer (entier), Float (valeur flottante), Boolean (valeur booléenne), String (chaîne de caractères), Date et Decimal (valeur décimale), qui sont appelés types primitifs. Cependant, de nombreux types supplémentaires sont définis comme partie intégrante de la spécification du CIM. Par exemple, ShuntCompensator a un attribut "maxU" du type Voltage. La définition de nombreux types partagés est contenue dans le paquetage Domain. Les stéréotypes Primitive, enumeration, CIMDatatype et Compound de l'UML sont ajoutés aux classes utilisées comme types. Le stéréotype CIMDatatype est utilisé avec une sémantique spécifique du CIM pour une valeur simple avec des attributs supplémentaires, qui décrit l'unité et le multiplicateur de la valeur, par exemple, unit, multiplier. Cela implique une mise en correspondance personnalisée avec des artéfacts de sérialisation tels que RDFS, OWL et XSD. Les classes ayant ces stéréotypes ne participent pas à des relations de généralisation ou d'association et sont simplement utilisées comme types pour des attributs. Le stéréotype enumeration est utilisé pour décrire un attribut avec une liste énumérée de choix. Le stéréotype Compound est utilisé pour décrire des ensembles d'attributs liés qui sont couramment réutilisés. Les classes Compound peuvent se composer de Primitive, enumeration, CIMDatatype ou d'autres classes Compound à condition qu'elles ne participent pas à une récursion.

Tous les attributs du CIM sont facultatifs en ce sens que les profils utilisant le CIM peuvent les éliminer tous.

Les relations entre les classes révèlent la façon dont elles sont structurées l'une par rapport à l'autre. Les classes CIM sont reliées de différentes façons, comme décrit de 4.4.2 à 4.4.4.

4.4.2 Generalization

Une generalization (généralisation) est une relation entre une classe générale et une classe plus spécifique. La classe plus spécifique ne peut contenir que des informations supplémentaires. L'association de type Generalization permet à une classe spécifique d'hériter d'attributs et de relations de toutes les classes plus générales situées au-dessus d'elle.

La Figure 3 est un exemple de generalization (généralisation). Dans cet exemple issu du paquetage Wires (fils), un Breaker (disjoncteur) est un type plus spécifique de ProtectedSwitch (commutateur protégé), qui à son tour est un type plus spécifique de Switch (commutateur), qui est un type plus spécifique de ConductingEquipment (équipement conducteur), etc. Un PowerTransformer (transformateur de puissance) est un autre type plus spécifique de ConductingEquipment. Noter que PowerSystemResource (ressource de système de puissance) hérite de la classe IdentifiedObject (objet identifié) qui ne figure pas dans le diagramme. IdentifiedObject est donc représenté en italique dans l'angle supérieur droit de la classe PowerSystemResource.

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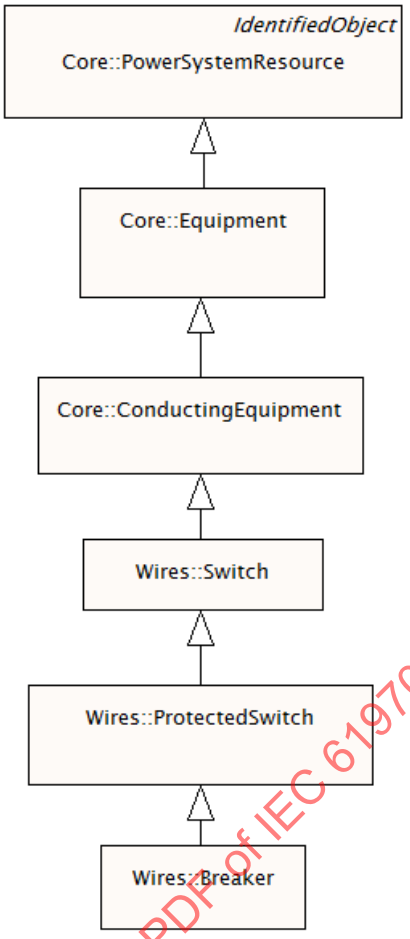
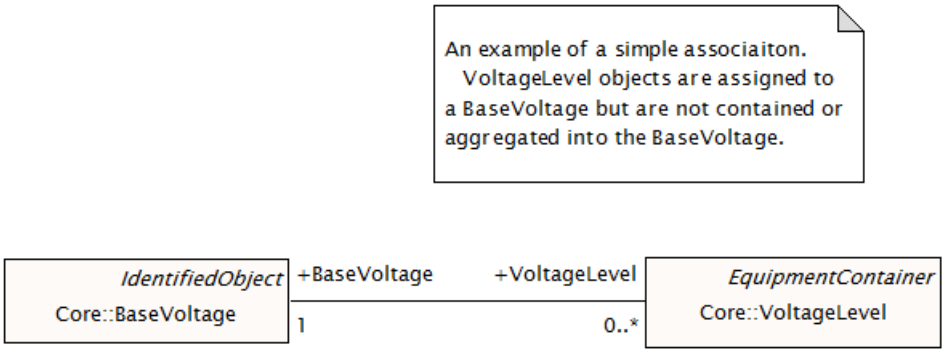


Figure 3 – Exemple de généralisation

4.4.3 Simple association (Association simple)

Une association est une connexion conceptuelle entre des classes. Chaque association a deux "extrémités d'association". Les "extrémités d'association" étaient appelées "rôles" avant la spécification UML 2.0. Chaque extrémité d'association décrit le rôle que la classe cible (c'est-à-dire, la classe *vers* laquelle l'extrémité d'association part) a en relation avec la classe source (c'est-à-dire, la classe *à partir de* laquelle l'extrémité d'association part). La coutume est d'attribuer aux extrémités d'association le nom de la classe cible avec ou sans expression verbale. Chaque extrémité d'association possède aussi une cardinalité/multiplicité, qui est une indication du nombre d'objets qui peuvent prendre part à la relation décrite. Dans le CIM, les associations ne sont pas nommées, seules les extrémités d'association sont nommées. Par exemple, comme représenté à la Figure 4, il y a dans le CIM une association entre une classe BaseVoltage (tension de base) et une classe VoltageLevel (niveau de tension). La multiplicité est représentée aux deux extrémités de l'association. Dans cet exemple, un objet VoltageLevel peut faire référence à 1 BaseVoltage, et une BaseVoltage peut être référencée par 0 ou plus d'objets VoltageLevel.

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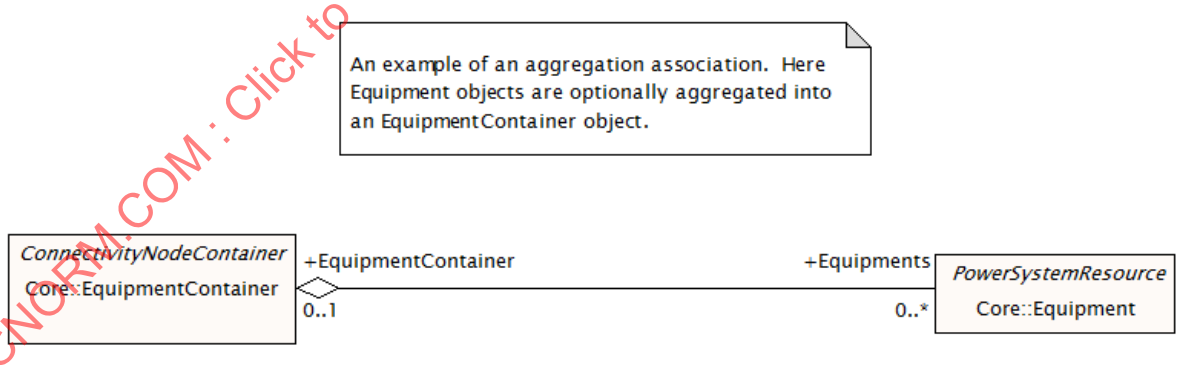


Anglais	Français
An example of a simple association. VoltageLevel objects are assigned to a BaseVoltage but are not contained or aggregated into the BaseVoltage.	Exemple d'association simple. Des objets VoltageLevel sont affectés à une BaseVoltage, mais ne sont ni contenus ni agrégés dans la BaseVoltage.

Figure 4 – Exemple d'association simple

4.4.4 Aggregation

Aggregation (agrégation) est un cas spécial d'association. L'agrégation indique que la relation entre les classes est une sorte de relation classe entière/classe partielle où la classe entière "consists of" (se compose de) ou "contains" (contient) la classe partielle, et cette classe partielle est une "part of" (partie de) la classe entière. La classe partielle n'hérite pas de la classe entière comme dans la généralisation. La Figure 5 représente une agrégation entre la classe EquipmentContainer (Conteneur d'équipements) et la classe Equipment, qui provient du paquetage Core. Comme représenté à la figure, un Equipment peut être un élément de un ou zéro objet EquipmentContainer mais l'objet EquipmentContainer peut contenir un nombre quelconque d'objets Equipment. Dans le cadre de l'utilisation du CIM comme modèle d'information, l'agrégation n'a pas d'interprétation précise ou formelle au-delà d'une association simple, et permet d'aider à représenter visuellement une utilisation normale.



Anglais	Français
An example of an aggregation association. Here Equipment objects are optionally aggregated into an EquipmentContainer object.	Exemple d'association d'agrégation. Ici, des objets Equipment sont facultativement agrégés en un objet EquipmentContainer.

Figure 5 – Exemple d'agrégation

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4.5 Concepts et exemples de modèles CIM

4.5.1 Concepts

Afin d'aider à comprendre comment interpréter le CIM, certains concepts-clés de modèles utilisés dans le CIM sont présentés et décrits de 4.5.2 à 4.5.16.

4.5.2 Hiérarchies d'emboîtement, d'équipements et dénomination

4.5.2.1 Structure de l'emboîtement

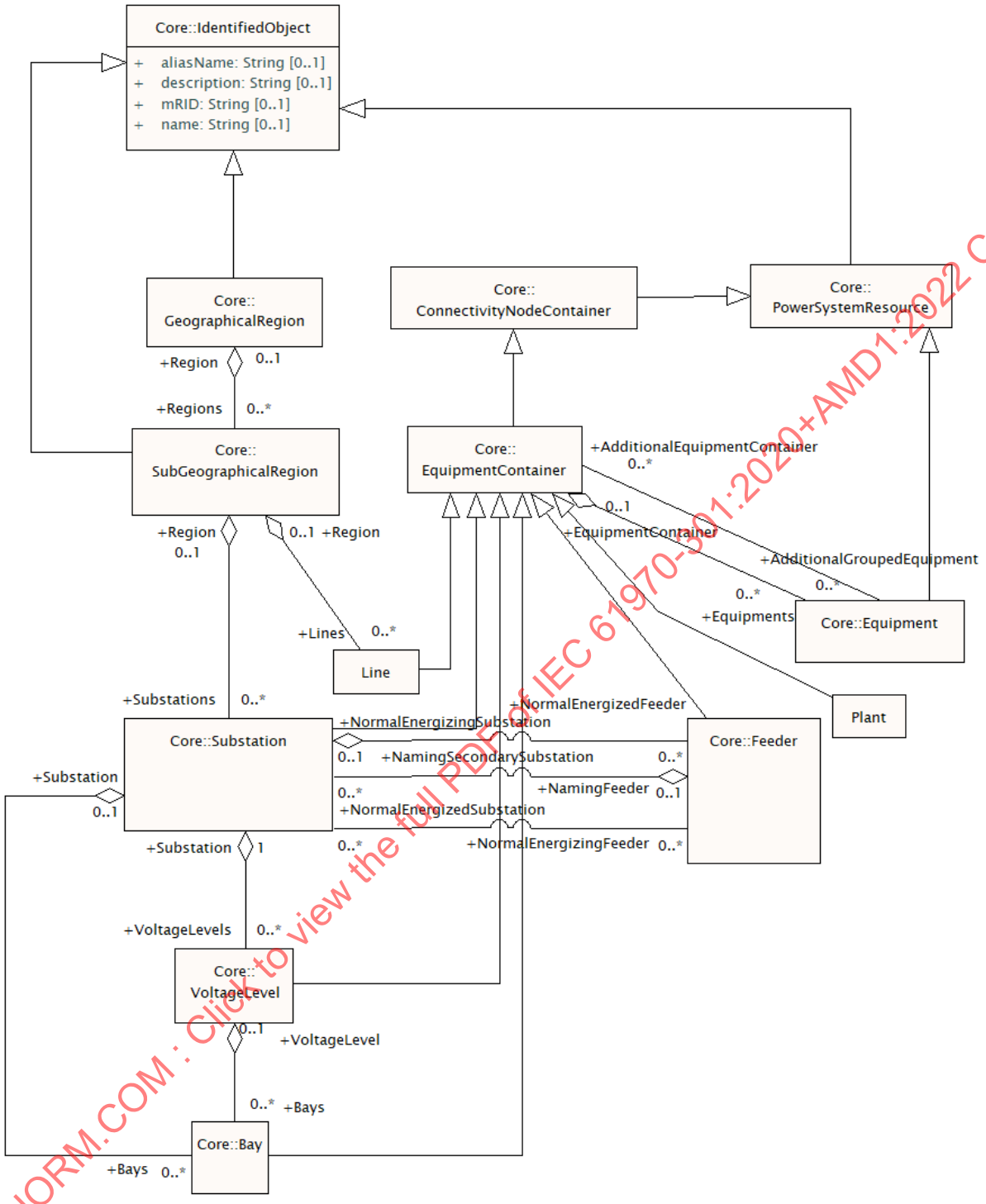
La Figure 6 représente le concept de conteneurs d'équipements (EquipmentContainer) pour former des hiérarchies dans le CIM. Les conteneurs d'équipements sont un moyen de regrouper et de nommer des équipements se trouvant généralement dans un poste (substation). Comme il peut être constaté de visu, les conteneurs offrent une certaine souplesse d'utilisation pour s'adapter aux différents usages internationaux, ainsi qu'aux différences observées habituellement entre les postes de transport et de distribution. Bay (cellule), VoltageLevel (niveau de tension), Substation (poste), Line (ligne) et Plant (centrale) sont tous des types de EquipmentContainer(s). En général, une Bay est contenue dans un VoltageLevel spécifique, qui à son tour est contenu dans un Substation. Les Substation(s) et les Line(s) peuvent être contenus dans des SubGeographicalRegion(s) (sous-régions géographiques) et GeographicalRegion(s) (régions géographiques).

Une hiérarchie d'emboîtement est utilisée avec la classe IdentifiedObject pour créer une désignation hiérarchique lisible par l'homme. Cette hiérarchie est utilisée spécifiquement pour nommer les équipements selon leur fonction dans le système de puissance. Il s'agit de la hiérarchie de dénomination fonctionnelle. Outre les noms fonctionnels, d'autres identifications communes sont les numéros de série des biens. Le nom fonctionnel diffère d'un numéro de série en ce qu'il renvoie à la fonction d'une position ou localisation particulière d'un équipement dans le système de puissance. Quel que soit l'élément spécifique d'équipement physique qui est placé en un endroit, le nom fonctionnel est le même, mais le numéro de série varie en fonction de l'équipement physique actuellement utilisé.

4.5.2.2 Classe IdentifiedObject

La classe IdentifiedObject (objet identifié) contenue dans le paquetage Core est héritée par tous les objets PowerSystemResource (ressource du système de puissance) et de nombreuses autres classes. Cette classe comporte les attributs et les associations à utiliser pour nommer tous les objets du CIM. Des noms supplémentaires peuvent être définis à l'aide des classes de noms de 4.5.3 ou en définissant des extensions. L'attribut mRID de la classe IdentifiedObject est un moyen direct et rigoureux pour l'identité des objets du CIM.

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Figure 6 – EquipmentContainers

Les diagrammes NamingHierarchyPart1 et NamingHierarchyPart2 du paquetage Wires représentent la hiérarchie fonctionnelle de dénomination.

4.5.3 Modèle de Names

Un modèle de dénomination souple et extensible est fourni pour spécifier des noms différents pour les objets. Plusieurs applications ou systèmes ayant différents noms pour le même objet constituent un cas d'utilisation dans lequel le modèle de Names est utile. Le modèle de Names permet alors l'échange de ces noms.

La Figure 7 représente le diagramme de classe pour des noms de remplacement et la manière dont ils peuvent être associés à un type de nom défini par un utilisateur spécifique. Ce modèle permet de définir spécifiquement les noms dans un domaine particulier et ne fait pas intervenir de règles spécifiques de dénomination. Les concepts de noms de remplacement, de noms de chemin et de noms locaux peuvent tous être utilisés avec ce modèle. Les modèles du CIM n'utilisent ni ne favorisent des conventions spécifiques de dénomination mais permettent d'échanger ces conventions de dénomination dans un contexte clair.

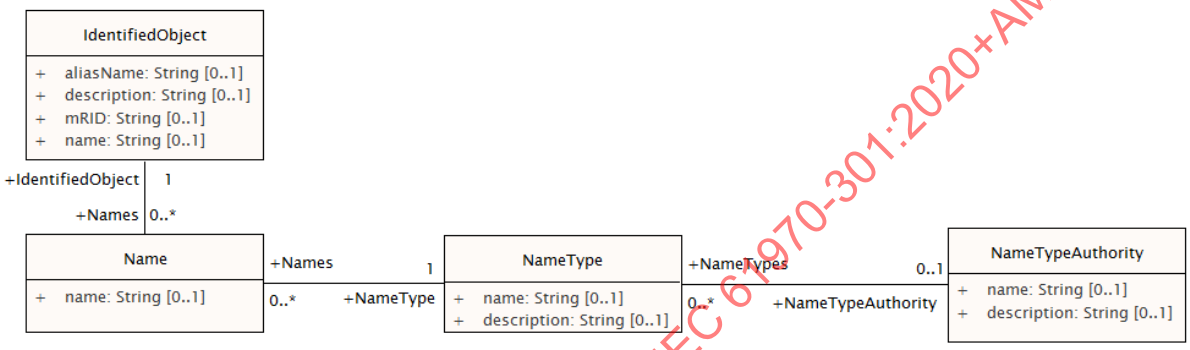


Figure 7 – Names

4.5.4 Modèle de connectivité

4.5.4.1 Description de la connectivité

La Figure 8 représente le diagramme de classe Topology qui modélise la connectivité entre différents types de ConductingEquipment. Elle inclut également une partie du diagramme de classe du paquetage Meas traitant des mesures pour représenter la façon dont les mesures sont associées aux équipements conducteurs.

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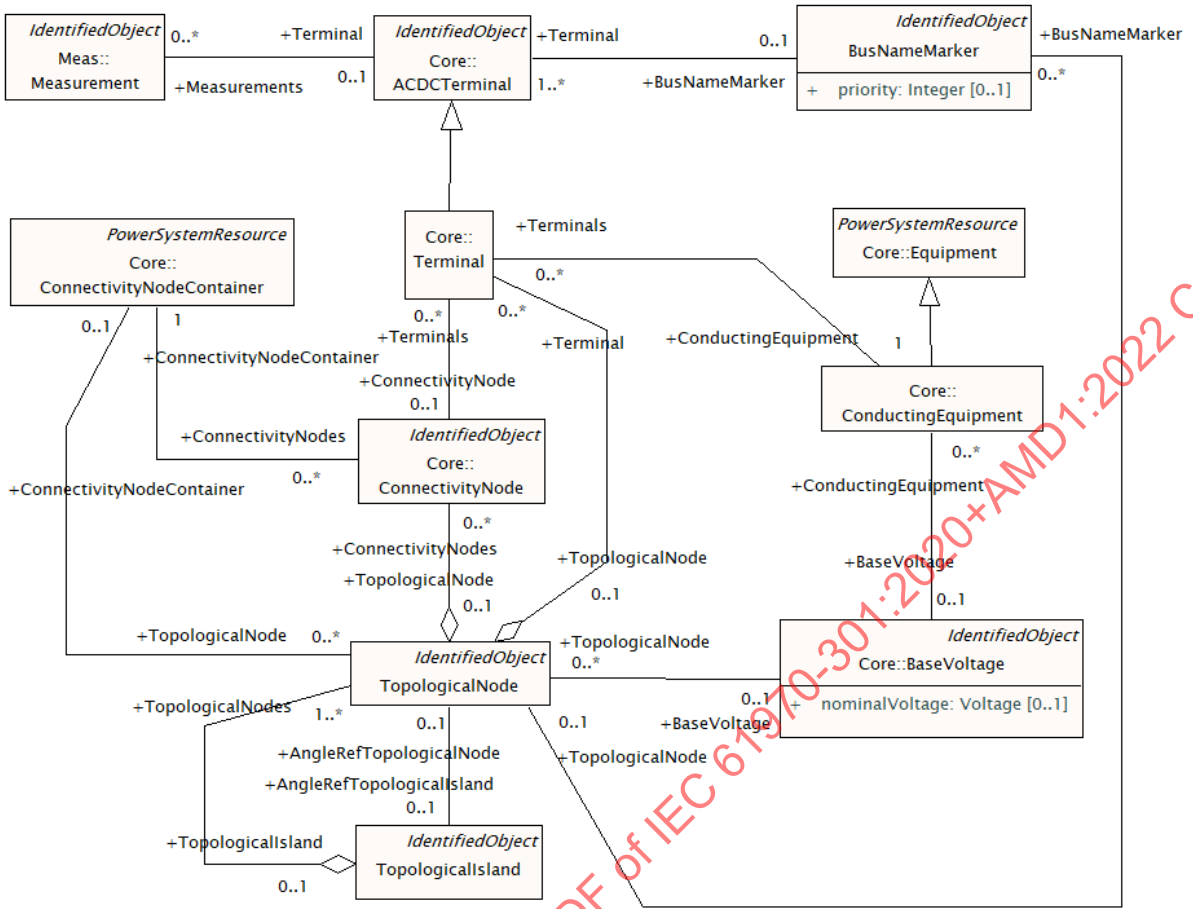


Figure 8 – Modèle de connectivité

Pour modéliser la connectivité, les classes Terminal (borne) et ConnectivityNode (nœud de connectivité) ont été définies. Une Terminal appartient à un ConductingEquipment, mais un ConductingEquipment peut avoir un nombre quelconque de Terminals (bornes). Chaque Terminal peut être connectée à un ConnectivityNode qui est un point auquel les bornes des équipements conducteurs sont connectées ensemble avec une impédance nulle. Un ConnectivityNode peut avoir un nombre quelconque de bornes connectées et peut être membre d'un TopologicalNode (nœud topologique) (c'est-à-dire, un bus) qui est membre d'un TopologicalIsland (îlot topologique). Les TopologicalNode-s et TopologicalIsland-s sont créés comme résultat d'un processeur topologique qui prend en compte la connectivité prédéfinie et les positions réelles des Switchs (commutateurs).

Il est possible d'échanger des documents impliquant directement TopologicalNode et contournant les détails de ConnectivityNode en utilisant l'association TopologicalNode à Terminal. Cela est souvent utile pour les échanges impliquant des modèles qui ne contiennent pas de détails relatifs aux commutateurs. Quand le modèle TopologicalNode est échangé, il est utile d'échanger aussi l'attribut "connected" (connecté) dans la classe Terminal. Cela permet de retenir la structure topologique du modèle, mais indique qu'une borne n'est pas entièrement connectée. Cette déconnexion résulte normalement de ce qu'un ou plusieurs commutateurs s'ouvrent dans le modèle détaillé qui n'est pas représenté dans un échange de modèle sans détail de commutateur.

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Les EquipmentContainer-s, qui sont une spécialisation d'un ConnectivityNodeContainer (Conteneur de nœuds de connectivité), peuvent avoir zéro à plusieurs de ConnectivityNode-s. Les associations ConductingEquipment–Terminal et Terminal–ConnectivityNode permettent de représenter la connectivité prédéfinie d'un système de puissance réel. Pour chaque Terminal connectée à un ConnectivityNode, les associations des autres Terminal(s) connectées au même ConnectivityNode identifient l'objet ou les objets ConductingEquipment qui sont connectés électriquement. Une connectivité similaire, au niveau de détail "topologie nodale", peut être exprimée à l'aide de TopologicalNode au lieu du ConnectivityNode. La classe BusNameMarker, qui a une association à ConnectivityNode, est utilisée pour contenir les noms de bus utilisateur devant être appliqués aux TopologicalNode-s. Les TopologicalNode-s sont créés à partir de ConnectivityNode-s et résultent du traitement de la topologie, il est possible d'appliquer de nombreux noms en fonction des instances de ConnectivityNode en présence.

Pour modéliser les valeurs analogiques telles que la tension et la puissance, chaque Terminal a une association avec une classe Measurement du paquetage Meas. Bien qu'il ne soit pas représenté à la Figure 8, un objet Measurement est associé à au moins un objet MeasurementValue (valeur de mesure). Chaque objet MeasurementValue est une instance de mesure d'une source spécifique, par exemple, une télémesure.

4.5.4.2 Exemple de connectivité et d'emboîtement

Pour représenter comment le modèle de connectivité et le modèle d'emboîtement peuvent être représentés comme des objets, un petit exemple est présenté à la Figure 9. L'exemple représente une ligne de transport avec une jonction en T entre deux postes et un poste avec deux niveaux de tension et un transformateur entre eux. La ligne de transport contient deux câbles différents. Un des niveaux de tension est représenté avec un tronçon de jeux de barres contenant un seul jeu de barres et deux baies de commutation très simples connectées au jeu de barres.

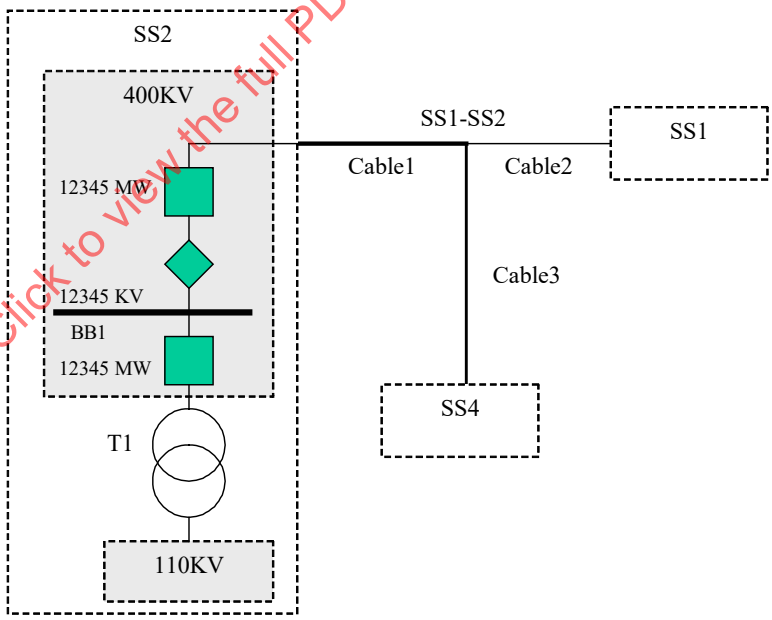


Figure 9 – Exemple de réseau simple

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La Figure 10 représente comment la connectivité est modélisée dans le CIM ainsi qu'une façon (mais pas nécessairement la seule) dont l'emboîtement est modélisé pour le diagramme de la Figure 9. Les carrés ombrés représentent les EquipmentContainer-s, et les carrés blancs les ConductingEquipments. Un ombrage plus sombre indique que l'EquipmentContainer est plus haut dans la hiérarchie d'emboîtement (c'est-à-dire que Substation est le plus haut, VoltageLevel vient ensuite, etc.). Les cercles blancs représentent les ConnectivityNode-s, et les petits cercles noirs les Terminals. Une Terminal appartient à un ConductingEquipment, et un ConnectivityNode appartient à un EquipmentContainer. Cela signifie que les frontières (ou points de contact) entre ConductingEquipments sont leurs Terminals interconnectées via les ConnectivityNode-s.

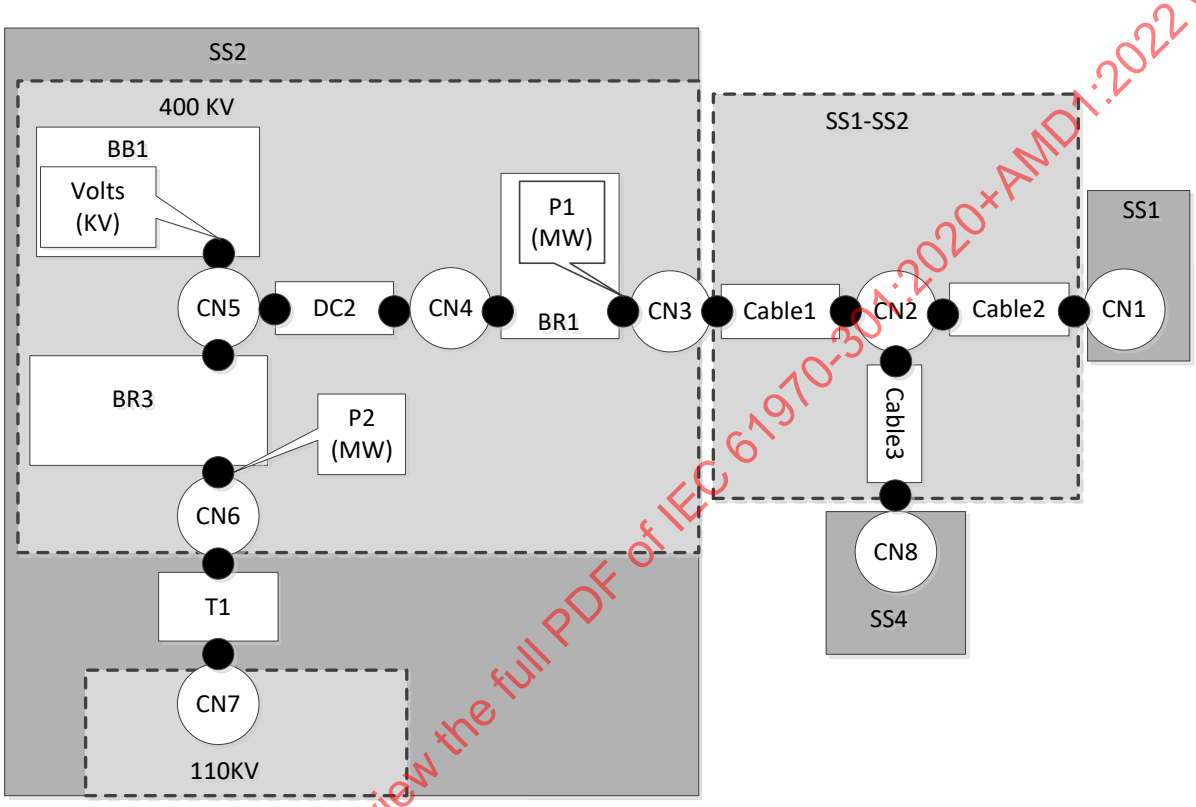


Figure 10 – Connectivité d'un réseau simple modélisé avec la topologie du CIM

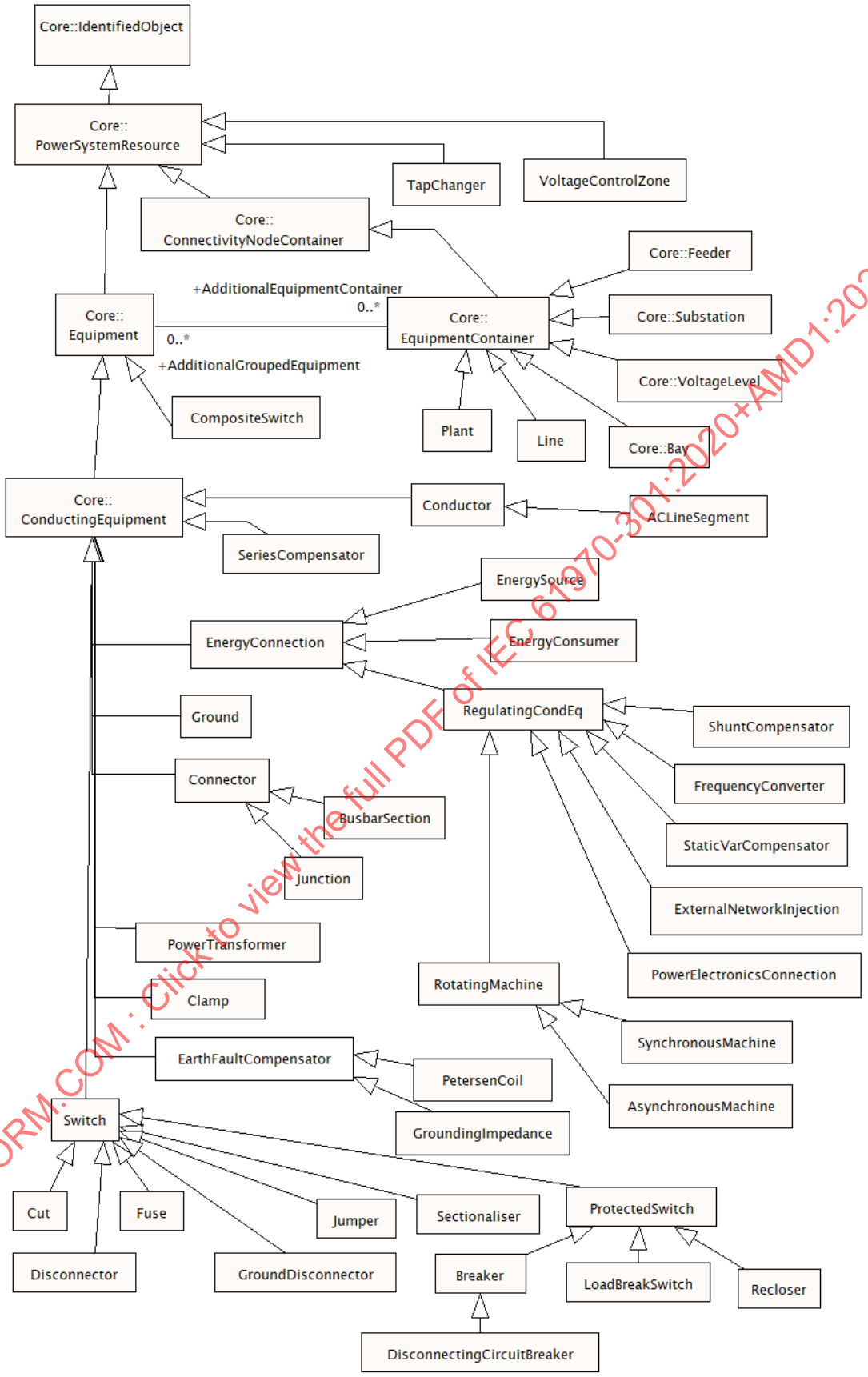
La Line (ligne) SS1-SS2 contient trois ACLineSegment-s (Cable1, Cable2, et Cable3) et le ConnectivityNode (CN2) associé pour modéliser une jonction en T, qui assure une connexion à SS4. Cela n'est qu'une façon dont cette configuration pourrait être modélisée. Chaque ACLineSegment a deux Terminals. Cable1 est connecté à CN3 et CN2 via ces Terminals. CN3 est contenu par le VoltageLevel 400KV. Le disjoncteur ("Breaker") BR1 a deux bornes dont l'une est connectée à CN3.

Les Measurements sont représentés par des bulles carrées dont les flèches pointent vers une Terminal. P1 est connecté à la Terminal de droite appartenant au Breaker BR1. Noter que P1 est tracé dans la boîte représentant BR1. C'est parce qu'un Measurement peut appartenir à une PowerSystemResource (PSR), comme c'est le cas avec BR1. P2 est tracé dans le VoltageLevel 400 KV, ce qui signifie qu'il appartient au VoltageLevel 400 KV et non à BR3.

4.5.5 Hiérarchie des héritages

La Figure 11 représente une vue d'ensemble de la hiérarchie des héritages modélisée dans le CIM. Cette vue d'ensemble qui est incluse comme l'un des diagrammes du paquetage Wires couvre plusieurs paquetages du CIM.

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Figure 11 – Hiérarchie des héritages de Equipment

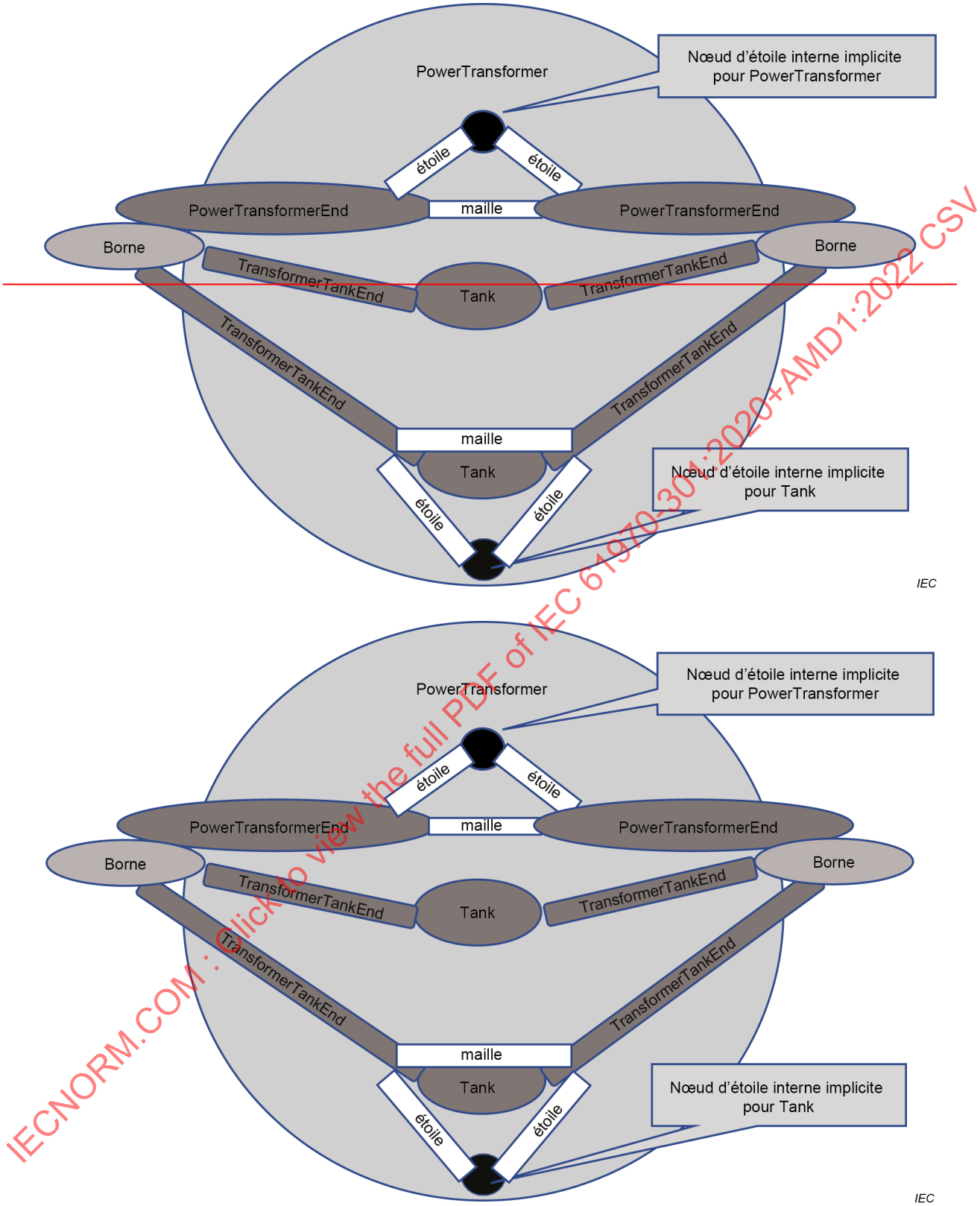
4.5.6 Modèle de Transformer

La Figure 13 représente une partie du paquetage Wires dans un diagramme de classe qui modélise un appareil PowerTransformer (Transformateur de puissance).

Le modèle de transformateur s'applique pour les modèles équilibrés et déséquilibrés. Le PowerTransformer est en outre désormais en soi un ConductingEquipment qui a potentiellement plusieurs bornes pour modéliser plus directement des transformateurs qui comportent une, deux, trois bornes ou davantage.

Comme représenté à la Figure 12, le PowerTransformer est aussi éventuellement en mesure de modéliser des détails de cuve (Tank), qui peuvent être utilisés pour décrire en détail les déséquilibres et les connexions des phases de l'enroulement intérieur du transformateur. Dans tous les cas, un PowerTransformer modélise un groupe d'appareils physiques qui agissent conjointement pour transformer la puissance sur les bornes et en un emplacement physique. Pour des systèmes de transport, une instance de PowerTransformer représente souvent trois appareils physiques monophasés. Il convient de modéliser en outre les objets TransformerTank s'il est exigé d'obtenir des détails sur chaque appareil monophasé.

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Figure 12 – Modèle de Transformer et Tank

Un PowerTransformer et un TransformerTank peuvent tous deux avoir l'impédance décrite soit dans une connexion étoile hypothétique avec la connexion centrale implicite soit sous forme d'impédance de maille en utilisant la classe facultative TransformerMeshImpedance. La forme en maille de l'impédance est exigée pour modéliser correctement des transformateurs qui ont plus de trois bornes. Si la forme d'impédance en maille est utilisée, il faudrait spécifier la classe

TransformerMeshImpedance pour chaque connexion possible borne à borne, donc une instance pour deux bornes, trois pour trois bornes, six pour quatre bornes et ainsi de suite. Si une connexion étoile est utilisée, les paramètres d'impédance peuvent être spécifiés directement dans la classe PowerTransformerEnd; une autre solution consiste à les répartir entre les transformateurs en utilisant la classe TransformerStarImpedance.

Comme représenté à la Figure 11, un PowerTransformer est une classe spécialisée de ConductingEquipment, elle-même classe spécialisée de Equipment. Ceci est représenté par l'utilisation du type généralisation de la relation qui utilise une flèche pour pointer vers la classe générale. L'héritage permet à PowerTransformer d'hériter des attributs de ConductingEquipment, de Equipment et de toutes les généralisations de Equipment que la Figure 11 ne représente pas.

Un PowerTransformer a aussi des relations avec PowerTransformerEnd et TransformerTank qui sont modélisés avec des relations de type association. Comme représenté dans la figure, un PowerTransformer peut être associé à zéro PowerTransformerEnd-s ou davantage, mais un PowerTransformerEnd ne peut être associé qu'à zéro ou un PowerTransformer. De façon similaire, le PowerTransformer peut être associé à zéro objet TransformerTank ou davantage, mais un TransformerTank ne peut être associé qu'à zéro ou un PowerTransformer.

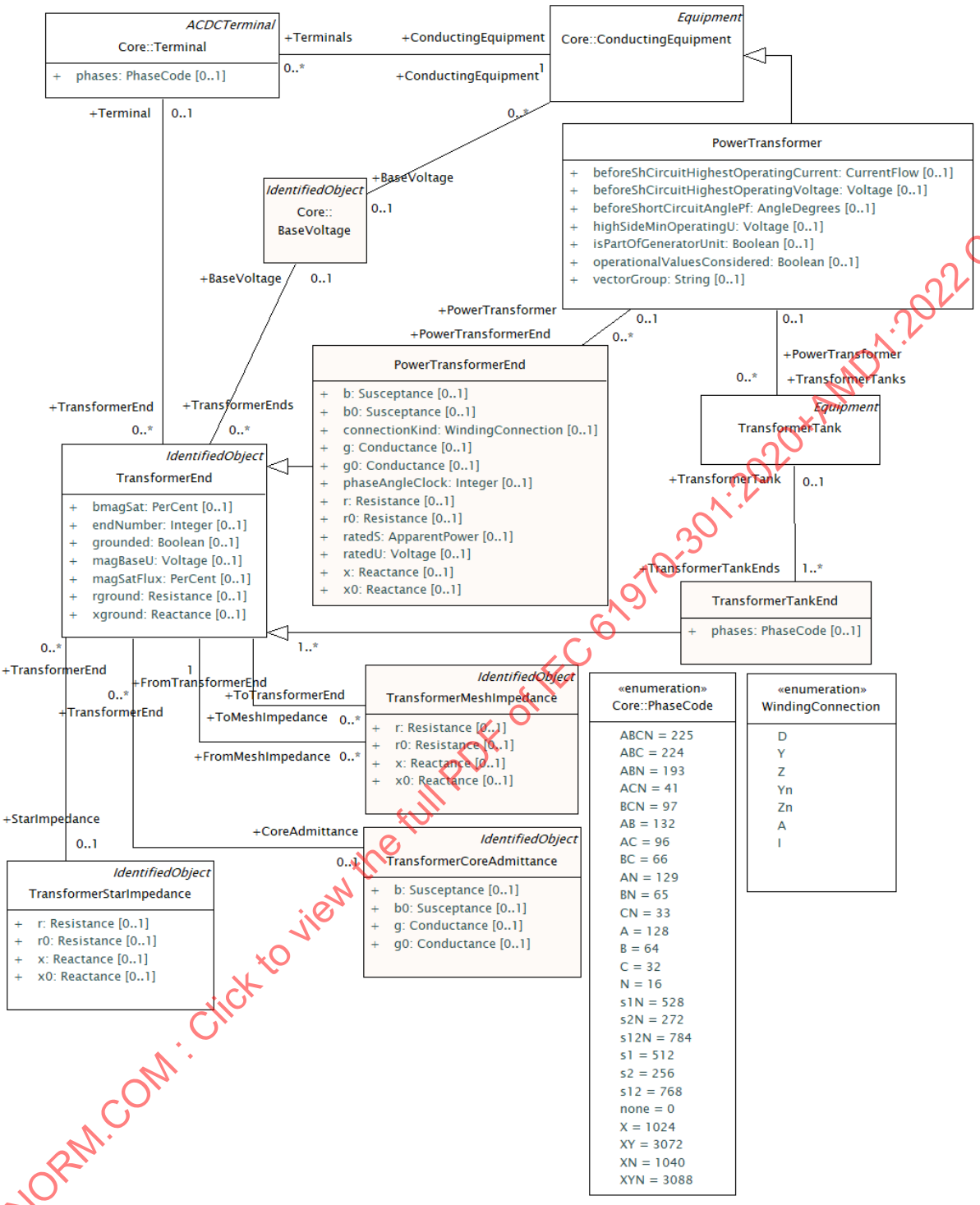
Le PowerTransformerEnd spécialise la classe TransformerEnd qui a aussi d'autres relations:

- une relation de généralisation avec IdentifiedObject;
- deux relations d'association avec la classe TransformerMeshImpedance, de sorte qu'un objet TransformerEnd peut être de (From) 0, 1 ou plusieurs objets TransformerMeshImpedance et vers (To) 0, 1 ou plusieurs objets TransformerMeshImpedance;
- des relations d'agrégation avec les classes PhaseTapChanger et RatioTapChanger, de sorte qu'un objet TransformerWinding peut avoir 0 ou 1 objet PhaseTapChanger et 0 ou 1 objet RatioTapChanger qui lui sont associés.

Pour un PowerTransfomer de réseau de transport ayant deux ou trois extrémités, les impédances équivalentes du modèle Pi apparaissent dans les attributs r, r0, x, x0, g, g0, b et b0 de la PowerTransformerEnd. La PowerTransformerEnd et sa Terminal connectée ont toutes les deux des numéros d'ordre TransformerEnd.endNumber et ACDCTerminal.sequenceNumber. Ces numéros peuvent ou peuvent ne pas être synchronisés.

La Figure 13 représente UML pour le modèle de Transformer.

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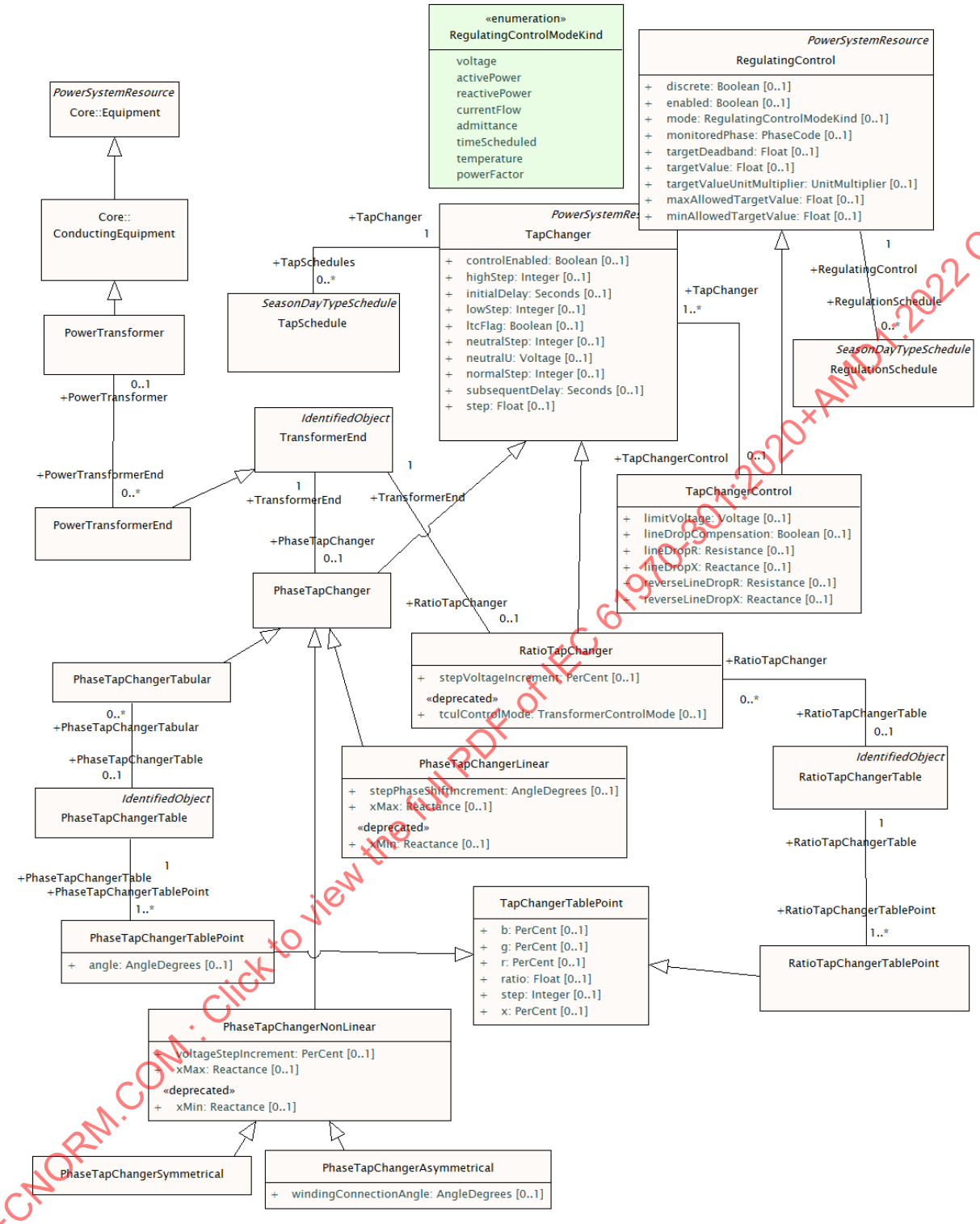
Figure 13 – Modèle de Transformer

4.5.7 Modélisation de prise du transformateur

4.5.7.1 Modélisation généralisée de prise

Plusieurs types de modèles de prise de transformateur sont pris en charge par le modèle CIM. En fonction de la structure physique, les effets du mouvement de prise doivent être définis en utilisant la classe RatioTapChanger ou la classe PhaseTapChanger et ses différentes spécialisations. Le PhaseTapChanger peut être spécialisé dans plusieurs types qui représentent la structure physique et donc le comportement. Les attributs de TapChanger sont applicables à toutes les spécialisations de RatioTapChanger. La Figure 14 représente le modèle UML pour les prises de transformateur.

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Figure 14 – Modèle de prise de transformateur

Plusieurs changeurs de prises peuvent être combinés à l'intérieur d'un transformateur de puissance, mais pour éviter les problèmes d'interprétation, un seul changeur de prises déphaseur et un seul changeur de prises qui modifie le rapport doivent être modélisés sur une borne donnée. Le changeur déphaseur et le changeur qui modifie le rapport sont documentés par rapport à l'autre ou aux autres bornes en partant de l'hypothèse que ces bornes ont le rapport nominal (1 PU) et le déphasage angulaire nominal (zéro). Des représentations tabulaires sont exigées lorsqu'il est nécessaire de combiner le changeur de prises déphaseur et le changeur de prises qui modifie le rapport sur une borne, car elles donnent les valeurs explicites des phases et des angles subséquents.

Des représentations tabulaires peuvent être utilisées à la fois pour des transformateurs déphaseurs et des transformateurs de rapport quand les modèles disponibles du CIM ne reflètent pas le comportement physique de manière appropriée. Les modèles tabulaires sont facultatifs pour les autres modèles de prises du CIM. Les modèles tabulaires peuvent être utilisés pour décrire la variation d'impédance dans la plage de prise.

Les différents modèles de changeurs de prises sont décrits plus en détail de 4.5.7.2 à 4.5.7.7.

4.5.7.2 Modélisation de transformateur de tension

La classe RatioTapChanger est utilisée pour définir une prise de transformateur qui change le rapport de la valeur de tension sans changer l'angle de phase à travers le transformateur. Un RatioTapChanger peut être utilisé dans des cas où le transformateur introduit intrinsèquement un déphasage fixe, comme à partir d'une connexion d'enroulement en étoile-triangle.

4.5.7.3 Modélisation tabulaire d'un transformateur de tension

Un RatioTapChangerTabular peut être facultativement associé à n'importe quel RatioTapChanger et représenter une relation non linéaire entre le nombre de prises, le rapport de prises et les impédances. S'il est associé, le modèle tabulaire de rapport a la priorité.

4.5.7.4 Modélisation d'un transformateur déphaseur linéaire

Un transformateur déphaseur est linéaire si l'incrément (accroissement) de déphasage par échelon de prise est uniforme et si la valeur de la tension est constante sur toute la plage du changeur de prises. Un déphaseur linéaire est modélisé en utilisant la classe PhaseTapChangerLinear.

4.5.7.5 Modélisation d'un déphaseur symétrique et asymétrique

4.5.7.5.1 Informations communes

Le paragraphe 4.5.7.5 décrit la modélisation de transformateurs déphaseurs (PST – Phase-Shifting Transformer) en fonction du type et de la technologie des équipements, et de manière plus spécifique, la réactance série équivalente des déphaseurs dans la séquence positive en fonction de l'angle de déphasage. Dans ces modèles spécifiques, les résistances et les courants magnétisants sont toujours négligés.

Les transformateurs déphaseurs compris dans 4.5.7.5 sont mis en correspondance avec les classes CIM comme décrit dans le Tableau 1.

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Tableau 1 – Mise en correspondance des transformateurs déphaseurs avec les classes CIM

Type de déphaseur	Classe CIM
Cas général	cim:PhaseTapChangerTabular
Déphaseurs symétriques	cim:PhaseTapChangerSymmetrical ou cim:PhaseTapChangerLinear
Déphaseur asymétrique	cim:PhaseTapChangerAsymmetrical
Transformateur en phase et déphaseur symétrique	cim:PhaseTapChangerSymmetrical et cim:RatioTapChanger
Transformateur en phase et déphaseur asymétrique	cim:PhaseTapChangerAsymmetrical et cim:RatioTapChanger

Il est fortement recommandé d'utiliser des données tabulaires pour échanger les paramètres PST (cim:PhaseTapChangerTabular) au lieu de devoir recalculer les paramètres par prise selon le type de chaque modèle.

Les symboles utilisés dans les formules de 4.5.7.5 sont mis en correspondance avec les classes CIM comme décrit dans le Tableau 2.

Tableau 2 – Mise en correspondance des symboles utilisés dans les formules avec les attributs CIM

Attribut de transformateur déphaseur	Attribut CIM
n	cim:PhaseTapChangerTablePoint.step
n_0	cim:TapChanger.neutralStep
δu	cim:PhaseTapChangerNonLinear.voltageStepIncrement
r	cim:TapChangerTablePoint.ratio
α	cim:PhaseTapChangerTablePoint.angle
$\delta\alpha$	cim:PhaseTapChangerLinear.stepPhaseShiftIncrement
$X(\alpha)$	cim:TapChangerTablePoint.x
$X(0)$	cim:PhaseTapChangerLinear.xMin ou cim:PhaseTapChangerNonLinear.xMin ou PowerTransformerEnd.x en tant que .xMin est un attribut déconseillé
$X(\alpha_{max})$	cim:PhaseTapChangerLinear.xMax ou cim:PhaseTapChangerNonLinear.xMax ou PowerTransformerEnd.x en tant que .xMin est un attribut déconseillé
θ	cim:PhaseTapChangerAsymmetrical.windingConnectionAngle

La variation d'impédance en fonction de la position de prise sur le transformateur déphaseur est décrite dans le Tableau 3 et les variables dans le Tableau 4.

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Tableau 3 – Variations d'impédance dans un transformateur déphaseur

Type d'équipement	Réactance série équivalente en fonction de l'angle de déphasage
Déphaseurs symétriques	$X(\alpha) = X(0) + \left(X(\alpha_{\max}) - X(0)\right)\left(\frac{\sin(\alpha/2)}{\sin(\alpha_{\max}/2)}\right)^2$
Déphaseur asymétrique	$X(\alpha) = X(0) + \left(X(\alpha_{\max}) - X(0)\right)\left(\frac{\tan\alpha}{\tan\alpha_{\max}}\frac{\sin\theta - \tan\alpha_{\max}\cos\theta}{\sin\theta - \tan\alpha\cos\theta}\right)^2$
Transformateur en phase et déphaseur symétrique	$X(r,\alpha) = X_r(r_{nom})\left(\frac{r}{r_{nom}}\right)^2 + X_\alpha(0) + \left(X_\alpha(\alpha_{\max}) - X_\alpha(0)\right)\left(\frac{\sin(\alpha/2)}{\sin(\alpha_{\max}/2)}\right)^2$
Transformateur en phase et déphaseur asymétrique	$X(r,\alpha) = X_r(r_{nom})\left(\frac{r}{r_{nom}}\right)^2 + X_\alpha(0)$ $+ \left(X_\alpha(\alpha^0_{\max}) - X_\alpha(0)\right)\left(\frac{\tan\alpha}{\tan\alpha_{\max}(r)}\frac{\sin\theta - \tan\alpha_{\max}(r)\cos\theta}{\sin\theta - \tan\alpha\cos\theta}\right)^2$ avec $\alpha_{\max}(r) = A\tan\left(\frac{\sin\theta}{\frac{r}{r_{nom}\tan\alpha^0_{\max}}\left(\sin\theta - \tan\alpha^0_{\max}\cos\theta\right) + \cos\theta}\right)$ et $\alpha^0_{\max} = \alpha_{\max}(r_{nom})$

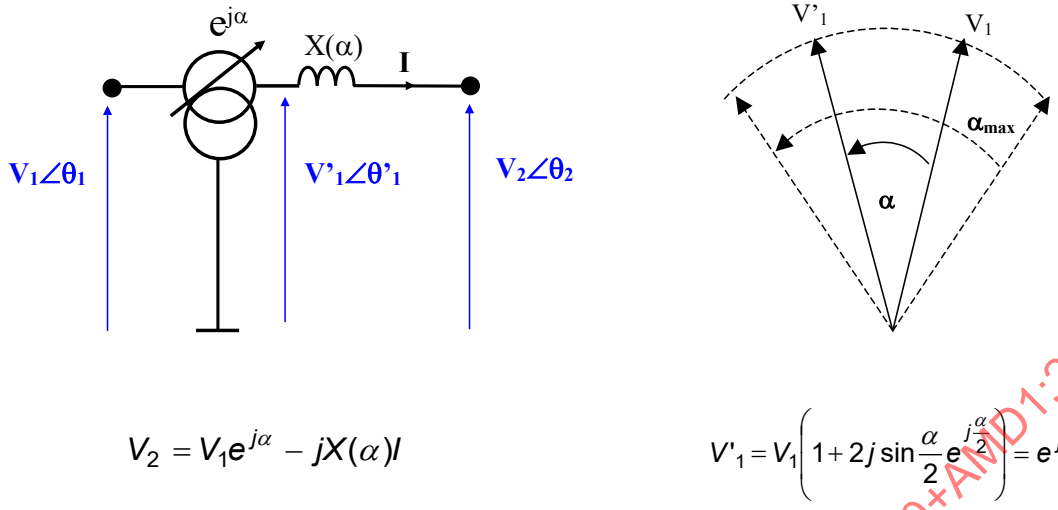
Tableau 4 – Description des variables

Variable	Signification
$\alpha_{\max}$	Déphasage maximal: valeur maximale d'angle figurant dans le tableau des angles de déphasage
r_{nom}	Rapport nominal du transformateur en phase
$\alpha^0_{\max}$	Déphasage maximal lorsque le rapport du transformateur en phase est nominal

4.5.7.5.2 Déphaseurs symétriques

Le diagramme et les équations du phaseur sont représentés à la Figure 15.

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$$V_2 = V_1 e^{j\alpha} - jX(\alpha)I$$

$$V'_1 = V_1\left(1 + 2j\sin\frac{\alpha}{2}e^{j\frac{\alpha}{2}}\right) = e^{j\alpha}V_1$$

Figure 15 – Schéma et équations du phaseur

Expression de l'angle et du rapport par prise

Selon la Figure 15:

$\alpha = (n - n_0)\cdot\delta\alpha$ ou $\alpha = 2A\tan\left(\frac{(n-n_0)\cdot\delta u}{2}\right)$

$r = 1$

Expression de la réactance série équivalente en fonction de l'angle

En partant de l'hypothèse que la réactance de l'enroulement de régulation varie à mesure que le carré du nombre de tours évolue, la réactance équivalente pour les technologies non triangulaires-hexagonales peut être écrite comme suit:

$$X(\alpha) = X(0) + \left(X(\alpha_{max}) - X(0)\right)\left(\frac{\sin(\alpha/2)}{\sin(\alpha_{max}/2)}\right)^2$$

Paramètres:

α_{max} déphasage maximal

X(0) réactance série équivalente pour un déphasage nul $\alpha=0$

$X(\alpha_{max})$ réactance série équivalente pour un déphasage maximal $\alpha = \alpha_{max}$

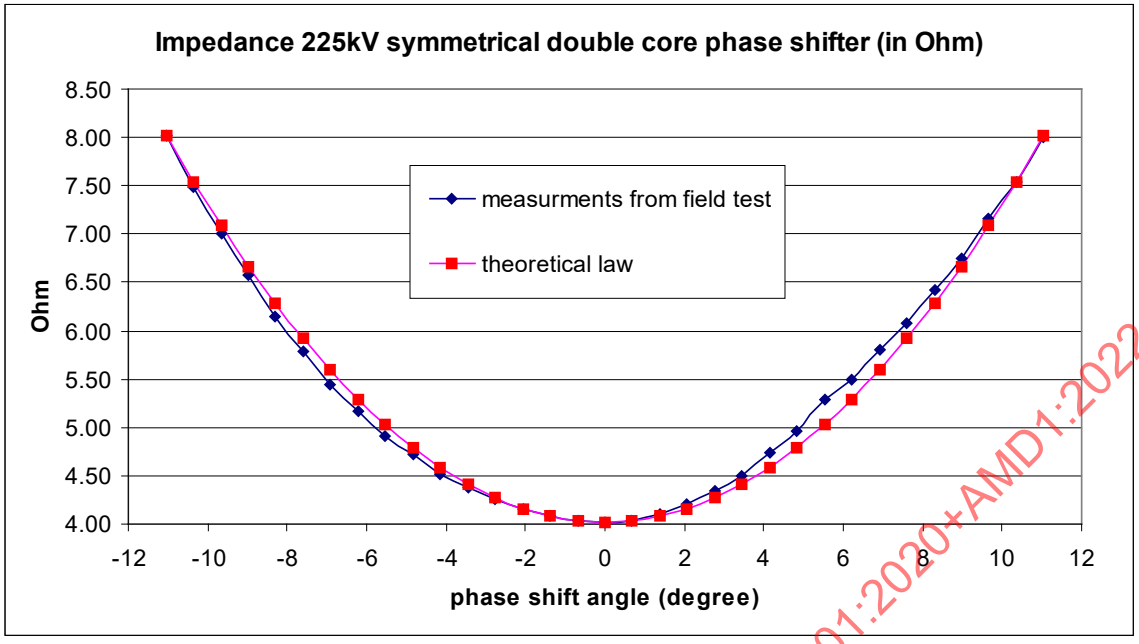
Variable:

α déphasage de courant

La formule ci-dessus est valide pour les déphaseurs symétriques simple ou double noyau, à l'exception de la technologie hexagonale.

Pour les déphaseurs symétriques à noyau simple: X(0) = 0. Un exemple de variation d'impédance est représenté à la Figure 16.

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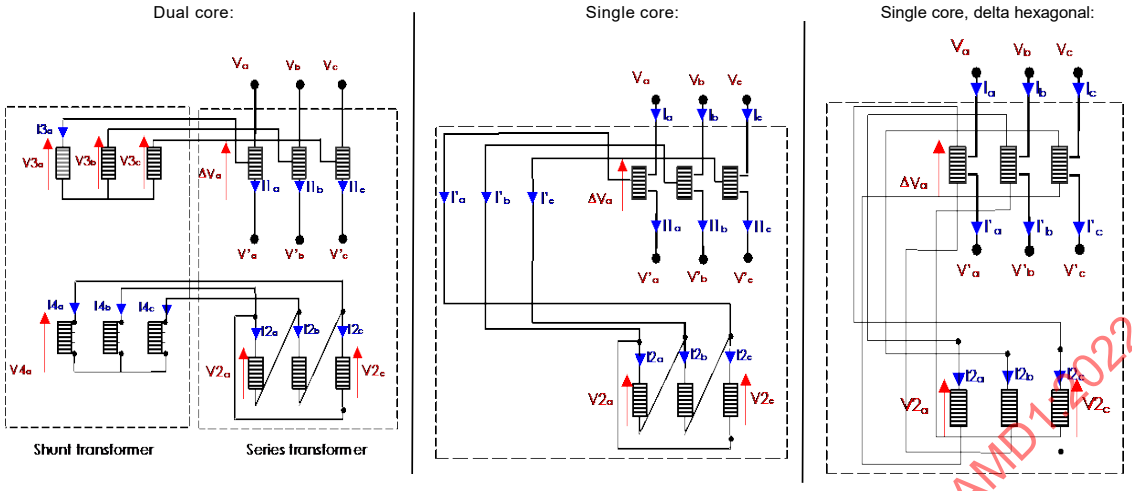


Anglais	Français
Impedance 225kV symmetrical double core phase shifter (in Ohm)	Déphaseur symétrique double noyau à 225kV d'impédance (en ohms)
measurements from field test	mesures effectuées lors des essais sur site
theoretical law	loi théorique
phase shift angle (degree)	angle de déphasage (degrés)

Figure 16 – Variation d'impédance de déphaseur symétrique

L'organisation triple noyau est représentée à la Figure 17.

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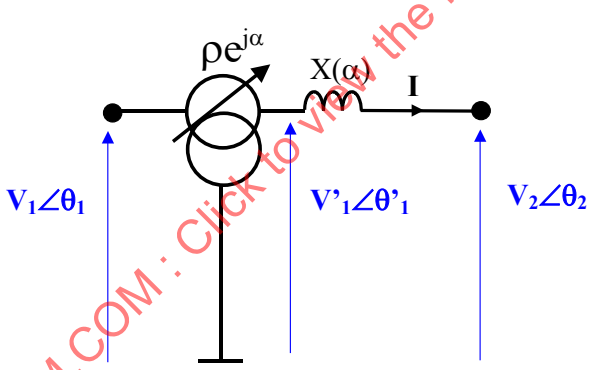


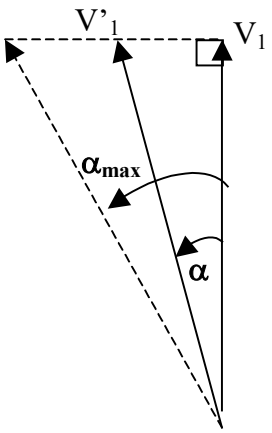
Anglais	Français
Shunt transformer	Transformateur shunt
Series transformer	Transformateur survolteur-dévolteur
Dual core	double noyau
Single core	Noyau simple
Single core, delta hexagonal	Noyau simple, triangle hexagonal

Figure 17 – Organisation du noyau

4.5.7.5.3 Transformateur déphaseur en quadrature

Le diagramme et les équations du phaseur sont représentés à la Figure 18.





$$V'_1 = V_1(1 + j\tan\alpha) = \rho e^{j\alpha} V_1 \qquad V_2 = V_1 \rho e^{j\alpha} - jX(\alpha)I$$

ρ et α vary avec ρ.cos α = constante.

Figure 18 – Schéma et équations du phaseur

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Expression de l'angle et du rapport par prise

D'après la Figure 18:

$$\alpha = A\tan((n - n_0)\cdot \delta u)$$

$$r = \frac{1}{\sqrt{((n - n_0)\cdot \delta u)^2 + 1}}$$

Expression de la réactance série équivalente en fonction de l'angle

En partant de l'hypothèse que la réactance de l'enroulement de régulation varie à mesure que le carré du nombre de tours évolue, la réactance équivalente du transformateur déphaseur en quadrature peut être écrite comme suit.

$$X(\alpha) = X(0) + (X(\alpha_{max}) - X(0))\left(\frac{\tan(\alpha)}{\tan(\alpha_{max})}\right)^2$$

Paramètres:

α_{max} déphasage maximal

X(0) réactance série équivalente pour un déphasage nul

X(α_{max}) réactance série équivalente pour un déphasage maximal

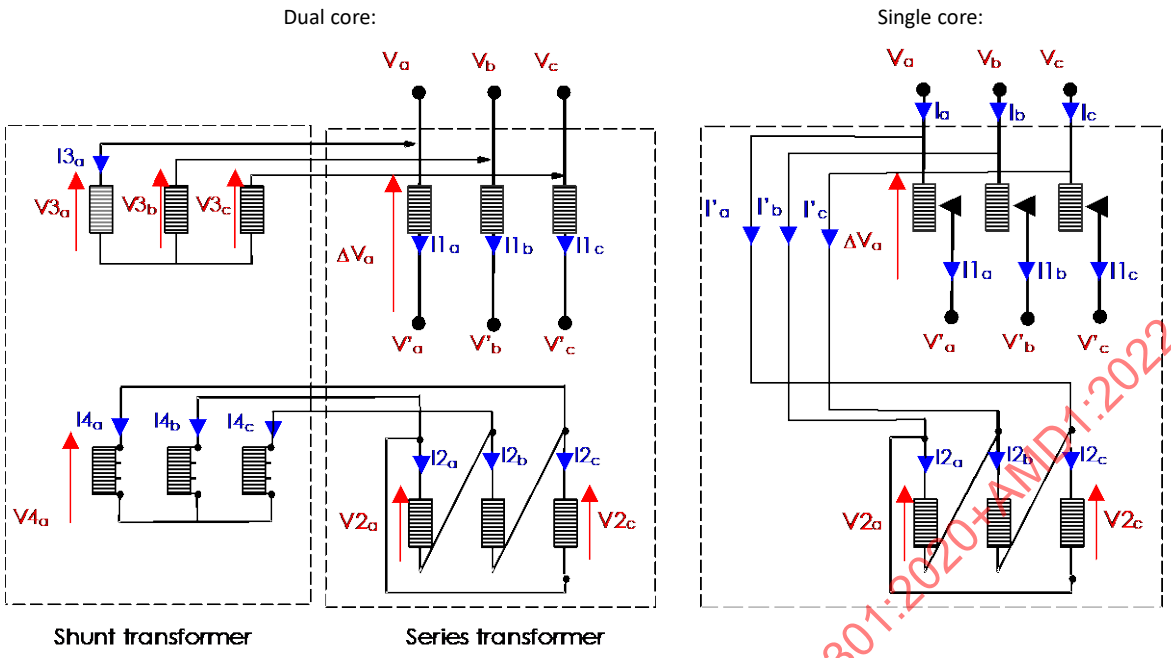
Variable:

α déphasage de courant

Pour des transformateurs déphaseurs en quadrature avec un noyau simple: X(0)=0

L'organisation triple noyau est représentée à la Figure 19

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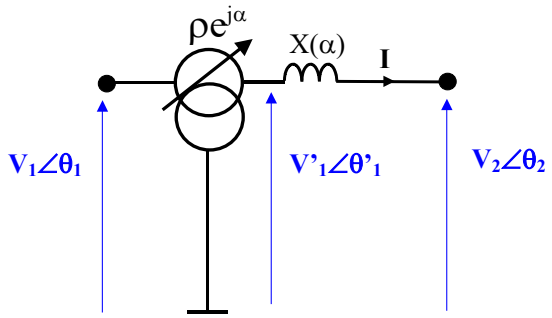
Anglais	Français
Shunt transformer	Transformateur shunt
Series transformer	Transformateur survolteur-dévolteur
Dual core	Double noyau
Single core	Noyau simple

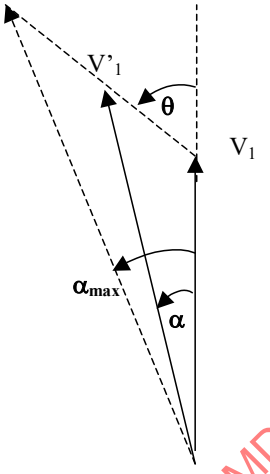
Figure 19 – Organisation du noyau

4.5.7.5.4 Modélisation d'un déphaseur asymétrique

Le diagramme et les équations du phaseur sont représentés à la Figure 20.

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$$V'_1 = V_1\left(1 + e^{j\theta}.\frac{\tan\alpha}{\sin\theta - \tan\alpha\cos\theta}\right) = \rho e^{j\alpha}V_1 \qquad V_2 = V_1.\rho e^{j\alpha} - jX(\alpha)I$$

θ Est fixe, seuls α et ρ varient.

Figure 20 – Schéma et équations du phaseur

Expression de l'angle et du rapport par prise

D'après la Figure 20:

$$\alpha = A\tan\left(\frac{(n-n_0)\cdot\delta u\cdot\sin\theta}{1+(n-n_0)\cdot\delta u\cdot\cos\theta}\right)$$

$$r = \frac{1}{\sqrt{((n-n_0)\cdot\delta u\cdot\sin\theta)^2 + (1+(n-n_0)\cdot\delta u\cdot\sin\theta)^2}}$$

Expression de la réactance série équivalente en fonction de l'angle

En partant de l'hypothèse que la réactance de l'enroulement de régulation varie à mesure que le carré du nombre de tours évolue, la réactance équivalente peut être écrite comme suit.

$$X(\alpha) = X(0) + (X(\alpha_{max}) - X(0))\left(\frac{\tan\alpha}{\tan\alpha_{max}}\frac{\sin\theta - \tan\alpha_{max}\cos\theta}{\sin\theta - \tan\alpha\cos\theta}\right)^2$$

Paramètres:

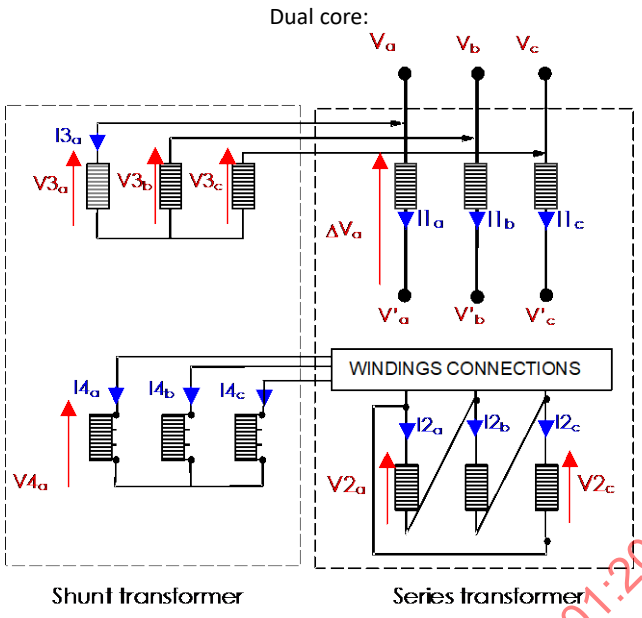
α_{max}	déphasage maximal
X(0)	réactance série équivalente pour un déphasage nul
$X(\alpha_{max})$	réactance série équivalente pour un déphasage maximal
θ	angle de la tension de charge rapide

Variable:

α déphasage de courant

Les organisations triphasées sont représentées à la Figure 21

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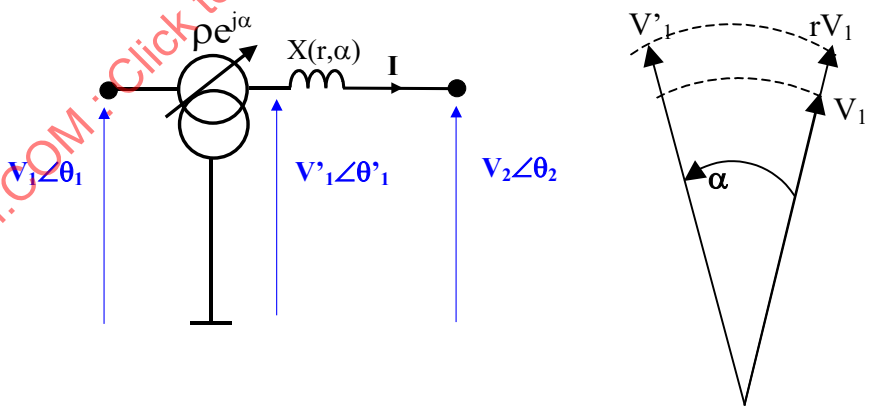


Anglais	Français
WINDINGS CONNECTIONS	CONNEXIONS ENTRE LES ENROULEMENTS
Shunt transformer	Transformateur shunt
Series transformer	Transformateur survolteur-dévolteur
Dual core	Double noyau

Figure 21 – Organisation du noyau

4.5.7.5.5 Transformateur en phase et déphaseur symétrique

Le diagramme et les équations du phaseur sont représentés à la Figure 22.



$$V_2 = \rho V_1 e^{j\alpha} - jX(\alpha)I. \qquad V'_1 = r.V_1\left(1 + 2j\sin\frac{\alpha}{2}e^{j\frac{\alpha}{2}}\right) = \rho e^{j\alpha}V_1$$

Figure 22 – Schéma et équations du phaseur

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Expression de l'angle et du rapport par prise

Idem qu'en 4.5.7.5.2 avec l'ajout du rapport r du transformateur en phase.

Réactance en série équivalente en fonction de l'angle et du rapport du transformateur en phase;

Hypothèses:

- la réactance de l'enroulement de régulation varie à mesure que le carré du nombre de tours évolue;
- la réactance équivalente est la somme de la réactance du transformateur en phase X_r et de la réactance de la partie X_α du déphaseur;
- l'angle de déphasage α ne dépend pas du rapport en phase r.

La réactance équivalente peut être écrite comme suit:

$$X(r,\alpha) = X_r(r_{nom})\left(\frac{r}{r_{nom}}\right)^2 + X_\alpha(0) + \left(X_\alpha(\alpha_{max}) - X_\alpha(0)\right)\left(\frac{\sin(\alpha/2)}{\sin(\alpha_{max}/2)}\right)^2$$

Paramètres:

r_{nom} rapport nominal du transformateur en phase

$X_r(r_{nom})$ réactance série équivalente du transformateur en phase pour le rapport nominal en phase

α_{max} déphasage maximal

$X_\alpha(0)$ réactance série équivalente de la partie du déphaseur en déphasage nul

$X_\alpha(\alpha_{max})$ réactance série équivalente de la partie du déphaseur en déphasage maximal pour le rapport nominal en phase (r_{nom})

Variables:

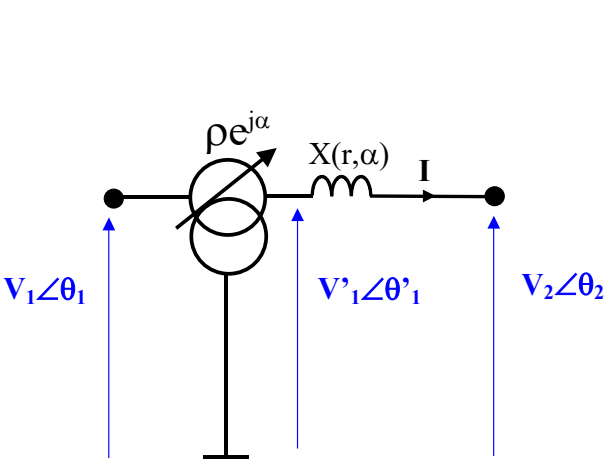
r rapport de courant du transformateur en phase

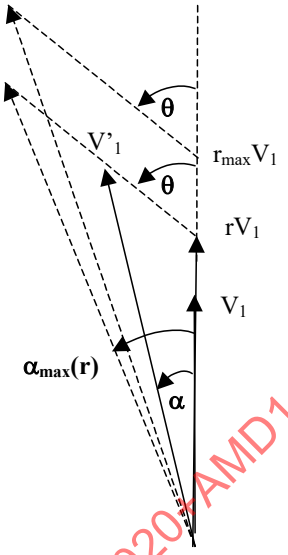
α déphasage de courant

4.5.7.5.6 Transformateur en phase et déphaseur asymétrique

Le diagramme et les équations du phaseur sont représentés à la Figure 23.

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$$V'_1 = rV_1\left(1 + e^{j\theta}.\frac{\tan\alpha}{\sin\theta - \tan\alpha\cos\theta}\right) = \rho e^{j\alpha}V_1 \qquad V_2 = (V1 - jX(\alpha)I).\rho e^{j\alpha}$$

θ est fixe, seuls r et α sont des variables, ρ varie de façon subséquente.

θ est fixe, seuls r et α sont des variables, ρ varie de façon subséquente.

Figure 23 – Schémas et équations du phaseur

Réactance série équivalente en fonction de l'angle et du rapport du transformateur en phase

Hypothèses:

- la réactance de l'enroulement de régulation varie à mesure que le carré du nombre de tours évolue;
- la réactance équivalente est la somme de la réactance du transformateur en phase X_r et de la réactance de la partie X_α du déphaseur.

La réactance série équivalente peut être écrite comme suit:

$$X(r,\alpha) = X_r(r_{nom})\left(\frac{r}{r_{nom}}\right)^2 + X_\alpha(0) + \left(X_\alpha(\alpha^0_{\max}) - X_\alpha(0)\right)\left(\frac{\tan\alpha}{\tan\alpha_{\max}(r)}\frac{\sin\theta - \tan\alpha_{\max}(r)\cos\theta}{\sin\theta - \tan\alpha\cos\theta}\right)^2$$

avec $\alpha_{\max}(r) = A\tan\left(\frac{\sin\theta}{\frac{r}{r_{nom}\tan\alpha^0_{\max}}\left(\sin\theta - \tan\alpha^0_{\max}\cos\theta\right) + \cos\theta}\right)$ avec $\alpha^0_{\max} = \alpha_{\max}(r_{nom})$

Paramètres:

r_{nom}	rapport nominal du transformateur en phase
$X_r(r_{nom})$	réactance série équivalente du transformateur en phase pour le rapport nominal en phase r_{nom}

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θ angle fixe de la tension de charge rapide

$\alpha^0_{\max} = \alpha_{\max}(r_{nom})$ déphasage maximal pour le rapport nominal en phase (r_{nom})

$X_\alpha(0)$ réactance série équivalente de la partie du déphaseur en déphasage nul

$X_\alpha(\alpha^0_{\max})$ réactance série équivalente de la partie du déphaseur en déphasage maximal pour le rapport nominal en phase (r_{nom})

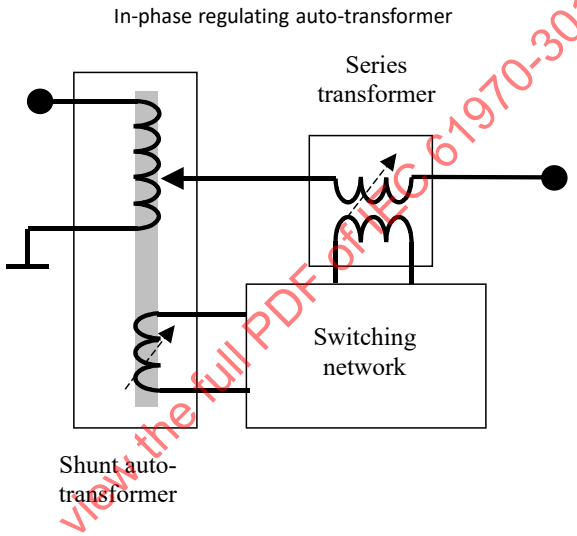
Variables:

r rapport de courant du transformateur en phase

α déphasage de courant

Pour $\theta = \pi/2$ (transformateur déphaseur en quadrature): $\alpha_{\max}(r) = A\tan\left(\frac{r_{nom}}{r}\tan\alpha^0_{\max}\right)$

Organisations triphasées sont représentées à la Figure 24



Anglais	Français
Series transformer	Transformateur survolteur-dévolteur
Switching network	Réseau de commutation
Shunt auto-transformer	Autotransformateur shunt
In-phase regulating auto-transformer	Autotransformateur de régulation en phase

Figure 24 – Organisation du noyau

La régulation du déphasage peut se faire sur le shunt ou sur le transformateur survolteur-dévolteur.

4.5.7.6 Modélisation tabulaire du transformateur déphaseur

Un PhaseTapChangerTabular est une représentation tabulaire explicite de la variation du déphasage, du rapport et de l'impédance sur la plage du changeur de prises. Le PhaseTapChangerTabular peut être associé au PhaseTapChanger représentant une relation non linéaire entre le nombre de prises, le déphasage, les rapports et les impédances.

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4.5.7.7 Commande du changeur de prises

La commande des changeurs de prises dans un type de calcul de répartition est effectuée à l'aide de la classe TapChangerControl et de TapChanger.ltcFlag. Si un TapChanger a une TapChangerControl (référencée comme TapChanger.TapChangerControl), cela signifie que le calcul de répartition peut commander le changeur de prises. L'attribut TapChanger.ltcFlag donne des informations selon lesquelles le TapChanger a la capacité physique de déplacer la prise en charge. L'attribut est également utilisé dans les calculs de l'IEC 60909.

La signification des combinaisons de TapChanger.TapChangerControl et TapChanger.ltcFlag est décrite au Tableau 5.

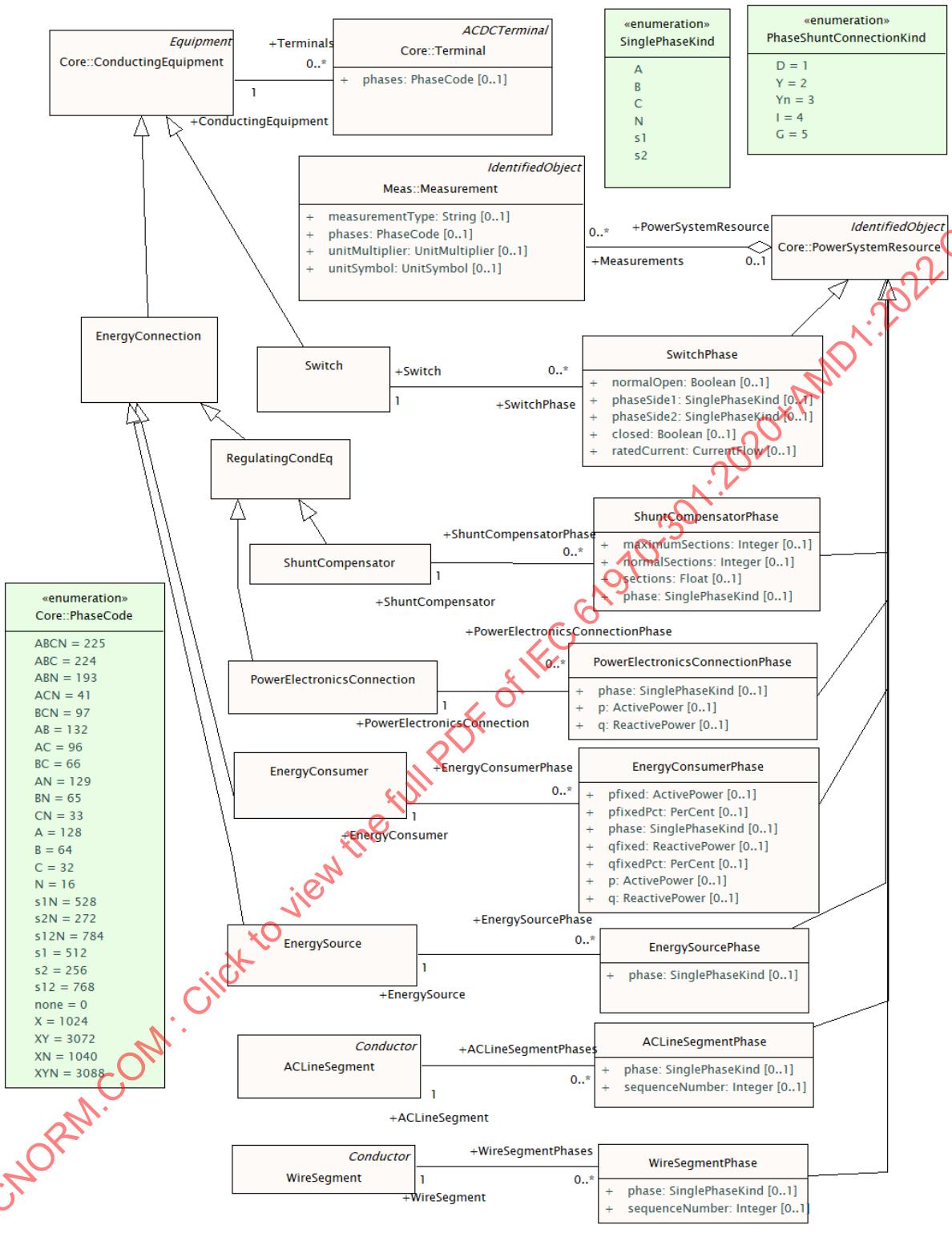
Tableau 5 – Options de commande du changeur de prises

TapChanger. ltcFlag	TapChanger. TapChangerControl	Description
False	Absent	Prise réelle et fixe non commandée et ne pouvant pas être déplacée en charge (changement manuel de prise). Le flux de puissance ne peut pas être défini de sorte à changer de prise pour commander la tension au cours du calcul.
True	Absent	Prise réelle et fixe non commandée mais pouvant être déplacée en charge, par exemple, manuellement. Le flux de puissance ne peut pas être défini de sorte à changer de prise pour commander la tension au cours du calcul. Le flux optimal de puissance peut avoir accès à ces prises et les changer à des fins d'optimisation. State Estimator (l'estimateur d'état) peut également estimer la position de prise afin de trouver une meilleure solution pour l'état du système.
True	Présent	Prise réelle présentant une possibilité de changer les prises de façon automatique pour activer la commande de la tension/la puissance active (flux de charge) activée. Le fait que le flux de puissance doit ou ne doit pas intervenir dans la régulation dépend de RegulatingControl.enabled et de TapChanger.controlEnabled dans SSH. Dans les cas où RegulatingControl est associé à plus d'un changeur de prises ou à d'autres appareils, l'attribut TapChanger.controlEnabled peut être réglé sur False afin de définir les prises non activées.
False	Présent	Prise artificielle pouvant être utilisée pour simuler le comportement de commande du flux de puissance.

4.5.8 Modélisation des phases

Les modèles du CIM fournissent des moyens de spécifier la représentation unifilaire équivalente de réseaux triphasés équilibrés ou, en sus ou en option, de spécifier le détail d'une phase donnée. Dans les réseaux monophasés, il y a correspondance directe entre les objets Terminal et les connexions physiques des fils. Dans une représentation unifilaire de réseaux triphasés équilibrés, une Terminal est utilisée pour représenter le groupe des connexions de phase de coordination. Une Terminal peut donc être utilisée pour spécifier une ou plusieurs connexions de phase de coordination en utilisant l'attribut Terminal.phases qui est un PhaseCode de type énumération. PhaseCode a pour combinaisons de phases possibles ABC, ABCN, AB, BC, CA, A, B, C et ainsi de suite. La spécification des phases à chaque borne permet de modéliser des cavaliers ou des commutateurs qui connectent les mêmes ou différentes phases. Cette spécification de la connectivité de phase est entendue comme spécification de phase nominale ou normale. Le résultat de la source de mise sous tension n'est pas reflété dans cette spécification. Cette spécification de phase fournit les moyens de connecter localement des phases semblables. La Figure 25 représente le modèle de données des phases.

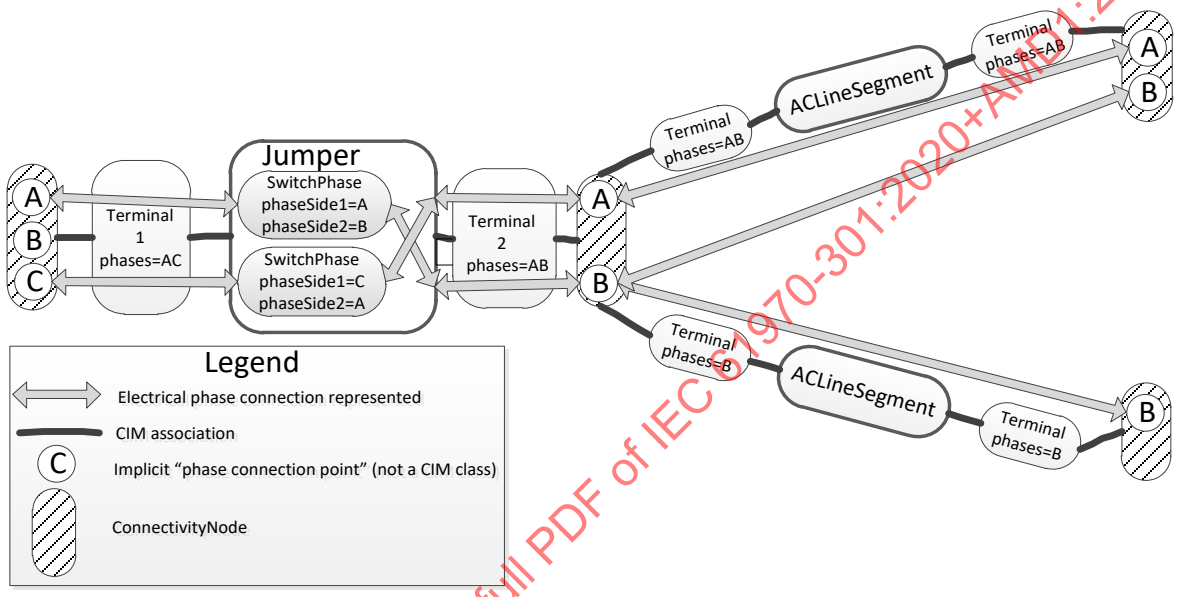
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Figure 25 – Modèle de données des phases

La Figure 26 donne un exemple de connexions de phases. Cet exemple présente une instance ConnectivityNode sur la gauche, les phases A, B et C étant concernées. Noter que ConnectivityNode ne spécifie pas le contenu de sa phase, mais connecte plutôt implicitement des phases semblables de bornes associées au ConnectivityNode. L'exemple présente un cavalier biphasé qui connecte sur la gauche (Terminal.sequenceNumber=1) les phases A et C et sur la droite (Terminal.sequenceNumber=2) les phases A et B, avec les parties intérieures des objets SwitchPhase du modèle de cavalier qui spécifient en détail le chemin des connexions de phases. L'attribut Terminal.phases spécifie uniquement la connexion externe d'un appareil. Plus loin sur la droite, deux tronçons de ligne sont raccordés. Le segment supérieur de la ligne est une ligne biphasée sur les phases A et B. Le segment inférieur de ligne est monophasé de phase B. Les lignes foncées indiquent les associations du CIM tandis que les flèches plus claires indiquent les connexions électriques représentées au niveau de la phase.



Anglais	Français
Legend	Légende
Electrical phase connection represented	Connexion de phase électrique représentée
CIM association	Association CIM
Implicit "phase connection point" (not a CIM class)	"Point de connexion de phase" implicite (pas une classe CIM)
ConnectivityNode	ConnectivityNode

Figure 26 – Connectivité de phase

A titre d'explication, l'attribut SwitchPhase appelé phaseSide1 spécifie une phase unique (comme A, B, C ou N) et se réfère à la Terminal dont le sequenceNumber est égal à 1. L'attribut SwitchPhase appelé phaseSide2 se réfère à la Terminal dont le sequenceNumber est égal à 2.

Le modèle de commutateur permet de modéliser les connexions entre phases de façon générale à l'intérieur de l'appareil. Le modèle de transformateur comporte aussi une modélisation explicite de la connectivité de phase interne de l'appareil. Actuellement, toutes les autres spécialisations de branche ConductingEquipment comme ACLineSegment prennent pour hypothèse que des phases identiques sont connectées aux deux bornes. Le modèle du CIM est ouvert aux extensions futures pour introduire la connectivité de phase interne des appareils.

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4.5.9 Modélisation des appareils de mise à la terre

4.5.9.1 Cas d'utilisation pour la modélisation des appareils de mise à la terre.

Ces appareils ont un impact important sur les courants de court-circuit pour les défauts déséquilibrés. Le fonctionnement des appareils est interchangé par des commutateurs lorsque le transformateur vers la commutation de lignes est reconfiguré. Une bobine Petersen est une bobine de mise à la terre utilisée dans les systèmes de transport de puissance à courant alternatif et conçue pour limiter l'intensité du courant vers la terre à l'emplacement d'un défaut en établissant un courant réactif vers la terre permettant d'équilibrer le courant capacitif circulant des lignes vers la terre. De plus, les bobines Petersen sont "accordées" pour correspondre au courant de charge attendu des défauts déséquilibrés. L'impédance des bobines Petersen peut être "accordée" en ajustant la position du régleur à la manière d'une prise. La position du régleur est parfois télémesurée. Parfois, un modèle linéaire suffit pour mettre en relation la position du régleur et la valeur d'impédance et parfois un tableau est nécessaire pour présenter la relation non linéaire entre la position de régleur et l'impédance.

4.5.9.2 Modèle

L'EarthFaultCompensator est un type d'équipement conducteur abstrait prévu pour modéliser les équipements de mise à la terre. L'EarthFaultCompensator est une spécialisation de ConductingEquipment, car un court-circuit exige des connexions appropriées et différents commutateurs qui peuvent s'ouvrir ou se fermer pour modifier la configuration de la topologie. L'EarthFaultCompensator est différent d'une branche telle que ACLineSegment, ShuntCompensator ou PowerTransformer dans le sens où il ne régule pas la tension et n'est jamais monté en étoile ou en triangle. Un transformateur de mise à la terre connecté en zigzag reste un PowerTransformer en raison de toutes les autres complexités du transformateur. Deux spécialisations permettent de manipuler les appareils à impédance fixe (GroundingImpedance) et les appareils réglables (variable) à bobine Petersen (PetersenCoil).

Le GroundingImpedance et le PetersenCoil se connectent de la même manière que les autres appareils utilisant la Terminal. L'attribut de phase sur la Terminal indique que la connexion est la phase neutre. L'une ou les deux bornes de l'EarthFaultCompensator peuvent être modélisées. Si la deuxième borne d'un EarthFaultCompensator est omise, la borne est par hypothèse solidement raccordée à la terre. S'il existe une sorte de topologie ou de résistivité locale à la terre qui est importante à la modélisation du côté terre de l'appareil, alors une deuxième borne est ajoutée.

Si un PowerTransformer à une connexion Y sur une Terminal (secondaire) et qu'un PetersenCoil est connecté à cette Terminal, il convient de spécifier la Terminal secondaire du PowerTransformer avec l'attribut de phase égal à ABCN, et il convient de spécifier la Terminal du PetersenCoil avec la phase N. Cela permet à ACLineSegment de se connecter avec les phases ABC (défaut) et au PetersenCoil de se connecter à la même TransformerTerminal, mais uniquement sur la phase N. Il est prévu que toutes les bornes PetersenCoil ne disposent que de la phase N.

Si une modélisation normale d'un réseau non neutre est réalisée, le modèle de bobine Petersen étant alors ajouté, lequel inclut:

1) ajout du phasage d'ABCN à la borne secondaire du transformateur, de manière à avoir une place pour connecter le neutre;
2) ajout de l'objet PetersenCoil à sa Terminal associée qui est la phase N, et étant donné qu'une seule Terminal est modélisée, la PetersenCoil est par hypothèse solidement mis à la terre;
3) association de la Terminal unique de la PetersenCoil au ConnectivityNode au niveau du transformateur secondaire.

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Une classe séparée de sectionneurs de terre (GroundDisconnector) est incluse étant donné que ces sectionneurs sont généralement très différents physiquement de la plupart des autres commutateurs et souvent exclus de l'analyse du flux normal de puissance. À l'instar des PetersenCoils, il est prévu que toutes les bornes GroundDisconnector ne comporteront que la phase N. Voir la Figure 27 pour la représentation du modèle de données.

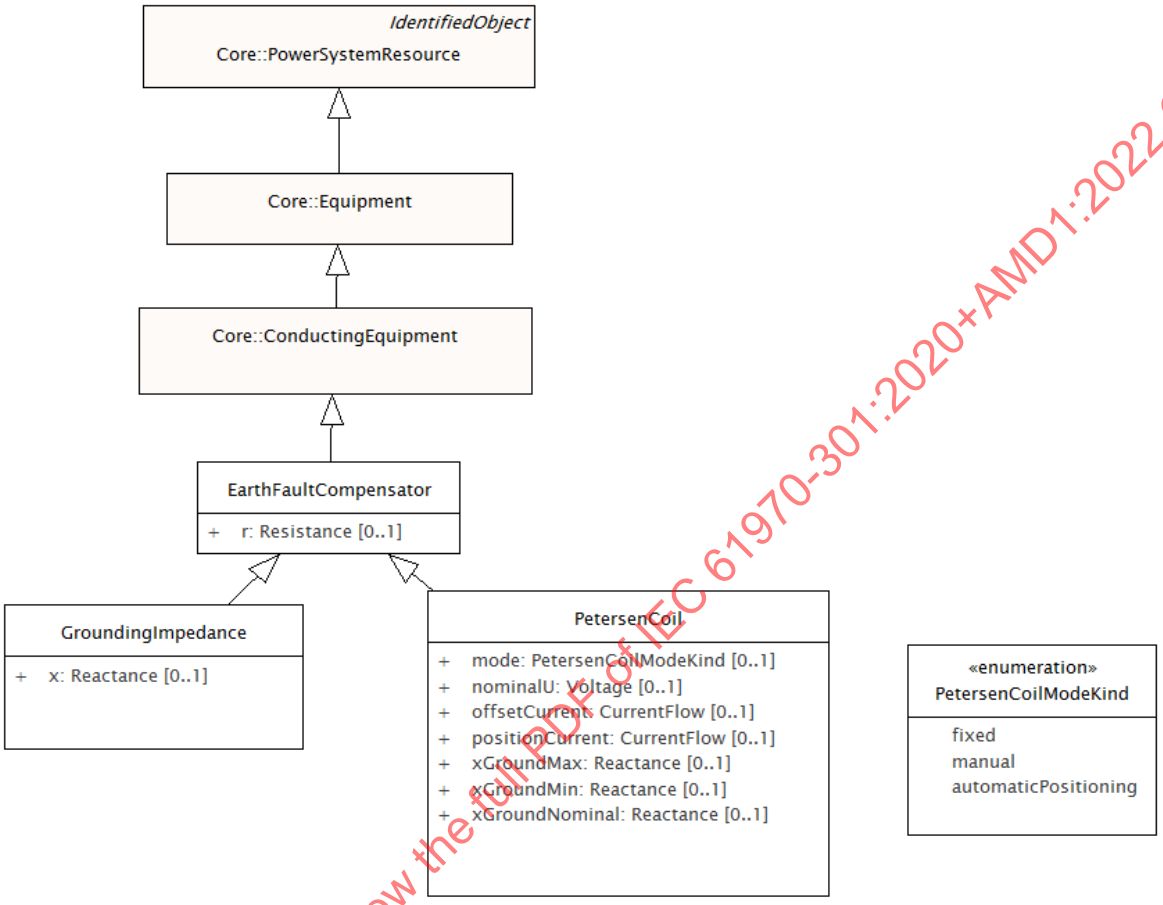


Figure 27 – Modèle de données de l'appareil de mise à la terre

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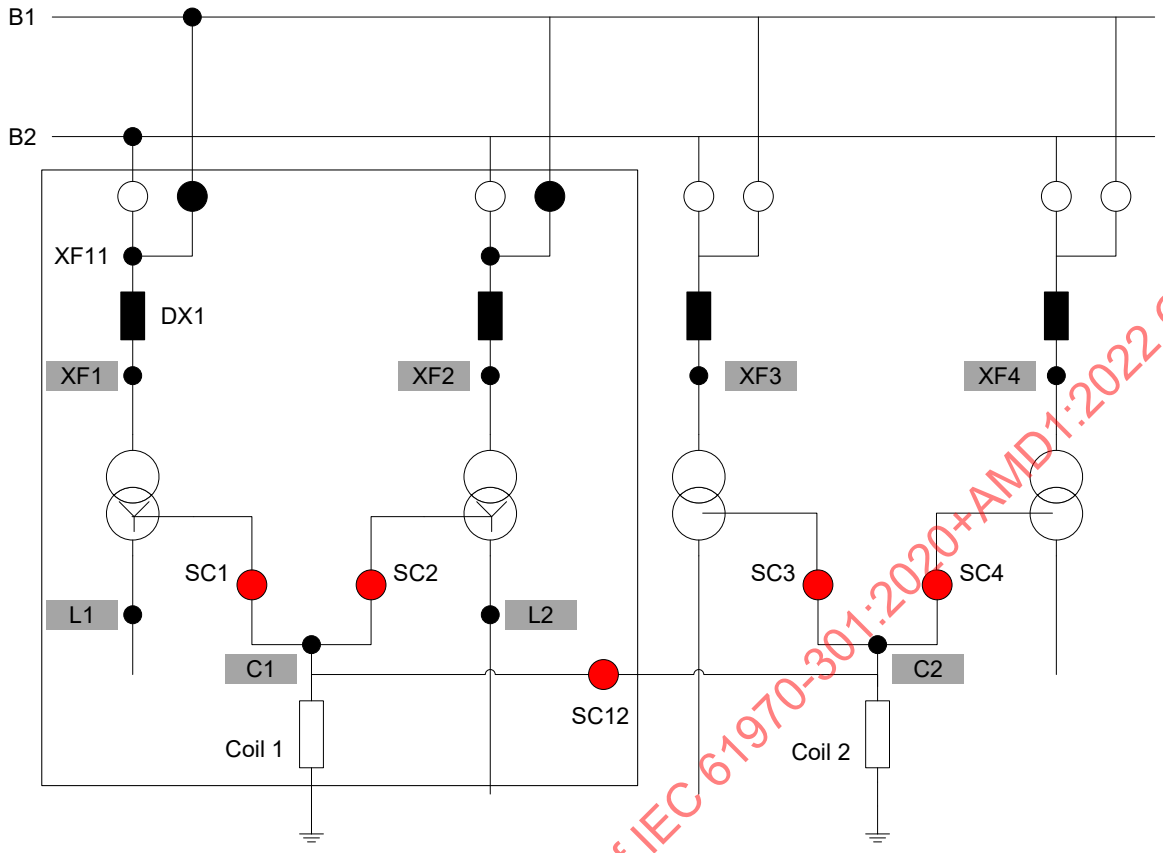


Figure 28 – Exemple de représentation de poste comprenant des bobines Petersen

Dans l'exemple ci-dessus, SC1, SC2, SC3, SC4 et SC12 sont les sectionneurs du circuit de mise à la terre. B1 et B2 sont les sections de jeu de barres. XF1, XF2, XF3, XF4, C1, C2, L1 et L2 sont les nœuds de connectivité.

Le point de mise à la terre d'un transformateur est le point médian des enroulements connectés en Y et les sectionneurs du circuit de mise à la terre sont connectés à ces points médians. Dans le CIM, le point médian est décrit par l'attribut de phasage de la Terminal au niveau des enroulements connectés en Y. Cela signifie que les commutateurs du circuit de mise à la terre sont connectés au nœud de connectivité au niveau de la Terminal avec les enroulements connectés en Y. Dans la Figure 28, cela signifie que SC1 est connecté à L1, que SC2 est connecté à L2 et que L1/L2 a les phases ABC ainsi que la phase N comme point médian.

4.5.9.3 Exemple de modèle d'instance CIM

La PetersenCoil représentée à la Figure 28 est modélisée à la Figure 29 avec une borne uniquement et la mise à la terre est implicite.

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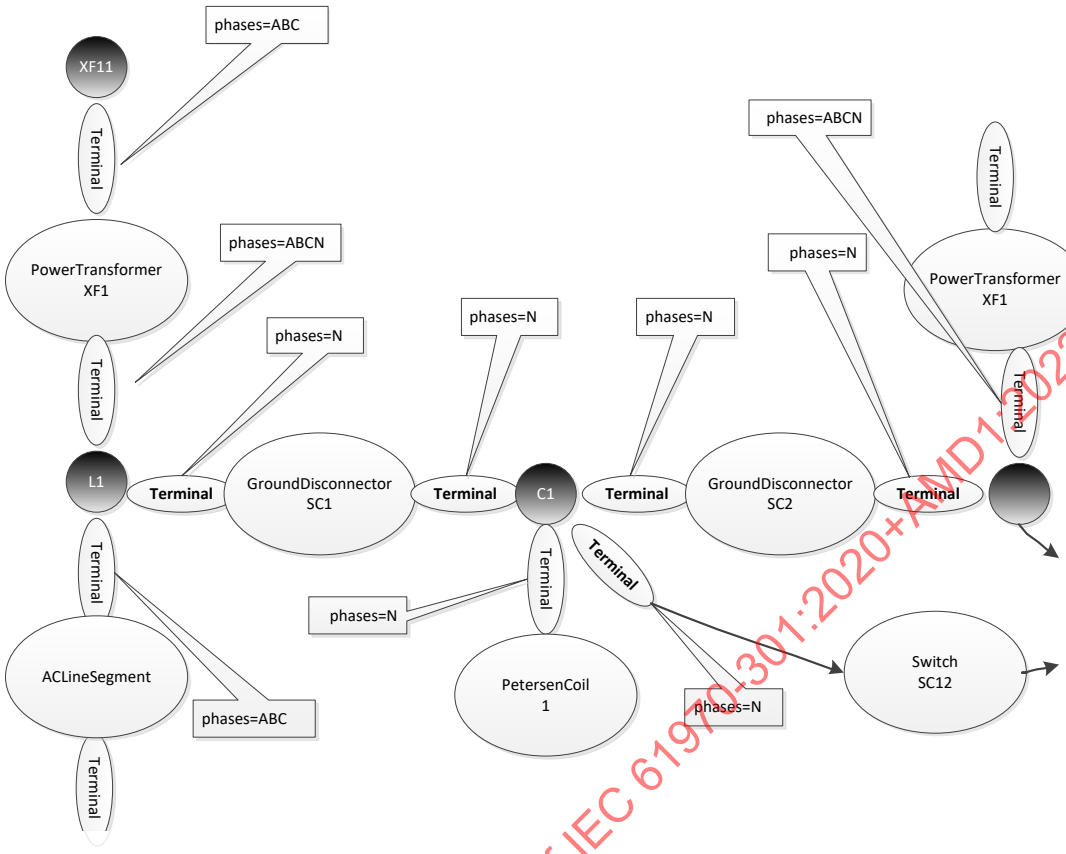


Figure 29 – Objets de diagramme d'instance avec une bobine à bornes

La Figure 29 représente la façon dont une Terminal du sectionneur de terre SC1 est en phase N et dont la Terminal du transformateur est connectée à L1 avec les phases ABCN.

4.5.10 Modèle de cuts, de clamps (serre-fils) et de jumpers (cavaliers)

Le modèle de l'UML pour les cuts et les jumpers (cavaliers) sur un segment de ligne et les connexions supplémentaires sont décrites à la Figure 30. La classe Jumper est une spécialisation de la classe plus générale Switch et permet des changements de phase ainsi qu'une connectivité de phase, comme représenté à la Figure 26. Les jumpers (cavaliers) peuvent donc connecter les bornes de façon normale. Les classes Cut et Clamp du CIM fournissent des moyens d'ajouter effectivement des Terminals à un ACLineSegment à une distance spécifiée sur la ligne en aval, en associant de nouveaux objets du CIM à un objet ACLineSegment sans autre modification du modèle ACLineSegment intégré. Chaque instance Clamp introduit une nouvelle borne connectée à la distance spécifiée en aval sur la ligne sans interrompre la ligne. Chaque instance Cut introduit deux nouvelles bornes qui sont effectivement les extrémités du cut. Par convention, chaque borne d'un cut est orientée vers la borne ACLineSegment dont le sequenceNumber est identique. Si le cut est ouvert, il n'y a pas de flux qui traverse l'ACLineSegment au point du cut mais le flux peut passer par l'un ou l'autre côté de l'ACLineSegment et par la borne de cut appropriée. Habituellement, les jumpers (cavaliers) sont connectés aux extrémités des cuts, mais ils peuvent aussi être connectés à un type quelconque d'équipement conducteur de façon normale en utilisant ConnectivityNode ou TopologicalNode.

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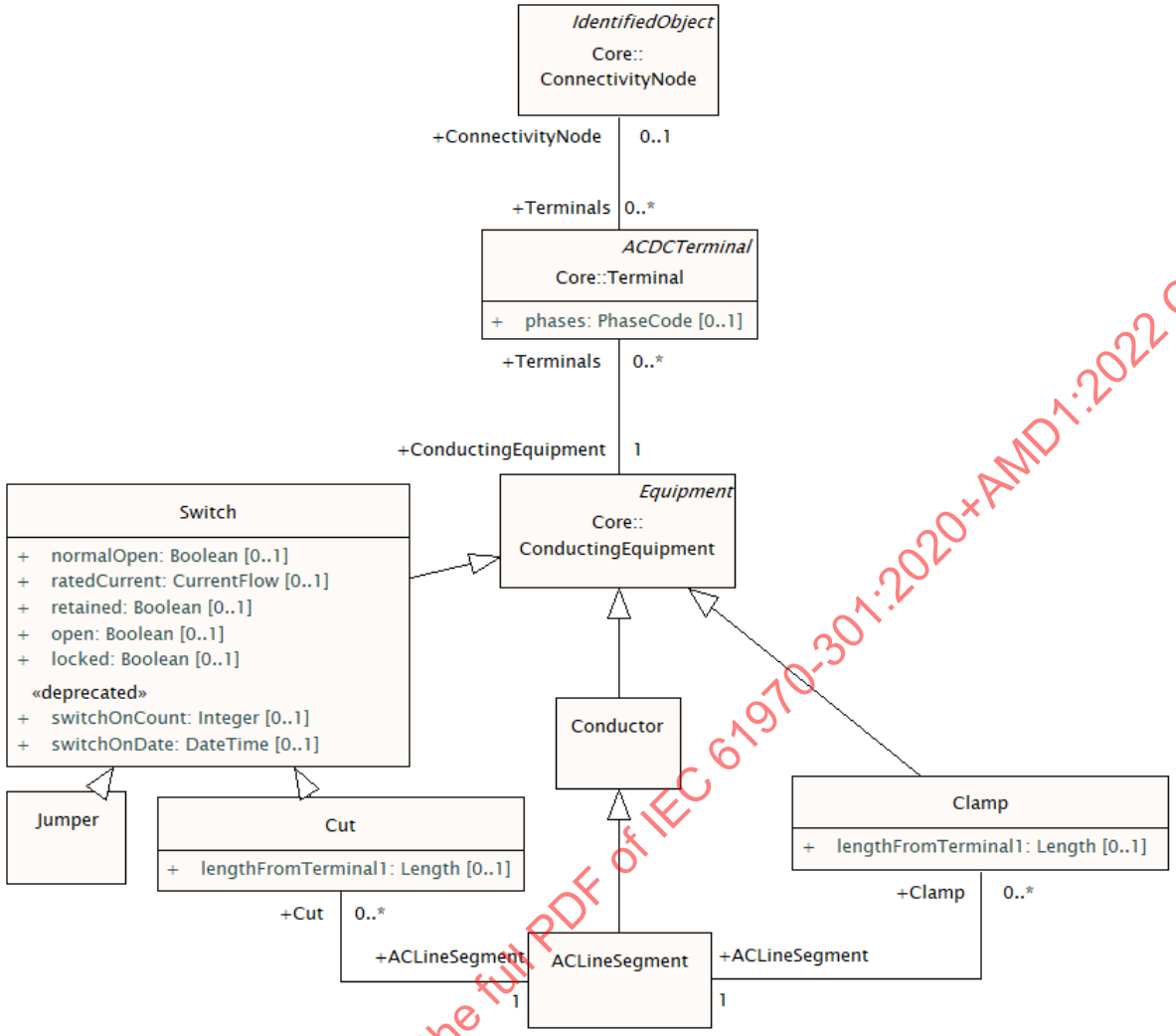
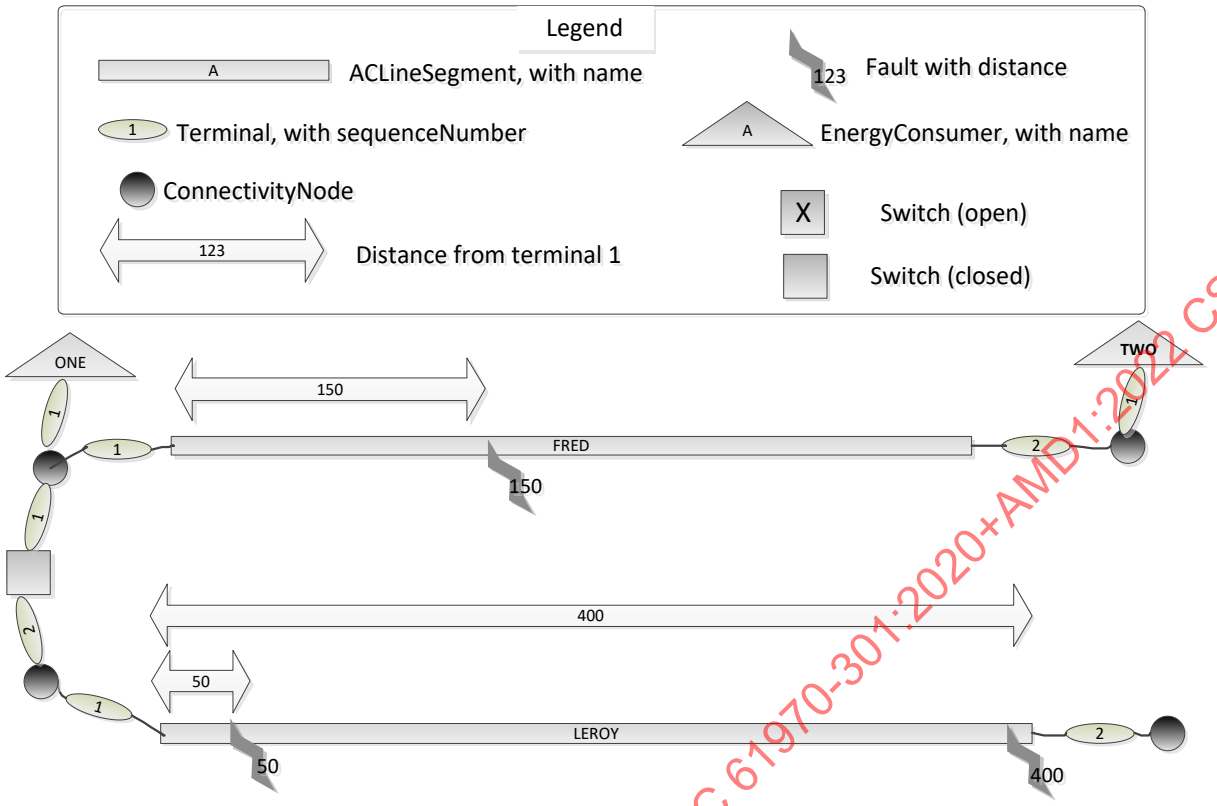


Figure 30 – Modèle UML de cuts, de clamps (serre-fils) et de jumpers (cavaliers)

Un exemple d'ajout de cuts et de clamps (serre-fils) à un modèle existant de CIM est donné à la Figure 31 et à la Figure 32. La Figure 31 représente deux tronçons de ligne physiques parallèles appelés "FRED" et "LEROY". Dans cet exemple, le système est mis sous tension à partir de la droite, le commutateur sur la gauche est fermé et les charges appelées "ONE" et "TWO" sont appliquées. Les trois défauts sont ensuite appliqués aux distances spécifiées par rapport à la Terminal 1 des tronçons respectifs de ligne. Dans cet exemple, le détail de phase n'est pas spécifié pour des raisons de simplicité mais le détail de phase peut suivre la même approche que celle présentée en 4.5.8.

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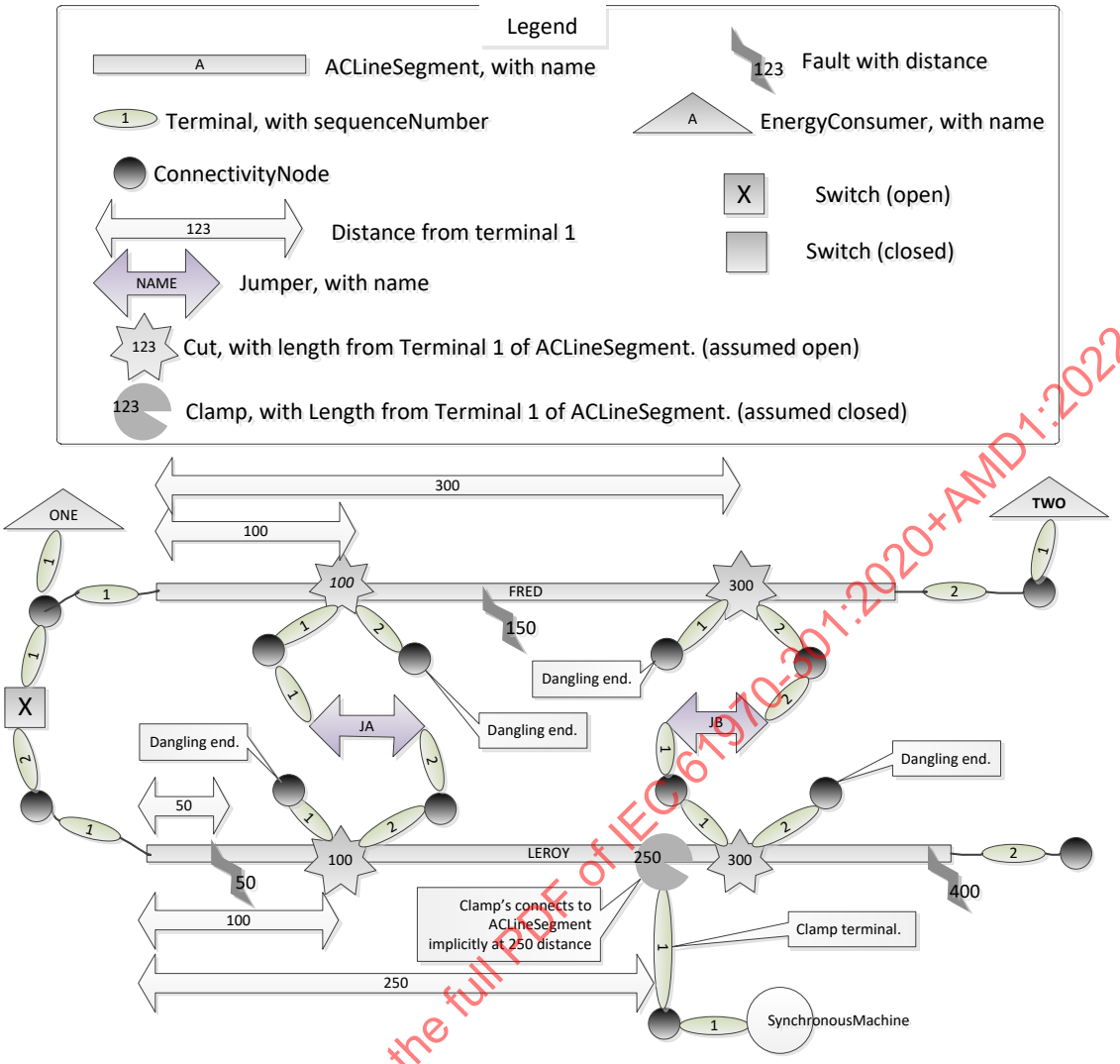


Anglais	Français
Legend	Légende
ACLineSegment, with name	ACLineSegment, avec nom
Terminal, with sequenceNumber	Borne, avec sequenceNumber
ConnectivityNode	ConnectivityNode
Distance from terminal 1	Distance du terminal 1
Fault with distance	Erreur avec distance
EnergyConsumer, with name	EnergyConsumer, avec nom
Switch (open)	Commutateur (ouvert)
Switch (closed)	Commutateur (fermé)
ONE	UN
TWO	DEUX

Figure 31 – Exemple avant application des cuts et des jumpers (cavaliers)

La Figure 32 représente la façon dont le simple ajout de Cut, ConnectivityNode, Jumper, Clamp et éventuellement d'un autre ConductingEquipment peut représenter des changements de modèle qui reflètent un travail temporaire typique. Les mêmes modèles peuvent donc être utilisés pour des changements permanents de modèle. L'exemple présente la façon dont des cuts appliqués aux distances spécifiées peuvent isoler les défauts en laissant pendre les extrémités défectueuses des cuts tandis que le réseau restant est connecté pour fournir les charges. Cet exemple présente également la façon dont plusieurs cuts peuvent être appliqués à un segment de ligne. Cet exemple présente des cuts ouverts, mais si un cut était fermé, le flux pourrait continuer à traverser ACLineSegment, avec une partie du flux potentiellement redirigée vers les bornes du cut, à peu près comme dans le cas d'un clamp (serre-fil).

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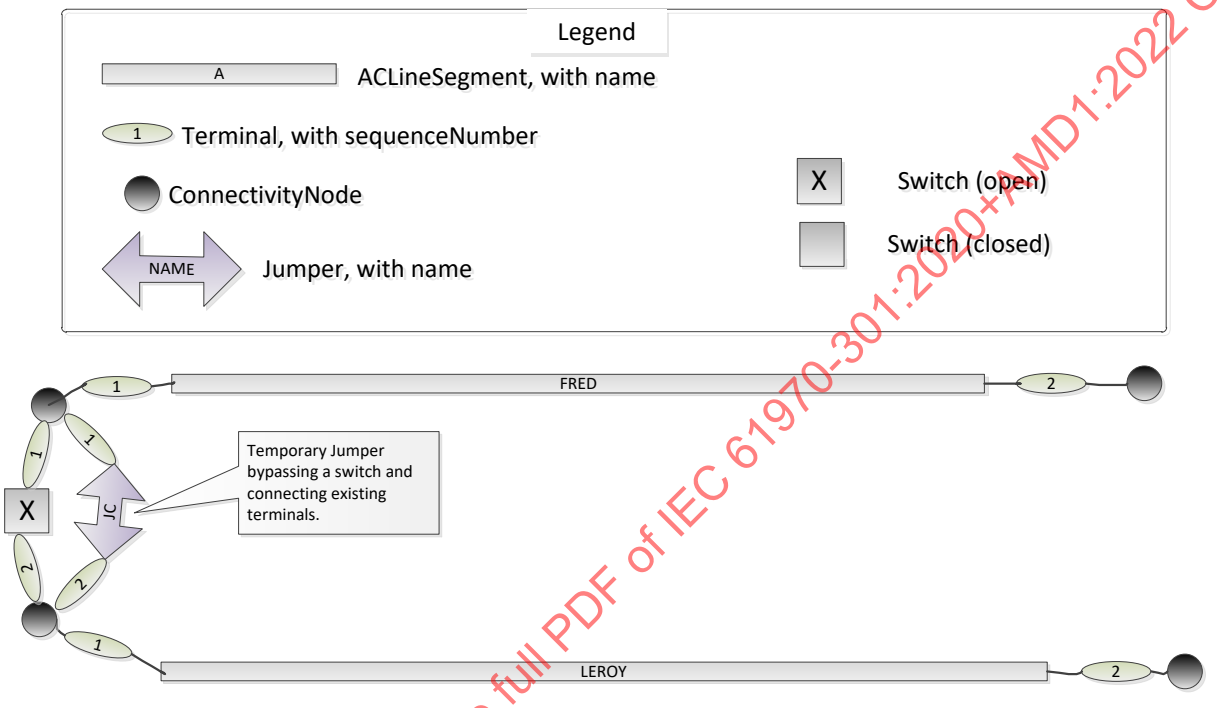
Anglais	Français
Legend	Légende
ACLineSegment, with name	ACLineSegment, avec nom
Terminal, with sequenceNumber	Borne, avec sequenceNumber
ConnectivityNode	ConnectivityNode
Distance from terminal 1	Distance du terminal 1
Jumper, with name	Cavalier, avec nom
Cut, with length from Terminal 1 of ACLineSegment. (assumed open)	Cut, avec longueur du Terminal 1 de ACLineSegment. (réputé être comme ouvert)
Clamp, with length from Terminal 1 of ACLineSegment. (assumed closed)	Serre-fil, avec longueur du Terminal 1 de ACLineSegment. (réputé être ouvert)
Fault with distance	Erreur avec distance
EnergyConsumer, with name	EnergyConsumer, avec nom
Switch (open)	Commutateur (ouvert)
Switch (closed)	Commutateur (fermé)
Dangling end	Extrémité qui pend
Clamp's connects to ACLineSegment implicitly at 250 distance	Le serre-fil se connecte à ACLineSegment de façon implicite à une distance de 250
Clamp terminal	Borne du serre-fil
ONE	UN
TWO	DEUX

Figure 32 – Exemple après application des cuts et des jumpers (cavaliers)

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Un cut fournit deux bornes et bien que l'exemple ci-dessus ne le représente pas, des connexions sont possibles à l'une des bornes du cut ou aux deux. Un cas d'exemple pourrait impliquer l'introduction d'un cut et la connexion des deux bornes de cut à l'aide d'un cavalier qui croise les phases.

Un cavalier peut être utilisé sans serre-fil ni cut lorsque des bornes existantes doivent être connectées. La Figure 33 représente un exemple d'utilisation d'un cavalier sans cut ni serre-fil. Dans ce cas, un cavalier temporaire peut être utilisé pour contourner un commutateur qui fait l'objet d'une maintenance.



Anglais	Français
Legend	Légende
Terminal, with sequenceNumber	Borne, avec sequenceNumber
ConnectivityNode	ConnectivityNode
Jumper, with name	Cavalier, avec nom
Switch (open)	Commutateur (ouvert)
Switch (closed)	Commutateur (fermé)
Temporary Jumper bypassing a switch and connecting existing terminals	Cavalier (Jumper) temporaire de contournement du commutateur et connexion des bornes existantes

Figure 33 – Exemple de cavalier sans cut ni serre-fil

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4.5.11 Mesures et commandes

4.5.11.1 Vue d'ensemble des mesures (Measurements)

Les Measurements (mesures) sont utilisés pour représenter les variables d'état qui peuvent être rencontrées dans des processus industriels. Chaque processus industriel a ses types spécifiques de mesures. Un système de puissance a généralement des flux de puissance, des tensions, des positions (par exemple, disjoncteurs, isolateurs), des indicateurs de défauts (pression atmosphérique, pression d'huile, surchauffe, etc.), des compteurs (par exemple, énergie), etc.

Le nom "Measurement" semble indiquer que toutes les variables d'état sont mesurées. Tel n'est pas toujours strictement le cas, car de nombreux "Measurement" sont calculés par des fonctions SCADA ou EMS/DMS, comme les calculs d'estimateur d'état ou de flux de puissance, par exemple. Par conséquent, un Measurement peut avoir plusieurs valeurs alternatives (par exemple, fournies manuellement, télémesurées, estimées par état, optimisées, etc.). Cela est pris en charge par les modèles Measurement et MeasurementValue dans le paquetage Meas. Les classes dans le paquetage StateVariables ont été ajoutées au modèle CIM, et ce, spécifiquement pour le besoin de prendre en charge l'échange de valeurs calculées par des fonctions telles que l'estimateur d'état et le calcul du flux de la puissance.

Le modèle de Measurement permet désormais de spécifier facultativement les phases spécifiques d'une mesure.

4.5.11.2 Vue d'ensemble des commandes

Les commandes sont utilisées pour représenter les variables de commande. Les variables de commande du système de puissance sont généralement des points de consigne, des commandes augmente/diminue, des commandes "Sélectionner avant d'exécuter" et des commandes marche/arrêt. Le paquetage Meas prend en charge les variables de commande avec le modèle Control.

4.5.11.3 Utilisation des classes liées à la classe Measurement

Un PowerSystemResource (PSR) peut avoir zéro à plusieurs Measurements qui lui sont associés en contenant un ou plusieurs Measurements. Chaque Measurement peut contenir une ou plusieurs valeurs de mesure. Le respect des lignes directrices suivantes permet aux applications de naviguer et de retrouver les valeurs de mesure exigées de manière cohérente (voir Figure 34):

a) les Measurements d'un PowerSystemResource sont classées par l'attribut measurementType (type de mesure). Les valeurs devant être utilisées pour Measurement.measurementType sont spécifiées dans le Tableau 6;

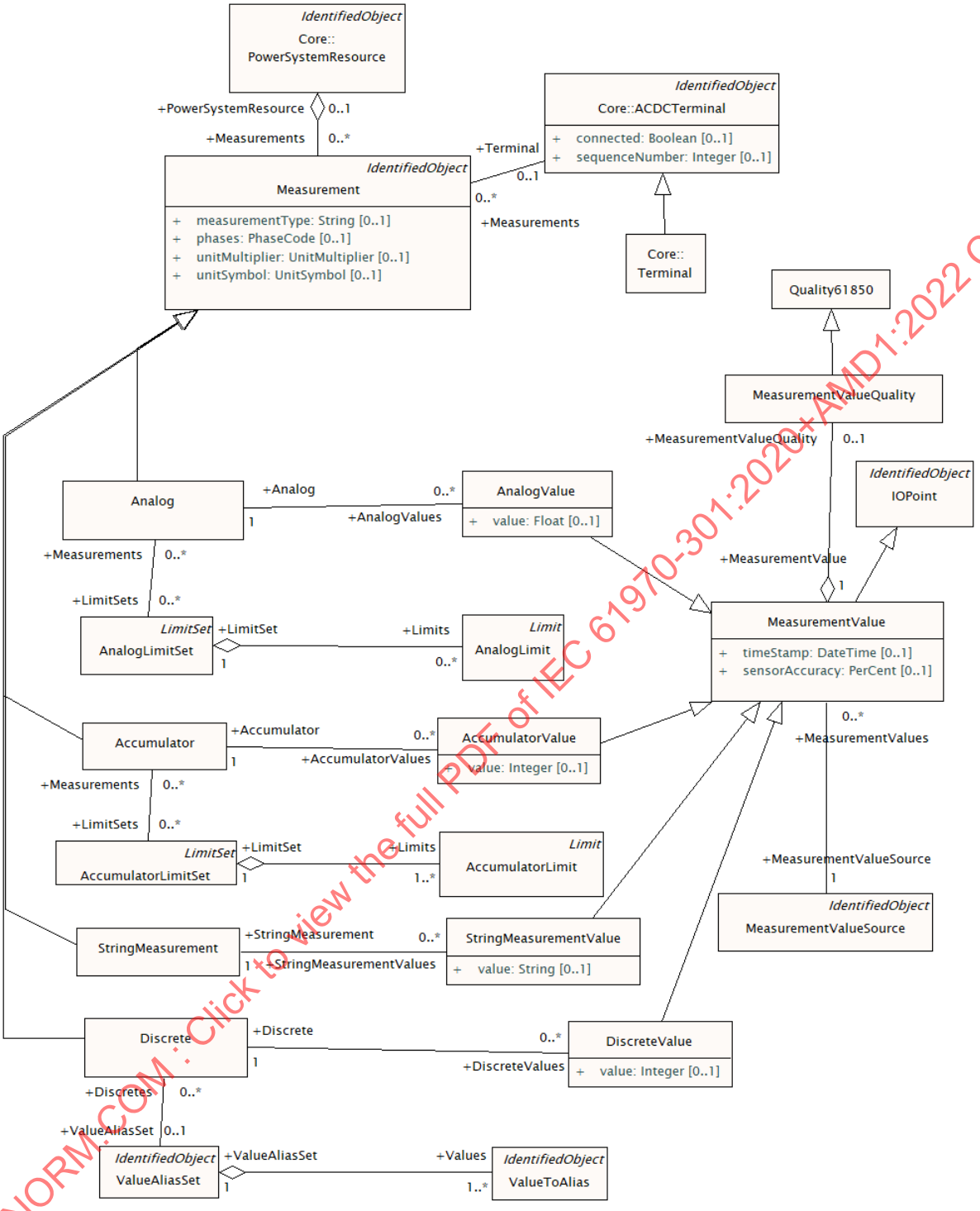
b) les MeasurementValues (valeurs de mesure) d'un Measurement sont classées par MeasurementValueSource (source de valeur de mesure);

c) measurementValueSource hérite de IdentifiedObject. Les valeurs à utiliser pour MeasurementValueSource.name sont spécifiées dans le Tableau 7. Ce tableau fournit plusieurs noms de sources à utiliser lorsque cela est possible. Cependant, les noms exacts à utiliser pour des applications spécifiques sont définis dans le document correspondant IEC 61970 CIS (Component Interface Specifications – Spécification d'interface de composants);

d) les tableaux peuvent être étendus pour des besoins propriétaires. Les noms ajoutés doivent commencer par un nom unique (par exemple, le nom de la société) et un caractère "souligné" ("underscore"). Exemple: xyz_AverageTemperature;

e) la valeur ValueAliasSet est utilisée pour des mesures discrètes et décrit des correspondances de valeurs vers des noms symboliques, comme des libellés d'énumération qui ont des valeurs entières spécifiques. Des protocoles de communication différents (par exemple pour les RTU (Remote Units – unités distantes) et pour les centres de conduite tels que ICCP (Intelligent Customer Contact Platform – plate-forme intelligente de relations avec l'abonné) ou ELCOM) utilisent des codages de données différents. Un système peut avoir une mise en correspondance à l'échelle du système pour toutes les valeurs Discrete (discrètes) ou regrouper les valeurs Discrete et effectuer la mise en correspondance par groupe. La création d'une mise en correspondance à l'échelle du système qui couvrirait des protocoles de communication existants ne relève pas du domaine d'application du présent document.

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Figure 34 – Navigation de PSR à MeasurementValue

Tableau 6 – Conventions de dénomination de measurementType

measurementType	61850 Name	description
Current	Amp	Courant (efficace) d'un circuit non triphasé
ThreePhaseCurrent	AvAmps	Courant total (efficace) dans un circuit triphasé
PhaseCurrent	A	Courant de phase mesuré.
Frequency	Hz	Fréquence
PowerFactor	PwrFact	Facteur de puissance non alloué à une phase
ThreePhasePowerFactor	TotPF	Facteur de puissance moyen dans un circuit triphasé
ThreePhaseApparentPower	TotVA	Puissance apparente totale dans un circuit triphasé
ThreePhaseReactivePower	TotVAr	Puissance réactive totale dans un circuit triphasé
ThreePhaseActivePower	TotW	Puissance réelle totale dans un circuit triphasé.
ApparentPower	VolAmp	Puissance apparente dans un circuit non triphasé
ReactivePower	VolAmpr	Puissance réactive dans un circuit non triphasé
Voltage	Vol	Tension (efficace) non allouée à une phase
ActivePower	Watt	Puissance réelle dans un circuit non triphasé
Pressure	Pres	Pression
Temperature	Tmp	Température
Angle	Ang	Angle entre la tension et le courant
ApparentEnergy	TotVAh	Énergie apparente
ReactiveEnergy	TotVArh	Énergie réactive
ActiveEnergy	TotWh	Énergie réelle
Automatic	Auto	Fonctionnement automatique (non manuel)
LocalOperation	Loc	Fonctionnement local (non télécommandé)
SwitchPosition	Pos	Position de commutation [2bits= intermédiaire,ouvert,fermé,ignorer]
TapPosition	TapPos	Position de prise du transformateur de puissance ou du déphaseur
Operation Count	OperCnt	Compteur d'opérations – généralement pour les commutateurs
LineToNeutralVoltage		Tension phase à neutre
LineToGroundVoltage		Tension phase à terre
Specialization		Utilisé lorsqu'une spécialisation de la classe Analog définit le type de mesure plutôt que l'attribut Measurement.measurementType.

Le Tableau 6 décrit divers types de mesures qui sont aussi définies dans l'IEC 61850. Les colonnes du Tableau 6 ont la signification suivante:

- measurementType (Measurement.measurementType) est le nom du type de mesure selon l'IEC 61970;
- 61850 Name est le nom attribué à l'objet de données dans l'IEC 61850. IEC 61850- 7- 4:2010, sémantique des noms d'objet de données);
- description est la description des données.

Il doit être noté que le Tableau 6 ne constitue pas une liste exhaustive et que la correspondance entre mesures telle que définie dans un centre de conduite et un poste n'est pas triviale.

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Tableau 7 – Conventions de dénomination de MeasurementValueSource (source de valeur de mesure)

Nom	description
SCADA	Valeurs télémesurées reçues d'un système SCADA local
CCLink	Valeur reçue d'un centre de conduite distant par l'intermédiaire de TASE.2 ou autre protocole
Operator	Valeur entrée par un opérateur (toujours maintenue manuellement, le PSR n'est pas connecté à une RTU)
Estimated	Valeur mise à jour par un estimateur d'état
PowerFlow	Valeur mise à jour par un Powerflow (flux de puissance)
Forecasted	Valeur qui est planifiée ou prévisionnelle.
Calculated	Valeur calculée à partir d'autres valeurs de mesure (par exemple, une somme)
Allocated	Valeur calculée par un allocateur de charge

En respectant ces conventions:

- chaque instance de Measurement représente une grandeur technique d'un PowerSystemResource;
- chaque MeasurementValue d'un Measurement représente une valeur pour la grandeur technique, fournie par une source unique;
- l'attribut source de MeasurementValueQuality indique alors si la source a vraiment fourni la valeur courante ou bien si elle est une valeur de substitution ou une valeur par défaut.

Noter qu'une nouvelle identité MeasurementValue n'est pas normalement créée pour chaque échange d'une valeur mesurée. Il est prévu que la même instance MeasurementValue puisse échanger de nouvelles valeurs dans des messages ultérieurs. C'est pourquoi l'identité d'une instance MeasurementValue peut être établie a priori pour échanger des valeurs mesurées. La modélisation d'une série chronologique de valeurs n'est pas explicitement mentionnée dans le modèle du CIM bien que le modèle permette aux systèmes de constituer en interne de tels modèles de série chronologique à l'aide d'une série d'échanges de valeurs de mesure.

4.5.11.4 Rattachement des Measurements

Comme mentionné en 4.5.11.3 et comme représenté à la Figure 34, les Measurements sont contenues par un PowerSystemResource. Cela est suffisant pour des Measurements qui ne sont pas reliées à la connectivité, par exemple la température, le poids, la taille.

Pour spécifier l'emplacement d'un Measurement dans le réseau, une association à Terminal est utilisée. Des exemples sont les flux de puissance, les tensions et les courants. Les tensions (Voltage) n'ont pas de sens et peuvent être jointes en fonction du placement du capteur. Les flux ont un sens et doivent être joints de façon à ce que le sens du flux soit évident d'après le placement.

La Figure 35 représente deux exemples de placement de Measurements.

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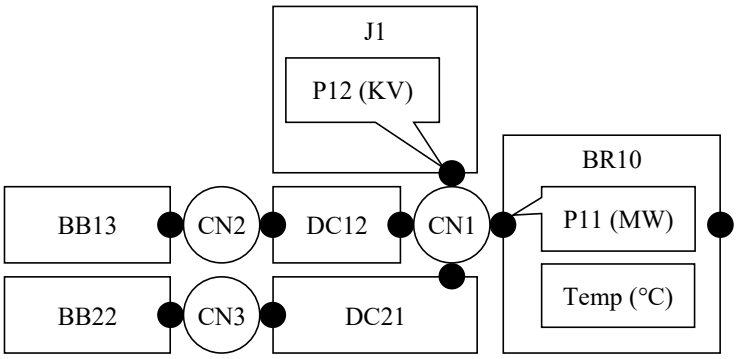


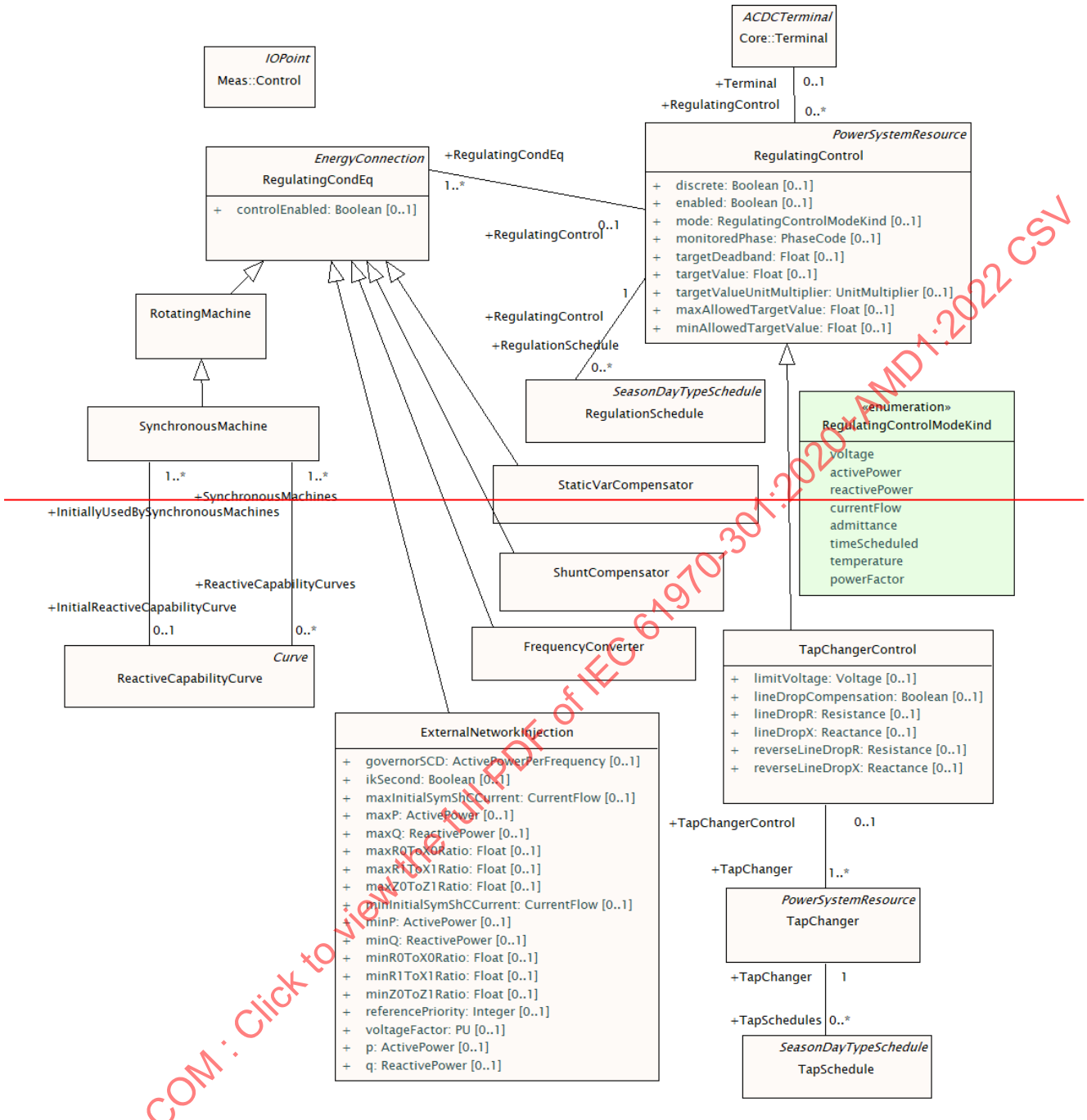
Figure 35 – Placement de Measurement

P12 est un Measurement de tension qui mesure la tension à la jonction J1. P12 est topologiquement relié au ConnectivityNode CN1 via la Terminal de la jonction J1. P11 est un Measurement qui mesure le flux traversant le disjoncteur BR10 du côté connecté au ConnectivityNode CN1. P11 est topologiquement relié au ConnectivityNode CN1 via la Terminal gauche du disjoncteur BR10. Temp est un Measurement qui mesure la température du disjoncteur. Comme la température n'est pas reliée à la connectivité, elle n'a pas de relation avec une Terminal – elle appartient seulement au disjoncteur BR10.

4.5.12 Modèles de commande de régulation

Une commande de régulation, par exemple une commande automatique de tension sur des générateurs ou une commande de prise de tension sur des transformateurs, est modélisée en utilisant la classe RegulatingControl qui offre la possibilité de modéliser plusieurs instances d'équipements qui participent à un plan de régulation. Ces plans de régulation peuvent être physiques ou mis en œuvre manuellement dans le fonctionnement réel du système de puissance, mais ils sont reflétés dans les modèles utilisés à des fins d'analyse des systèmes de puissance. La Figure 36 représente la façon dont les classes RegulatingCondEq et TapChanger peuvent participer à la régulation.

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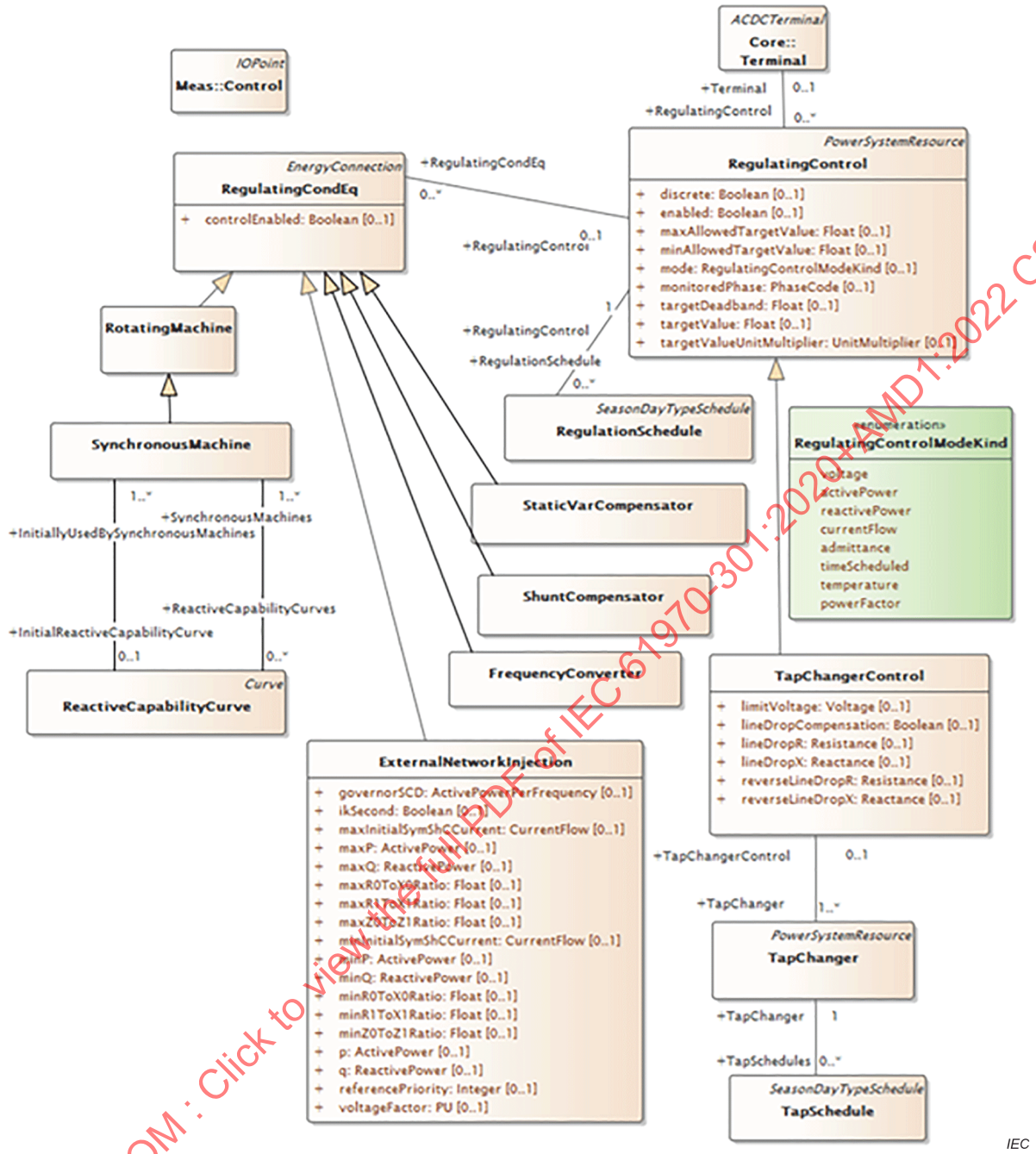


Figure 36 – Modèles de commande de régulation

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4.5.13 Modèle en courant continu pour le CIM

4.5.13.1 Introduction

4.5.13.1.1 Généralités

Les systèmes de commande qui modélisent l'interconnexion en courant continu à haute tension ont généralement trois niveaux de détail en matière de modélisation:

- le modèle simplifié d'injection n'utilisant pas le paquetage en courant continu du CIM;
- le modèle détaillé de courant continu à haute tension (CCHT) utilisant le paquetage en courant continu du CIM avec les postes CCHT fictifs;
- le modèle détaillé de courant continu à haute tension (CCHT) utilisant le paquetage en courant continu du CIM sans les postes CCHT fictifs.

Le présent document a pour objet de présenter le modèle de courant continu à haute tension le plus minimaliste possible pouvant être utilisé dans les calculs de flux de puissance de systèmes SCADA/EMS/de planification et de court-circuit et dans les études dynamiques. Les études transitoires ne sont pas couvertes.

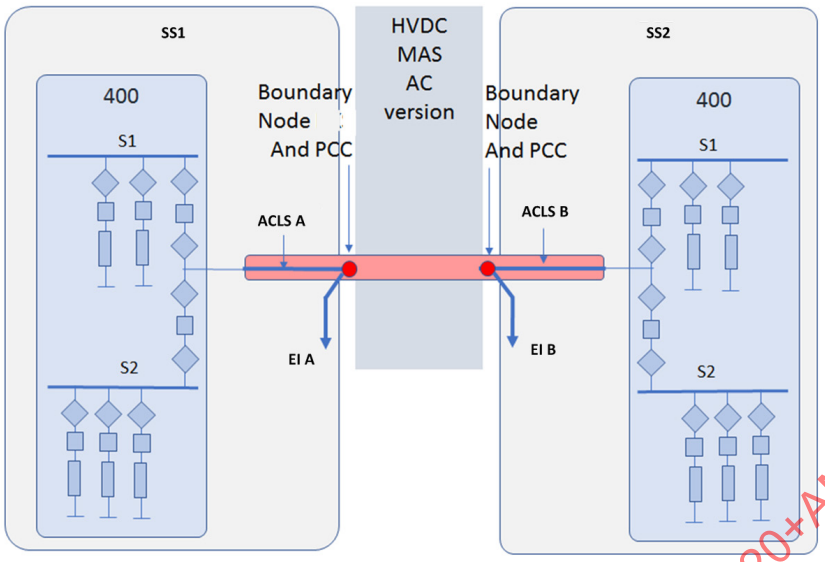
Les règles générales suivantes sont définies:

- le flux traversant un pôle en courant continu se rapporte au Point de couplage commun (PCC) aux extrémités d'un pôle. Ceci signifie que le PCC est toujours du côté du courant alternatif;
- le modèle détaillé CCHT utilisant le paquetage en courant continu du CIM sans postes CCHT fictifs constitue la modélisation préférentielle car il correspond à la méthode de construction des postes et de dénomination des équipements;
- les règles de commutation des filtres de courant alternatif des LCC ne sont pas prises en charge par la norme;
- le transformateur convertisseur est généralement raccordé aux commutateurs situés dans un VoltageLevel auquel le réseau en courant alternatif est raccordé;
- les filtres sont généralement situés dans le VoltageLevel auquel le transformateur convertisseur est raccordé;
- le transformateur convertisseur n'utilise aucun TapChangerControl, la fonction de commande est définie dans les ACDCConverter-s;
- la borne du côté haute tension du transformateur convertisseur, la plus proche du réseau en courant alternatif, doit être associée au point limite (Boundary Point)/point de connexion (Connection point) avec les autres MAS *(Master Authority Set* – Entité principale responsable des données);
- le transformateur convertisseur et chaque instance de ACDCConverter, appartenant au même pôle de poste, ainsi que tous les équipements de commande du convertisseur, les dispositifs essentiels de protection et de commutation et les appareils auxiliaires, le cas échéant, utilisés pour la conversion, doivent être contenus dans la même instance de conteneur cim:DCConverterUnit. Ceci s'applique également aux compensateurs shunt et série du côté basse tension du transformateur convertisseur et aux inductances de lissage en courant continu;
- en cas d'installations dos à dos, deux instances séparées de DCConverterUnit sont utilisées, chacune étant associée à un transformateur convertisseur;
- toutes les lignes et tous les câbles aériens raccordant deux postes ou plus doivent être contenus dans le même conteneur DCLine pour chaque pôle de système CCHT.

4.5.13.1.2 Modèle simplifié d'injection

Le modèle simplifié d'injection représenté à la Figure 37 raccorde les postes réels à chaque extrémité du pôle en courant continu à la Line comportant deux limites ConnectivityNodes (CN) ou TopologicalNodes dans le cas d'une représentation du modèle en topologie nodale, une pour chaque extrémité de pôle en courant continu. Les CN constituent également le Point de couplage commun (PCC) de chaque côté. Les postes réels raccordent la limite CN/PCC avec un ACLineSegment (ACLS) et une EquivalentInjection (EI).

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Anglais	Français
Boundary Node And PCC	Nœuds limites et PCC

Figure 37 – Exemple simplifié de représentation d'un modèle CCHT

Les éléments en bleu dans la Figure 37 représentent les objets dans un MAS régulier et les éléments en rouge représentent les objets dans une limite MAS.

Les ACLS "A", EI "A", ACLS "B" et EI "B" sont situés au niveau des PCC de chaque côté du pôle en courant continu. Les PCC représentent les nœuds limites ou les points de connexion convenus par les parties responsables du MAS de SS1 et SS2.

Pour un convertisseur de source de courant, la puissance réactive est fixée à zéro en partant du principe que la consommation de puissance réactive est maintenue à un niveau pratiquement nul par les filtres de courant alternatif. Si le poste à courant alternatif modélise les filtres de courant alternatif, la consommation de puissance réactive du LCC doit alors être prise en considération. La consommation de puissance réactive peut généralement être approchée par une demande en puissance réactive approximativement égale à 0,45-0,55 de la valeur absolue du transfert de puissance active. Lorsque les pôles CCHT sont remplacés par une représentation interne caractérisée par deux "modèles simplifiés d'injection CCHT", et que le transferr de puissance est modifié, la puissance réactive peut se maintenir à la même valeur. Ceci facilite l'application de la solution de flux de puissance sans nécessiter la commutation des filtres de courant alternatif.

Pour les convertisseurs de source de courant, les capacités de contrôle de la puissance réactive peuvent être définies en établissant les attributs EquivalentInjection.regulationCapability et regulatingStatus à True (vrai). Les limites minQ et maxQ ou la ReactiveCapabilityCurve associée doivent refléter la plage de capacité réactive si regulatingStatus est True (vrai).

4.5.13.1.3 Modèle détaillé CCHT utilisant le paquetage en courant continu du CIM et des postes CCHT fictifs

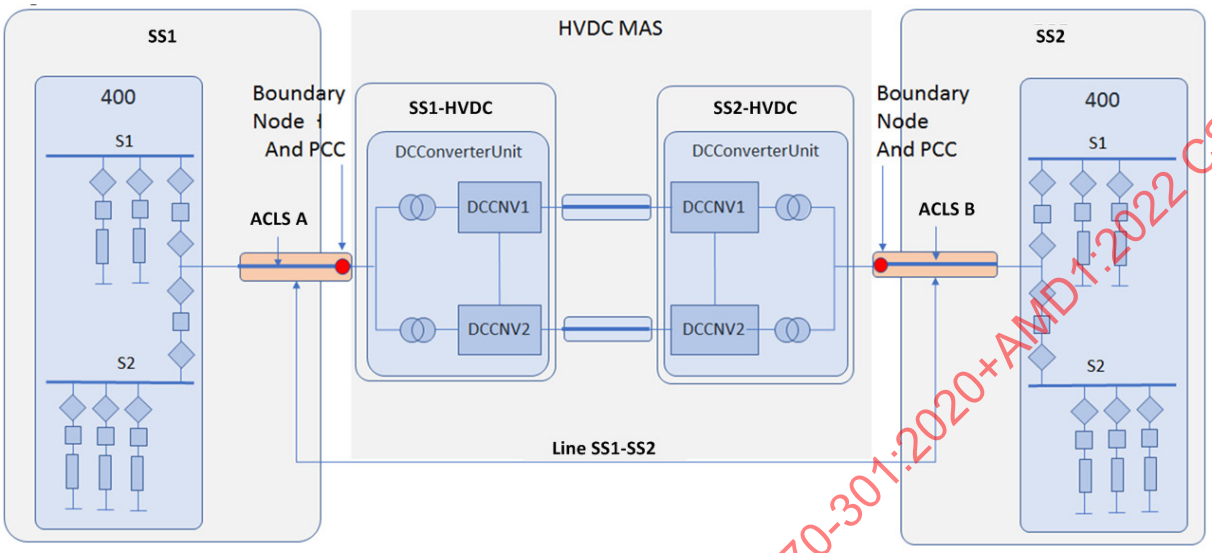
Un modèle détaillé comprend les éléments suivants:

- les postes réels de chaque côté de la connexion;
- la même limite que celle pour le modèle simplifié car dans tous les cas, les liaisons CCHT ont deux points limite/de connexion, voir 4.5.13.1.2;

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- pour chaque poste réel, un poste fictif qui représente la partie CCHT et se raccorde à la limite des PCC à chaque extrémité de pôle de courant continu.

La Figure 38 représente un modèle détaillé d'une connexion CCHT.



Anglais	Français
Boundary Node And PCC	Nœuds limites et PCC

Figure 38 – Exemple détaillé de représentation de modèle CCHT avec postes CCHT fictifs

Les éléments en bleu dans la Figure 38 représentent les objets dans un MAS régulier et les éléments en rouge représentent les objets dans la limite.

Les postes SS1 et SS2 constituent les postes réels, SS1-HVDC et SS2-HVDC constituent les postes fictifs avec l'équipement CCHT. "SS1-SS2" représente la limite Line avec les deux limites CN/PCC qui se raccordent aux pôles de courant continu.

Pour convertir un modèle détaillé en modèle simplifié, les postes CCHT fictifs sont retirés et les EI au niveau des PCC sont insérés.

4.5.13.1.4 Modèle détaillé CCHT utilisant le paquetage en courant continu du CIM sans postes CCHT fictifs

Le modèle CCHT préférentiel est constitué de tous les composants situés dans le poste réel sans postes fictifs ou limite Lines comme cela est représenté à la Figure 39.

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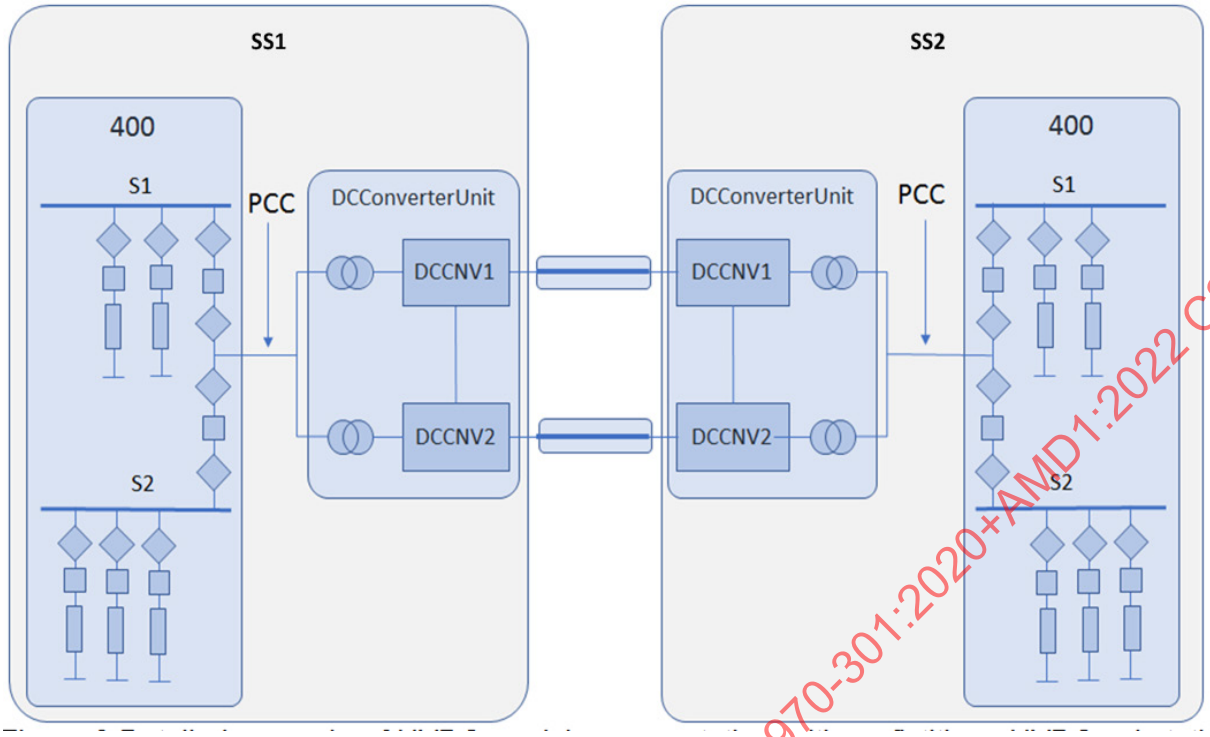


Figure 39 – Exemple détaillé de représentation de modèle CCHT sans postes CCHT fictifs

Un point limite dans un poste est défini par les flèches du PCC dans la Figure 39.

Il n'est pas facile de convertir un modèle détaillé CCHT utilisant le paquetage en courant continu du CIM sans postes CCHT fictifs en un modèle simplifié. Il doit tout d'abord être transformé en un modèle détaillé CCHT utilisant le paquetage en courant continu du CIM avec modèle de postes CCHT fictifs avant de pouvoir être converti.

4.5.13.2 Conception de base de courant continu à haute tension

4.5.13.2.1 Généralités

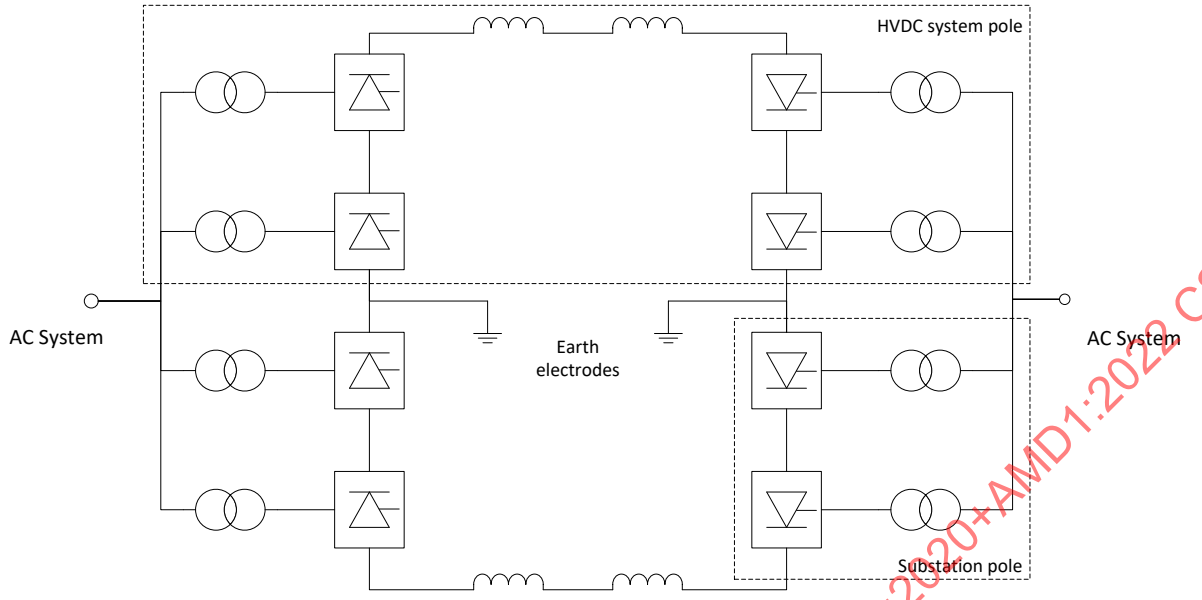
Le modèle proposé est issu des documents suivants:

- IEC 60633:1998+AMD1:2009, *Terminologie pour le transport d'énergie en courant continu à haute tension (CCHT);*
- "VSC Transmission", CIGRÉ B4-37, avril 2005;
- IEC 62747, *Terminologie relative aux convertisseurs de source de tension (VSC) des systèmes en courant continu à haute tension (CCHT);*
- HVDC Transmission by Dennis A. Woodford, Manitoba HVDC Research Centre;
- "ABB technical description of HVDC light technology";
- Flexible Power Transmission. Jos Arrillaga, Y. H. Liu, Neville R. Watson, 2007;
- "Power System Stability Benefits with VSC DC-Transmission Systems", CIGRÉ B4- 204, 2004.

4.5.13.2.2 Topologie d'un VSC (voltage source converter – convertisseur de source de tension)

Une liaison CCHT d'une source de courant est modélisée comme représenté à la Figure 40.

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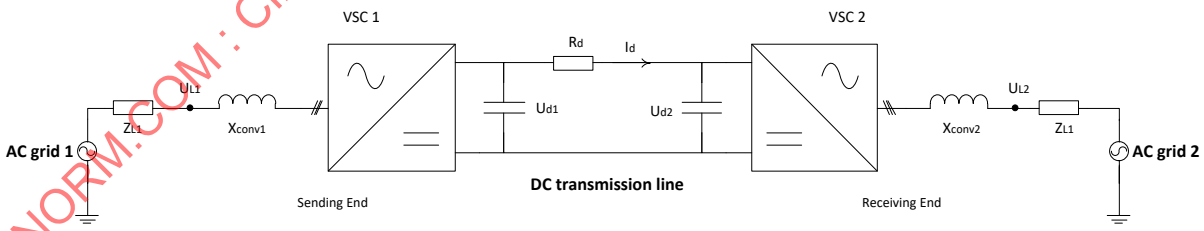


Anglais	Français
HVDC system pole	Pôle de système CCHT
AC System	Système en courant alternatif
Earth electrodes	Électrodes mises à la terre
Substation pole	Pôle du poste

Figure 40 – Liaison CCHT bipolaire issue de l'IEC 60633

Une liaison CCHT bipolaire est constituée de deux pôles, l'un avec une polarité positive et l'autre avec une polarité négative, les deux ayant leurs points naturels mis à la terre. Aucun flux de courant à la terre ne revient, car la circulation de courant dans les pôles est la même. Pour un CCHT CSC, le transformateur doit être modélisé de manière explicite.

4.5.13.2.3 Topologie d'un VSC (voltage source converter – convertisseur de source de tension)



Anglais	Français
AC grid 1	Réseau en courant alternatif 1
Sending end	Extrémité émettrice
DC transmission line	Ligne de transport de courant continu
Receiving end	Extrémité de réception
AC grid 2	Réseau en courant alternatif 2

Figure 41 – Schéma de transport point à point par un VSC

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Le schéma de transport point à point par un VSC représenté à la Figure 41 est constitué de deux VSC interconnectés du côté courant continu par le biais d'une ligne de transport de courant continu et connectés aux deux différents systèmes en courant alternatif du côté courant alternatif. L'une des caractéristiques du VSC est que la polarité de la tension continue est toujours la même. Par conséquent, le sens du flux de puissance sur la ligne de courant continu est déterminé par le sens du courant continu.

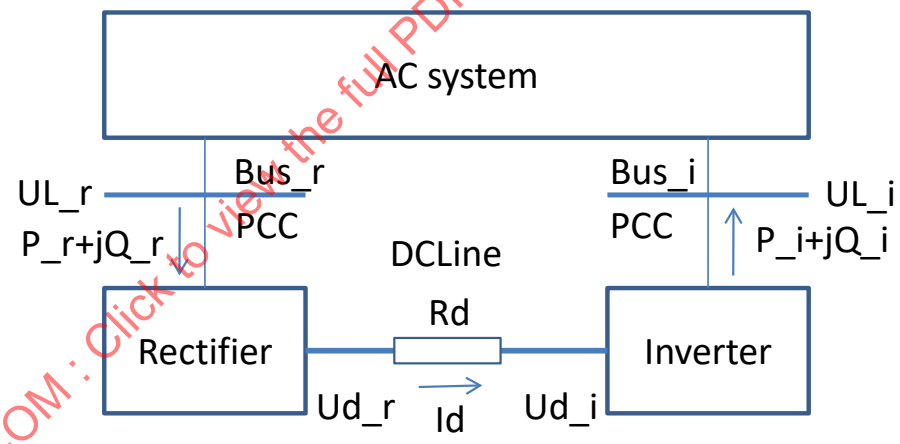
Le sens du courant continu va toujours du niveau de tension continue le plus élevé au niveau de tension continue le plus faible. La tension continue à l'extrémité émettrice de la ligne de courant continu doit, par conséquent, être plus élevée que la tension continue à l'extrémité de réception.

Dans un convertisseur commuté en ligne CCHT, le flux de puissance en courant continu peut être commandé en maintenant la tension continue au niveau du convertisseur à l'extrémité de réception (l'onduleur) à une valeur constante, et en laissant le convertisseur à l'extrémité émettrice (le redresseur) commander le courant continu. La même approche peut être utilisée pour le transport par VSC. Cependant, une des principales différences est que dans un convertisseur commuté en ligne CCHT, le sens du courant est toujours le même. Par conséquent, le sens de la puissance est modifié lors de la modification de la polarité de la tension continue.

4.5.13.3 Modélisation de flux de puissance CCHT

4.5.13.3.1 Généralités

Un modèle de flux de puissance dérivé de la Figure 41 est représenté à la Figure 42.



Anglais	Français
AC system	Système en courant alternatif
Rectifier	Redresseur
Inverter	Onduleur
PCC = Point of Common Coupling	PCC = point de couplage commun

Figure 42 – Modèle de flux de puissance CCHT

Les variables côté courant alternatif sont les suivantes:

- P est l'injection de puissance active côté courant alternatif au niveau du redresseur (indice r) et de l'onduleur (indice i);

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- Qest l'injection de puissance réactive côté courant alternatif au niveau du redresseur (indice r) et de l'onduleur (indice i);
- U_{L} est l'injection de tension côté courant alternatif au niveau du redresseur (indice r) et de l'onduleur (indice i).

Les variables côté courant continu sont les suivantes:

- U_{d} est l'injection de tension côté courant continu au niveau du redresseur (indice r) et de l'onduleur (indice i);
- U_{dN} est la tension continue assignée;
- I_{d} est le courant de la ligne de courant continu;
- I_{dN} est le courant assigné de la ligne de courant continu;
- R_{d} est la résistance de la ligne de courant continu.

L'interface entre le système CCHT et le système en courant alternatif est établie par les deux bus Bus_r et Bus_i. La tension aux bornes de Bus_r est $U_{\mathrm{L_r}}$ et la tension aux bornes de Bus_i est $U_{\mathrm{L_i}}$. La puissance injectée dans le redresseur depuis le système en courant alternatif est $P_{\mathrm{r}} + jQ_{\mathrm{r}}$ et la puissance injectée dans l'onduleur est $P_i + jQ_{\mathrm{i}}$. Les bus Bus_r et Bus_i proviennent du système en courant alternatif et sont perçus comme des nœuds PQ pour une source de courant CCHT et comme nœuds PV pour une source de tension CCHT. Pour les nœuds PQ, les injections $P_{\mathrm{r}} + jQ_{\mathrm{r}}$ et $P_{\mathrm{i}} + jQ_{\mathrm{i}}$ et pour les nœuds PV, l'injection de puissance active et la tension $P_{\mathrm{r}}, UL_{\mathrm{r}}$ et $P_{\mathrm{i}}, UL_{\mathrm{i}}$ sont calculées à partir de la liaison CCHT. Les conditions initiales de la liaison CCHT sont fournies de deux manières:

- P_{r} ou P_{i} ;
- $U_{\mathrm{d_r}}$ ou $U_{\mathrm{d_i}}$.

La relation entre les variables est donnée par $I_d = P_{\mathrm{r}}/U_{d_{\mathrm{r}}} = P_{\mathrm{i}}/U_{\mathrm{d}_i}$.

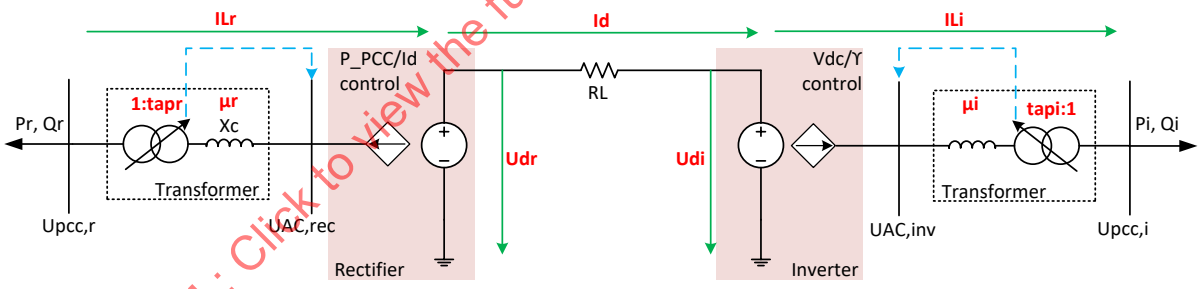


Figure 43 – Modèle détaillé de flux de puissance CCHT

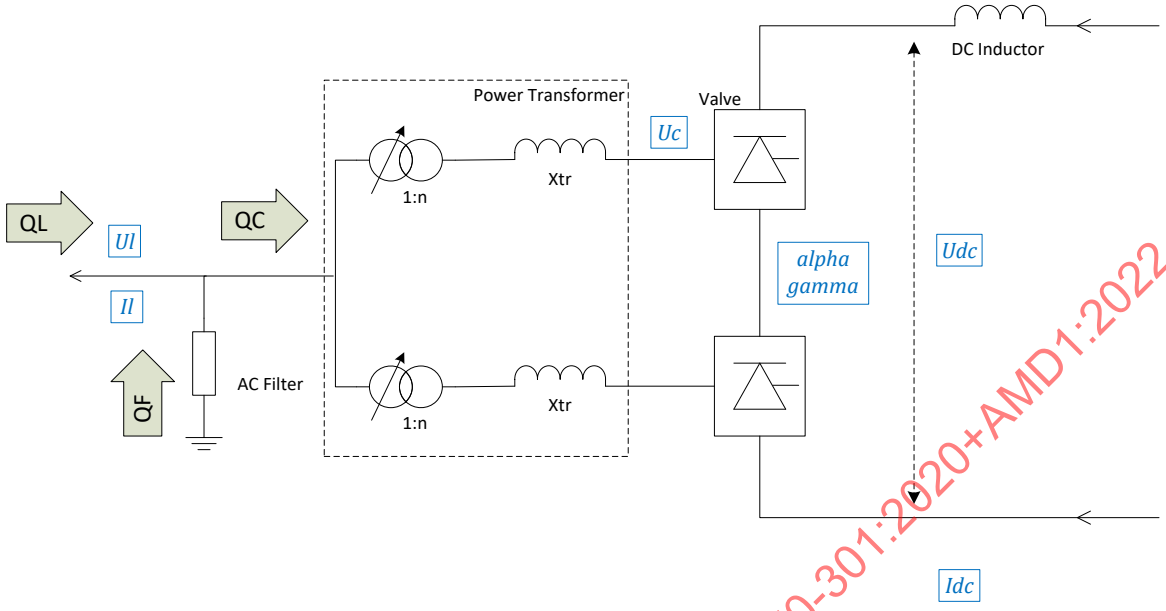
La puissance active et la puissance réactive au niveau des PCC sont dérivées, pour les convertisseuts sans pertes, par les équations suivantes:

- $P_{\mathrm{r}} = U_{\mathrm{dr}} * I_{\mathrm{d}}$;
- $Q_{\mathrm{r}} = U_{\mathrm{d0r}} * I_{\mathrm{d}} * \frac{\sin 2\alpha - \sin 2(\alpha - \mu_r) + 2\mu_r}{4*(\cos\alpha - \cos(\alpha + \mu_r))}$;
- $P_i = -U_{\mathrm{d}i} * I_{\mathrm{d}}$
- $Q_i = U_{\mathrm{d0}i} * I_{\mathrm{d}} * \frac{\sin 2\gamma - \sin 2(\gamma - \mu_r) + 2\mu_r}{4*(\cos\gamma - \cos(\gamma + \mu_r))}$.

Le flux de puissance est représenté à la Figure 44 et à la Figure 45.

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4.5.13.3.2 Convertisseur de source de courant (CSC)



Anglais	Français
DC inductor	Inductance de courant continu
Power transformer	Transformateur de puissance
Valve	Valve
AC filter	Filtre de courant alternatif

Figure 44 – Flux de puissance d'un convertisseur de source de courant

Dans un convertisseur de source de courant, la puissance réactive n'est pas commandée. Au lieu de cela, elle est déterminée par l'angle d'amorçage de pont qui affecte le facteur de puissance. Les équations des CSC exigent une commande en cascade de la réactance de commutation, du changeur de prises et de l'angle d'amorçage. La réactance de commutation pour les CsConverters est fondée sur le PowerTransformer qui appartient à DcConverterUnit, c'est-à-dire que l'impédance du transformateur convertisseur est utilisée en tant que Xc. La commande du changeur de prises pour le réglage de l'angle d'amorçage utilise également les données du changeur de prises du transformateur convertisseur. Dans le cas d'un changeur de prises partagé dans les configurations à 2 ponts à 6 impulsions (transformateur convertisseur à 3 enroulements), les ponts à 6 impulsions doivent être commandés en maître/esclave.

Les équations suivantes doivent être prises en compte:

- $U_{\mathrm{d}} = U_{\mathrm{d0}} * \cos\alpha - \left(\frac{3}{\pi}\right) * X_{\mathrm{tr}} * I_{\mathrm{d}} * B$ ou $U_{\mathrm{d}} = U_{\mathrm{d0}} * \cos\gamma - \left(\frac{3}{\pi}\right) * X_{\mathrm{tr}} * I_{\mathrm{d}} * B$;
- $\varphi \approx cos^{-1}\left(\frac{V_d}{V_{d0}}\right)$;
- $P = V_{\mathrm{d}} * I_{\mathrm{d}} = P_{\mathrm{ac}}$;
- $Q = P * tan\varphi$
- tension continue assignée: $U_{\mathrm{d0}} = ((3 * \sqrt{2})/\pi) * U_{\mathrm{C}} * B * T$;
- $U_{\mathrm{t}} = U_{\mathrm{L}} * tapratio$.

L'approximation de l'injection de puissance réactive peut être présentée de la manière suivante:

- $Q_{\mathrm{L}} = Q_{\mathrm{C}} - Q_{\mathrm{F}} = \left(\frac{P}{2}\right) - Q_{\mathrm{F}} \approx \frac{P}{2}$

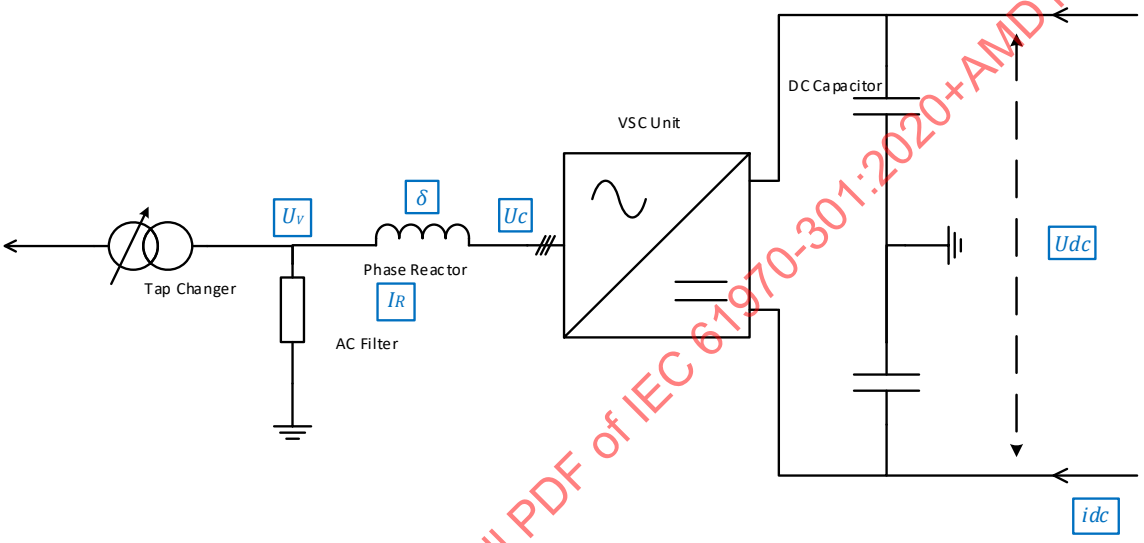
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où:

- α – angle d'amorçage;
- B – nombre de ponts en séries;
- T – rapport des nombres de spires du transformateur;
- I_d, V_d – courant continu et tension continue par pôle.

4.5.13.3.3 Convertisseur de source de tension

Les composants électriques et leurs interconnexions au sein d'un convertisseur sont représentés à la Figure 45. La Figure 45 sert de référence pour les formules en 4.5.13.3.



Anglais	Français
Tap Changer	Changeur de prises
Phase Reactor	Composant réactif de phase
VSC Unit	Unité de VSC
DC Capacitor	Condensateur de courant continu
AC Filter	Filtre de courant alternatif

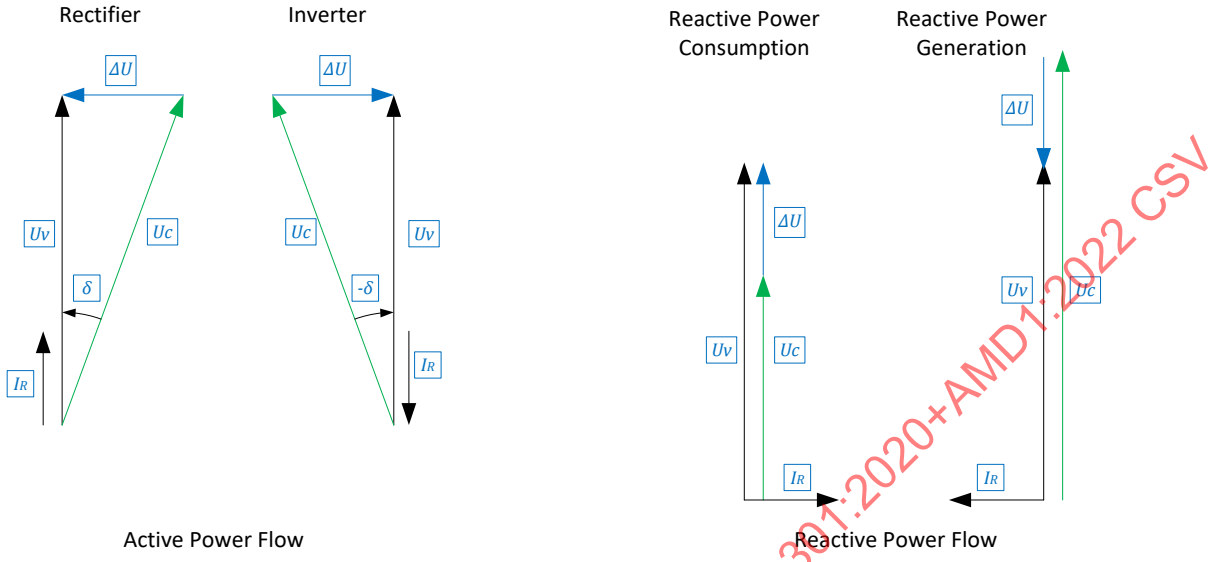
Figure 45 – Flux de puissance d'un convertisseur de source de tension

Les paramètres supplémentaires qui viennent s'ajouter à ceux énumérés précédemment sont les suivants:

- U_{dc} est la tension côté courant continu du VSC;
- I_{dc} est le courant côté courant continu du VSC;
- U_C est la tension côté courant alternatif du VSC, également appelée tension du convertisseur;
- U_V est la tension aux bornes du bus du filtre;
- l'indice de modulation est le rapport entre U_{dc} et U_C. Il s'agit d'un paramètre du VSC dont les valeurs types sont comprises entre 0 et 1;
- I_R est le courant qui circule dans le composant réactif de phase;
- X_C est la réactance du composant réactif de phase;
- δ est l'angle entre les tensions U_V et U_C.

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Les diagrammes de la Figure 46 représentent les vecteurs de tension et les cas de flux de puissance subséquents.



Anglais	Français
Rectifier	Redresseur
Inverter	Onduleur
Reactive Power Consumption	Consommation de puissance réactive
Reative Power Generation	Production de puissance réactive
Active Power Flow	Flux de puissance active
Reactive Power Flow	Flux de puissance réactive

Figure 46 – Cas de flux de puissance

Le comportement du redresseur et de l'onduleur peut être décrit par un ensemble de formules ayant les mêmes paramètres, dont certains sont représentés à la Figure 42 et la Figure 45.

- U_{rated} est la tension continue assignée du convertisseur (une de chaque pour le redresseur et l'onduleur).
- S_{rated} est la puissance continue assignée du convertisseur.
- R_{C} est la résistance du composant réactif de phase
- nombre de ponts de convertisseur (un de chaque pour le redresseur et l'onduleur)
- I_{dmax} et I_{dmin} sont les limites supérieure et inférieure du flux en courant continu.
- R_{d} est la résistance de la ligne de courant continu.
- Les composants actif et réactif (voir la Figure 46) sont calculés par $P = U_{\text{V}} * U_{\text{C}} * (\sin(\delta)/X_{\text{C}})$
- $Q = U_{\text{V}} * (U_{\text{V}} - U_{\text{C}}) * (\cos(\delta)/X_{\text{C}})$

Les pertes au niveau d'un pôle sont décrites par l'équation:

- $P(poleLoss) = idleLossFactor + switchLossFactor * I_{\text{dc}} + resistiveLossFactor * I_{\text{dc}} + resistiveLossFactor * I_{\text{dc}}^2$

Où:

- $P_{\text{dc}} = P_{\text{ac}}$ pour un fonctionnement sans perte;

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- $P_{dc} = P_{ac} - P_{loss}$ pour un fonctionnement du redresseur avec des pertes;
- $P_{dc} = P_{ac} + P_{loss}$ pour un fonctionnement de l'onduleur avec des pertes.

La Figure 47 représente un diagramme de convertisseur de source de tension à monopole symétrique.

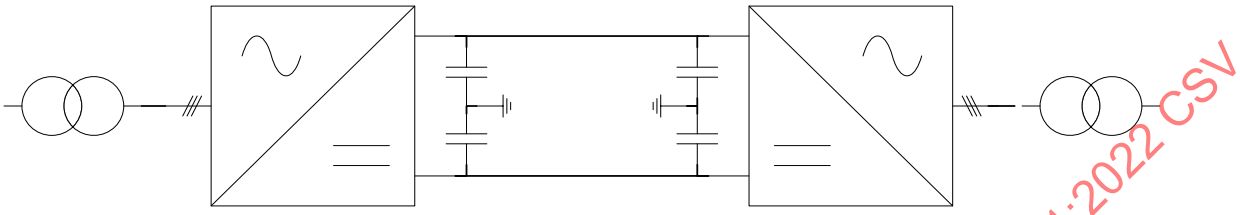
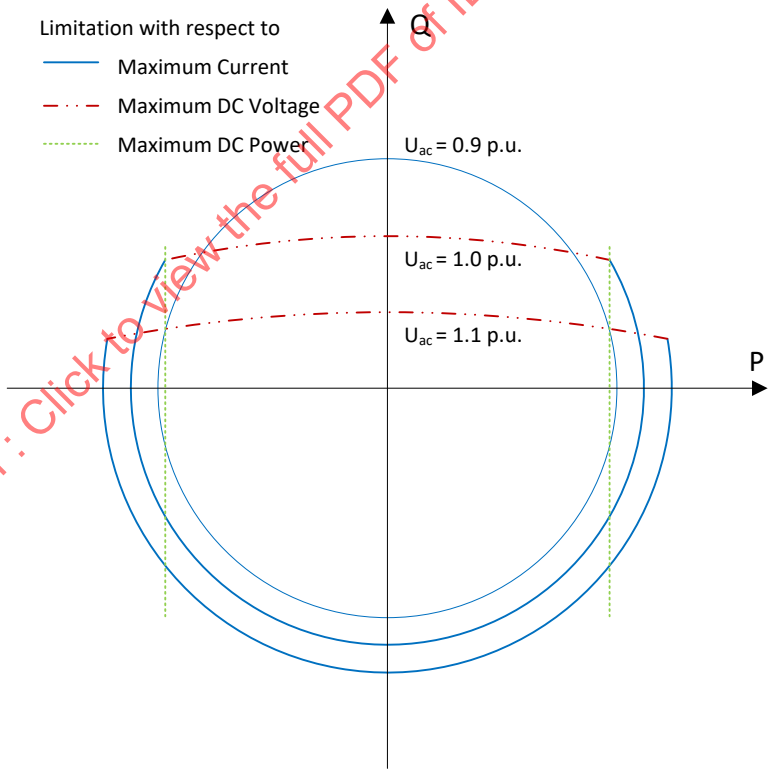


Figure 47 – Transport par VSC à monopole symétrique représenté avec mise à la terre capacitive côté courant continu (IEC 62747)

En commandant l'angle δ entre les tensions U_V/U_C et l'écart de tension $U_V - U_C$, la commande indépendante des puissances active et réactive est possible.

Les limites des résultats donnés par le VSC donnent lieu à une courbe P-Q. Un exemple de courbe P-Q est représenté à la Figure 48.



Anglais	Français
Limitation with respect to	Limite relative
Maximum Current	À l'intensité maximale
Maximum DC Voltage	À la tension continue maximale
Maximum DC Power	À la puissance continue maximale

Figure 48 – Courbe de capacité P-Q du VSC

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Le VSC peut également être utilisé dans les configurations bipolaires, comme représenté à la Figure 49.

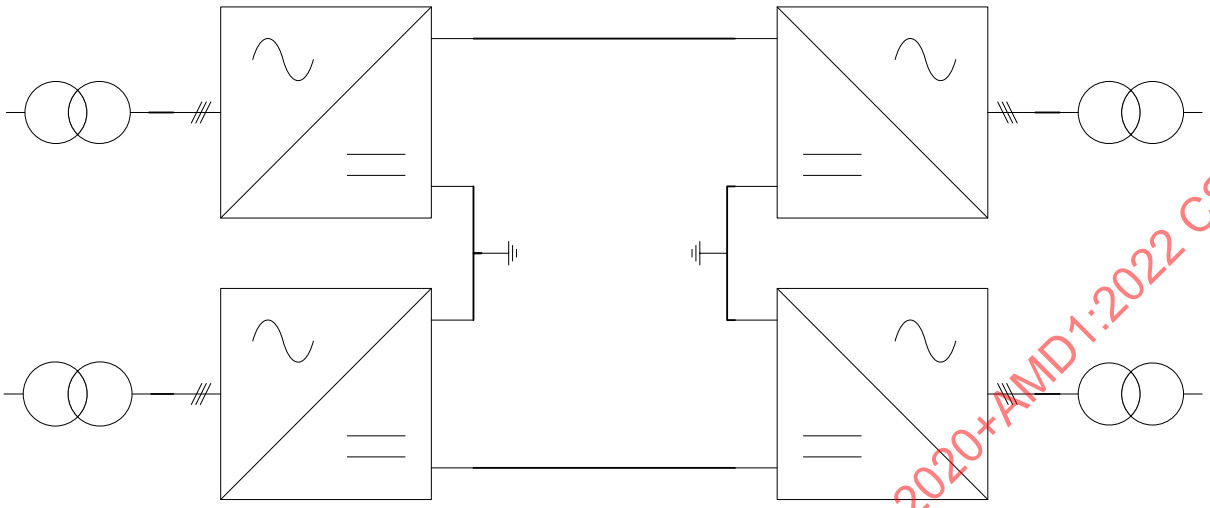


Figure 49 – Transport par VSC bipolaire avec retour par la terre (IEC 62747)

Dans cette configuration, deux câbles CCHT sont utilisés pour les tensions positives (+DC) et négatives (−DC). Une tension médiane est utilisée pour le neutre.

4.5.13.4 Modèle de données

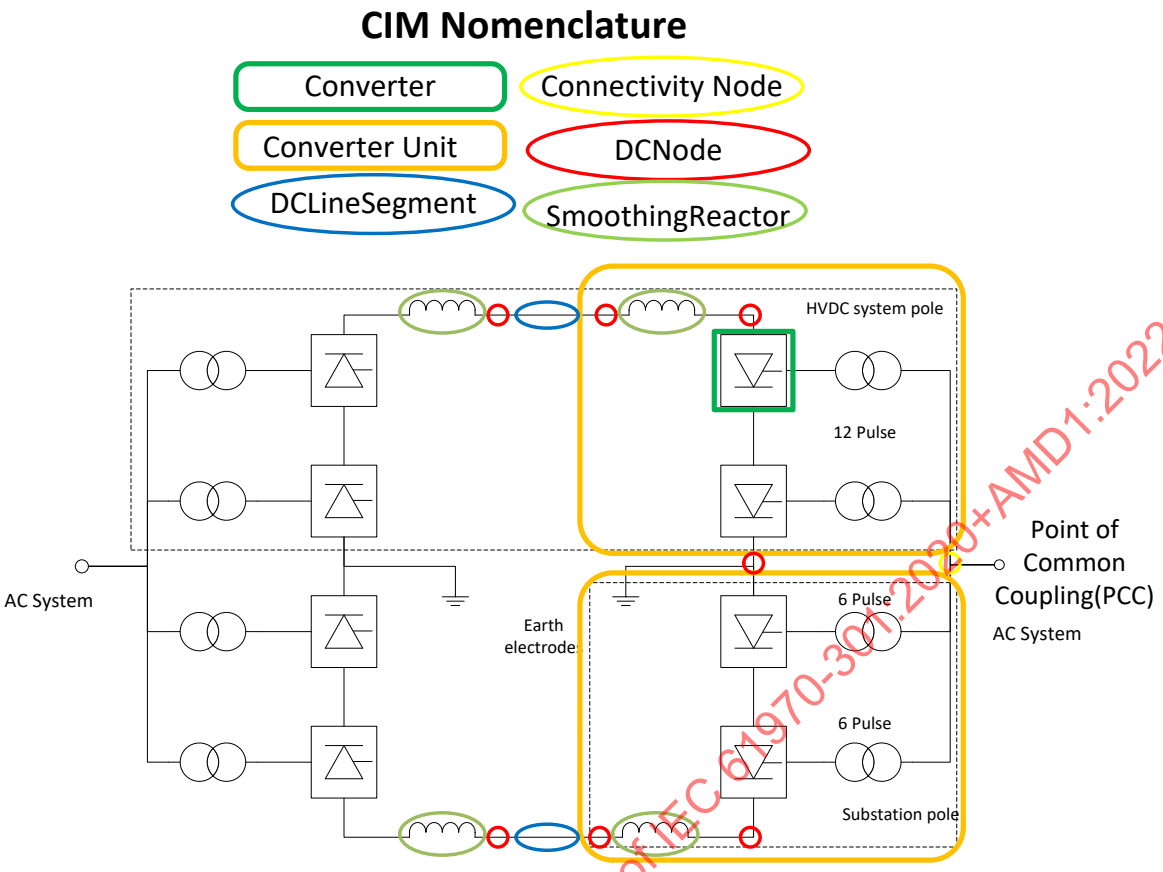
4.5.13.4.1 Généralités

Un modèle de données est créé sur la base des hypothèses suivantes.

- La DCConverterUnit du CIM est identique à celle du pôle de poste de l'IEC 60633 qui est un conteneur.
- Le pôle de système de l'IEC 60633 n'est pas modélisé dans le CIM. Cela s'explique par le fait que le pôle de système de l'IEC°60633 n'est pas pertinent pour les réseaux en courant continu. Les ponts, les filtres et les montages en pont ne sont pas explicitement modélisés dans le CIM et sont considérés comme faisant partie du Converter.
- L'utilisation de ConnectivityNode et Terminal également pour la connectivité dans les réseaux en courant continu établit une connexion ensemble des composants en courant continu et en courant alternatif, c'est-à-dire une erreur. Les attributs ont également différentes significations dans les réseaux en courant alternatif et en courant continu. Par exemple, DCNode n'a pas d'angle de phase ou d'injection de puissance réactive. Par conséquent, les artéfacts sont utilisés pour décrire les réseaux en courant alternatif et en courant continu.

La Figure 50 donne un exemple d'objets modélisés d'une ligne CCHT de source bipolaire de courant.

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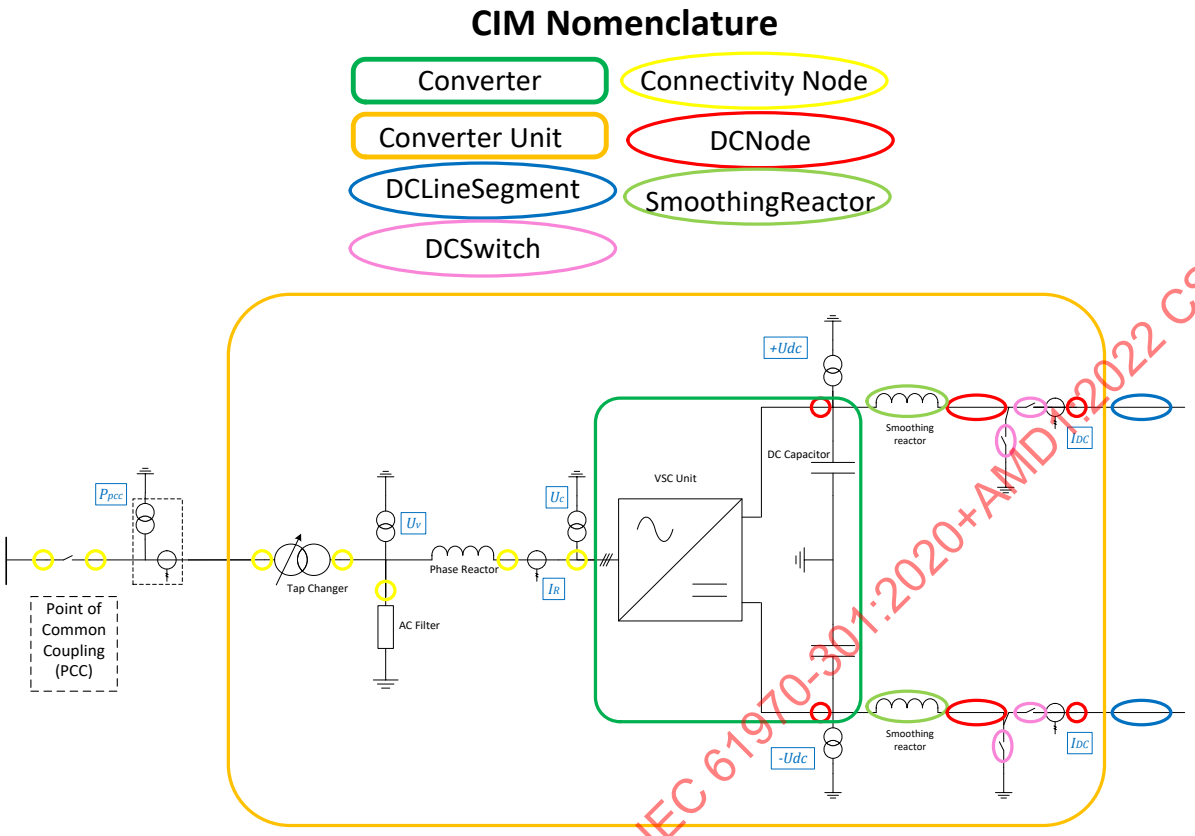
Anglais	Français
CIM Nomenclature	Nomenclature du CIM
Converter	Convertisseur
Connectivity Node	Nœud de connectivité
Converter Unit	Unité de convertisseur
DCNode	DCNode
DCLineSegment	DCLineSegment
SmoothingReactor	SmoothingReactor
HVDC System pole	Pôle du système CCHT
12 Pulse	12 impulsions
AC system	Système en courant alternatif
Earth electrode	Électrode de mise à la terre
Point of Common Coupling (PCC)	Point de couplage commun (PCC)
Substation pole	Pôle du poste

Figure 50 – Instances d'objets d'une ligne CCHT de source bipolaire de courant

La Converter Unit (unité de convertisseur) est l'objet qui établit un pont entre les réseaux en courant alternatif et ceux en courant continu.

Le diagramme correspondant pour les VSC est représenté à la Figure 51.

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Anglais	Français
CIM Nomenclature	Nomenclature du CIM
Converter	Convertisseur
Connectivity Node	Nœud de connectivité
Converter Unit	Unité de convertisseur
DCNode	DCNode
DCLineSegment	DCLineSegment
SmoothingReactor	SmoothingReactor
DCSwitch	DCSwitch
Point of Common Coupling (PCC)	Point de couplage commun (PCC)
Tap changer	Changeur de prises
AC Filter	Filtre de courant alternatif
Phase Reactor	Composant réactif de phase
VSC Unit	Unité de VSC
DC Capacitor	Condensateur de courant continu
Smoothing reactor	Inductance de lissage

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Figure 51 – Instances d'objets d'un modèle de données CCHT d'un VSC à monopole symétrique

Comme indiqué dans la Figure 50 et la Figure 51, un poste CCHT est constitué

- d'un ou de plusieurs convertisseurs;
- de SmoothingReactors (inductances de lissage);

- de commutateurs de courant continu pour la reconfiguration des lignes de courant continu;
- d'un point de couplage commun qui établit l'interface avec le système en courant alternatif.

Un Converter est constitué d'un ou de plusieurs ensembles des éléments suivants:

- des ponts;
- un PowerTransformer;
- un filtre de courant alternatif;
- un convertisseur ou un composant réactif de phase pour VSC, dans les systèmes CCHT à plusieurs niveaux, plusieurs Bridges (ponts) existent dans les bras de convertisseur. L'inductance de Converter fait alors partie des bras plutôt que d'être une inductance unique comme représentée à la Figure 51;
- des disjoncteurs et des sectionneurs.

La HVDC Link (liaison CCHT) peut être établie de plusieurs manières:

- bipolaire, voir la Figure 49;
- monopole symétrique avec mise à la terre capacitive côté courant continu, voir la Figure 47;
- monopole asymétrique avec retour par la terre – cette capacité de puissance active inférieure et le fonctionnement prolongé ne sont pas admis;
- monopole asymétrique avec retour métallique – cette capacité de puissance active inférieure et le fonctionnement prolongé sont admis.

Un Converter comprenant plusieurs Bridges peut avoir la capacité de reconfigurer la manière dont les Bridges sont connectés. Une reconfiguration donne normalement lieu à une réduction des limites assignées.

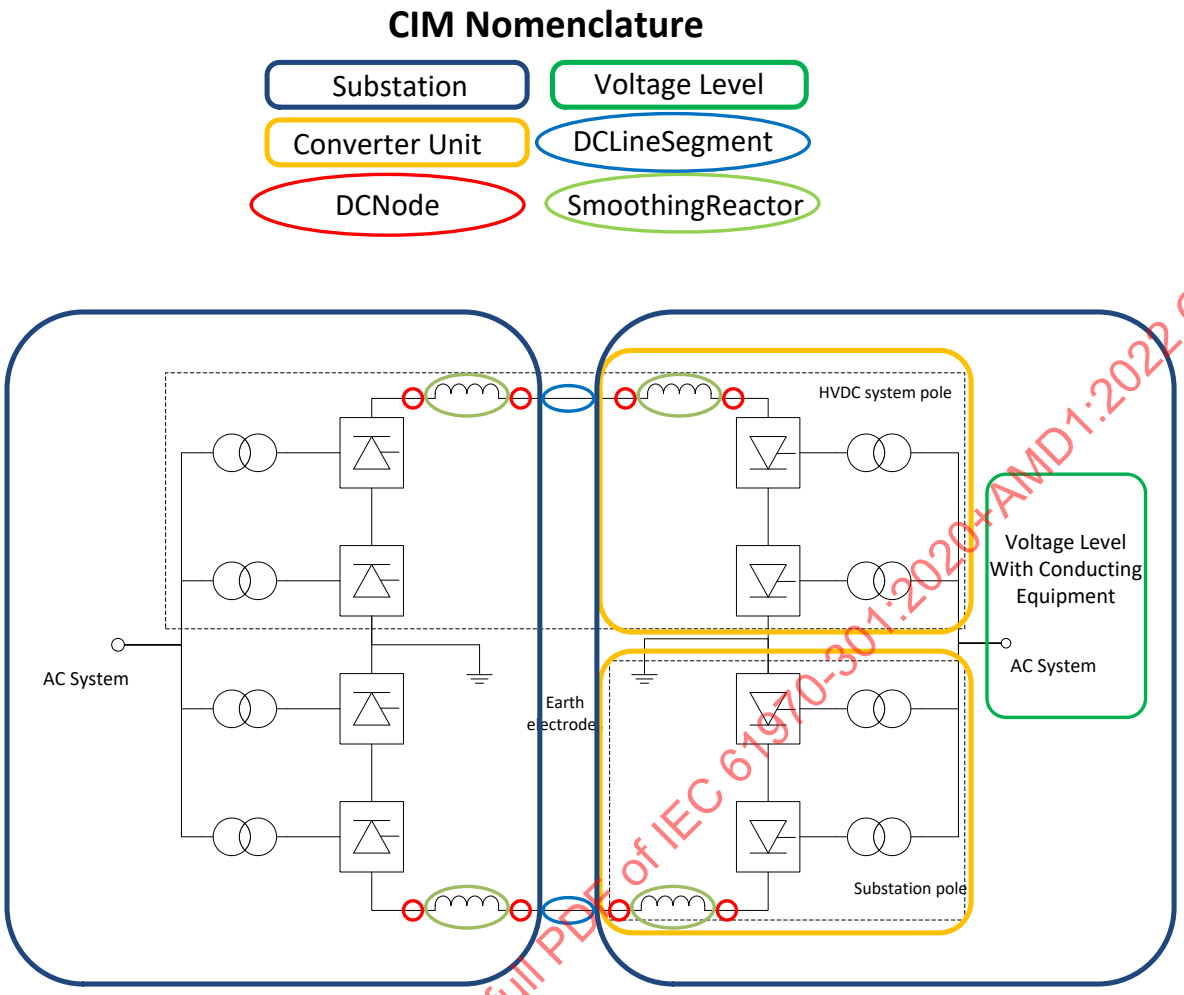
Un poste CCHT envoie l'état opérationnel sous forme des signaux SCADA à un SCADA supérieur. Dans le mode de fonctionnement bipolaire, la réduction des limites assignées du Converter est généralement envoyée au SCADA de niveau supérieur.

Les structures d'emboîtement pour deux cas distincts sont représentées à la Figure 52 et à la Figure 53.

- Pour les transformateurs, noter qu'ils ne sont pas situés dans un Substation (poste), mais dans une DCConverterUnit.
- Aucun VoltageLevel n'existe des côtés haute tension et basse tension d'un transformateur.

Par conséquent, les règles d'emboîtement pour les transformateurs du réseau en courant alternatif sont remplacées par des règles spécifiques au DCConverterUnit.

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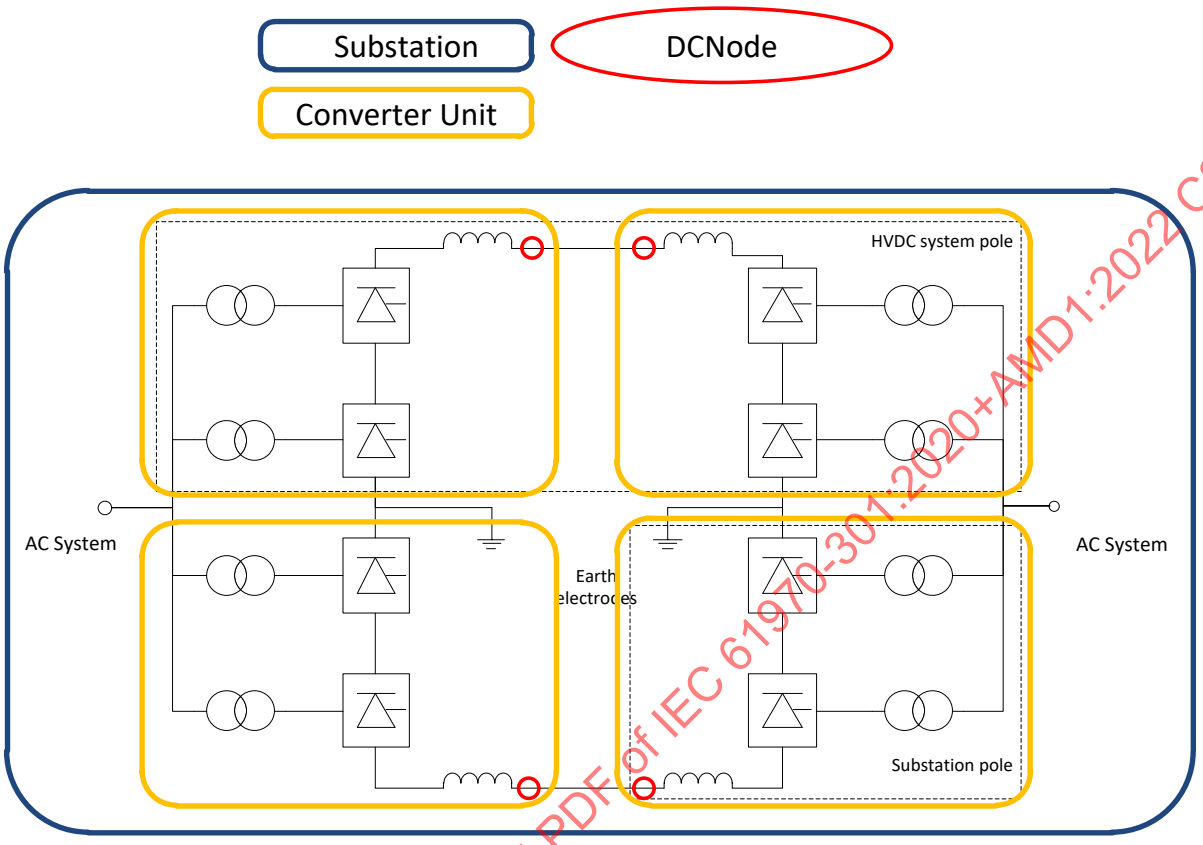
Anglais	Français
CIM Nomenclature	Nomenclature du CIM
Substation	Poste
Converter Unit	Unité de convertisseur
DCLineSegment	DCLineSegment
DCNode	DCNode
SmoothingReactor	SmoothingReactor
HVDC system pole	Pôle du système CCHT
AC system	Système en courant alternatif
Earth electrode	Electrode de mise à la terre
Voltage Level with Conducting Equipment	Niveau de tension avec équipement conducteur
Substation pole	Pôle du poste

Figure 52 – Structure d'emboîtement d'une ligne CCHT bipolaire

Les deux DCLineSegments font partie d'une Line. Cela s'explique par le fait que les DCLineSegments sont généralement au même pylône ou dans le même caniveau.

Les deux postes sont des Substations normaux qui mélangent des équipements en courant continu et en courant alternatif. La DCConverterUnit et les Converters sont au niveau Substation et sont connectés à l'équipement en courant alternatif d'un VoltageLevel.

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Anglais	Français
CIM Nomenclature	Nomenclature du CIM
Substation	Poste
Converter Unit	Unité de convertisseur
DCNode	DCNode
HVDC system pole	Pôle du système CCHT
AC system	Système en courant alternatif
Earth electrodes	Electrodes de mise à la terre
Substation pole	Pôle du poste

Figure 53 – Structure d'emboîtement d'un poste CCHT bipolaire dos à dos

4.5.13.4.2 Réseaux en courant continu

Les réseaux en courant continu utilisent des commutateurs pour reconfigurer les DCLine-s du réseau. Pour ce faire, il est important d'inclure les commutateurs dans le modèle et de les placer aux emplacements appropriés du réseau. La Figure 51 représente une DCLine connectée à un Converter avec une disposition simple de commutateurs. Étant donné que l'inductance de lissage appartient au Substation plutôt qu'à la DCLine, elle ne peut pas être comprise comme l'inductance de la DCLine. Pour le réseau en courant continu, les connexions DCLine entrantes établies avec le Converter ont plus de commutateurs, et il est nécessaire que le modèle d'informations prenne ceci en charge. Le traitement de la topologie du réseau en courant continu est exigé de la même manière que le traitement de la topologie du réseau en courant alternatif déjà effectué.

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4.5.13.4.3 Topologie

La connectivité de base d'un système en courant alternatif est représentée à la Figure 54.

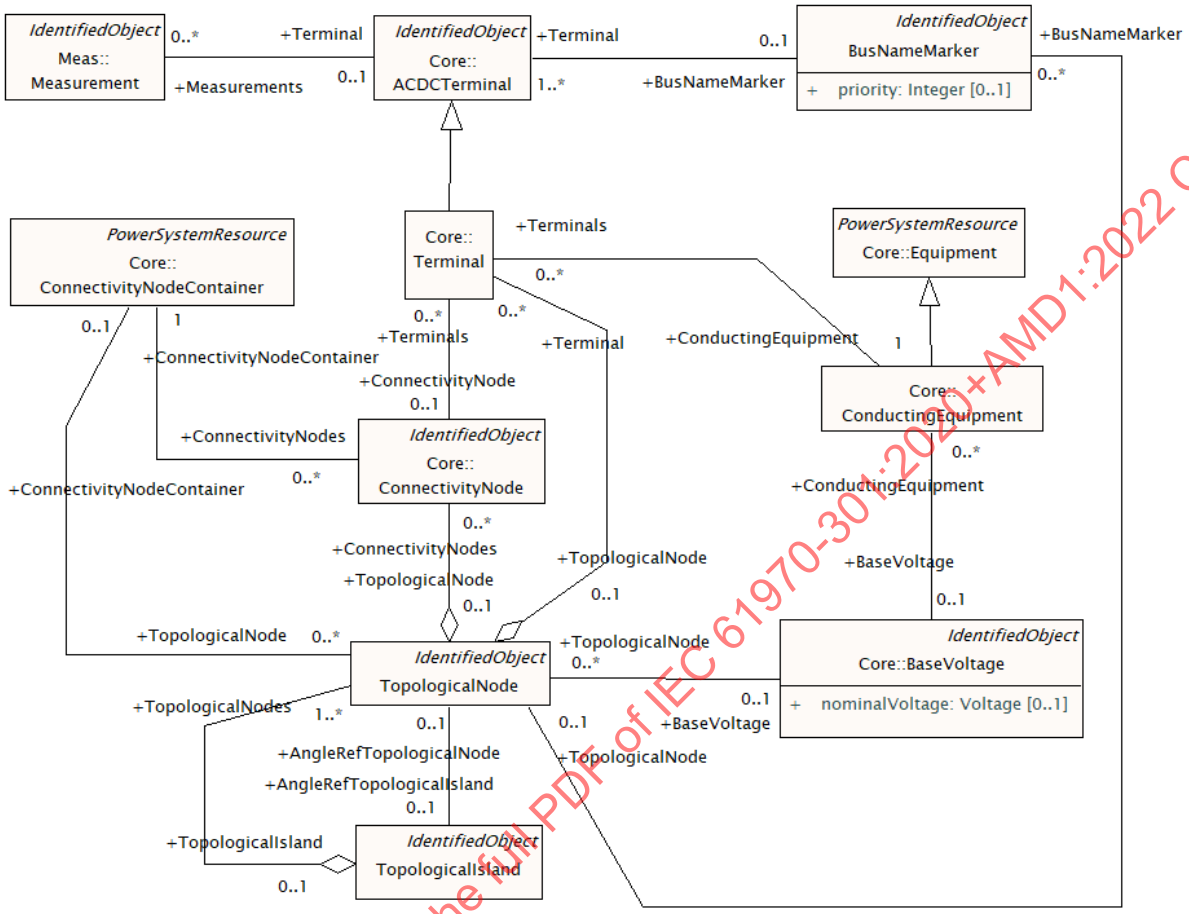


Figure 54 – Topologie de base (Basic) dans le paquetage Core

Comme représenté à la Figure 54, la Terminal est utilisée uniquement pour ConductingEquipment en courant alternatif. Une nouvelle classe ACDCTerminal a été ajoutée pour conserver les caractéristiques communes en courant alternatif et en courant continu.

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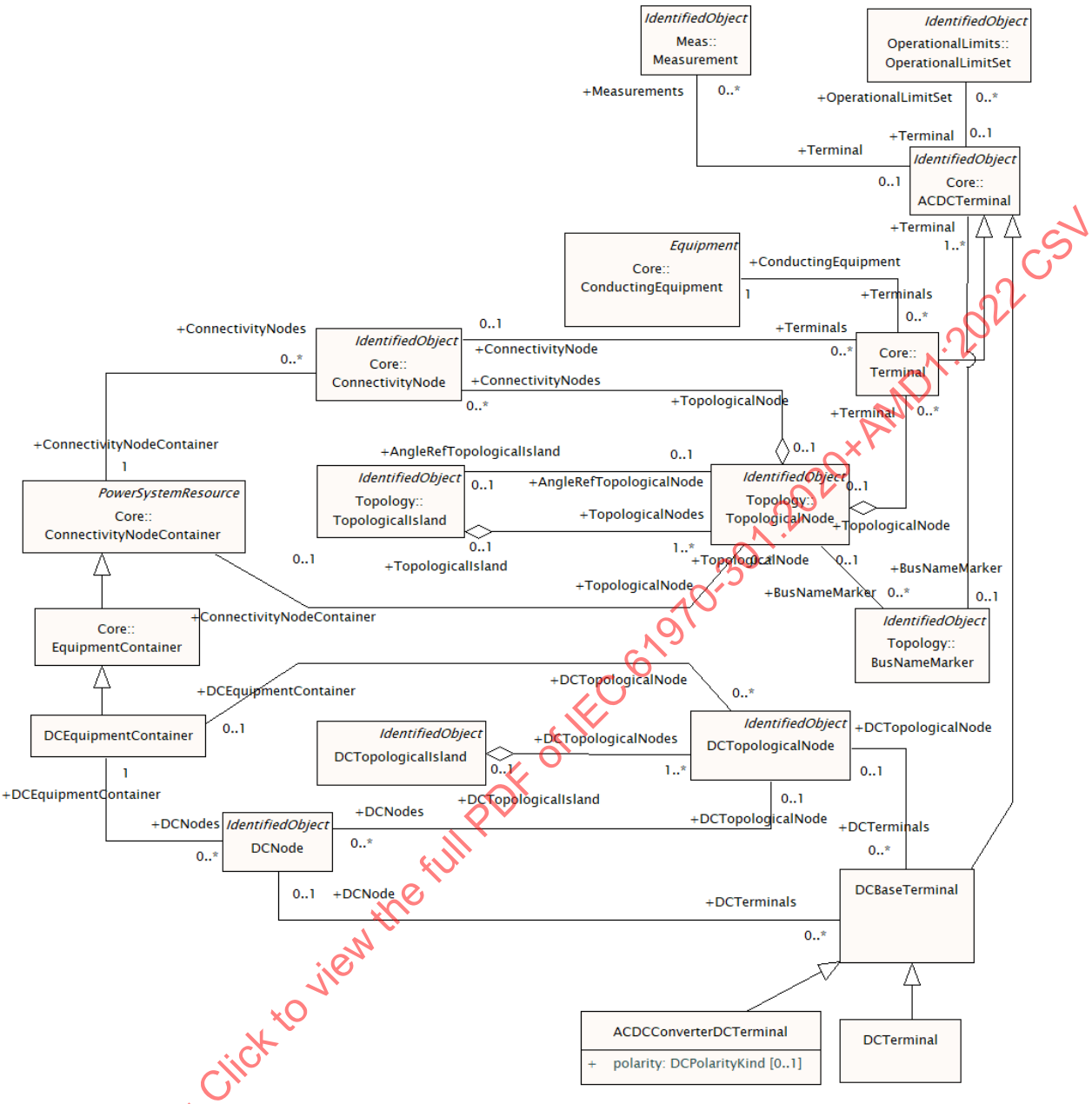


Figure 55 – Topologie en courant continu et en courant alternatif

Comme représenté à la Figure 55, le modèle ConductingEquipment-Terminal-ConnectivityNode provenant du réseau en courant alternatif est répété pour le réseau en courant continu avec les classes DCConductingEquipment-DCTerminal-DCNode.

4.5.13.4.4 Equipment

Le modèle d'Equipment à courant continu est représenté à la Figure 56.

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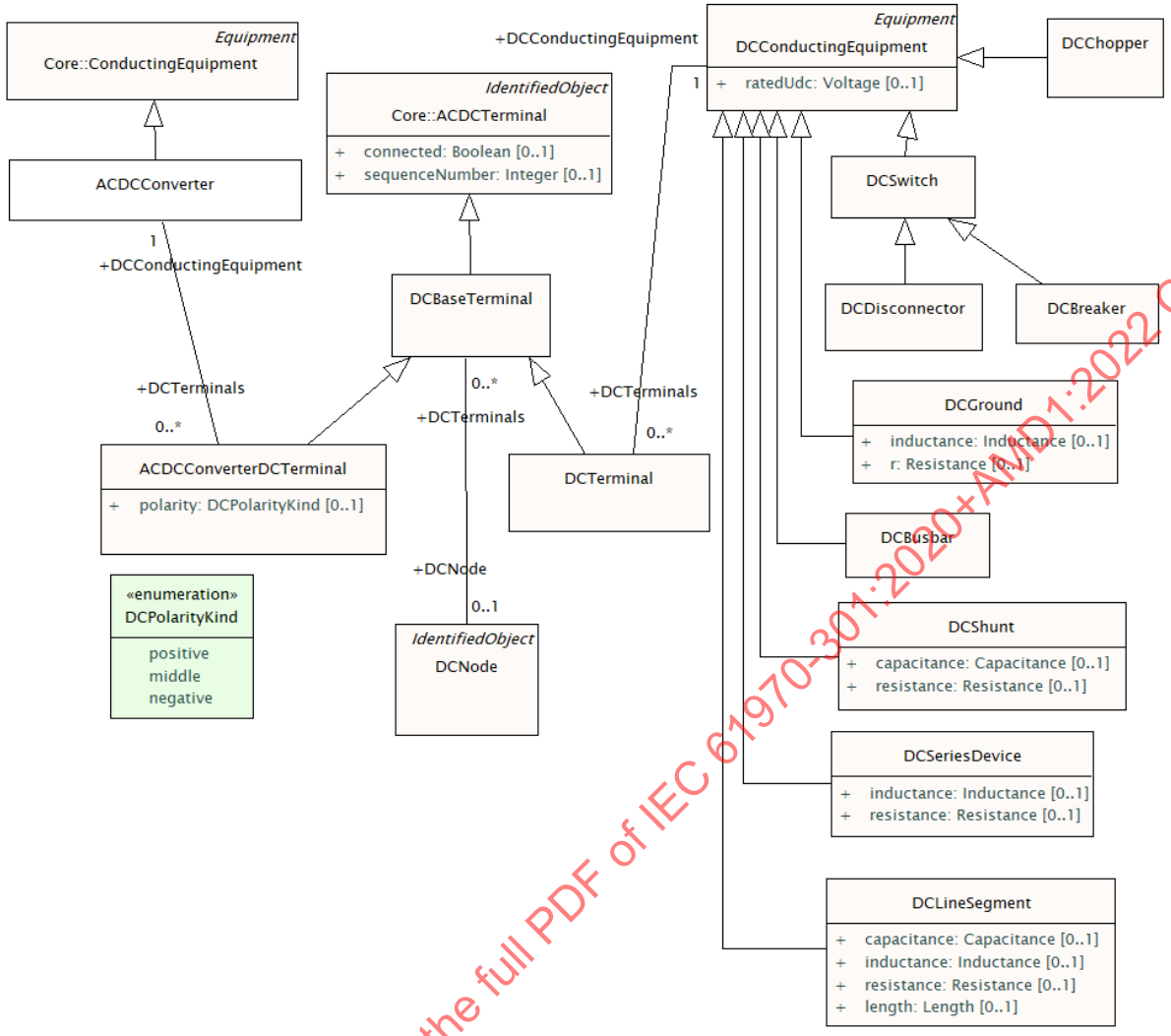


Figure 56 – Modèle d'Equipment

Afin que l'ACDCTerminal comprenne à la fois ACDCConverter et DCConductingEquipment, deux types de bornes à courant continu ont été mis en œuvre, comme représenté à la Figure 56: ACDCConverterDCTerminal et DCTerminal. ACDCConverterDCTerminal est associée à ACDCConverter. La DCTerminal est associée à DCConductingEquipment. Afin d'associer DCNode avec DCTerminal et ACDCConverterDCTerminal, DCBaseTerminal, héritée de ACDCTerminal, est ajoutée.

Étant donné que, dans de nombreux cas, DCConductingEquipment a des paramètres différents en comparaison avec l'équipement à courant alternatif correspondant, des classes spécifiques de courant continu sont nécessaires dans tous les cas, par exemple le DCBreaker et le DCBusbar.

Les SvPowerFlow-s aux bornes des PCCTerminal-s maintiennent les injections de courant alternatif dans le convertisseur.

Le modèle de ligne à courant continu est représenté à la Figure 57.

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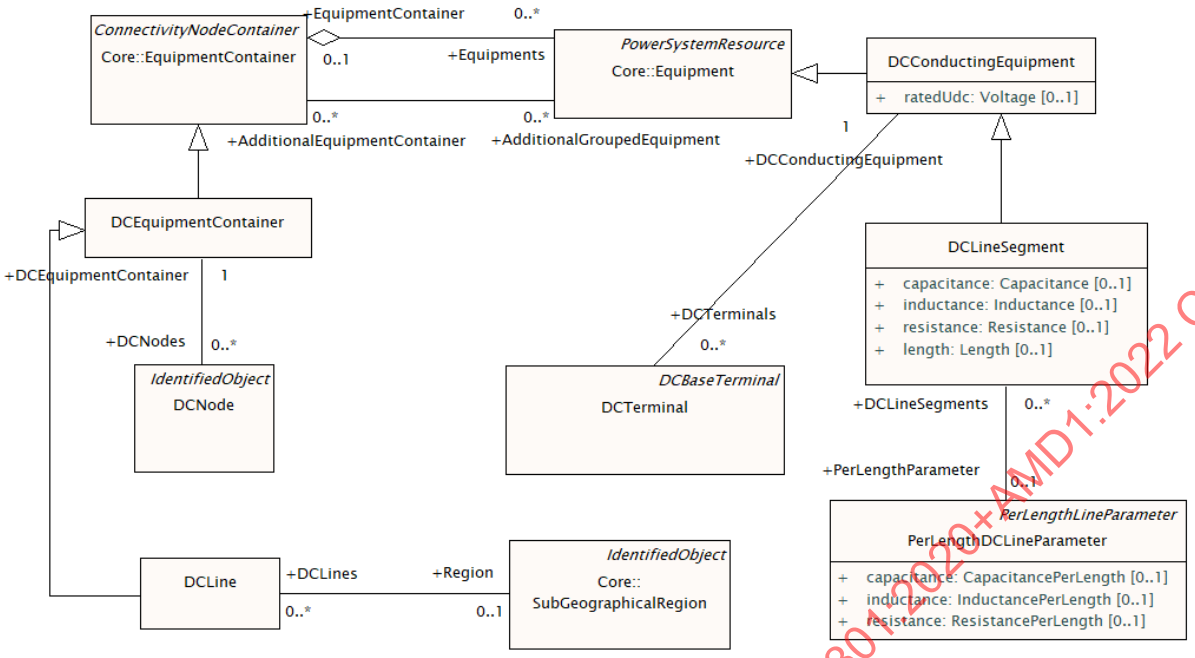


Figure 57 – Modèle de ligne CCHT

Comme représenté à la Figure 57, DCLineSegment n'est plus un Conductor mais un DCConductingEquipment, et n'est pas connecté au réseau à courant alternatif. Il a ses propres attributs par classe de longueur PerLengthDCLineParameter.

Chaque type d'équipement d'un réseau CCHT nécessite sa classe... à courant continu. Les types existants d'équipements sont

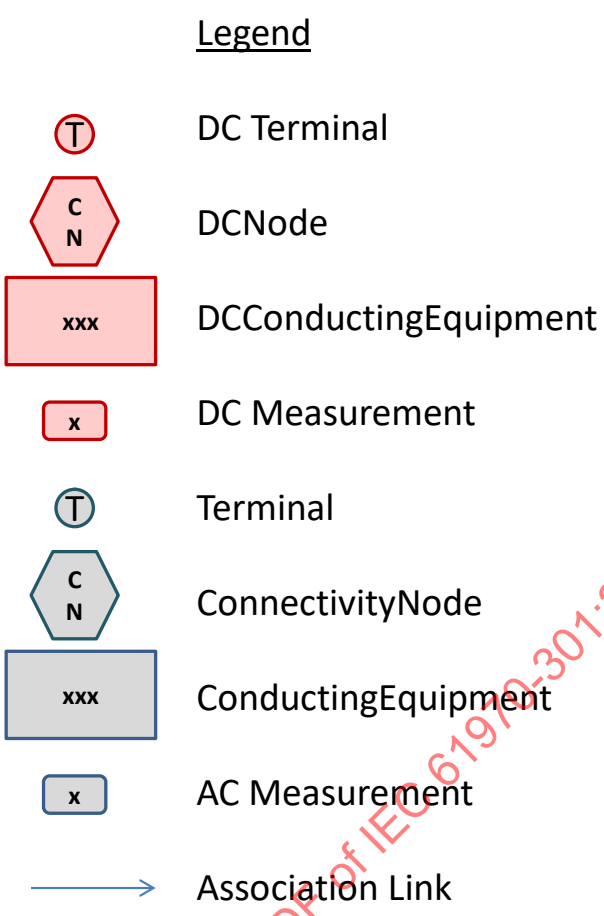
- DCSwitch
- DCGround

La méthode des classes... à courant continu spécifiques peut donner lieu à la duplication des attributs avec les classes... à courant alternatif correspondantes.

4.5.13.5 Diagrammes d'instances

La Figure 58 est la légende des exemples d'équipements à courant continu: monopole simple, bipolaire simple et côté détaillé d'un monopole (voir respectivement la Figure 59, la Figure 60 et la Figure 61).

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Anglais	Français
Legend	Légende
DC Terminal	Borne de courant continu
DC Measurement	Mesure de courant continu
Terminal	Borne
AC Measurement	Mesure de courant alternatif
Association Link	Liaison d'association

Figure 58 – Légende

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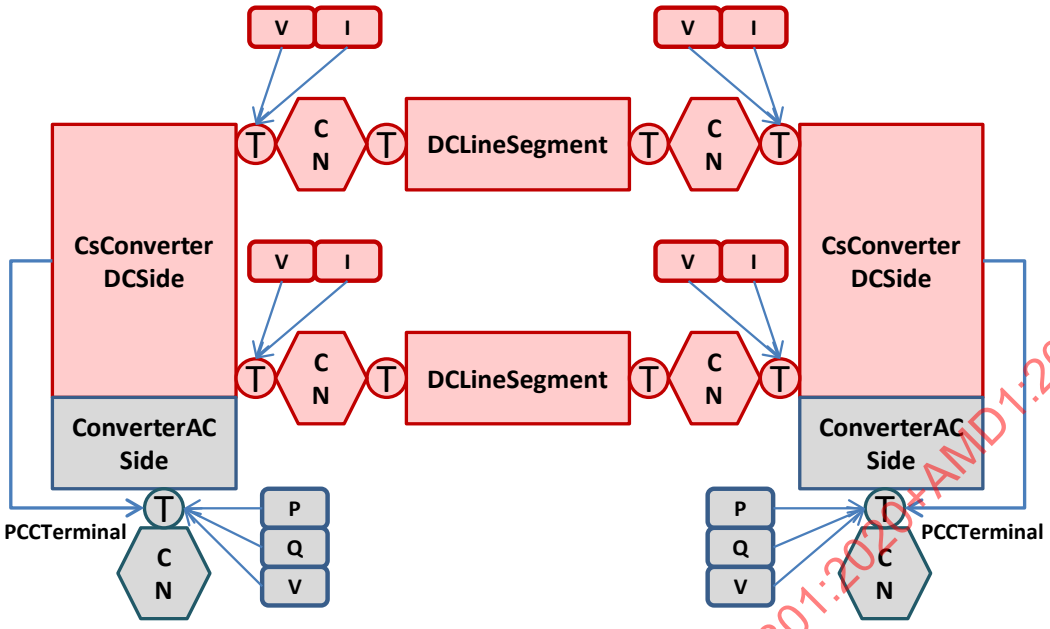


Figure 59 – Monopole simple et mesures

Voir la Figure 58 pour avoir une explication concernant les symboles de la Figure 59.

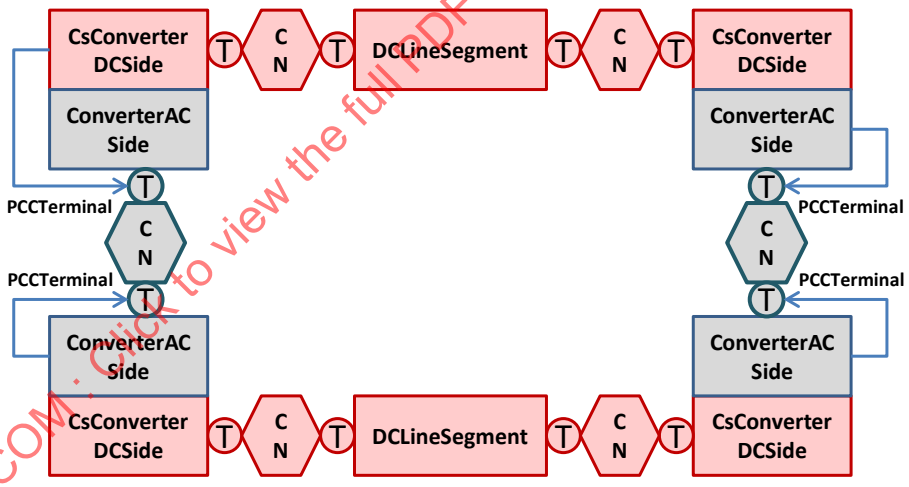


Figure 60 – Bipolaire simple

Voir la Figure 58 pour avoir une explication concernant les symboles de la Figure 60.

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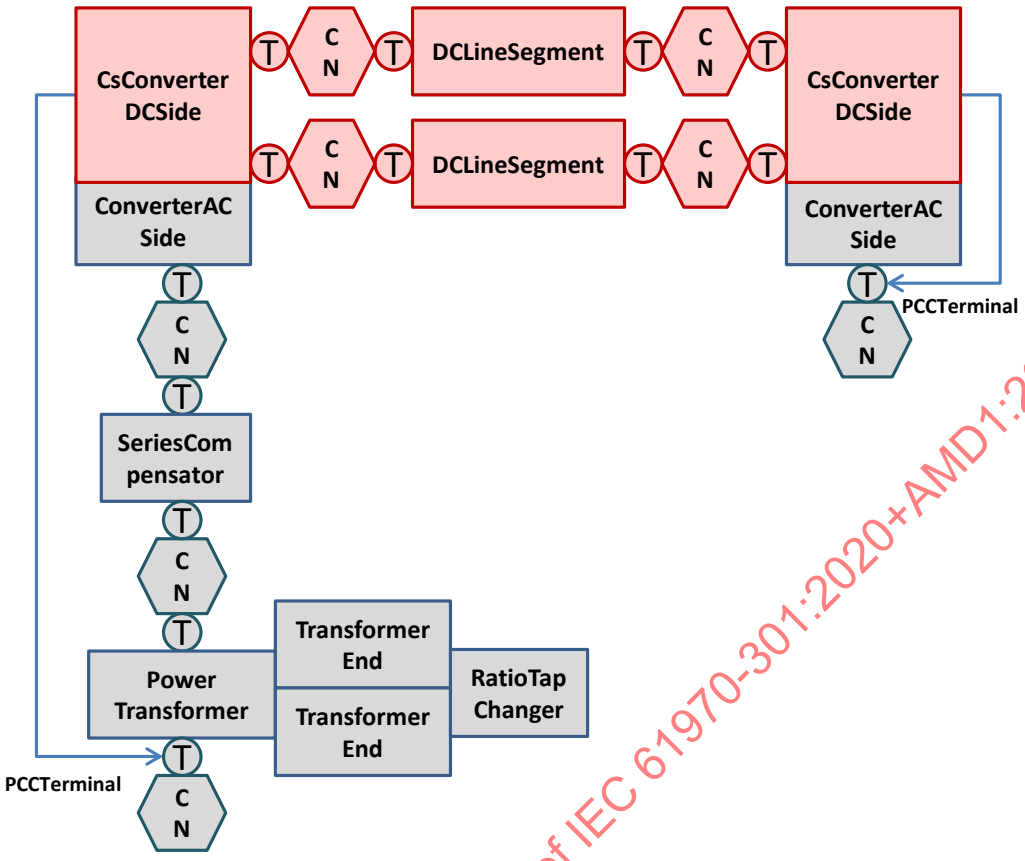


Figure 61 – Côté de monopole avec modèle détaillé

Voir la Figure 58 pour avoir une explication concernant les symboles de la Figure 61.

4.5.14 Régulation de la tension du compensateur de Var statique

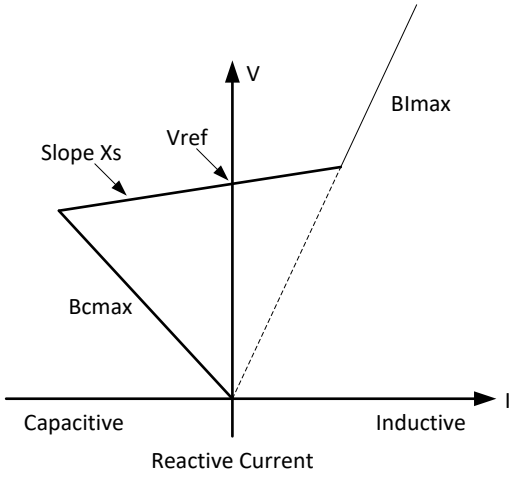
4.5.14.1 Historique

Le compensateur de VAR statique (SVC – Static VAR Compensator) est un appareil shunt de la famille des FACTS (systèmes flexibles de transport à courant alternatif) utilisant l'électronique de puissance pour commander le flux de puissance et améliorer la stabilité transitoire sur les réseaux de puissance. Le SVC peut fonctionner dans deux modes différents:

- le mode de régulation de la tension (la tension est régulée dans les limites spécifiées ci-dessous);
- le mode commande de la Var (la susceptance du SVC reste constante).

Lorsque le SVC fonctionne en mode de régulation de la tension, il met en œuvre la caractéristique V-I représentée à la Figure 62.

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Anglais	Français
Capacitive	Capacitif
Reactive current	Courant réactif
Inductive	Inductif

Figure 62 – Caractéristique V-I du SVC

Tant que la susceptance B du SVC reste dans les valeurs maximale et minimale de susceptance imposées par la puissance réactive totale des batteries de condensateurs (Bcmax) et des batteries d'inductance (BI_{max}), a tension est régulée à la tension de référence V_{ref} (également appelée point de consigne de la tension). La tension à laquelle le SVC n'absorbe pas ou ne produit pas de puissance réactive est la tension de référence (V_{ref}).

Un statisme de tension est normalement utilisé (généralement entre 1 % et 4 % à la puissance réactive maximale en sortie), et la caractéristique V-I a la pente indiquée dans la figure. La caractéristique V-I est décrite par les trois équations suivantes:

$$V = \begin{cases} V_{ref} + X_S * I & si\ le\ SVC\ est\ en\ mode\ de\ régulation \quad (-Bc_{max} < B < BI_{max}) \\ -\dfrac{I}{Bc_{max}} & si\ le\ SVC\ est\ entièrement\ capacitif \quad (B = Bc_{max}) \\ \dfrac{I}{BI_{max}} & si\ le\ SVC\ est\ entièrement\ inductif \quad (B = BI_{max}) \end{cases}$$

Où:

V est la tension directe (pu) aux bornes du bus régulé;

I est le courant réactif ($I > 0$ indique un courant inductif);

X_S est la pente ou réactance de statisme;

V_{ref} est la tension de référence (point de consigne de la tension);

Bc_{max} est la susceptance capacitive maximale;

BI_{max} est la susceptance inductive maximale.

Le point de consigne de la tension est généralement choisi de sorte que, dans des conditions normales de fonctionnement, le SVC fournisse une puissance réactive proche de zéro et fonctionne sur sa plage totale de commande.

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Le point de consigne de tension d'un SVC est fondamentalement différent d'une tension cible. La sortie réactive d'un SVC est proportionnelle au carré de la différence entre la tension régulée du bus et le point de consigne de la tension. Si le SVC produit ou absorbe de la puissance réactive, par définition, une différence s'établit entre la tension régulée du bus et le point de consigne de la tension.

4.5.14.2 Modèle CIM

StaticVarCompensator hérite des attributs suivants de RegulatingCondEq:

controlEnabled – Spécifie le statut de régulation de l'équipement. True, il régule. False, il ne régule pas.

La Terminal de StaticVarCompensator est régulée par l'association à RegulatingControl, hérité de RegulatingCondEq.

4.5.15 Modèle de configuration ICCP

4.5.15.1 Cas d'utilisation de la configuration

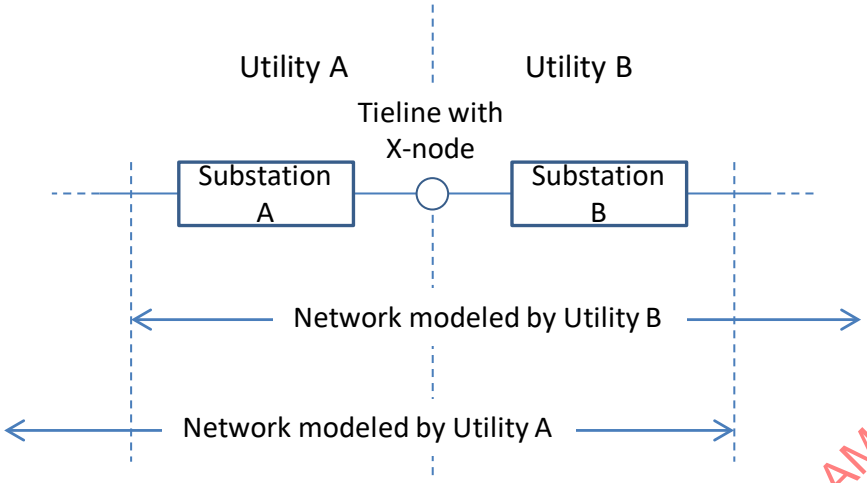
Une configuration ICCP peut être créée de deux manières:

1) les points E/S (valeurs de mesure et commandes) qui sont échangés sur ICCP sont connus dans le cadre d'un échange du profil d'équipement IEC 61970-452/EQ, la configuration ICCP étant directement associée à ces points E/S;
2) les points E/S qui sont échangés sur ICCP ne sont pas connus dans le cadre d'un échange du profil d'équipement, et la configuration ICCP utilise à la place un nom intermédiaire faisant l'objet d'un accord commun, le nom de point fourni par ICCP pour les points E/S à échanger sur ICCP. Cela correspond au cas de configuration ICCP traditionnel.

L'exemple suivant concerne le cas d'utilisation 1 ci-dessus.

Deux services publics d'électricité, Utility A et Utility B, peuvent disposer de modèles de réseau chevauchant (voir la Figure 63) et échanger des fichiers CIMXML EQ avec le nœud de connectivité en limite. Utility A et Utility B souhaitent obtenir des valeurs de mesure provenant de chacune d'elles. La description des points E/S dans le modèle de réseau est incluse dans les fichiers CIMXML IEC 61970-452/EQ échangés. Utility A et Utility B disposent d'un sous-ensemble de mesures dans les fichiers CIMXML IEC 61970-452/EQ pour l'échange ICCP.

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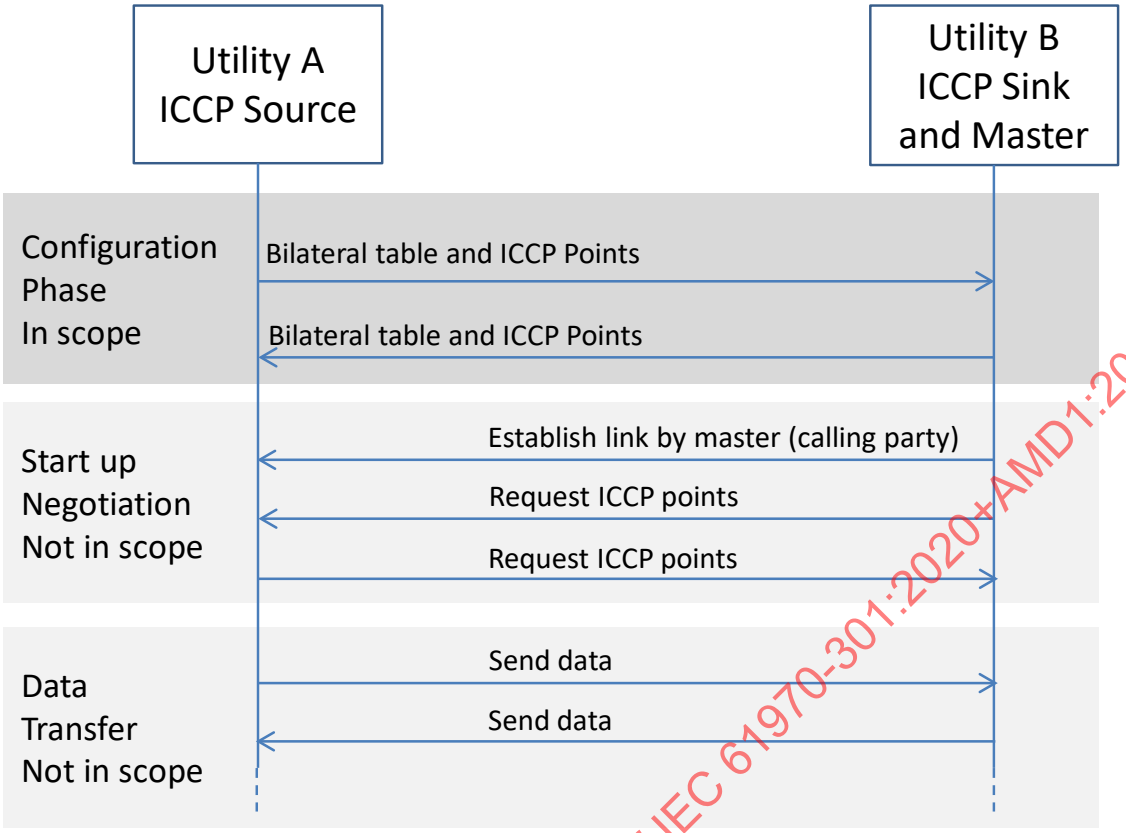
Anglais	Français
Utility A	Utility A
Utility B	Utility B
Tieline with X-node	Ligne d'interconnexion avec X-node
Substation	Poste
Network modeled by Utility B	Réseau modélisé par Utility B
Network modeled by Utility A	Réseau modélisé par Utility A

Figure 63 – Mesures ICCP et modèles de réseau

Selon le cas d'utilisation 2 ci-dessus, le moyen traditionnel de configurer ICCP consiste, pour les différentes parties, à convenir d'un ensemble commun de noms pour les mesures échangées, les points fournis par ICCP. Il est pris pour hypothèse que les deux parties utilisent des noms différents pour la même mesure et, de ce fait, qu'un troisième nom ayant fait l'objet d'un accord commun est nécessaire, les noms de point fournis par ICCP.

En s'appuyant sur cette hypothèse, la Figure 64 représente une séquence simplifiée de configuration et de démarrage d'ICCP.

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Anglais	Français
Utility A ICCP source	Source ICCP de Utility A
Utility B ICCP sink and master	Collecteur et maître ICCP de Utility B
Configuration phase in scope	Phase de configuration dans le domaine d'application
Bilateral table and ICCP points	Table bilatérale et points ICCP
Start up negotiation not in scope	Démarrage de la négociation hors du domaine d'application
Establish link by master (calling party)	Etablir liaison par maître (partie appelante)
Request ICCP points	Demande de points ICCP
Data transfer not in scope	Transfert de données hors du domaine d'application
Send data	Envoi des données

Figure 64 – Configuration et démarrage d'ICCP

Dans la phase de configuration, les fichiers décrivant les tables bilatérales et les listes de points ICCP sont échangés, la zone ombrée en gris foncé étant représentée à la Figure 64. La configuration de cet échange relève du domaine d'application du présent document.

La configuration ICCP implique de créer une référence croisée pour chaque valeur de mesure entre les parties. La création d'une référence croisée est un travail manuel fastidieux.

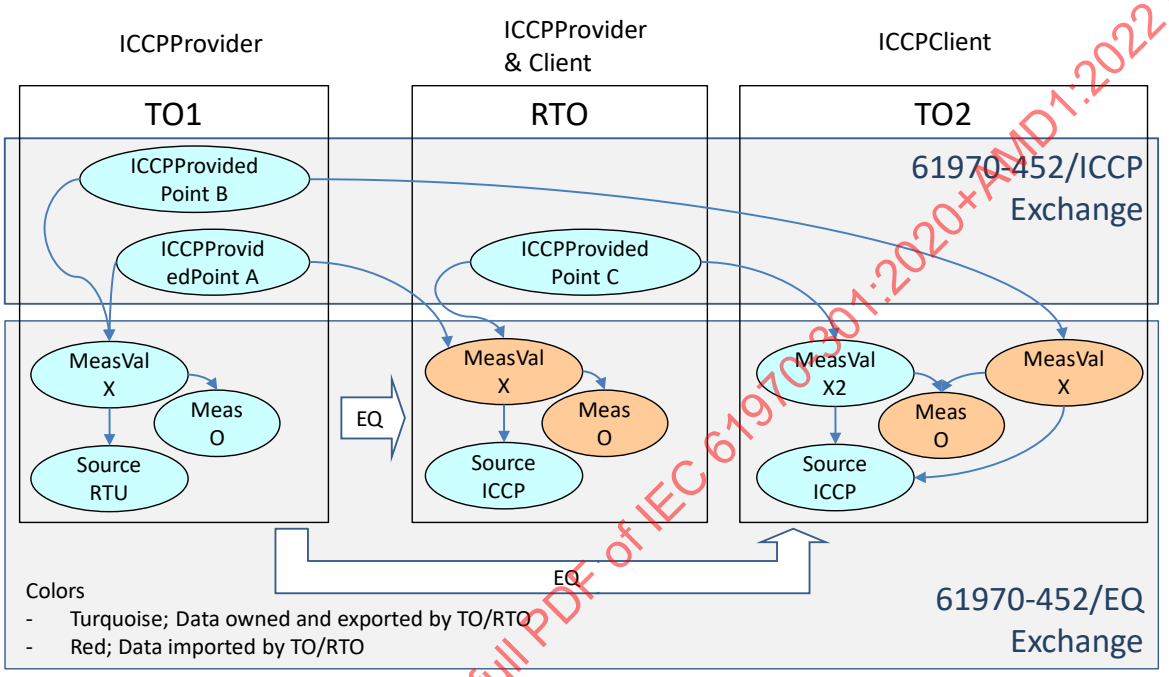
Si les modèles de réseau sont échangés sous la forme de données CIMXML, les données IEC 61970-452/EQ et les données de configuration ICCP décrites dans le présent document sont échangées. Dès lors, les identifiants de point E/S et les noms sont connus des deux parties. Par conséquent, la mise en correspondance de point ICCP est déjà connue et le référencement croisé manuel est remplacé par une liaison automatique.

Tous les points E/S définis dans un fichier IEC 61970-452/EQ peuvent ne pas être disponibles sur ICCP. De ce fait, il y a lieu de décrire la disponibilité d'un point E/S sur ICCP par point E/S.

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Le protocole ICCP aide les fournisseurs de données ICCP à accorder différents droits d'accès à différents utilisateurs ICCP, par exemple, pour l'exemple de la Figure 63, Utility A peut souhaiter autoriser Utility B à accéder à Substation A pour les mesures, mais pas aux autres services publics d'électricité. Ainsi, un fournisseur ICCP doit pouvoir décrire la disponibilité de point ICCP par utilisateur ICCP. ICCP prend également en charge les points E/S qui sont globalement disponibles à tous les utilisateurs ICCP.

La Figure 65 donne un exemple de configuration ICCP pour une valeur de mesure entre différentes parties.



Anglais	Français
Colors	Couleurs
Turquoise; Data owned and exported by TO/RTO	Turquoise: données détenues et exportées par TO/RTO
Red; Data imported by TO/RTO	Rouge: données importées par TO/RTO

Figure 65 – Exemple de fournisseur et d'utilisateur de valeur de mesure

TO1 et RTO sont des centres de conduite où TO1 fournit la valeur de mesure MeasVal X à un RTO et à TO2. TO2 peut obtenir la valeur de mesure MeasVal X directement auprès de TO1 ou indirectement auprès du RTO. L'échange indirect comme entre le RTO et TO2 peut ne pas être admis, même s'il est possible d'un point de vue technique.

4.5.15.2 Modèle d'informations

Les données ICCP (appelées officiellement IEC 61870-6 TASE.2) sont échangées à l'aide des classes Measurement (Analog, Discrete et Accumulator), des classes MeasurementValue (AnalogValue, DiscreteValue, et AccumulatorValue) et de la classe MeasurementValueSource. La classe MeasurementValueSource est utilisée pour définir le centre de conduite qui fournit les données ICCP. La MeasurementValueSource doit être associée à une instance du Name dans laquelle l'attribut Name.name contient le nom du centre de conduite fournisseur. L'instance du NameType associée au Name du centre de conduite doit avoir "ICCP Provider ID" pour attribut NameType.name.

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Les classes MeasurementValue sont utilisées pour spécifier l'ICCP ID. La MeasurementValue doit être associée à une instance de Name dont l'attribut Name.name contient l'ICCP ID. L'instance du NameType associé à l'ICCP ID Name doit avoir "ICCP ID" pour attribut NameType.name. L'attribut MeasurementValue.name contient le nom de point SCADA. Chaque MeasurementValue est associée à un Measurement.

Chaque MeasurementValue qui est fournie à l'aide d'ICCP doit aussi avoir une association à une MeasurementValueSource.

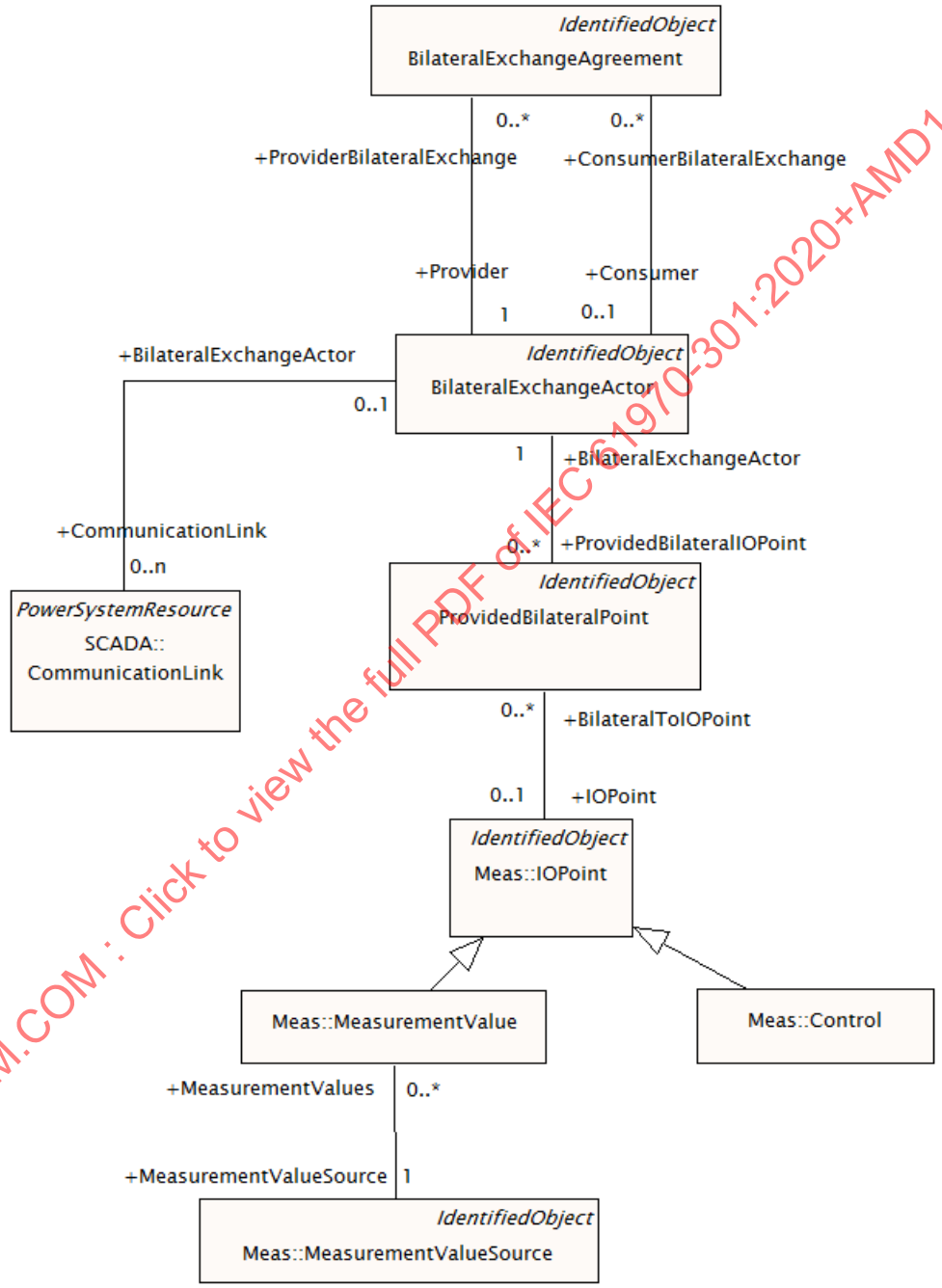


Figure 66 – Modèle de données d'échange bilatéral généralisé

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Le modèle de données de la Figure 66 est généralisé à tous les échanges bilatéraux. Il décrit les acteurs de ce type d'échange avec BilateralExchangeActor. Il existe deux types d'acteurs:

- les fournisseurs qui peuvent également être des consommateurs;
- des consommateurs uniquement.

Les fournisseurs offrent des IOPoint-s disponibles à l'échange, actuellement MeasurementValue-s et Controls. La disponibilité des données est décrite par BilateralExchangeAgreement. Un BilateralExchangeAgreement comporte deux BilateralExchangeActor-s référencés par BilateralExchangeAgreement.Provider et BilateralExchangeAgreement.Consumer. L'acteur référencé par BilateralExchangeAgreement.Provider est toujours un fournisseur, mais il peut également s'agir d'un consommateur. L'acteur référencé par BilateralExchangeAgreement.Consumer est toujours un consommateur, mais il peut également s'agir d'un fournisseur. Si l'acteur référencé par BilateralExchangeAgreement.Consumer est également un fournisseur, cela signifie que celui référencé par BilateralExchangeAgreement.Provider est également un consommateur, de sorte que l'échange de données est bidirectionnel pour ce BilateralExchangeAgreement. Un échange bidirectionnel entre deux acteurs peut également être assuré avec deux BilateralExchangeAgreement-s unidirectionnels, où l'un des BilateralExchangeAgreement-s comporte un acteur en tant que fournisseur uniquement et l'autre en tant que consommateur uniquement, ce qui est l'inverse dans l'autre BilateralExchangeAgreement.

Les données fournies par un BilateralExchangeActor sont décrites par le ProvidedBilateralPoint qui représente une relation plusieurs à plusieurs entre le BilateralExchangeActor et l'IOPoint. IOPoint est une classe de base pour MeasurementValue et Control, et fournit l'association entre les mesures et les points ICCP décrite par la classe ProvidedBilateralPoint.

Si les modèles de réseau sont échangés sous la forme de fichiers IEC 61970-452/EQ CIMXML, la référence ProvidedBilateralPoint.IOPont donne l'IOPoint de sorte qu'un consommateur connaisse les identifiants IOPoint (mRIDs) et les noms. Sur cette base, un consommateur peut choisir l'ensemble ou un sous-ensemble des IOPoint-s fournis pour l'échange sur ICCP. Il s'agit d'une décision interne côté consommateur qu'il n'y a pas lieu d'échanger en tant que données de configuration.

Si les modèles de réseau ne sont pas échangés sous la forme de fichiers IEC 61970-452/EQ CIMXML, la référence ProvidedBilateralPoint.IOPont n'est pas spécifiée, et un consommateur ne connaît pas les identifiants IOPoint (mRIDs) et les noms. Le nom ProvidedBilateralPoint est alors utilisé comme étant le nom ICCP ayant fait l'objet d'un accord commun. L'industrie électrique a établi les règles concernant les noms ICCP, qu'il convient de respecter lorsqu'ils sont utilisés.

L'accord d'échange bilatéral UML pour ICCP est représenté à la Figure 72.

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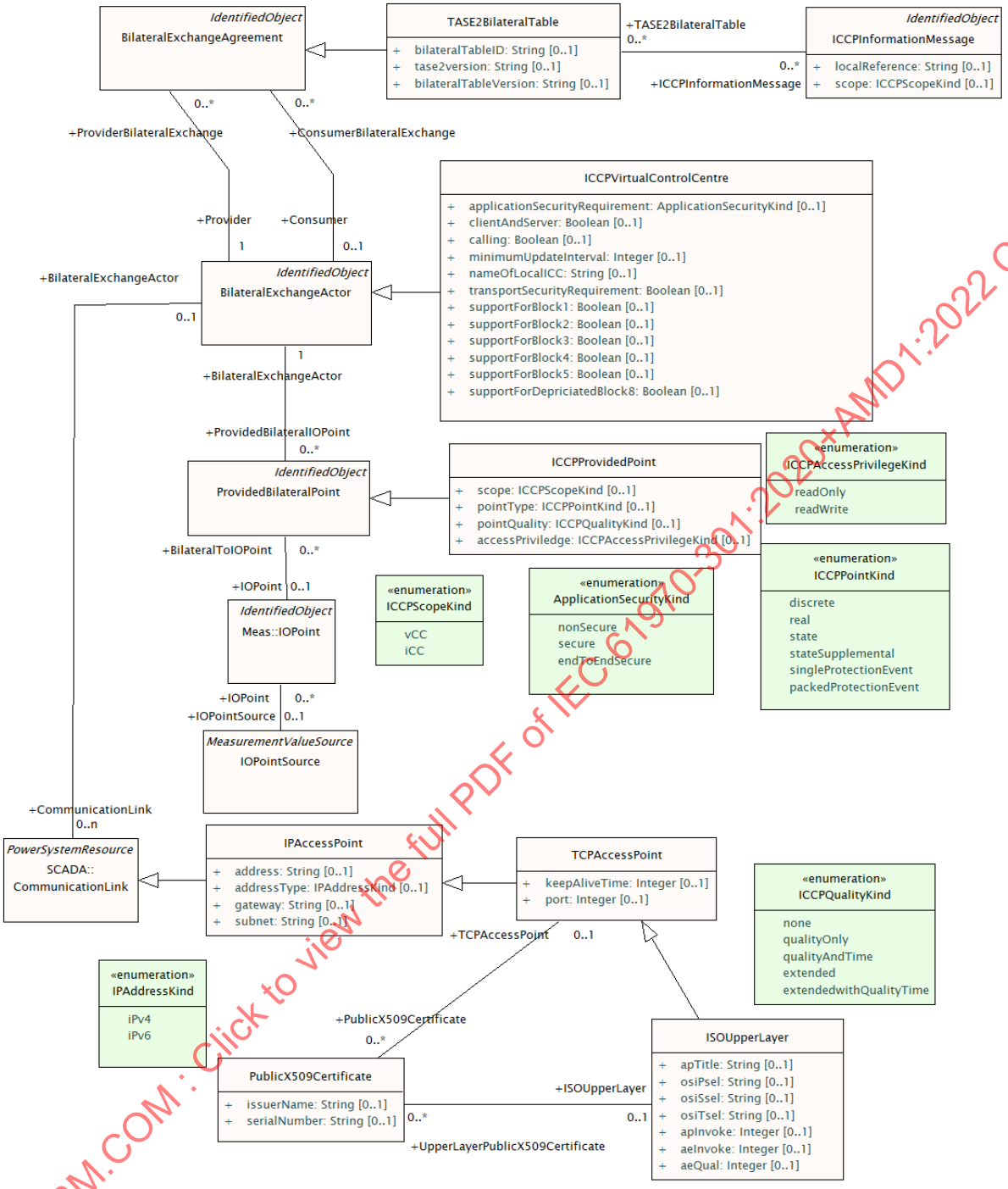


Figure 67 – Modèle de données d'échange bilatéral ICCP

Les sous-types suivants issus du modèle de données générique sont définis

- BilateralExchangeAgreement à TASE2BilateralTable.
- BilateralExchangeActor à ICCPVirtualControlCenter.
- ProvidedBilateralPoint à ICCPProvidedPoint.
- CommunicationLink à IPAccessPoint.

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4.5.16 Modèle Feeder

Le modèle Feeder est utilisé pour représenter les lignes d'alimentation "intégrées". Feeder étant un type de ~~ConductingEquipment~~ ConnectivityNodeContainer, il peut contenir un Equipment, comme un Substation ou un VoltageLevel. Outre l'association d'emboîtement entre EquipmentContainer et Equipment, utilisée pour les besoins de dénomination hiérarchique, il existe une seconde association entre ces deux classes, laquelle permet de regrouper un élément d'Equipment avec un EquipmentContainer supplémentaire. Cette modélisation permet d'associer Equipment à plusieurs Feeder.

Un Feeder peut être contenu par le Substation qui a alimenté de manière nominale la ligne d'alimentation. Au moins une borne (Terminal) peut également être associée à un Feeder pour définir la hauteur de chute normale spécifique qui l'alimente. Un Feeder peut également contenir un Substation de distribution secondaire. Un Substation secondaire peut être associé à plusieurs Feeder pour représenter les Feeders qui alimentent en principe le Substation.

Le modèle UML pour le Feeder est représenté à la Figure 68.

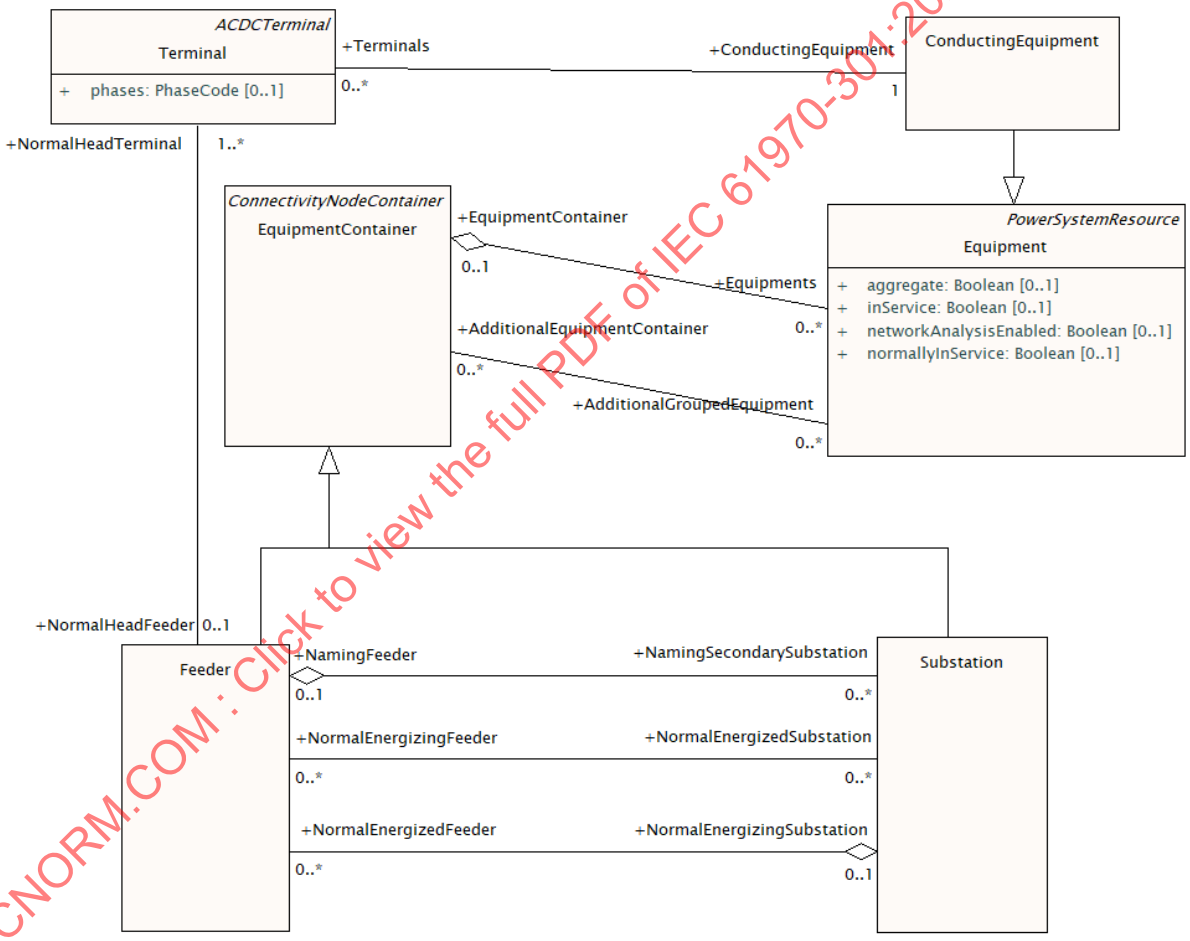


Figure 68 – Modèle de données Feeder

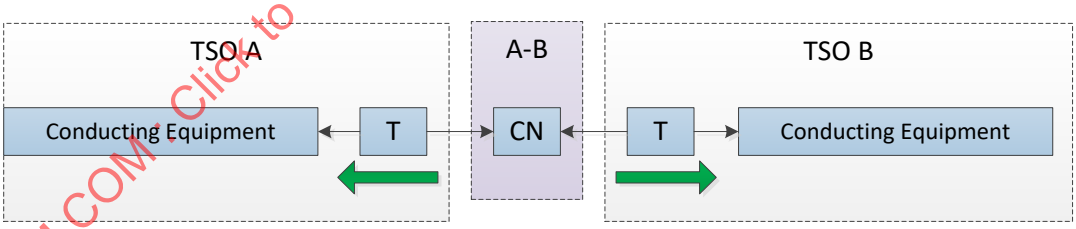
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4.5.17 Modélisation de la zone de commande

Les contraintes d'échange net de la zone de commande sont importantes pour l'analyse du réseau car lors de l'établissement des cas de flux de puissance, la situation à étudier commence pratiquement toujours par une spécification de la charge utile et de l'échange net pour chaque zone de commande. Les contraintes de la zone de commande doivent être correctement définies pour correspondre aux définitions des responsables d'équilibre dans le réseau. Les contraintes de la zone de commande dans le flux de puissance sont représentées comme un ensemble de contraintes d'égalité de la zone de commande comme suit:

> Echange net de la zone de commande = SUM (flux de la zone de commande dans la zone sur chaque interconnexion)

Les interconnexions définissent les zones de commande et elles doivent être définies de sorte que chaque élément conducteur du réseau soit exactement à l'intérieur d'une zone de commande – en d'autres termes, les zones de commande recouvrent le réseau et ne se chevauchent pas. C'est également ce qui se produit dans le réseau réel de manière naturelle et ainsi les emplacements des interconnexions sont généralement bien connus. L'échange net de la zone de commande est déterminé en faisant la somme des flux dans les Terminals. Les Terminals sont identifiées en créant un ensemble d'objets TieFlow associés à un objet ControlArea. Chaque objet TieFlow est associé à une Terminal. Un attribut de l'objet ControlArea spécifie l'échange net (ControlArea.netInterchange). L'orientation de la zone de commande pour l'échange net est positive pour une importation, elle est négative pour une exportation. Une interconnexion entre deux zones de commande apparaît dans les deux spécifications de la zone de commande. Elle doit être modélisée dans chaque zone de sorte que la somme des deux représentations du flux d'interconnexion soit égale à zéro. L'orientation normale du flux de la Terminal est positive pour le flux vers l'équipement conducteur de la Terminal. (C'est-à-dire que la direction du flux d'un bus vers un appareil est positive.) Cependant, l'orientation de chaque flux dans la spécification de la zone de commande doit être conforme à la convention de la zone de commande, c'est-à-dire que l'importation est positive. Si l'orientation du flux de la Terminal référencée par un TieFlow est positive dans la zone de commande, ceci est ensuite confirmé en réglant TieFlow.positiveFlowIn flag TRUE. Dans le cas contraire, l'orientation doit être inversée en réglant TieFlow.positiveFlowIn flag FALSE. La Figure 69 représente une interconnexion simple dans laquelle les flèches vertes indiquent l'orientation du flux de la Terminal (non le flux réel mais la direction du flux qui comporte un signe plus):

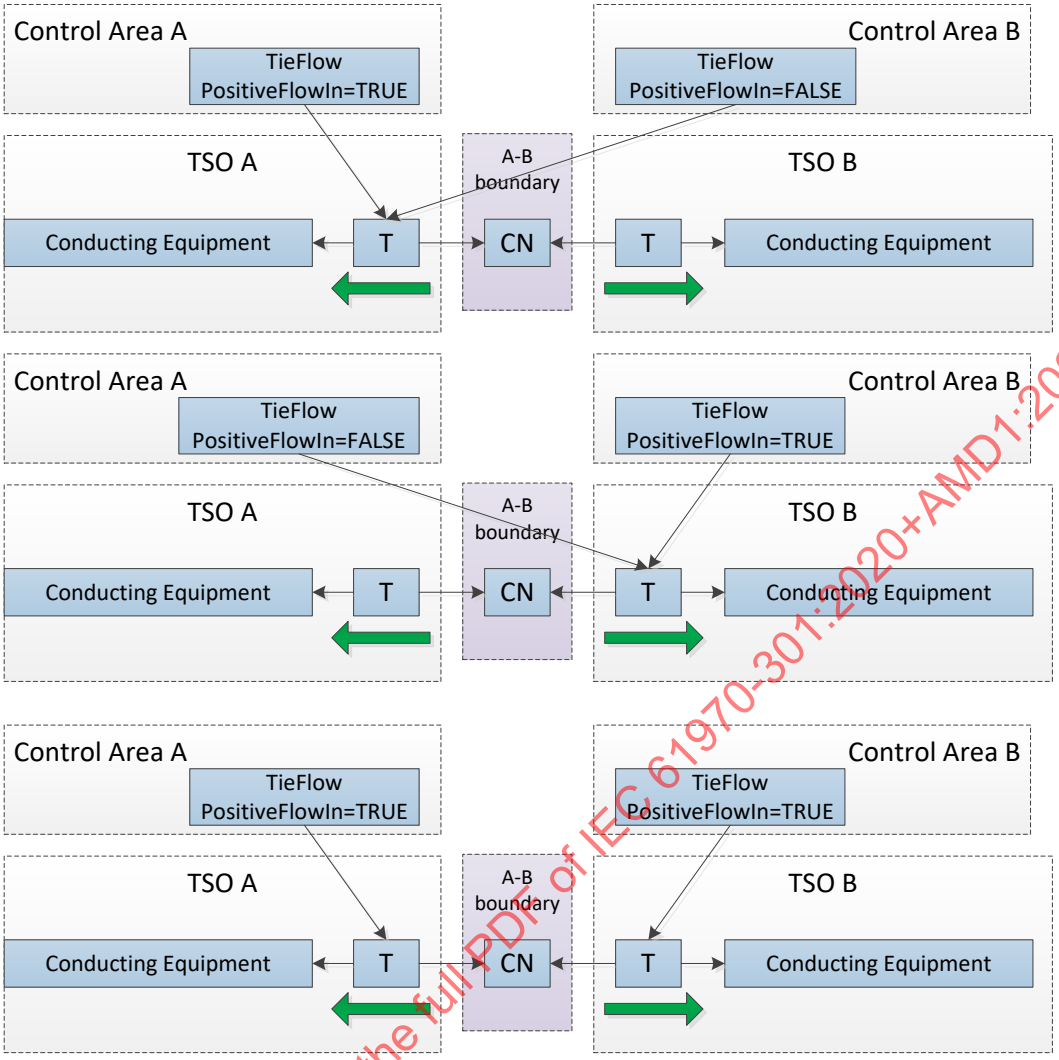


Anglais	Français
Conducting equipment	Équipement conducteur

Figure 69 – Orientation du flux de la Terminal

La Figure 70 représente les différentes manières qu'il est possible d'appliquer pour décrire correctement les interconnexions correspondantes de la zone de commande. Les deux premiers exemples ci-dessous impliquent une seule Terminal simple dont les deux parties mesurent le flux. Le troisième exemple concerne des Terminals se situant dans le modèle de réseau TSO de sorte que la commande de zone fait toujours référence à son propre modèle de réseau.

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Anglais	Français
Conducting equipment	Équipement conducteur
Control area	Zone de commande
A-B boundary	Limite entre A et B

Figure 70 – Différentes manières de décrire les interconnexions de la zone de commande

4.6 Lignes directrices de modélisation

4.6.1 Modélisation pour modifications

Les Paragraphes 4.6.2 à 4.6.5 donnent des lignes directrices sur la façon de maintenir et étendre le CIM.

Le CIM est destiné à contenir les classes et les attributs qui sont échangés sur des interfaces publiques entre des applications principales. L'objectif est de ne conserver, autant que possible, que les caractéristiques génériques à partir desquelles une mise en œuvre détaillée peut être extraite. Il est, en général, plus facile de modifier la valeur ou le domaine d'un attribut que de modifier une définition de classe. Cela rend le modèle plus solide, car il peut supporter une plus large classe d'exigences, et plus stable, car il peut être possible de gérer de nouvelles exigences sans avoir à modifier le modèle.

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4.6.2 Processus pour les amendements au CIM

Il peut être souhaitable de modifier le CIM pour réviser le modèle existant ou pour étendre le CIM afin de modéliser des éléments supplémentaires d'un système de puissance. Le processus recommandé pour ces amendements est le suivant.

1) Préparer un ou plusieurs cas d'utilisation et une demande de modification qui décrivent les modifications souhaitées. Il convient que cela inclue les modifications proposées aux diagrammes de classes concernés avec représentation des classes, attributs et associations nouveaux ou révisés.
2) Le ou les cas d'utilisation et la demande de modification sont ensuite examinés par le Groupe de Travail approprié de l'IEC, qui va décider s'il convient que les modifications demandées soient traitées en tant que révisions de la norme CIM actuelle ou s'il convient qu'elles soient traitées comme des amendements privés sans exigence de modification pour la norme.
3) Les propositions d'amendements acceptés par le groupe de travail sont ajoutées à la liste des sujets majeurs et le moment venu, une nouvelle version du modèle CIM est élaborée et une mise à jour de la spécification du CIM appropriée de l'IEC est faite.

4.6.3 Modifications apportées au modèle UML du CIM

Du point de vue de la modélisation, lorsque le CIM est étendu, l'approche consiste à partir du modèle UML de CIM existant. Les extensions peuvent être ajoutées de plusieurs façons disponibles avec UML, mais dans tous les cas, la bonne approche consiste à examiner le modèle actuel et à déterminer le meilleur moyen pour commencer à partir des diagrammes de classes existants. Les extensions peuvent prendre une des formes suivantes, de la plus simple à la plus complexe:

- ajouter des attributs supplémentaires à des classes existantes;
- ajouter de nouvelles classes qui sont des spécialisations de classes existantes;
- ajouter de nouvelles classes à l'aide d'associations avec des classes existantes.

Dans le but d'étendre la présente norme, le principal objectif est de réutiliser le CIM existant dans toute la mesure du possible. Du point de vue des paquetages, il convient que les extensions soient faites aux paquetages existants chaque fois que c'est possible. Si les extensions comprennent un nouveau domaine d'application, il convient d'envisager de créer un nouveau paquetage pour les ajouts, mais en créant toujours les associations nécessaires au paquetage existant, en gardant à l'esprit que, bien qu'un nouveau paquetage soit créé, le CIM continue d'être un modèle unique.

Quand il s'agit d'apporter des modifications non normatives au modèle d'information, il convient d'étendre le CIM normalisé sans modifier le CIM normalisé. Il convient, de préférence, de placer ces extensions dans de nouveaux paquetages, à la fois pour identifier que les modifications ne sont pas normatives et pour faciliter le transfert des modifications vers une version de la norme mise à jour.

4.6.4 Modifications apportées aux documents normatifs du CIM

D'un point de vue documentaire, lorsque le CIM est étendu, une décision doit être prise quant à la question de savoir si les modifications constituent des mises à jour de documents normatifs existants sur le CIM ou si une nouvelle IEC 61970-3x spécifique est exigée. Dans les deux cas, les extensions deviennent une partie de la norme IEC sur le CIM.

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4.6.5 Éléments déconseillés

Le modèle du CIM peut parfois contenir des paquetages, des classes, des attributs ou des associations qui sont considérés comme déconseillés. Ces éléments sont notés "déconseillés" dans la documentation ou portent un stéréotype de l'UML "déconseillé". Un élément déconseillé figure dans la présente version du modèle, mais il est prévu de le supprimer dans les versions futures. Il n'est pas garanti qu'un élément non déconseillé soit retenu dans les versions futures, mais il convient d'éviter autant que possible l'utilisation d'un terme marqué comme déconseillé.

4.6.6 Profils CIM

Une mise en œuvre du CIM ne nécessite pas d'inclure toutes les classes, attributs et associations de la spécification de la norme CIM pour être conforme à la norme CIM. Des profils peuvent être définis pour spécifier les éléments qui doivent être inclus (c'est-à-dire, les éléments obligatoires) pour une utilisation particulière du CIM, ainsi que ceux qui sont facultatifs. Ces profils sont définis dans les documents concernant les profils de la série IEC 61970 ainsi que dans d'autres séries de normes IEC qui utilisent et étendent le CIM de base spécifié dans le présent document.

Un exemple est l'IEC 61970-452, Profils du modèle de réseau de transport statique CIM. Ce profil spécifie comment le CIM doit être utilisé pour échanger des modèles de systèmes de puissance en XML, et il spécifie aussi les classes, attributs et associations, obligatoires et facultatifs, devant être pris en charge pour cette utilisation du CIM. Les profils peuvent être maintenus à l'aide de nombreux outils tels que l'outil open source (c'est-à-dire de source ouverte) CIMTool[1].

4.7 Outils de modélisation

Cette version du CIM a été établie en utilisant le produit Enterprise Architect[2]). Le modèle UML du CIM complet existe sous la forme d'un fichier de projet Enterprise Architect et peut être visualisé avec cet outil, y compris les diagrammes de classe et les descriptions des classes, des attributs, des types et des relations. La visualisation du CIM de cette façon offre une interface de navigation graphique qui permet de visualiser toutes les données de spécification du CIM par simple pointer-cliquer sur le diagramme de classe dans chaque paquetage. Une visionneuse gratuite est disponible auprès de Sparx Systems.

Idéalement, le modèle d'informations du CIM est indépendant de tout outil UML spécifique, bien que l'expérience ait montré que les échanges entre des outils différents soient souvent loin d'être parfaits. En attendant la réalité de l'interopérabilité des outils, les futures modifications apportées à la spécification du CIM, débouchant sur de nouvelles versions de la présente norme, sont incorporées en premier lieu dans la description du projet Enterprise Architect pour garantir une source unique pour les données de modèle CIM.

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1 Disponible à l'adresse <~~http://www.CIMTool.org~~ https://cimug-org.github.io/CIMTool/>. CIMTool est l'appellation commerciale d'un produit distribué par Free Software Foundation. Cette information est donnée à l'intention des utilisateurs du présent document et ne signifie nullement que l'IEC approuve ou recommande l´emploi exclusif du produit ainsi désigné. Des produits équivalents peuvent être utilisés s'il peut être démontré qu'ils conduisent aux mêmes résultats.

2 Enterprise Architect est l'appellation commerciale d'un produit distribué par Sparx Systems. Cette information est donnée à l'intention des utilisateurs du présent document et ne signifie nullement que l'IEC approuve ou recommande l´emploi exclusif du produit ainsi désigné. Des produits équivalents peuvent être utilisés s'il peut être démontré qu'ils conduisent aux mêmes résultats.

L'Article 6 du présent document a été généré automatiquement en utilisant l'outil libre jCleanCim[3]), qui utilise les interfaces d'automatisation de Microsoft® Word[4]) et d'Enterprise Architect ainsi que le format et les styles normalisés de l'IEC.

4.8 Conventions de mise en œuvre pour les utilisateurs

4.8.1 Conventions au-delà de l'UML

Le paragraphe 4.8 propose des conventions d'utilisateur recommandées pour l'utilisation du CIM dans la mise en œuvre des systèmes réels.

4.8.2 Nombre de bornes pour les objets ConductingEquipment

Les classes ConductingEquipment suivantes ont deux bornes: ACLineSegment, DCLineSegment, DCSeriesDevice, DCSwitch (et ses spécialisations), DCChopper, Switch et toutes leurs spécialisations (y compris Jumper, Fuse, Breaker, Disconnector, LoadBreakSwitch et Cut), SeriesCompensator et EquivalentBranch. La classe PowerTransformer a généralement deux bornes, mais elle peut aussi avoir une borne ou davantage. Par exemple, un transformateur de mise à la terre connecté en zigzag peut avoir une borne. Des transformateurs à trois bornes sont couramment utilisés dans des systèmes de transport et les transformateurs pour cas spéciaux peuvent comporter quatre, cinq bornes ou davantage. Toutes les autres sous-classes ConductingEquipment (notamment qui comprennent Clamp et BusbarSection) et DCConductingEquipment ont une seule borne.

4.8.3 Grandeurs nominales

De nombreux attributs du modèle de réseau expriment des grandeurs nominales. Les principes suivants s'appliquent à ces attributs.

- Les grandeurs nominales ne sont pas liées à l'équipement, mais à la tension nominale du système dans le réseau.
- Les grandeurs assignées (ratedU, par exemple) sont liées aux données de la plaque d'identification.

4.8.4 Datatypes

Le document W3C XML Schema Definition Language (XSD) 1.1 Part 2: Datatypes permet d'utiliser les valeurs particulières suivantes: INF, NaN pour exprimer des grandeurs telles que l'infinité positive, l'infinité négative, et non un nombre. Les types de données CIM dans leur ensemble et la primitive Float ne peuvent pas utiliser INF et NaN s'ils n'y sont pas explicitement autorisés dans une description d'un attribut.

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3 Disponible à l'adresse <http://tanjakostic.org/jcleancim>. JCleanCim est l'appellation commerciale d'un produit distribué par Free Software Foundation. Cette information est donnée à l'intention des utilisateurs du présent document et ne signifie nullement que l'IEC approuve ou recommande l´emploi exclusif du produit ainsi désigné. Des produits équivalents peuvent être utilisés s'il peut être démontré qu'ils conduisent aux mêmes résultats.

4 Word est l'appellation commerciale d'un produit distribué par Microsoft. Cette information est donnée à l'intention des utilisateurs du présent document et ne signifie nullement que l'IEC approuve ou recommande l´emploi exclusif du produit ainsi désigné. Des produits équivalents peuvent être utilisés s'il peut être démontré qu'ils conduisent aux mêmes résultats.

4.9 Exemples de modélisation CIM

Des modèles de systèmes de puissance ont été créés de plusieurs façons à partir du modèle UML du CIM. Le premier exemple est une version du schéma RDF (Resource Description Framework – cadre général pour la description des ressources) du CIM, qui utilise XML (eXtensible Markup Language – langage de balisage extensible) pour décrire un modèle de réseau de système de puissance. L'IEC 61970-501 et d'autres normes de profil en développement sont utilisées pour spécifier le format d'échange de modèles. Des versions de schémas RDF du CIM ont été utilisées pour créer les fichiers de modèles XML de réseaux réels pour des essais d'interopérabilité. Une version de schéma RDF du CIM est générée à partir du fichier de modèle UML du CIM en utilisant des outils logiciels fondés sur une spécification de schéma RDF du CIM.

Il convient de noter qu'une version de schéma RDF du CIM est du niveau métadonnées plutôt qu'une instanciation d'un réseau réel. Cependant, des fichiers de modélisation complets de réseaux avec tous les éléments du réseau ainsi que leurs connexions électriques peuvent être générés par des fournisseurs utilisant des outils d'exportation propriétaires, puis importés par d'autres systèmes avec un outil d'importation similaire, qui est utilisé pour remplir une base de données technique locale sur le réseau.

5 Modèle détaillé

5.1 Vue d'ensemble

La partie du Modèle d'Information Commun (CIM) dont traite l'IEC 61970-301 représente une vue logique complète des informations échangées entre différents systèmes des entreprises de service public d'électricité. Cette définition inclut les classes et les attributs publics, ainsi que leurs relations.

5.2 Contexte

Le CIM est fractionné en sous-paquetages. Les classes au sein des paquetages sont répertoriées dans l'ordre dans lequel elles sont définies dans le modèle UML. Les attributs natifs de la classe sont d'abord répertoriés, suivis des attributs hérités dans l'ordre de la hiérarchie d'héritage. Les associations natives sont énumérées en premier pour chaque classe, suivies des associations héritées dans l'ordre de profondeur d'héritage, puis par ordre alphabétique selon le nom de l'extrémité d'association. Les associations sont décrites selon le rôle de chaque classe participant à l'association. Les extrémités d'associations sont répertoriées pour chaque classe à chaque extrémité d'une association.

La Figure 71 représente les paquetages de haut niveau inclus dans le présent document.

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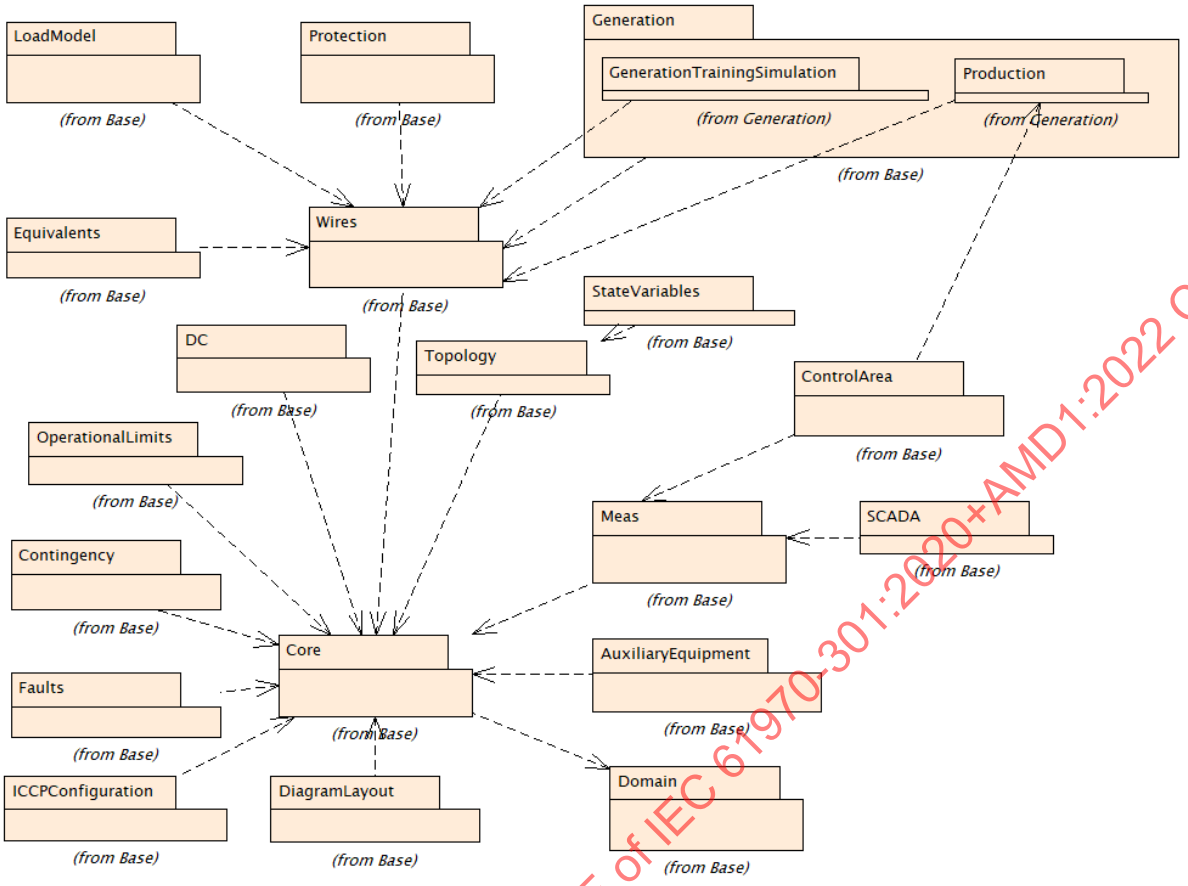


Figure 71 – Paquetages de haut niveau du CIM

Pour chaque paquetage, le modèle d'information de chaque classe est entièrement décrit. Les informations d'attribut et d'extrémité d'association pour des attributs natifs et hérités sont énumérées dans le Tableau 8 et dans le Tableau 9 en prenant une classe appelée "Class1" à titre d'exemple dans un paquetage "Package1" à titre d'exemple. Pour tous les éventuels attributs ou extrémités d'association hérités, la colonne "description" contient le texte indiquant que les attributs sont hérités d'une classe spécifique. Dans cet exemple, Class1 est par hypothèse héritée de la classe IdentifiedObject. La colonne "description" pour les attributs natifs et extrémités d'associations contient la description réelle. Pour des attributs hérités, la classe de base est notée dans la description et la documentation complète sur l'attribut est disponible dans cette classe de base sous forme d'attribut natif.

Tableau 8 – Attributs de Package1::Class1

nom	type	description
native1	Float	Un attribut natif virgule flottante de la classe est décrit ici.
native2	ActivePower	Documentation pour un autre attribut natif du type ActivePower.
name	String	Hérité de: IdentifiedObject

Dans les cas où un attribut est une constante, le Tableau 8 ajoute l'expression "(const)" à la colonne du nom. Dans ces cas, l'attribut a normalement une valeur initiale aussi qui est précédée du signal "égal" et accolée au nom d'attribut.

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Tableau 9 – Extrémités d'association de Package1::Class1 avec d'autres classes

[mult à partir de]	[mult vers] name	type	description
[0..*]	[0..1] Class2	Class2	Description de l'extrémité d'association à une autre classe appelée "Class1". Noter qu'il est typique, mais non exigé, que l'extrémité d'association soit identique au type de référence. Cette extrémité d'association peut référencer zéro ou un objet. L'autre extrémité de l'association peut référencer un Nabre quelconque d'instances de Class1.
[0..1]	[0..*] SecondClass2	Class2	Description de références à la classe appelée "Class2". Dans ce cas, un nombre quelconque de références peut être effectué. La référence inverse peut référencer zéro ou une instance de Class1.
[1..1]	[0..*] Class3	Class3	Référence à un nombre quelconque d'instances de Class3. La référence inverse doit référencer une seule instance de Class1.
[0..*]	[0..*] Class4	Class4	Association plusieurs à plusieurs.
[0..1]	[0..*] DiagramObjects	DiagramObject	hérité de: IdentifiedObject
[1..1]	[0..*] Names	Name	hérité de: IdentifiedObject

Dans le Tableau 9, la première colonne décrit la multiplicité en cette extrémité de l'association (c'est-à-dire, la façon dont cette classe participe à l'association). La deuxième colonne décrit l'autre extrémité d'association. Sa multiplicité est insérée entre des crochets. Le nom de l'extrémité d'association est répertorié en texte en clair. La classe à l'autre extrémité de l'association est donnée dans la troisième colonne. Une multiplicité zéro indique une association facultative. Une multiplicité "*" indique que n'importe quel nombre est autorisé. Par exemple, une multiplicité [1..*] indique qu'une plage allant de 1 à n'importe quel nombre plus grand est autorisée.

Lorsqu'une classe est une énumération appelée "Enumeration1", le tableau des attributs est remplacé par la documentation de libellés comme représenté au Tableau 10, puisque les libellés d'énumération n'ont pas de type. Il n'existe pas de libellés d'énumération hérités pour une classe d'énumération.

Tableau 10 – Libellés de Package1::Enumeration1

libellé	description
native1	Il s'agit de la première valeur enumeration native.
native2	Il s'agit de la deuxième valeur enumeration native.
native3	Il n'y a généralement pas d'attributs hérités pour les énumérations.

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6 Paquetage Base

6.1 Généralités

[nsuri = http://iec.ch/TC57/CIM100#, nsprefix = cim]

Contenu de la CIM de base publié comme IEC 61970-301.

6.2 Paquetage Domain

6.2.1 Généralités

Le paquetage Domain définit les types primitifs de données qui sont utilisés par des classes dans d'autres paquetages. Des stéréotypes sont utilisés pour décrire les types de données. Les stéréotypes suivants sont définis:

- <<enumeration>> Liste des valeurs constantes permises;
- <<Primitive>> type de données le plus simple qui est utilisé pour composer tous les autres types de données;
- <<CIMDatatype>> Type de données qui contient un attribut de valeur, une unité facultative de mesure et un multiplicateur d'unité. L'unité et le multiplicateur peuvent être spécifiés comme des variables statiques initialisées à la valeur autorisée;
- <<Compound>> Composé de Primitive, enumeration, CIMDatatype ou classes Compound, dans la mesure où les classes Compound ne sont pas inversées.

Pour tous les types de données, des valeurs positives et négatives sont admises, sauf indication contraire pour un type de données particulier.

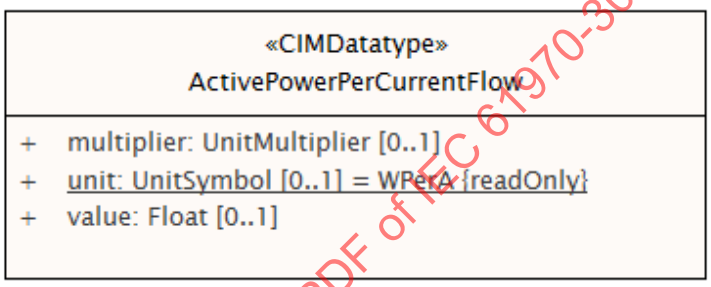


Figure 72 – Diagramme de classe Domain::CombinedElectricalDatatypes

Figure 72: Ce diagramme représente les types de données électriques qui sont des combinaisons d'autres types de données électriques.

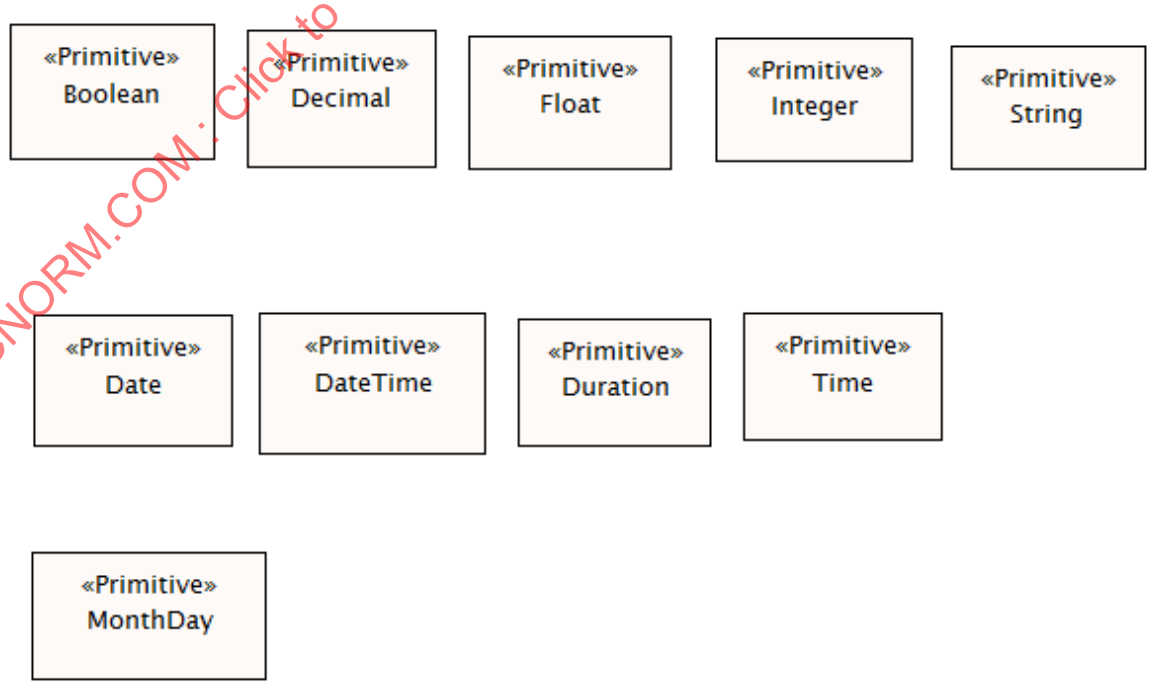
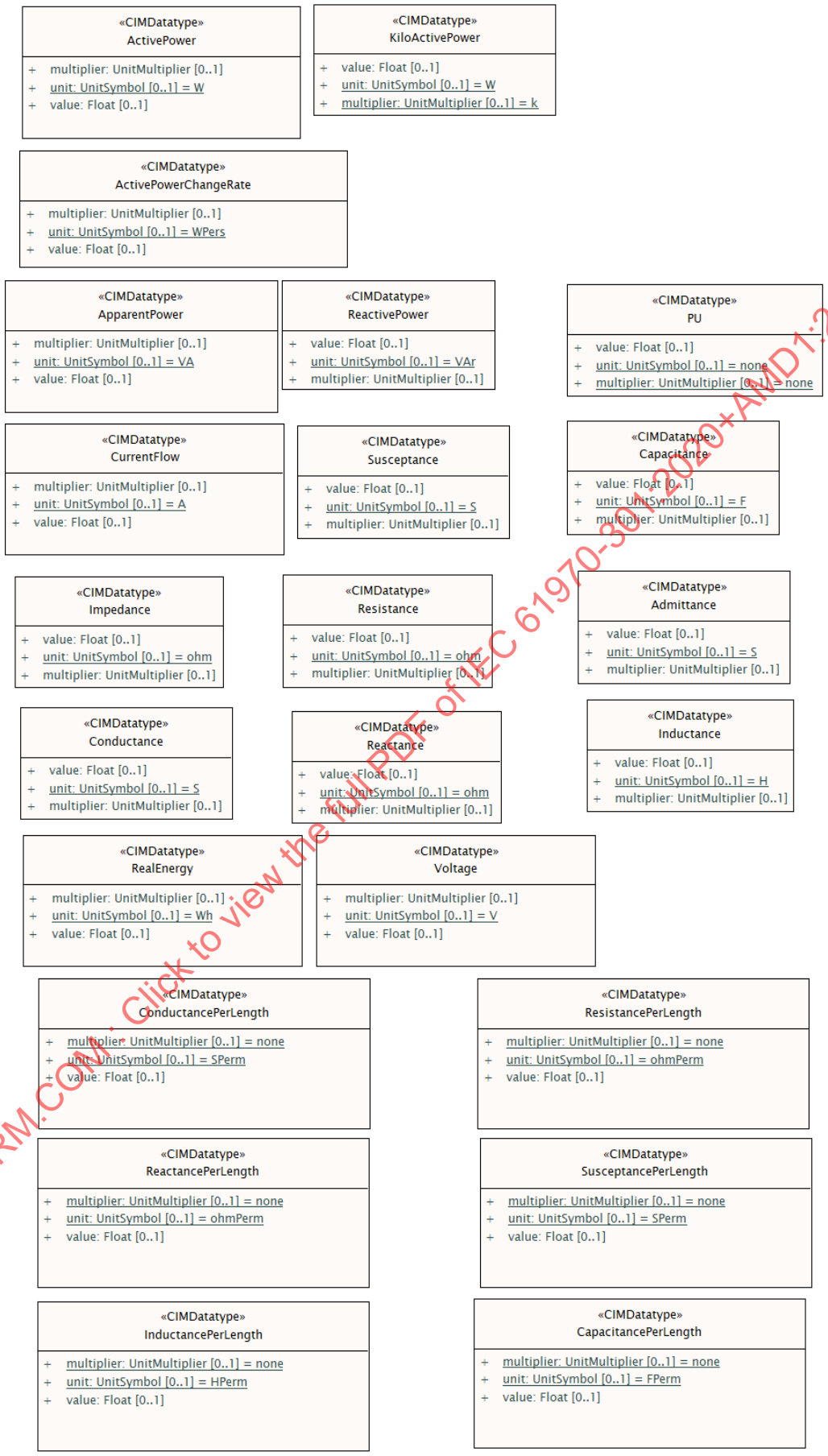


Figure 73 – Diagramme de classe Domain::BasicDatatypes

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Figure 73: Ce diagramme représente les types de données de base qui sont à l'origine de tous les autres types de données.

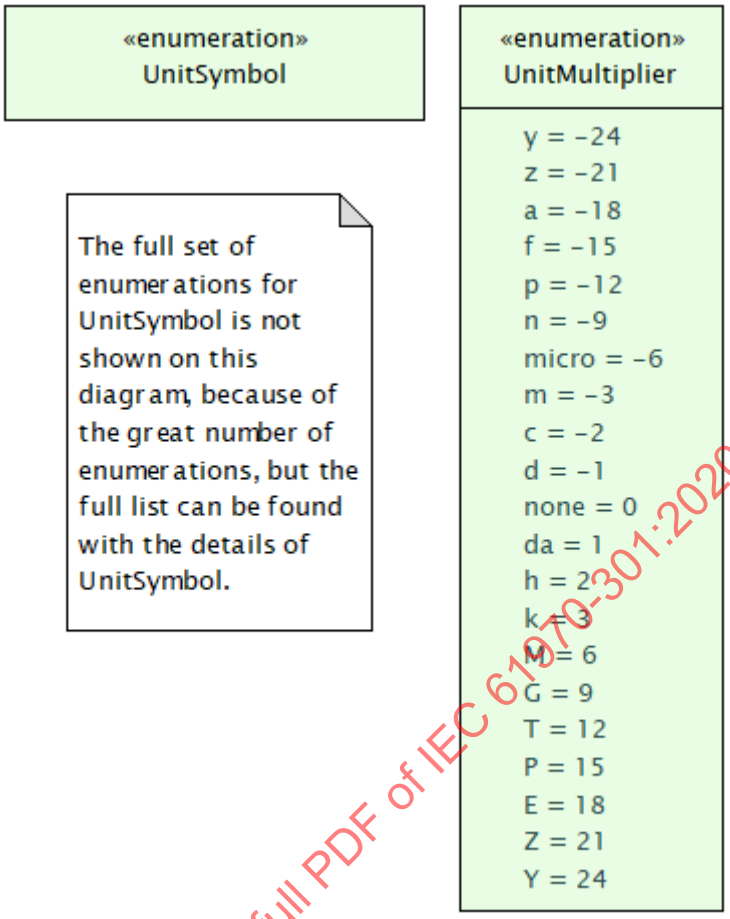
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Figure 74 – Diagramme de classe Domain::ElectricityDatatypes

Figure 74: Ce diagramme représente les types de données liées à l'électricité.

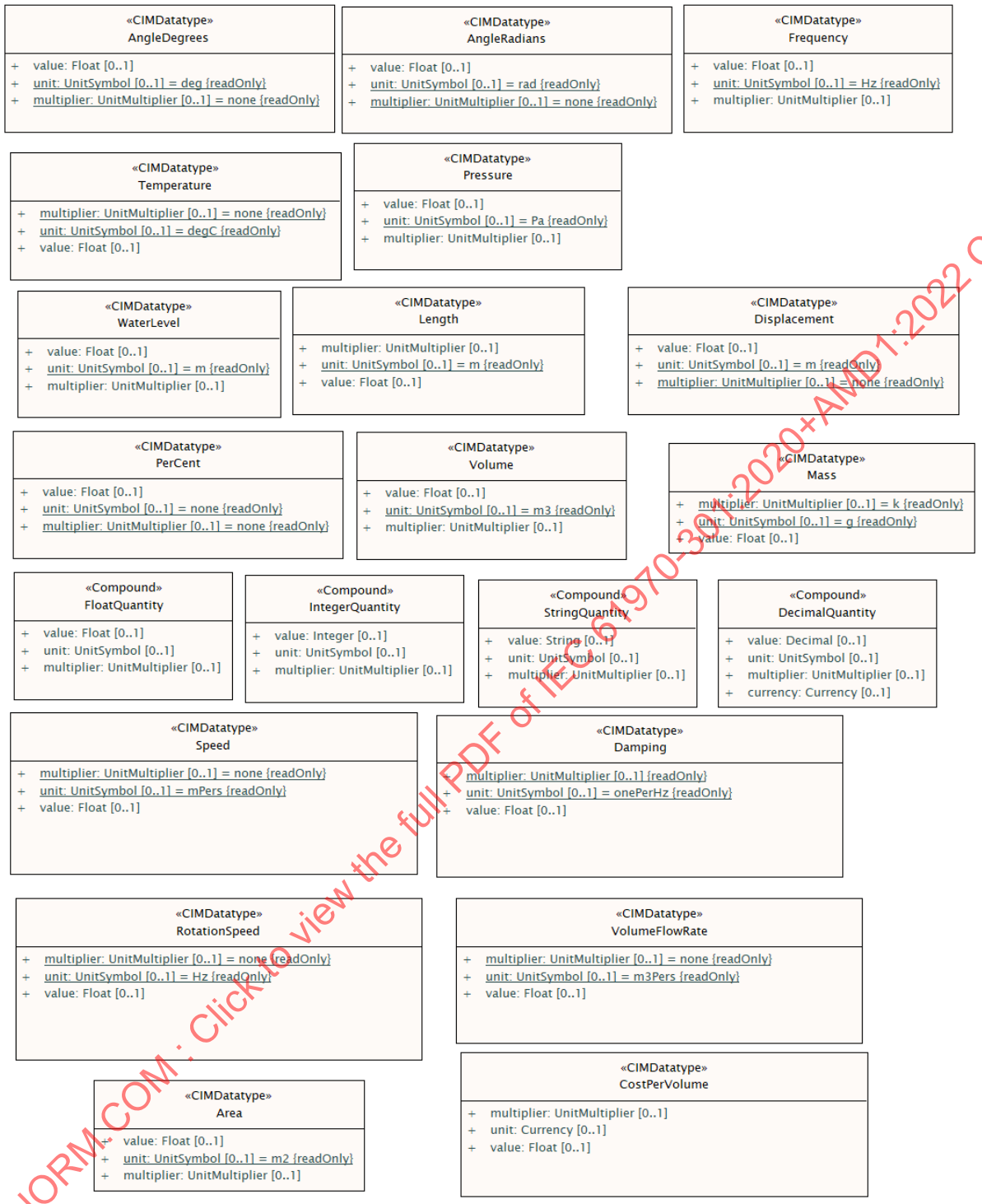


Anglais	Français
The full set of enumerations for UnitSymbol is not shown on this diagram, because of the great number of enumerations, but the full list can be found with the details of UnitSymbol	L'ensemble complet des énumérations pour UnitSymbol n'est pas représenté dans ce diagramme du fait du grand nombre d'énumérations mais la liste complète peut être consultée dans les informations détaillées de UnitSymbol

Figure 75 – Diagramme de classe Domain::EnumeratedUnitDatatypes

Figure 75: Ce diagramme représente les types de données énumérés liés au système d'unités SI.

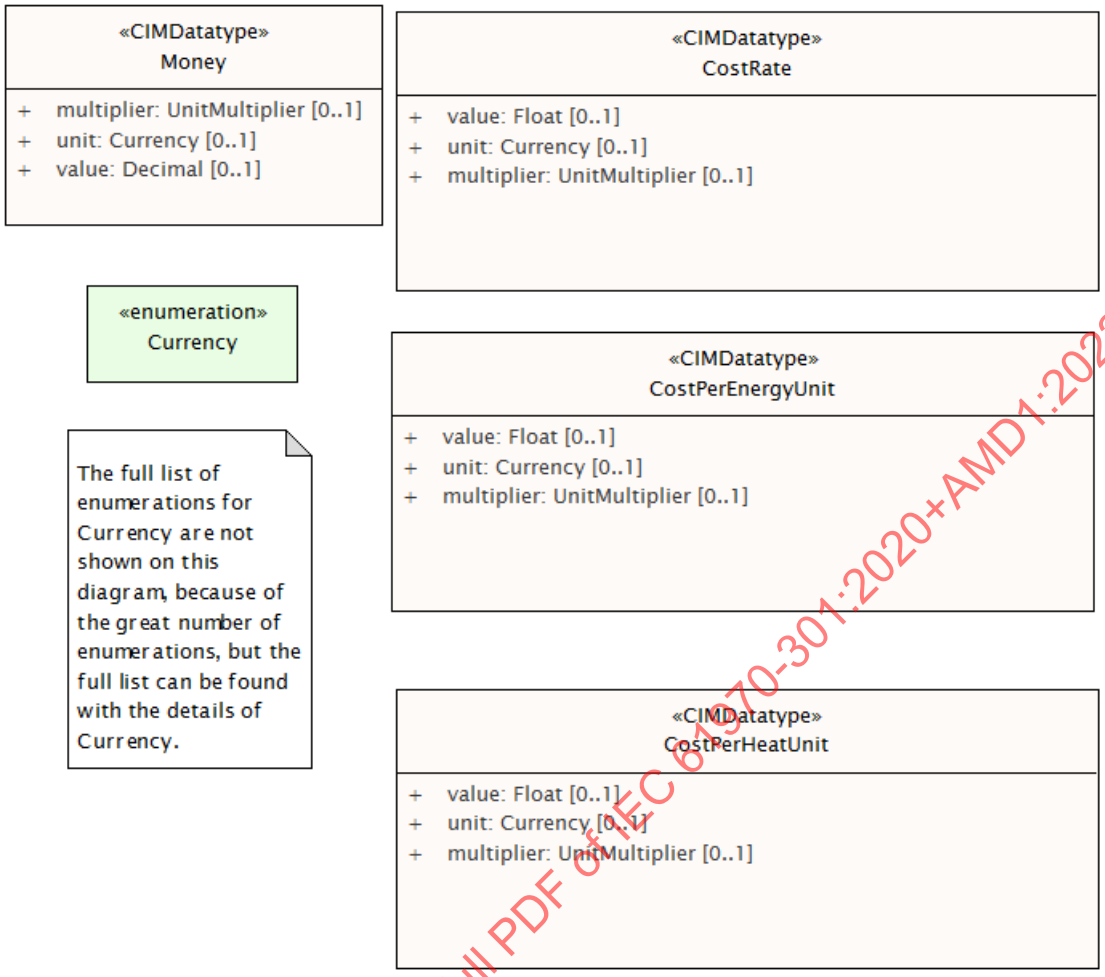
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Figure 76 – Diagramme de classe Domain::GeneralDatatypes

Figure 76: Ce diagramme représente les types généraux de données.



Anglais	Français
The full set of enumerations for Currency are not shown on this diagram, because of the great number of enumerations, but the full list can be found with the details of Currency	L'ensemble complet des énumérations pour Currency n'est pas représenté dans ce diagramme du fait du grand nombre d'énumérations mais la liste complète peut être consultée dans les informations détaillées de Currency

Figure 77 – Diagramme de classe Domain::MonetaryDatatypes

Figure 77: Ce diagramme représente les types de données liés à la monnaie.

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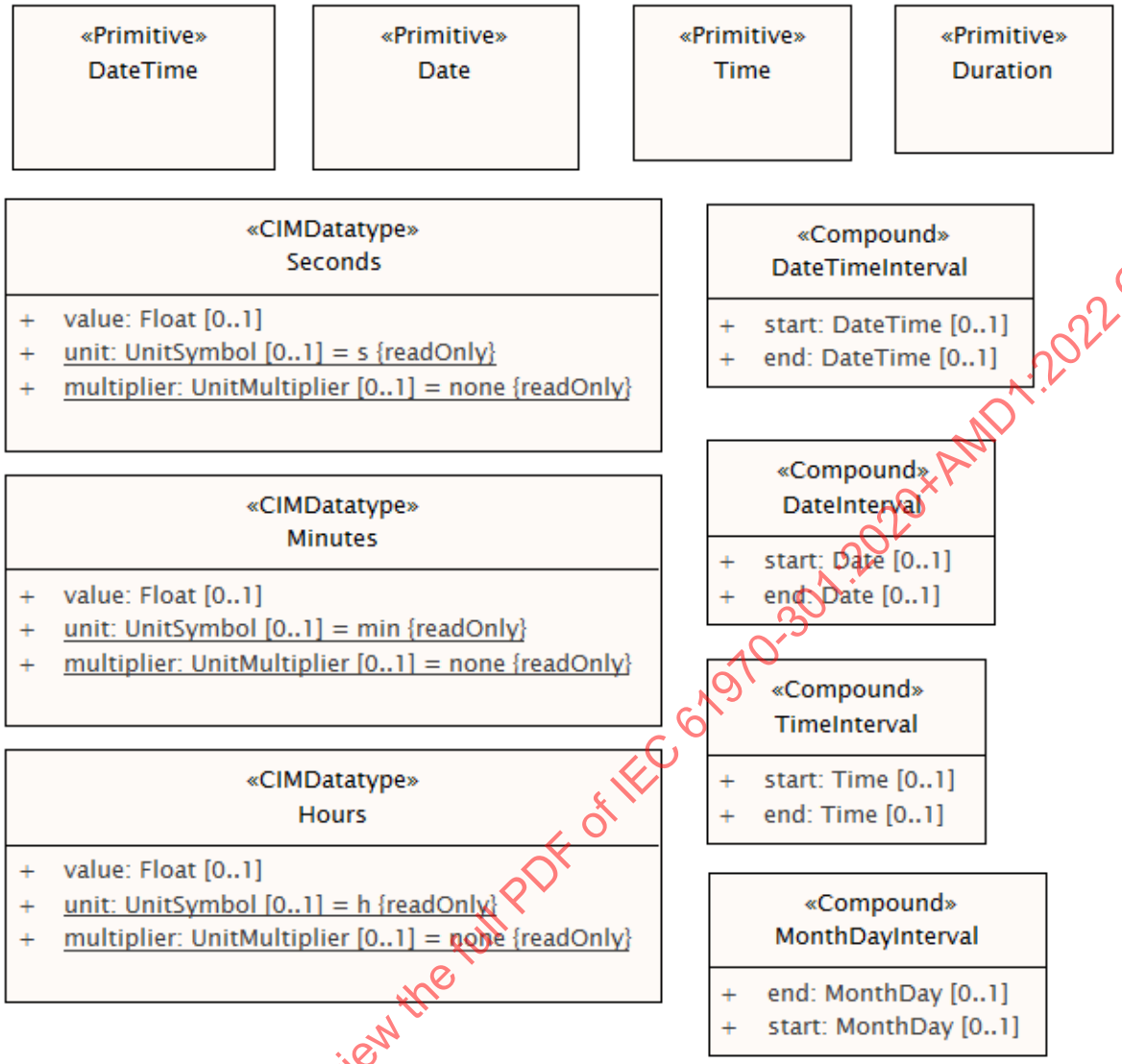


Figure 78 – Diagramme de classe Domain::TimeDatatypes

Figure 78: Ce diagramme représente les types de données liés au temps.

6.2.2 Type de données ActivePower

Produit de la valeur RMS (valeur efficace) de la tension et de la valeur RMS de l'élément en phase du courant.

Le Tableau 11 présente tous les attributs de ActivePower.

Tableau 11 – Attributs de Domain::ActivePower

nom	mult	type	description
multiplier	0..1	UnitMultiplier	
unit	0..1	UnitSymbol	(const=W)
value	0..1	Float	

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6.2.3 Type de données ActivePowerChangeRate

Taux de variation de la puissance active par unité de temps.

Le Tableau 12 présente tous les attributs de ActivePowerChangeRate.

Tableau 12 – Attributs de Domain::ActivePowerChangeRate

nom	mult	type	description
multiplier	0..1	UnitMultiplier	
unit	0..1	UnitSymbol	(const=WPers)
value	0..1	Float	

6.2.4 Type de données ActivePowerPerCurrentFlow

Variation de puissance active avec l'intensité.

Le Tableau 13 présente tous les attributs de ActivePowerPerCurrentFlow.

Tableau 13 – Attributs de Domain::ActivePowerPerCurrentFlow

nom	mult	type	description
multiplier	0..1	UnitMultiplier	
unit	0..1	UnitSymbol	(const=WPerA)
value	0..1	Float	

6.2.5 Type de données ActivePowerPerFrequency

Variation de puissance active avec la fréquence.

Le Tableau 14 présente tous les attributs de ActivePowerPerFrequency.

Tableau 14 – Attributs de Domain::ActivePowerPerFrequency

nom	mult	type	description
multiplier	0..1	UnitMultiplier	
unit	0..1	UnitSymbol	(const=WPers)
value	0..1	Float	

6.2.6 Type de données Admittance

Rapport courant/tension.

Le Tableau 15 présente tous les attributs de Admittance.

Tableau 15 – Attributs de Domain::Admittance

nom	mult	type	description
value	0..1	Float	
unit	0..1	UnitSymbol	(const=S)
multiplier	0..1	UnitMultiplier	

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6.2.7 Type de données AngleDegrees

Mesure d'angle en degrés.

Le Tableau 16 présente tous les attributs de AngleDegrees.

Tableau 16 – Attributs de Domain::AngleDegrees

nom	mult	type	description
value	0..1	Float	
unit	0..1	UnitSymbol	(const=deg)
multiplier	0..1	UnitMultiplier	(const=none)

6.2.8 Type de données AngleRadians

Angle de phase en radians.

Le Tableau 17 présente tous les attributs de AngleRadians.

Tableau 17 – Attributs de Domain::AngleRadians

nom	mult	type	description
value	0..1	Float	
unit	0..1	UnitSymbol	(const=rad)
multiplier	0..1	UnitMultiplier	(const=none)

6.2.9 Type de données ApparentPower

Produit de la valeur efficace de la tension et de la valeur efficace du courant.

Le Tableau 18 présente tous les attributs de ApparentPower.

Tableau 18 – Attributs de Domain::ApparentPower

nom	mult	type	description
multiplier	0..1	UnitMultiplier	
uncfactUnitCode	0..1	UncefactUnitCode	
unit	0..1	UnitSymbol	(const=VA)
value	0..1	Float	

6.2.10 Type de données Area

Zone.

Le Tableau 19 présente tous les attributs de Area.

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Tableau 19 – Attributs de Domain::Area

nom	mult	type	description
value	0..1	Float	
unit	0..1	UnitSymbol	(const=m2)
multiplier	0..1	UnitMultiplier	

6.2.11 Type primitif de données Boolean

Type avec l'espace de valeurs "true" (vrai) et "false" (faux).

6.2.12 Type de données Capacitance

Partie capacitive de la réactance (partie imaginaire de l'impédance), à la fréquence assignée.

Le Tableau 20 présente tous les attributs de Capacitance.

Tableau 20 – Attributs de Domain::Capacitance

nom	mult	type	description
value	0..1	Float	
unit	0..1	UnitSymbol	(const=F)
multiplier	0..1	UnitMultiplier	

6.2.13 Type de données CapacitancePerLength

Capacité par unité de longueur.

Le Tableau 21 présente tous les attributs de CapacitancePerLength.

Tableau 21 – Attributs de Domain::CapacitancePerLength

nom	mult	type	description
multiplier	0..1	UnitMultiplier	(const=none)
unit	0..1	UnitSymbol	(const=F)
value	0..1	Float	

6.2.14 Type de données Classification

Classification du niveau. Spécifié comme 1..n, 1 étant la priorité la plus détaillée et la plus élevée, etc., comme le décrit l'attribut qui utilise ce type de données.

Le Tableau 22 présente tous les attributs de Classification.

Tableau 22 – Attributs de Domain::Classification

nom	mult	type	description
value	0..1	Integer	
unit	0..1	UnitSymbol	(const=none)
multiplier	0..1	UnitMultiplier	(const=none)

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6.2.15 Type de données Conductance

Facteur par lequel doit être multipliée la tension pour obtenir la puissance correspondante perdue dans un circuit. Partie réelle de l'admittance.

Le Tableau 23 présente tous les attributs de Conductance.

Tableau 23 – Attributs de Domain::Conductance

nom	mult	type	description
value	0..1	Float	
unit	0..1	UnitSymbol	(const=S)
multiplier	0..1	UnitMultiplier	

6.2.16 Type de données ConductancePerLength

Partie réelle de l'admittance par unité de longueur.

Le Tableau 24 présente tous les attributs de ConductancePerLength.

Tableau 24 – Attributs de Domain::ConductancePerLength

nom	mult	type	description
multiplier	0..1	UnitMultiplier	(const=none)
unit	0..1	UnitSymbol	(const=SPerm)
value	0..1	Float	

6.2.17 Type de données CostPerEnergyUnit

Coût, en unités monétaires, par quantité d'énergie électrique produite.

Le Tableau 25 présente tous les attributs de CostPerEnergyUnit.

Tableau 25 – Attributs de Domain::CostPerEnergyUnit

nom	mult	type	description
value	0..1	Float	
unit	0..1	Currency	
multiplier	0..1	UnitMultiplier	

6.2.18 Type de données CostPerHeatUnit

Coût, en unités monétaires, par quantité de chaleur générée.

Le Tableau 26 présente tous les attributs de CostPerHeatUnit.

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Tableau 26 – Attributs de Domain::CostPerHeatUnit

nom	mult	type	description
value	0..1	Float	
unit	0..1	Currency	
multiplier	0..1	UnitMultiplier	

6.2.19 Type de données CostPerVolume

Coût par unité de volume.

Le Tableau 27 présente tous les attributs de CostPerVolume.

Tableau 27 – Attributs de Domain::CostPerVolume

nom	mult	type	description
multiplier	0..1	UnitMultiplier	
unit	0..1	Currency	
value	0..1	Float	

6.2.20 Type de données CostRate

Coût en unités monétaires, selon le temps écoulé.

Le Tableau 28 présente tous les attributs de CostRate.

Tableau 28 – Attributs de Domain::CostRate

nom	mult	type	description
value	0..1	Float	
unit	0..1	Currency	
multiplier	0..1	UnitMultiplier	

6.2.21 Enumération Currency

Devises monétaires. Norme ISO 4217 incluant un code de devise monétaire en 3 caractères.

Le Tableau 29 présente tous les libellés de Currency.

Tableau 29 – Libellés de Domain::Currency

libellé	value	description
AED	784	Dirham des Émirats arabes unis.
AFN	971	Afghan afghani.
ALL	008	Lek albanais.
AMD	051	Dram arménien.
ANG	532	Florin des Antilles néerlandaises.
AOA	973	Kwanza angolais.
ARS	032	Peso argentin.
AUD	036	Dollar australien.

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libellé	value	description
AWG	533	Florin arubais.
AZN	944	Mazerbaïdjanais.
BAM	977	Mark convertible de Bosnie-Herzégovine.
BBD	052	Dollar des Barbades.
BDT	050	Taka du Bangladesh.
BGN	975	Lev bulgare.
BHD	048	Dinar du Bahrain.
BIF	108	Franc du Burundi.
BMD	060	Dollar bermudien (communément appelé dollar des Bermudes).
BND	096	Dollar du Brunei.
BOB	068	Boliviano.
BOV	984	Mvdol bolivien (code des fonds).
BRL	986	Real brésilien.
BSD	044	Dollar bahaméen.
BTN	064	Ngultrum bhoutanais.
BWP	072	Pula du Botswana.
BYR	974	Rouble biélorusse.
BZD	084	Dollar de Belize.
CAD	124	Dollar canadien.
CDF	976	Franc congolais.
CHF	756	Franc suisse.
CLF	990	Unidad de Fomento (code des fonds), Chili.
CLP	152	Peso chilien.
CNY	156	Yuan chinois.
COP	170	Peso colombien.
COU	970	Unidad de Valor Real.
CRC	188	Colon costaricien.
CUC	931	Peso convertible cubain.
CUP	192	Peso cubain.
CVE	132	Escudo du Cap-Vert.
CZK	203	Couronne tchèque.
DJF	262	Franc de Djibouti.
DKK	208	Couronne danoise.
DOP	214	Peso dominicain.
DZD	012	Dinar algérien.
EEK	233	Couronne estonienne.
EGP	818	Livre égyptienne.
ERN	232	Nafka érythréen.
ETB	230	Birr éthiopien.
EUR	978	Euro.
FJD	242	Dollar fidjien.
FKP	238	Livre des Îles Malouines.
GBP	826	Livre sterling.

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libellé	value	description
GEL	981	Lari georgien.
GHS	936	Cedi ghanéen.
GIP	929	Livre de Gibraltar.
GMD	270	Dalasi gambien.
GNF	324	Franc guinéen.
GTQ	320	Quetzal quatémalien.
GYD	328	Dollar guyanais.
HKD	344	Dollar de Hong Kong.
HNL	340	Lempira hondurien.
HRK	191	Kuna croate.
HTG	332	Gourde haïtienne.
HUF	348	Forint hongrois.
IDR	360	Roupie indonésienne.
ILS	376	Nouveau shekel israélien.
INR	356	Roupie indienne.
IQD	368	Dinar irakien.
IRR	364	Rial iranien.
ISK	352	Couronne islandaise.
JMD	388	Dollar jamaïcain.
JOD	400	Dinar jordanien.
JPY	392	Yen japonais.
KES	404	Shilling kényan.
KGS	417	Som du Kyrgyzstan.
KHR	116	Riel cambodgien.
KMF	174	Franc comorien.
KPW	408	Won nord-coréen.
KRW	410	Won sud-coréen.
KWD	414	Dinar koweïtien.
KYD	136	Dollar des Îles Caïmans.
KZT	398	Tenge kazakh.
LAK	418	Kip laotien.
LBP	422	Livre libanaise.
LKR	144	Roupie du Sri Lanka.
LRD	430	Dollar libérien.
LSL	426	Loti du Lesotho.
LTL	440	Litas lituanien.
LVL	428	Lats letton.
LYD	434	Dinar libyen.
MAD	504	Dirham marocain.
MDL	498	Leu moldave.
MGA	969	Ariary malgache.
MKD	807	Denar macédonien.
MMK	104	Kyat de Myanmar.
MNT	496	Tukrit mongol.

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libellé	value	description
MOP	446	Pataca macaense.
MRO	478	Ouguiya mauritanienne.
MUR	480	Roupie mauricienne.
MVR	462	Rufiyaa des Maldives.
MWK	454	Kwacha Malawien.
MXN	484	Peso mexicain.
MYR	458	Ringgit malaisien.
MZN	943	Metical mozambicain.
NAD	516	Dolla namibien.
NGN	566	Naira nigérian.
NIO	558	Cordoba oro.
NOK	578	Couronne norvégienne.
NPR	524	Roupie népalaise.
NZD	554	Dollar néo-zélandais.
OMR	512	Rial Omanais.
PAB	590	Balboa panaméen.
PEN	604	Nouveau sol péruvien.
PGK	598	Kina papouan-néo-guinéen.
PHP	608	Peso philippin.
PKR	586	Roupie pakistanaise.
PLN	985	Zloty polonais.
PYG	600	Guaraní paraguayen.
QAR	634	Rial qatari.
RON	946	Nouveau leu roumain.
RSD	941	Dinar serbe.
RUB	643	Rouble russe.
RWF	646	Franc rwandais.
SAR	682	Riyal saoudien.
SBD	090	Dollar des Îles Salomon.
SCR	690	Roupie des Seychelles.
SDG	938	Livre soudanaise.
SEK	752	Couronne suédoise.
SGD	702	Dollar de Singapour.
SHP	654	Livre de Sainte-Hélène.
SLL	694	Leone sierra-léonais.
SOS	706	Shilling somalien.
SRD	968	Dollar du Suriname.
STD	678	Dobra de São Tomé et Príncipe.
SYP	760	Livre syrienne.
SZL	748	Lilangeni.
THB	764	Baht thai.
TJS	972	Somoni du Tadjikistan.
TMT	934	Manat turkème.
TND	788	Dinar tunisien.

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libellé	value	description
TOP	776	Pa'anga tongien.
TRY	949	Lire turque.
TTD	780	Dollar de Trinidad et Tobago.
TWD	901	Nouveau dollar de Taïwan.
TZS	834	Shilling tanzanien.
UAH	980	Hryvnia ukrainienne.
UGX	800	Shilling ougandais.
USD	840	Dollar américain.
UYU	858	Peso uruguayen.
UZS	860	Som d'Ouzbékistan.
VEF	937	Bolívar fuerte vénézuelien.
VND	704	Dong vietnamien.
VUV	548	Vatu du Vanuatu.
WST	882	Tala samoan.
XAF	950	Franc CFA (BEAC).
XCD	951	Dollar des Caraïbes orientales.
XOF	952	Franc CFA (BCEAO).
XPF	953	Franc pacifique.
YER	886	Rial yéménite.
ZAR	710	Rand sud-africain.
ZMK	894	Kwacha zambien.
ZWL	932	Dollar du Zimbabwe.

6.2.22 Type de données CurrentFlow

Courant électrique avec le signe conventionnel: un flux positif circule de l'équipement conducteur jusque dans le nœud de connectivité. Il peut être alternatif ou continu.

Le Tableau 30 présente tous les attributs de CurrentFlow.

Tableau 30 – Attributs de Domain::CurrentFlow

nom	mult	type	description
multiplier	0..1	UnitMultiplier	
unit	0..1	UnitSymbol	(const=A)
value	0..1	Float	

6.2.23 Type de données Damping

Variation de puissance active par unité avec une fréquence référencée dans la base de puissance apparente du système. Les valeurs types sont comprises entre 1,0 et 2,0.

Le Tableau 31 présente tous les attributs de Damping.

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Tableau 31 – Attributs de Domain::Damping

nom	mult	type	description
multiplier	0..1	UnitMultiplier	
unit	0..1	UnitSymbol	(const=onePerHz)
value	0..1	Float	

6.2.24 Type primitif de données Date

Date sous la forme "aaaa-mm-jj" conformément à ISO 8601. Le fuseau horaire TUC est spécifié sous forme "aaaa-mm-jjZ". Un temps TUC par rapport à un fuseau horaire local est spécifié sous la forme "aaaa-mm-jj(+/-)hh:mm".

6.2.25 Compound DateInterval

Intervalle de temps entre deux dates.

Le Tableau 32 présente tous les attributs de DateInterval.

Tableau 32 – Attributs de Domain::DateInterval

nom	mult	type	description
start	0..1	Date	Date à laquelle commence cet intervalle de temps.
end	0..1	Date	Date à laquelle finit cet intervalle de temps.

6.2.26 Type primitif de données DateTime

Date et heure sous la forme"aaaa-mm-jjThh:mm:ss.sss", conformément à ISO 8601. Le fuseau horaire TUC est spécifié sous la forme "aaaa-mm-jjThh:mm:ss.sssZ". Un temps TUC par rapport à un fuseau horaire local est spécifié sous la forme "aaaa-mm-jjThh:mm:ss.sss-hh:mm". La deuxième composante (représentée ici sous la forme "ss.sss") peut avoir un nombre quelconque de chiffres dans sa partie fractionnelle afin de permettre toute sorte de précision en quelques secondes.

6.2.27 Compound DateTimeInterval

Intervalle de temps entre deux dates et instants, où l'intervalle inclut l'heure de début, mais exclut l'heure de fin.

Le Tableau 33 présente tous les attributs de DateTimeInterval.

Tableau 33 – Attributs de Domain::DateTimeInterval

nom	mult	type	description
start	0..1	DateTime	Date et heure de début de cet intervalle de temps. La date et l'heure de début sont incluses dans l'intervalle défini.
end	0..1	DateTime	Date et heure de fin de cet intervalle de temps. Date et heure de fin jusqu'auxquelles l'intervalle est défini, mais exclu.

6.2.28 Type primitif de données Decimal

Le type Decimal renvoie au système de notation décimal utilisant la base 10 pour représenter les nombres réels.

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6.2.29 Compound DecimalQuantity

Grandeur avec valeur décimale et informations associées relatives aux unités ou aux devises.

Le Tableau 34 présente tous les attributs de DecimalQuantity.

Tableau 34 – Attributs de Domain::DecimalQuantity

nom	mult	type	description
value	0..1	Decimal	Valeur de cette grandeur.
unit	0..1	UnitSymbol	Unité de cette grandeur.
multiplier	0..1	UnitMultiplier	Multiplicateur d'unité de cette grandeur.
currency	0..1	Currency	Devise de cette grandeur.

6.2.30 Type de données Displacement

Unité de déplacement par rapport à une position de référence. Elle peut donc être négative.

Le Tableau 35 présente tous les attributs de Displacement.

Tableau 35 – Attributs de Domain::Displacement

nom	mult	type	description
value	0..1	Float	
unit	0..1	UnitSymbol	(const=m)
multiplier	0..1	UnitMultiplier	(const=none)

6.2.31 Type primitif de données Duration

Durée représentée sous le format "PnYnMnDTnHnMnS", conformément à l'ISO 8601, où nY exprime un nombre d'années, nM un nombre de mois, nD un nombre de jours. La lettre T sépare l'expression de la date de l'expression de l'heure; ensuite, nH identifie un nombre d'heures, nM un nombre de minutes et nS un nombre de secondes. Le nombre de secondes peut être exprimé en nombre décimal alors que tous les autres nombres sont des entiers.

6.2.32 Type de données Emission

Quantité d'émission par capacité calorifique de chaleur du combustible.

Le Tableau 36 présente tous les attributs de Emission.

Tableau 36 – Attributs de Domain::Emission

nom	mult	type	description
multiplier	0..1	UnitMultiplier	(const=none)
unit	0..1	UnitSymbol	(const=kgPerJ)
value	0..1	Float	

6.2.33 Type primitif de données Float

Un nombre à virgule flottante. La plage est indéterminée et n'est pas limitée.

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6.2.34 Compound FloatQuantity

Grandeur avec valeur float (flottante) et informations associées relatives aux unités.

Le Tableau 37 présente tous les attributs de FloatQuantity.

Tableau 37 – Attributs de Domain::FloatQuantity

nom	mult	type	description
value	0..1	Float	Valeur de cette grandeur.
unit	0..1	UnitSymbol	Unité de cette grandeur.
multiplier	0..1	UnitMultiplier	Multiplicateur d'unité de cette grandeur.

6.2.35 Type de données Frequency

Cycles par seconde.

Le Tableau 38 présente tous les attributs de Frequency.

Tableau 38 – Attributs de Domain::Frequency

nom	mult	type	description
value	0..1	Float	
unit	0..1	UnitSymbol	(const=Hz)
multiplier	0..1	UnitMultiplier	

6.2.36 Type de données HeatRate

Chaleur générée, en énergie par unité de durée de temps écoulé.

Le Tableau 39 présente tous les attributs de HeatRate.

Tableau 39 – Attributs de Domain::HeatRate

nom	mult	type	description
unit	0..1	UnitSymbol	(const=J)
value	0..1	Float	
multiplier	0..1	UnitMultiplier	

6.2.37 Type de données Hours

Temps spécifié en heures.

Le Tableau 40 présente tous les attributs de Hours.

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Tableau 40 – Attributs de Domain::Hours

nom	mult	type	description
value	0..1	Float	
unit	0..1	UnitSymbol	(const=h)
multiplier	0..1	UnitMultiplier	(const=none)

6.2.38 Type de données Impedance

Rapport tension/courant.

Le Tableau 41 présente tous les attributs de Impedance.

Tableau 41 – Attributs de Domain::Impedance

nom	mult	type	description
value	0..1	Float	
unit	0..1	UnitSymbol	(const=ohm)
multiplier	0..1	UnitMultiplier	

6.2.39 Type de données Inductance

Partie inductive de la réactance (partie imaginaire de l'impédance), à la fréquence assignée.

Le Tableau 42 présente tous les attributs de Inductance.

Tableau 42 – Attributs de Domain::Inductance

nom	mult	type	description
value	0..1	Float	
unit	0..1	UnitSymbol	(const=H)
multiplier	0..1	UnitMultiplier	

6.2.40 Type de données InductancePerLength

Inductance par unité de longueur.

Le Tableau 43 présente tous les attributs de InductancePerLength.

Tableau 43 – Attributs de Domain::InductancePerLength

nom	mult	type	description
multiplier	0..1	UnitMultiplier	(const=none)
unit	0..1	UnitSymbol	(const=HPerm)
value	0..1	Float	

6.2.41 Type primitif de données Integer

Nombre entier. La plage est indéterminée et n'est pas limitée.

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6.2.42 Compound IntegerQuantity

Grandeur avec valeur integer (entière) et informations associées relatives aux unités.

Le Tableau 44 présente tous les attributs de IntegerQuantity.

Tableau 44 – Attributs de Domain::IntegerQuantity

nom	mult	type	description
value	0..1	Integer	Valeur de cette grandeur.
unit	0..1	UnitSymbol	Unité de cette grandeur.
multiplier	0..1	UnitMultiplier	Multiplicateur d'unité de cette grandeur.

6.2.43 Type de données KiloActivePower

Puissance active, en kilowatts.

Le Tableau 45 présente tous les attributs de KiloActivePower.

Tableau 45 – Attributs de Domain::KiloActivePower

nom	mult	type	description
value	0..1	Float	
unit	0..1	UnitSymbol	(const=W)
multiplier	0..1	UnitMultiplier	(const=k)

6.2.44 Type de données Length

Unité de longueur. La valeur doit être positive ou égale à zéro.

Le Tableau 46 présente tous les attributs de Length.

Tableau 46 – Attributs de Domain::Length

nom	mult	type	description
multiplier	0..1	UnitMultiplier	
unit	0..1	UnitSymbol	(const=m)
value	0..1	Float	

6.2.45 Type de données Mass

Masse.

Le Tableau 47 présente tous les attributs de Mass.

Tableau 47 – Attributs de Domain::Mass

nom	mult	type	description
multiplier	0..1	UnitMultiplier	(const=k)
unit	0..1	UnitSymbol	(const=g)
value	0..1	Float	

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6.2.46 Type de données Minutes

Temps, en minutes.

Le Tableau 48 présente tous les attributs de Minutes.

Tableau 48 – Attributs de Domain::Minutes

nom	mult	type	description
value	0..1	Float	
unit	0..1	UnitSymbol	(const=min)
multiplier	0..1	UnitMultiplier	(const=none)

6.2.47 Type de données Money

Quantité d'argent.

Le Tableau 49 présente tous les attributs de Money.

Tableau 49 – Attributs de Domain::Money

nom	mult	type	description
multiplier	0..1	UnitMultiplier	
unit	0..1	Currency	
value	0..1	Decimal	

6.2.48 Type primitif de données MonthDay

Format MonthDay sous la forme "--mm-dd" conforme au type de données XSD gMonthDay.

6.2.49 Compound MonthDayInterval

Intervalle entre deux fois spécifiées comme "month" (mois) et "day" (jour).

Le Tableau 50 présente tous les attributs de MonthDayInterval.

Tableau 50 – Attributs de Domain::MonthDayInterval

nom	mult	type	description
end	0..1	MonthDay	Heure à laquelle finit cet intervalle de temps.
start	0..1	MonthDay	Heure à laquelle commence cet intervalle de temps.

6.2.50 Type de données PU

Par unité – valeur négative ou positive se référant à une base définie. Valeurs généralement comprises entre −10 et +10.

Le Tableau 51 présente tous les attributs de PU.

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Tableau 51 – Attributs de Domain::PU

nom	mult	type	description
value	0..1	Float	
unit	0..1	UnitSymbol	(const=none)
multiplier	0..1	UnitMultiplier	(const=none)

6.2.51 Type de données PerCent

Pourcentage sur une base définie. Spécifier par exemple 100 pour indiquer la base définie.

Le Tableau 52 présente tous les attributs de PerCent.

Tableau 52 – Attributs de Domain::PerCent

nom	mult	type	description
value	0..1	Float	En principe 0 à 100 sur une base définie.
unit	0..1	UnitSymbol	(const=none)
multiplier	0..1	UnitMultiplier	(const=none)

6.2.52 Type de données Pressure

Pression en pascals.

Le Tableau 53 présente tous les attributs de Pressure.

Tableau 53 – Attributs de Domain::Pressure

nom	mult	type	description
value	0..1	Float	
unit	0..1	UnitSymbol	(const=Pa)
multiplier	0..1	UnitMultiplier	

6.2.53 Type de données Reactance

Réactance (partie imaginaire de l'impédance), à une fréquence assignée.

Le Tableau 54 présente tous les attributs de Reactance.

Tableau 54 – Attributs de Domain::Reactance

nom	mult	type	description
value	0..1	Float	
unit	0..1	UnitSymbol	(const=ohm)
multiplier	0..1	UnitMultiplier	

6.2.54 Type de données ReactancePerLength

Réactance (partie imaginaire de l'impédance) par unité de longueur, à la fréquence assignée.

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Le Tableau 55 présente tous les attributs de ReactancePerLength.

Tableau 55 – Attributs de Domain::ReactancePerLength

nom	mult	type	description
multiplier	0..1	UnitMultiplier	(const=none)
unit	0..1	UnitSymbol	(const=ohmPerm)
value	0..1	Float	

6.2.55 Type de données ReactivePower

Produit de la valeur RMS (valeur efficace) de la tension et de la valeur RMS de la composante en quadrature du courant.

Le Tableau 56 présente tous les attributs de ReactivePower.

Tableau 56 – Attributs de Domain::ReactivePower

nom	mult	type	description
value	0..1	Float	
unit	0..1	UnitSymbol	(const=VAr)
multiplier	0..1	UnitMultiplier	

6.2.56 Type de données RealEnergy

Énergie électrique réelle.

Le Tableau 57 présente tous les attributs de RealEnergy.

Tableau 57 – Attributs de Domain::RealEnergy

nom	mult	type	description
multiplier	0..1	UnitMultiplier	
unit	0..1	UnitSymbol	(const=Wh)
value	0..1	Float	

6.2.57 Type de données Resistance

Résistance (partie réelle de l'impédance).

Le Tableau 58 présente tous les attributs de Resistance.

Tableau 58 – Attributs de Domain::Resistance

nom	mult	type	description
value	0..1	Float	
unit	0..1	UnitSymbol	(const=ohm)
multiplier	0..1	UnitMultiplier	

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6.2.58 Type de données ResistancePerLength

Résistance (partie réelle de l'impédance) par unité de longueur.

Le Tableau 59 présente tous les attributs de ResistancePerLength.

Tableau 59 – Attributs de Domain::ResistancePerLength

nom	mult	type	description
multiplier	0..1	UnitMultiplier	(const=none)
unit	0..1	UnitSymbol	(const=ohmPerm)
value	0..1	Float	

6.2.59 Type de données RotationSpeed

Nombre de tours par seconde.

Le Tableau 60 présente tous les attributs de RotationSpeed.

Tableau 60 – Attributs de Domain::RotationSpeed

nom	mult	type	description
multiplier	0..1	UnitMultiplier	(const=none)
unit	0..1	UnitSymbol	(const=Hz)
value	0..1	Float	

6.2.60 Type de données Seconds

Temps, en secondes.

Le Tableau 61 présente tous les attributs de Seconds.

Tableau 61 – Attributs de Domain::Seconds

nom	mult	type	description
value	0..1	Float	Temps, en secondes
unit	0..1	UnitSymbol	(const=s)
multiplier	0..1	UnitMultiplier	(const=none)

6.2.61 Type de données Speed

Distance par unité de temps.

Le Tableau 62 présente tous les attributs de Speed.

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Tableau 62 – Attributs de Domain::Speed

nom	mult	type	description
multiplier	0..1	UnitMultiplier	(const=none)
unit	0..1	UnitSymbol	(const=mPers)
value	0..1	Float	

6.2.62 Type primitif de données String

Chaîne constituée d'une séquence de caractères. Le codage de caractères est UTF-8. La longueur de la chaîne n'est ni spécifiée ni limitée.

6.2.63 Compound StringQuantity

Grandeur avec valeur chaîne de caractères (lorsqu'il importe peu qu'il s'agisse d'un entier ou d'un nombre à virgule flottante) et informations associées relatives aux unités.

Le Tableau 63 présente tous les attributs de StringQuantity.

Tableau 63 – Attributs de Domain::StringQuantity

nom	mult	type	description
value	0..1	String	Valeur de cette grandeur.
unit	0..1	UnitSymbol	Unité de cette grandeur.
multiplier	0..1	UnitMultiplier	Multiplicateur d'unité de cette grandeur.

6.2.64 Type de données Susceptance

Partie imaginaire de l'admittance.

Le Tableau 64 présente tous les attributs de Susceptance.

Tableau 64 – Attributs de Domain::Susceptance

nom	mult	type	description
value	0..1	Float	
unit	0..1	UnitSymbol	(const=S)
multiplier	0..1	UnitMultiplier	

6.2.65 Type de données SusceptancePerLength

Partie imaginaire de l'admittance par unité de longueur.

Le Tableau 65 présente tous les attributs de SusceptancePerLength.

Tableau 65 – Attributs de Domain::SusceptancePerLength

nom	mult	type	description
multiplier	0..1	UnitMultiplier	(const=none)
unit	0..1	UnitSymbol	(const=SPerm)
value	0..1	Float	

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6.2.66 Type de données Temperature

Valeur de température en degrés Celsius.

Le Tableau 66 présente tous les attributs de Temperature.

Tableau 66 – Attributs de Domain::Temperature

nom	mult	type	description
multiplier	0..1	UnitMultiplier	(const=none)
unit	0..1	UnitSymbol	(const=degC)
value	0..1	Float	

6.2.67 Type primitif de données Time

Heure sous la forme "hh:mm:ss.sss", conformément à l'ISO 8601. Le fuseau horaire TUC est spécifié sous forme "hh:mm:ss.sssZ". Un temps TUC par rapport à un fuseau horaire local est spécifié sous la forme "hh:mm:ss.sss±hh:mm". La deuxième composante (représentée ici sous la forme "ss.sss") peut avoir un nombre quelconque de chiffres dans sa partie fractionnelle afin de permettre toute sorte de précision en quelques secondes.

6.2.68 Compound TimeInterval

Intervalle de temps entre deux instants.

Le Tableau 67 présente tous les attributs de TimeInterval.

Tableau 67 – Attributs de Domain::TimeInterval

nom	mult	type	description
start	0..1	Time	Heure à laquelle commence cet intervalle de temps.
end	0..1	Time	Heure à laquelle finit cet intervalle de temps.

6.2.69 Enumération UnitMultiplier

Multiplicateurs d'unité définis pour le CIM. Lorsqu'ils sont appliqués à un symbole d'unité, ce dernier est traité comme une unité déduite. Quel que soit le contenu de son texte, le symbole d'unité doit être traité comme s'il s'agissait d'un symbole d'unité à un seul caractère. Il convient que les symboles d'unité ne contiennent pas de multiplicateur et qu'il revienne au multiplicateur de définir le multiple d'un type de données entier.

Par exemple, si un symbole d'unité est "m2Pers" et que le multiplicateur est "k", alors la valeur est k(m**2/s) et le multiplicateur s'applique à l'ensemble de la valeur finale, et pas à une partie individuelle de cette valeur. Cela peut être conceptualisé en remplaçant un symbole d'unité déduite par le type d'unité. Par exemple, si le symbole "Þ" représente l'unité déduite "m2Pers", l'application du multiplicateur "k" peut être simplement conceptualisée sous la forme "kÞ".

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Par exemple, l'unité SI de la masse est "kg", pas "g". Si le symbole d'unité est défini sous la forme "kg", alors le multiplicateur est appliqué à "kg" dans son ensemble et ne remplace pas le "k" placé devant le "g". Dans ce cas, le multiplicateur de "m" serait utilisé avec le symbole d'unité "kg" pour représenter un gramme. En tant que chaîne de texte, cela ne respecte pas les instructions de l'IEC 80000-1. Toutefois, le symbole d'unité dans le CIM étant traité comme une unité déduite plutôt qu'une unité SI, la conceptualisation de "kg" prend tout son sens, comme si elle était remplacée par l'un des éléments proposés pour le symbole d'unité SI. Par exemple, si le "kg" était remplacé par le symbole "Þ", il serait plus facile de conceptualiser le multiplicateur "m" en créant l'unité "mÞ" correcte, et pas l'unité interdite "mkg".

Le Tableau 68 présente tous les libellés d'UnitMultiplier.

Tableau 68 – Libellés de Domain::UnitMultiplier

libellé	value	description
y	-24	Yocto 10**-24.
z	-21	Zepto 10**-21.
a	-18	Atto 10**-18.
f	-15	Femto 10**-15.
p	-12	Pico 10**-12.
n	-9	Nano 10**-9.
micro	-6	Micro 10**-6.
m	-3	Milli 10**-3.
c	-2	Centi 10**-2.
d	-1	Deci 10**-1.
none	0	Aucun multiplicateur ou multiplié par 1 de manière équivalente.
da	1	Deca 10**1.
h	2	Hecto 10**2.
k	3	Kilo 10**3.
M	6	Mega 10**6.
G	9	Giga 10**9.
T	12	Tera 10**12.
P	15	Peta 10**15.
E	18	Exa 10**18.
Z	21	Zetta 10**21.
Y	24	Yotta 10**24.

6.2.70 Enumération UnitSymbol

Unités déduites définies en vue de leur utilisation dans le CIM. Dans certains cas, l'unité déduite est égale à une unité SI. Dans la mesure du possible, le symbole déduit normalisé est utilisé à la place de la formule de l'unité déduite. Par exemple, le symbole d'unité Farad est défini sous la forme "F" au lieu de "CPerV". Si un symbole normalisé n'existe pas pour une unité déduite, la formule de l'unité est utilisée en tant que symbole d'unité. Par exemple, la densité n'a pas de symbole normalisé et est donc représentée par "kgPerm3". A l'exception de "kg", qui est une unité SI, les symboles d'unité ne contiennent pas de multiplicateur et, de ce fait, représentent l'unité déduite de base à laquelle un multiplicateur peut être appliqué dans son ensemble.

Chaque symbole d'unité est traité comme un texte dont la syntaxe n'est pas analysable, comme s'il s'agissait d'un symbole à une seule lettre. La signification de chaque symbole d'unité est définie par le texte descriptif qui l'accompagne, et pas par le contenu textuel du symbole d'unité.

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Pour élargir le plus possible l'éventail des sérialisations sans manipulation particulière des caractères, plusieurs substitutions sont réalisées, lesquelles s'écartent du format décrit dans l'IEC 80000-1. Le symbole de division "/" est remplacé par les lettres "Per". Les exposants sont écrits en texte clair après l'unité présentée sous la forme "m3" au lieu de "m" avec un exposant de 3 ou en introduisant un symbole comme "m^3". Le symbole de degré "°" est remplacé par les lettres "deg". La signification d'une substitution est précisée dans la description du symbole d'unité.

Les unités non-SI sont incluses dans la liste des symboles d'unité pour permettre de libeller correctement les sources de données avec leurs unités non-SI (par exemple, un capteur GPS qui consigne les numéros représentant les "pieds" plutôt que les "mètres"). Cela permet au logiciel qui utilise les informations de symbole d'unité de convertir correctement et de mettre à l'échelle les données brutes de ces sources en unités SI.

Les valeurs entières sont utilisées pour harmonisation avec l'IEC 61850.

Le Tableau 69 présente tous les libellés d'UnitSymbol.

Tableau 69 – Libellés de Domain::UnitSymbol

libellé	value	description
none	0	Grandeur sans dimension, par exemple: compte, par unité, etc.
m	2	Longueur en mètres.
kg	3	Masse en kilogrammes. Note: le multiplicateur "k" est inclus dans ce symbole d'unité pour des raisons de compatibilité avec l'IEC 61850-7-3.
s	4	Temps en secondes.
A	5	Courant en ampères.
K	6	Température en kelvins.
mol	7	Quantité de substance en moles.
cd	8	Intensité lumineuse en candelas.
deg	9	Angle plan en degrés.
rad	10	Angle plan en radians (m/m).
sr	11	Angle solide en stéradians (m2/m2).
Gy	21	Dose absorbée en grays (J/kg).
Bq	22	Radioactivité en becquerels (1/s).
degC	23	Température relative en degrés Celsius. Le symbole est °C dans le système international d'unités (SI). La charge électrique est mesurée en coulombs qui a pour symbole C. Pour distinguer les degrés Celsius et le coulomb, le symbole utilisé dans l'UML est degC. La raison pour laquelle °C n'est pas utilisé tient à ce qu'il est difficile de gérer le caractère spécial ° dans le logiciel.
Sv	24	Equivalent de dose en sieverts (J/kg).
F	25	Capacité électrique en farads (C/V).
C	26	Charge électrique en coulombs (A·s).
S	27	Conductance en siemens.
H	28	Inductance électrique en henrys (Wb/A).
V	29	Potentiel électrique en volts (W/A).
ohm	30	Résistance électrique en ohms (V/A).
J	31	Énergie en joules (N m = C V = W s).

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libellé	value	description
N	32	Force en newtons (kg m/s^2).
Hz	33	Fréquence en hertz (1/s).
lx	34	Éclairement en lux (lm/m^2).
lm	35	Flux lumineux en lumens (cd·sr).
Wb	36	Flux magnétique en webers (V·s).
T	37	Densité de flux magnétique en teslas (Wb/m2).
W	38	Puissance réelle en watts (J/s). La puissance électrique peut avoir des composantes réelles et réactives. La partie réelle de la puissance électrique (I²R ou VIcos(phi)) est exprimée en Watts. Voir également la puissance apparente et la puissance réactive.
Pa	39	Pression en pascals (N/m^2). Note: la mesure absolue ou relative de la pression est implicite dans cette entrée. Voir ci-dessous pour des formes plus explicites.
m2	41	Surface en mètres carrés (m^2).
m3	42	Volume en mètres cubes (m^3).
mPers	43	Vitesse en mètres par seconde (m/s).
mPers2	44	Accélération en mètres par seconde au carré (m/s^2).
m3Pers	45	Débit volumétrique en mètres cubes par seconde (m^3/s).
mPerm3	46	Rendement énergétique en mètres cubes pas mètres (m/m^3).
kgm	47	Moment de masse en kilogrammes-mètres (kg m) (premier moment de masse). Note: le multiplicateur "k" est inclus dans ce symbole d'unité pour des raisons de compatibilité avec l'IEC 61850-7-3.
kgPerm3	48	Densité en kilogramme/mètres cubes (kg/ m^3). Note: le multiplicateur "k" est inclus dans ce symbole d'unité pour des raisons de compatibilité avec l'IEC 61850-7-3.
m2Pers	49	Viscosité en mètres carrés/seconde (m^2/s).
WPermK	50	Conductivité thermique en watt/mètres kelvin.
JPerK	51	Capacité thermique en joules/kelvin.
ppm	52	Concentration en parties par million.
rotPers	53	Tours par seconde (1/s). Voir également Hz (1/s).
radPers	54	Vitesse angulaire en radians par seconde (rad/s).
WPerm2	55	densité de flux thermique, éclairement énergétique, watts par mètre carré.
JPerm2	56	Densité d'énergie d'isolement, joules par mètre carré ou watt seconde par mètre carré.
SPerm	57	Conductance par longueur (F/m).
KPers	58	Taux de variation de température en kelvins par seconde.
PaPers	59	Taux de variation de pression en pascals par seconde.
JPerkgK	60	Capacité thermique spécifique, entropie spécifique, joules par kilogramme Kelvin.
VA	61	Puissance apparente en volts ampères. Voir également la puissance réelle et la puissance réactive.

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libellé	value	description
VAr	63	Puissance réactive en volts ampères réactifs. Composante "réactive" ou "imaginaire" de la puissance électrique (VIsin(phi)). (Voir également la puissance réelle et la puissance apparente). NOTE Différentes conceptions d'appareil de mesure obtiennent leurs résultats par des méthodes différentes. Certains appareils de mesure calculent la puissance réactive sous la forme d'une valeur arithmétique, alors que d'autres la calculent de manière vectorielle. Il convient que l'utilisateur des données détermine la méthode à utiliser et la pertinence du mesurage pour les besoins prévus.
cosPhi	65	Facteur de puissance, sans dimension. NOTE 1 Cette définition du facteur de puissance ne concerne que les systèmes équilibrés. Voir l'autre définition sous le code 153. NOTE 2 Attention aux différentes conventions en matière de signe utilisées entre l'IEC et l'EEI. Il est pris pour hypothèse que l'utilisateur des données connaît le type d'appareil de mesure utilisé et la convention en matière de signe utilisée par l'entreprise de service public d'électricité.
Vs	66	Volt secondes (Ws/A).
V2	67	Volt carré (W^2/A^2).
As	68	Ampère secondes (A·s).
A2	69	Ampères carrés (A^2).
A2s	70	Temps ampère carré en ampères carré (A^2s).
VAh	71	Energie apparente en heures volt-ampère.
Wh	72	Energie réelle en wattheures.
VArh	73	Energie réactive en heures réactives volt-ampère.
VPerHz	74	Flux magnétique en volt par hertz.
HzPers	75	Taux de variation de fréquence en hertz par seconde.
character	76	Nombre de caractères.
charPers	77	Vitesse de données (baud) en caractères par seconde.
kgm2	78	Moment de masse en kilogramme mètres carrés ($kg\ m^2$) (Second moment de masse, souvent appelé moment d'inertie). Note: le multiplicateur "k" est inclus dans ce symbole d'unité pour des raisons de compatibilité avec l'IEC 61850-7-3.
dB	79	Niveau de pression acoustique en décibels. Note: le multiplicateur "d" est inclus dans ce symbole d'unité pour des raisons de compatibilité avec l'IEC 61850-7-3.
WPers	81	Taux de rampe en watts par seconde.
lPers	82	Débit volumétrique en litres par seconde.
dBm	83	Niveau de puissance (rapport logarithmique de l'intensité du signal, Bel-mW), normalisé à 1 mW. Note: le multiplicateur "d" est inclus dans ce symbole d'unité pour des raisons de compatibilité avec l'IEC 61850-7-3.
h	84	Temps en heures, heure = 60 min = 3 600 s.
min	85	Temps en minutes, minute = 60 s.
Q	100	Grandeur de puissance, Q.
Qh	101	Grandeur d'énergie, Qh.
ohmm	102	Résistivité, ohms mètres (rho).

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libellé	value	description
APerm	103	A/m, intensité du champ magnétique, ampères par mètre.
V2h	104	Volt carré heure, volt-carré-heures.
A2h	105	Ampère carré heure, ampère-carré-heures.
Ah	106	Ampères-heures, ampères heures.
count	111	Quantité de substance, Valeur de compteur.
ft3	119	Volume, pied cube.
m3Perh	125	Débit volumétrique, mètres cubes par heure.
gal	128	Volume en gallons, US gallon (1 gal = 231 in3 = 128 fl once).
Btu	132	Energie, British Thermal Units.
l	134	Volume en litres, litre = dm3 = m3/1 000.
lPerh	137	Débit volumétrique, litres par heure.
lPerl	143	Concentration, rapport du volume d'un soluté divisé par le volume de la solution. Note: les utilisateurs peuvent utiliser un préfixe comme "µ" pour exprimer une grandeur comme "µL/L".
gPerg	144	Concentration, rapport de la masse d'un soluté divisée par la masse de la solution. Note: les utilisateurs peuvent utiliser un préfixe comme "µ" pour exprimer une grandeur comme "µg/g".
molPerm3	145	Concentration, quantité de concentration de substance, (c), quantité de solvant en moles divisée par le volume de la solution en m³.
molPermol	146	Concentration, fraction molaire, rapport de la quantité molaire d'un soluté divisée par la quantité molaire de la solution.
molPerkg	147	Concentration, Molalité, quantité de soluté en moles et quantité de solvant en kilogrammes.
sPers	149	Temps, Rapport de temps. Note: les utilisateurs peuvent indiquer un préfixe comme "µ" pour indiquer des taux comme "µs/s".
HzPerHz	150	Fréquence, taux de variation de fréquence. Note: les utilisateurs peuvent indiquer un préfixe comme "m" pour indiquer des taux comme "mHz/Hz".
VPerV	151	Tension, rapport de tensions. Note: les utilisateurs peuvent indiquer un préfixe comme "m" pour indiquer des taux comme "mV/V".
APerA	152	Courant, rapport des ampérages. Note: les utilisateurs peuvent indiquer un préfixe comme "m" pour indiquer des taux comme "mA/A".
VPerVA	153	Facteur de puissance, PF, rapport de la puissance active sur la puissance apparente. Note: la convention de signe utilisée pour le facteur de puissance est différente entre les mètres de l'IEC et les mètres de l'EEI (ANSI). Il est pris pour hypothèse que les utilisateurs des données connaissent le type d'appareil de mesure utilisé et se mettent d'accord sur la convention en matière de signe utilisée par une entreprise de service public d'électricité donnée.
rev	154	Nombre de tours, révolutions.
kat	158	Activité catalytique, katal = mol / s.
JPerkg	165	Énergie spécifique, Joules / kg.
m3Uncompensated	166	Volume, mètres cubes, avec la valeur non compensée des effets météorologiques.

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libellé	value	description
m3Compensated	167	Volume, mètres cubes, avec la valeur compensée des effets météorologiques.
WPerW	168	Force du signal, rapport de puissance. Note: les utilisateurs peuvent indiquer un préfixe comme "m" pour indiquer des taux comme "mW/W"
therm	169	Energie, therms.
onePerm	173	Nombre d'ondes, mètres réciproques, (1/m).
m3Perkg	174	Volume spécifique, mètres cubes par kilogramme, v.
Pas	175	Viscosité dynamique, pascals secondes.
Nm	176	Moment de force, newtons mètres.
NPerm	177	Tension de surface, newton par mètre.
radPers2	178	Accélération angulaire, radians par seconde au carré.
JPerm3	181	Densité d'énergie, joules par mètre cube.
VPerm	182	Intensité du champ électrique, volts par mètre.
CPerm3	183	Densité de charge électrique, coulombs par mètre cube.
CPerm2	184	Densité de charge en surface, coulombs par mètre carré.
FPerm	185	Permittivité, farads par mètre.
HPerm	186	Perméabilité, henrys par mètre.
JPermol	187	Energie molaire, joules par mole.
JPermolK	188	Entropie molaire, capacité thermique molaire, joules par mole kelvin.
CPerkg	189	Exposition (rayons x), coulombs par kilogramme.
GyPers	190	Débit de dose absorbée, grays par seconde.
WPersr	191	Intensité énergétique, watts par stéradian.
WPerm2sr	192	Luminance énergétique, watts par stéradian-mètre carré.
katPerm3	193	Concentration d'activité catalytique, katals par mètre cube.
d	195	Temps en jour, jour =24 h = 86 400 s.
anglemin	196	Angle plan, minutes.
anglesec	197	Angle plan, secondes.
ha	198	Surface, hectares.
tonne	199	Masse en tonnes, "tonne" or "tonne métrique" (1 000 kg = 1 Mg).
bar	214	Pression en bars, (1 bar = 100 kPa).
mmHg	215	Pression, millimètres de mercure (1 mmHg correspond à environ 133,3 Pa).
M	217	Longueur, miles nautiques (1 M = 1 852 m).
kn	219	Vitesse, nœuds (1 kn = 1 852/3 600) m/s.
Mx	276	Flux magnétique, maxwells (1 Mx = 10-8 Wb).
G	277	Densité de flux magnétique, gausses (1 G = 10-4 T).
Oe	278	Champ magnétique en œrsteds, (1 Oe = (103/4p) A/m).
Vh	280	Volt-heure, Volt heures.
WPerA		Puissance active par flux de courant, watts par Ampère.
onePerHz		Réciproque de la fréquence (1/Hz).

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libellé	value	description
VPerVAr		Facteur de puissance, PF, rapport de la puissance active sur la puissance apparente. Note: la convention de signe utilisée pour le facteur de puissance est différente entre les compteurs de l'IEC et les compteurs de l'EEI (ANSI). Il est pris pour hypothèse que les utilisateurs des données connaissent le type d'appareil de mesure utilisé et se mettent d'accord sur la convention en matière de signe utilisée par une entreprise de service public d'électricité donnée.
ohmPerm	86	Résistance électrique par longueur en ohms par mètre ((V/A)/m).
kgPerJ		Poids par énergie en kilogramme par joule (kg/J). Note: le multiplicateur "k" est inclus dans ce symbole d'unité pour des raisons de compatibilité avec l'IEC 61850-7-3.
JPers		Taux d'énergie en joules par seconde (J/s).

6.2.71 Type de données Voltage

Tension électrique. Elle peut être alternative ou continue.

Le Tableau 70 présente tous les attributs de Voltage.

Tableau 70 – Attributs de Domain::Voltage

nom	mult	type	description
multiplier	0..1	UnitMultiplier	
unit	0..1	UnitSymbol	(const=V)
value	0..1	Float	

6.2.72 Type de données VoltagePerReactivePower

Variation de la tension avec la puissance réactive.

Le Tableau 71 présente tous les attributs de VoltagePerReactivePower.

Tableau 71 – Attributs de Domain::VoltagePerReactivePower

nom	mult	type	description
multiplier	0..1	UnitMultiplier	
unit	0..1	UnitSymbol	(const=VPerVAr)
value	0..1	Float	

6.2.73 Type de données Volume

Volume.

Le Tableau 72 présente tous les attributs de Volume.

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Tableau 72 – Attributs de Domain::Volume

nom	mult	type	description
value	0..1	Float	
unit	0..1	UnitSymbol	(const=m3)
multiplier	0..1	UnitMultiplier	

6.2.74 Type de données VolumeFlowRate

Volume par unité de temps.

Le Tableau 73 présente tous les attributs de VolumeFlowRate.

Tableau 73 – Attributs de Domain::VolumeFlowRate

nom	mult	type	description
multiplier	0..1	UnitMultiplier	(const=none)
unit	0..1	UnitSymbol	(const=m3Pers)
value	0..1	Float	

6.2.75 Type de données WaterLevel

Niveau d'eau présente dans le réservoir par rapport à une référence de type niveau moyen de la mer.

Le Tableau 74 présente tous les attributs de WaterLevel.

Tableau 74 – Attributs de Domain::WaterLevel

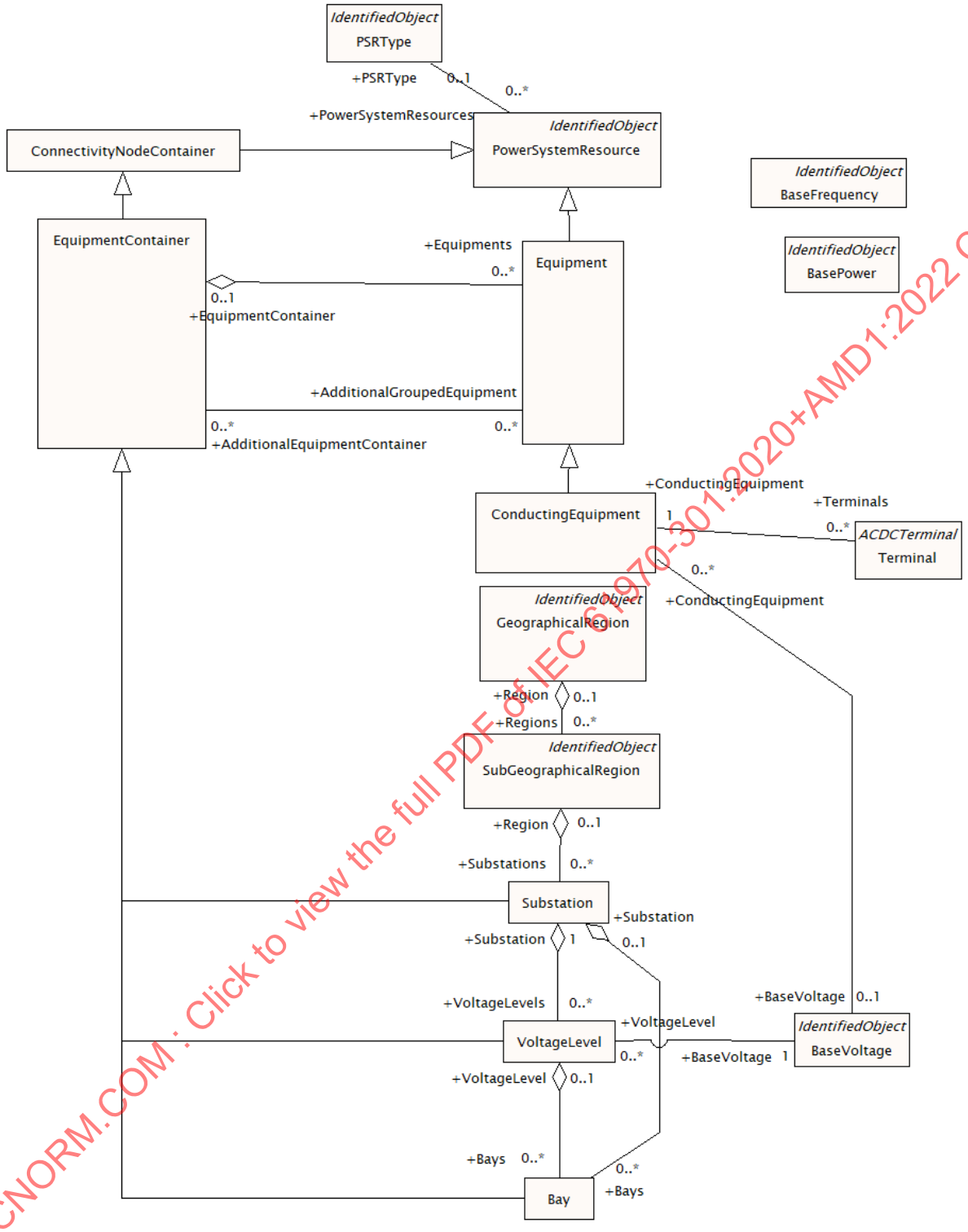
nom	mult	type	description
value	0..1	Float	
unit	0..1	UnitSymbol	(const=m)
multiplier	0..1	UnitMultiplier	

6.3 Paquetage Core

6.3.1 Généralités

Contient les entités Core PowerSystemResource et ConductingEquipment partagées par toutes les applications, plus des collections communes de ces entités. Toutes les applications n'exigent pas toutes les entités Core. Ce paquetage ne dépend d'aucun autre paquetage (à l'exception du paquetage Domain), mais en revanche, la plupart des autres paquetages ont des associations et des généralisations qui dépendent de ce paquetage.

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Figure 79 – Diagramme de classe Core::Main

Figure 79: Ce diagramme représente les principales classes nécessaires à toute application du CIM pour modéliser des systèmes de transport et de production.

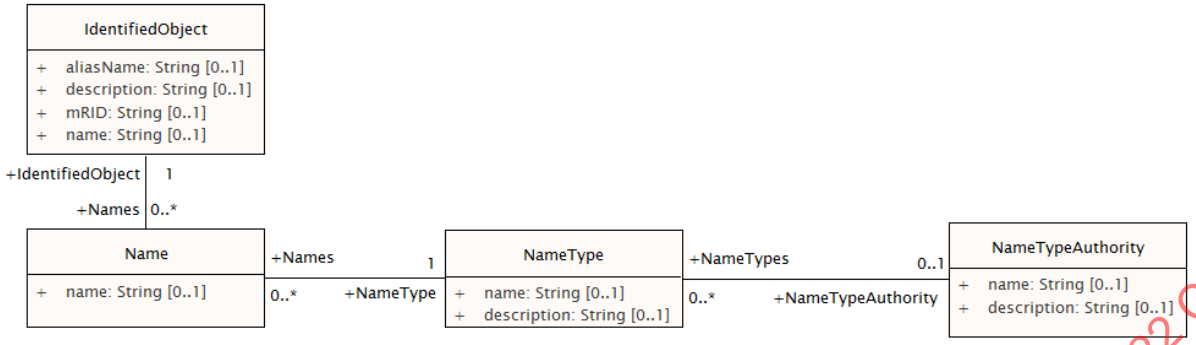


Figure 80 – Diagramme de classe Core::Names

Figure 80: Ce diagramme représente les classes utilisées pour attribuer des noms aux objets identifiés.

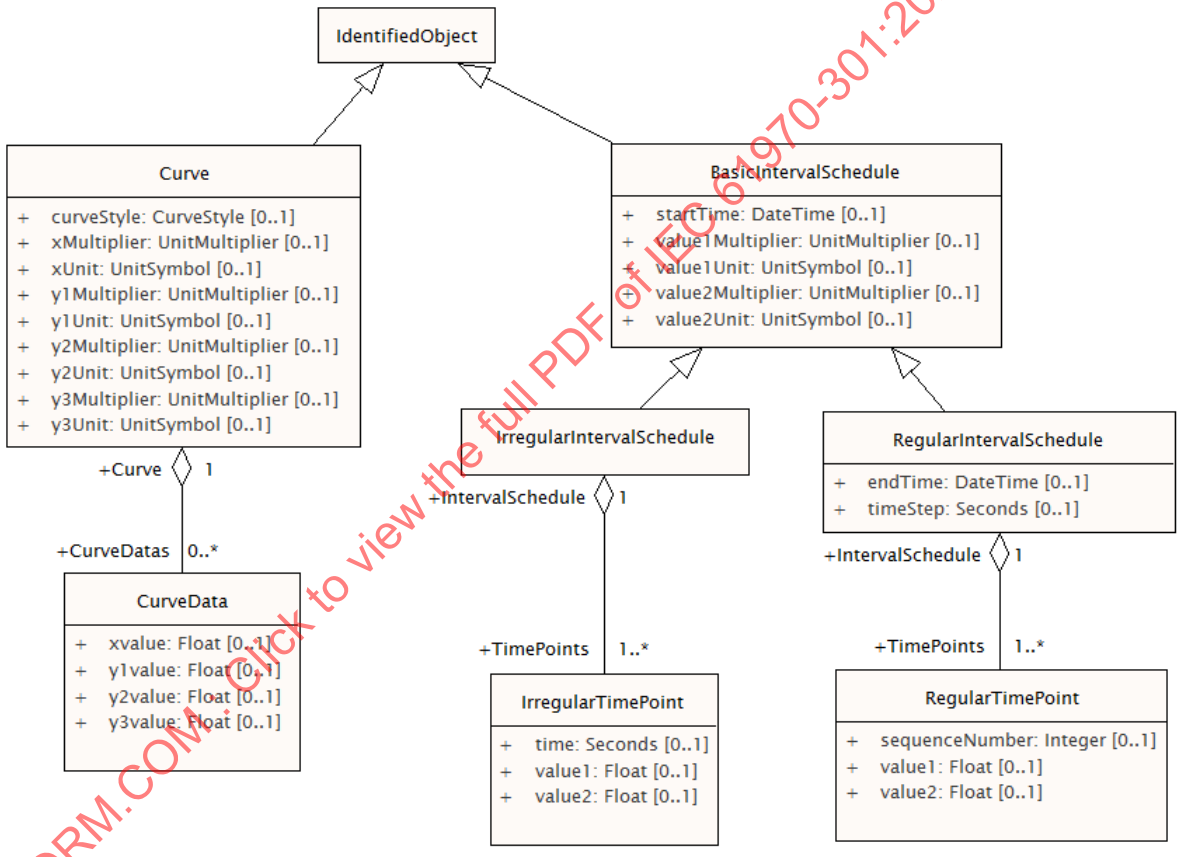


Figure 81 – Diagramme de classe Core::CurveSchedule

Figure 81: Ce diagramme représente le modèle commun pour des courbes et des programmes liés au temps.

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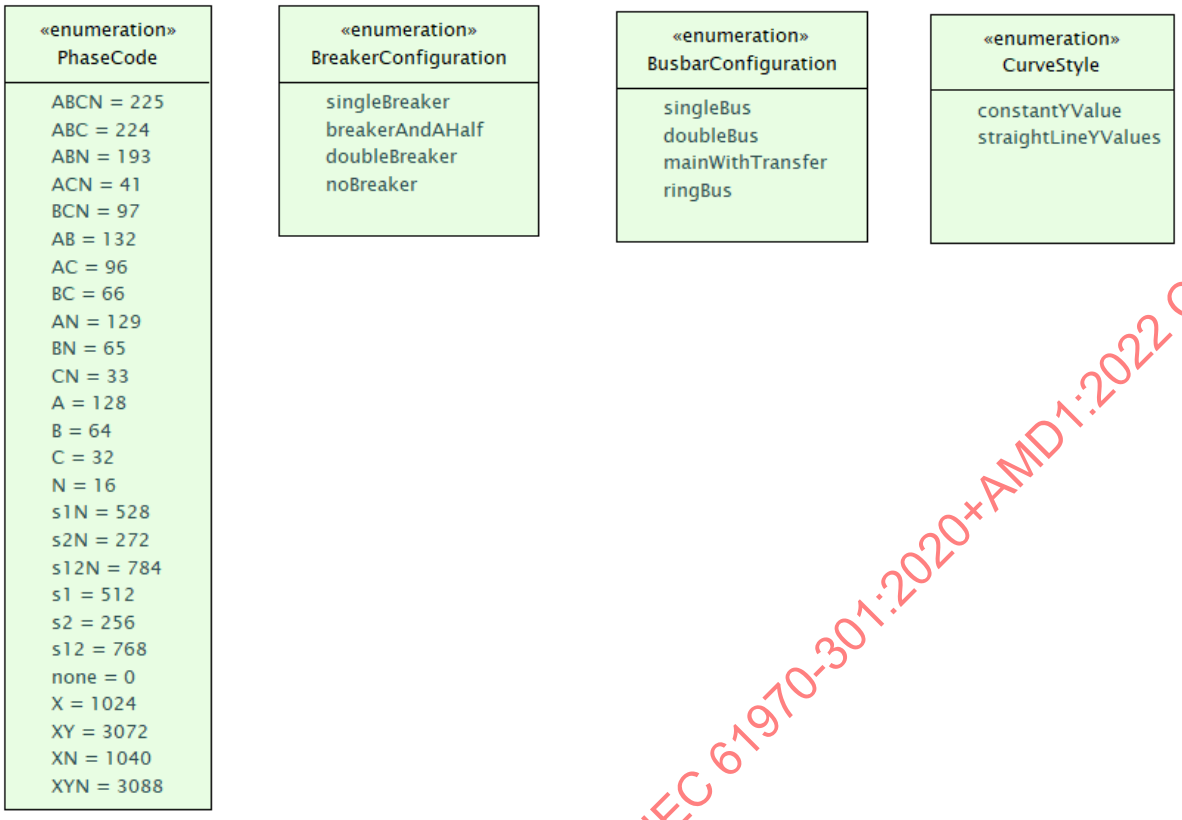


Figure 82 – Diagramme de classe Core::Datatypes

Figure 82: Ce diagramme représente les types de données spécifiques au paquetage Core.

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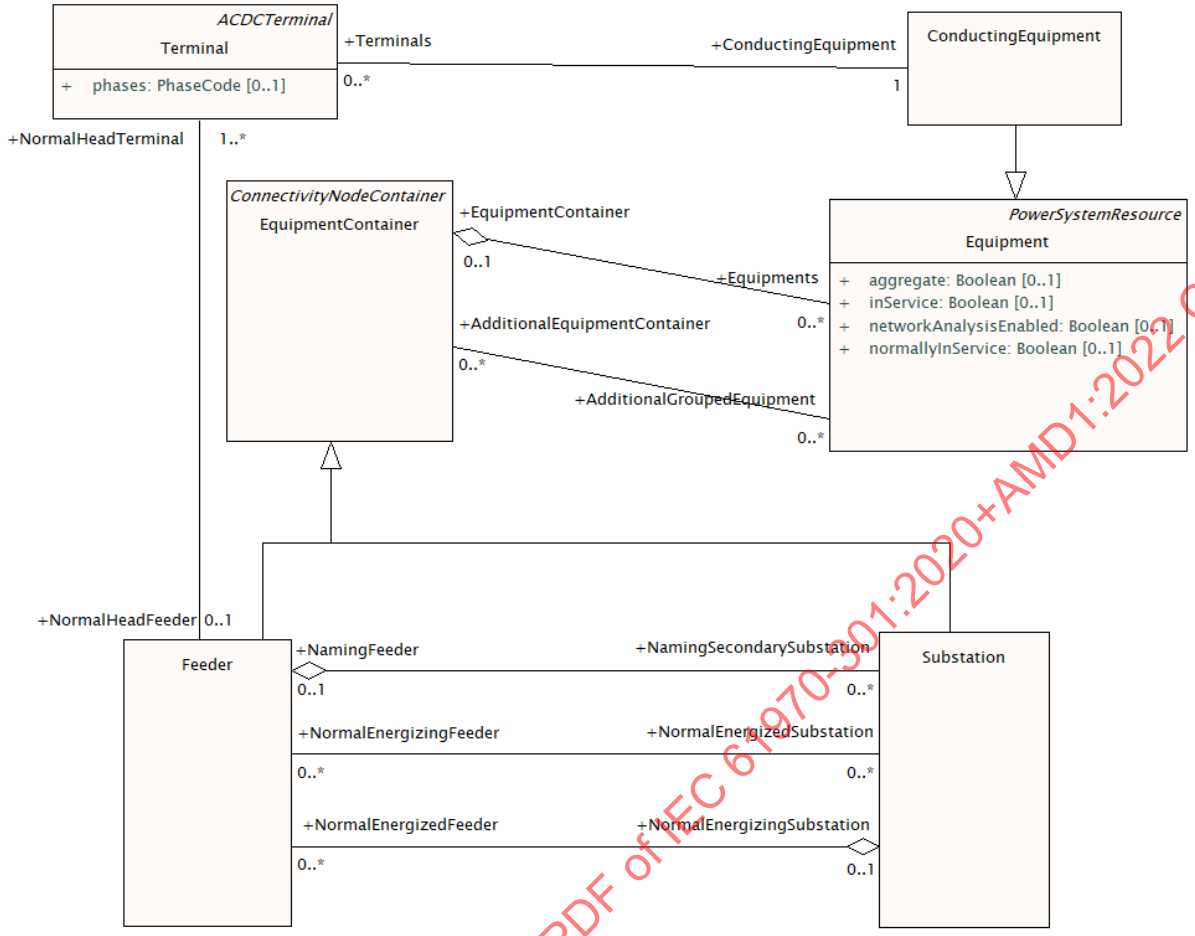


Figure 83 – Diagramme de classe Core::FeederContainment

Figure 83: Ce diagramme représente l'emboîtement feeder.

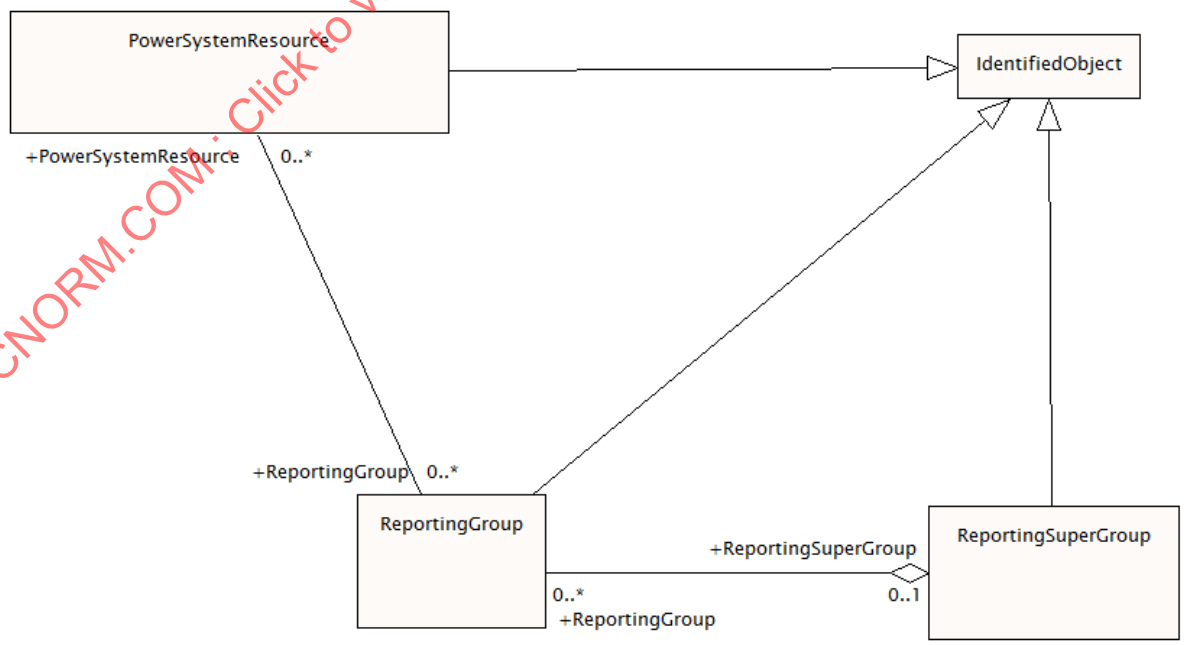


Figure 84 – Diagramme de classe Core::Reporting

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Figure 84: Ce diagramme représente le modèle commun pour le reporting ad hoc.

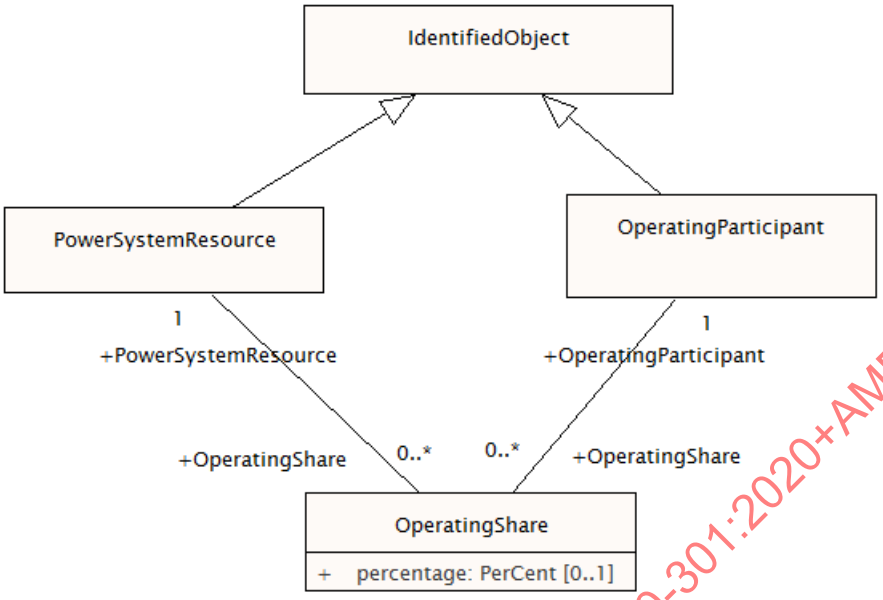


Figure 85 – Diagramme de classe Core::OperatingShare

Figure 85: Ce diagramme représente le modèle commun pour la quote-part d'exploitation.

6.3.2 ACDCTerminal

Point de connexion électrique (à courant alternatif ou à courant continu) à une partie d'un équipement conducteur. Les Terminals (bornes) sont connectées sur des points de connexion physiques appelés nœuds de connectivité (ConnectivityNode).

Le Tableau 75 présente tous les attributs de ACDCTerminal.

Tableau 75 – Attributs de Core::ACDCTerminal

nom	mult	type	description
connected	0..1	Boolean	Le statut "connected" (connecté) est relatif à un modèle de topologie nodale et à la relation nœud topologique-borne. "True" (vrai) implique que la borne est connectée au nœud topologique connexe et "false" (faux) implique qu'elle ne l'est pas. Dans un modèle de topologie nodale, le statut "connected" (connecté) est utilisé pour indiquer si l'équipement est déconnecté sans devoir changer la connectivité décrite par la relation nœud topologique-borne. Un cas valide est lorsque l'équipement conducteur peut être connecté à une extrémité et ouvert à l'autre. C'est un cas approprié, en particulier pour un segment de ligne de courant alternatif où la charge de ligne réactive peut être significative.
sequenceNumber	0..1	Integer	Orientation des connexions de bornes pour un équipement conducteur à plusieurs bornes. La numérotation séquentielle commence à 1 et il convient que les bornes supplémentaires suivent l'ordre croissant. La première borne est le "point de départ" d'une branche à deux bornes.
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject

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nom	mult	type	description
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 76 présente toutes les extrémités d'association de ACDCTerminal avec d'autres classes.

Tableau 76 – Extrémités d'association de Core::ACDCTerminal avec d'autres classes

mult à partir de	nom	mult vers	type	description
1..*	BusNameMarker	0..1	BusNameMarker	Marqueur de nom du bus utilisé pour nommer le bus (nœud topologique).
0..1	OperationalLimitSet	0..*	OperationalLimitSet	Jeu de limites opérationnelles au niveau de la borne.
0..1	Measurements	0..*	Measurement	Les Measurements associées à cette borne définissent l'emplacement de Measurement dans la topologie de réseau. Elles peuvent être utilisées, par exemple, pour représenter la position d'un capteur, comme un transformateur de tension (PT: Voltage transformer) sur un jeu de barres ou un transformateur de courant (CT: Current transformer) sur une barre entre un disjoncteur et un isolateur.
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.3.3 BaseFrequency

La classe BaseFrequency décrit une fréquence de base pour un réseau de système de puissance. En cas de réseaux d'alimentation multiples avec différentes fréquences, par exemple 50 Hz ou 60 Hz, chaque réseau a sa propre classe de fréquence de base. Par conséquent, les objets de systèmes de puissance ayant différentes fréquences de base sont réputés figurer dans des documents séparés dans lesquels chaque document a une instance de fréquence de base unique.

Le Tableau 77 présente tous les attributs de BaseFrequency.

Tableau 77 – Attributs de Core::BaseFrequency

nom	mult	type	description
frequency	0..1	Frequency	La fréquence de base.
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 78 présente toutes les extrémités d'association de BaseFrequency avec d'autres classes.

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Tableau 78 – Extrémités d'association de Core::BaseFrequency avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.3.4 BasePower

La classe BasePower définit la puissance de base dans les calculs par unité.

Le Tableau 79 présente tous les attributs de BasePower.

Tableau 79 – Attributs de Core::BasePower

nom	mult	type	description
basePower	0..1	ApparentPower	Valeur utilisée comme puissance de base.
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 80 présente toutes les extrémités d'association de BasePower avec d'autres classes.

Tableau 80 – Extrémités d'association de Core::BasePower avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.3.5 BaseVoltage

Définit une tension de base du système qui est référencée.

Le Tableau 81 présente tous les attributs de BaseVoltage.

Tableau 81 – Attributs de Core::BaseVoltage

nom	mult	type	description
nominalVoltage	0..1	Voltage	Tension de base de ressource du système de puissance. Doit être une valeur positive et non nulle.
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 82 présente toutes les extrémités d'association de BaseVoltage avec d'autres classes.

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Tableau 82 – Extrémités d'association de Core::BaseVoltage avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..1	ConductingEquipment	0..*	ConductingEquipment	Tout équipement conducteur qui a cette tension de base. À n'utiliser que lorsqu'aucun conteneur de niveau de tension n'est utilisé et qu'une seule tension de base s'applique. Par exemple, n'est pas utilisée pour des transformateurs.
1..1	VoltageLevel	0..*	VoltageLevel	Niveaux de tension ayant cette tension de base.
0..1	TransformerEnds	0..*	TransformerEnd	Extrémités de transformateur à la tension de base. Elle est primordiale pour calculer le PU.
0..1	TopologicalNode	0..*	TopologicalNode	Nœuds topologiques à la tension de base.
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.3.6 BasicIntervalSchedule

Programme de valeurs à des instants donnés.

Le Tableau 83 présente tous les attributs de BasicIntervalSchedule.

Tableau 83 – Attributs de Core::BasicIntervalSchedule

nom	mult	type	description
startTime	0..1	DateTime	Heure pour le premier TimePoint. La valeur peut être une heure du jour, pas une date particulière.
value1Multiplier	0..1	UnitMultiplier	Multiplicateur de value1.
value1Unit	0..1	UnitSymbol	Unités de mesure pour value1.
value2Multiplier	0..1	UnitMultiplier	Multiplicateur de value2.
value2Unit	0..1	UnitSymbol	Unités de mesure pour value2.
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 84 présente toutes les extrémités d'association de BasicIntervalSchedule avec d'autres classes.

Tableau 84 – Extrémités d'association de Core::BasicIntervalSchedule avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

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6.3.7 Bay

Ensemble des ressources du système de puissance (au sein d'un poste donné) comprenant équipement conducteur, relais de protection, mesures et télémesure. Une cellule (bay) représente généralement un groupement physique lié à la modularisation de l'équipement.

Le Tableau 85 présente tous les attributs de Bay.

Tableau 85 – Attributs de Core::Bay

nom	mult	type	description
bayEnergyMeasFlag	0..1	Boolean	Indique la présence/l'absence de mesures d'énergie.
bayPowerMeasFlag	0..1	Boolean	Indique la présence/l'absence de mesures de puissance active/réactive.
breakerConfiguration	0..1	BreakerConfiguration	Configuration du disjoncteur.
busBarConfiguration	0..1	BusbarConfiguration	Configuration du jeu de barres.
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 86 présente toutes les extrémités d'association de Bay avec d'autres classes.

Tableau 86 – Extrémités d'association de Core::Bay avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..*	Substation	0..1	Substation	Poste qui contient la cellule.
0..*	VoltageLevel	0..1	VoltageLevel	Niveau de tension qui contient cette cellule.
0..1	Equipments	0..*	Equipment	hérité de: EquipmentContainer
0..*	AdditionalGrouped Equipment	0..*	Equipment	hérité de: EquipmentContainer
1..1	ConnectivityNodes	0..*	ConnectivityNode	hérité de: ConnectivityNodeContainer
0..1	TopologicalNode	0..*	TopologicalNode	hérité de: ConnectivityNodeContainer
0..*	PSRType	0..1	PSRType	hérité de: PowerSystemResource
0..1	Controls	0..*	Control	hérité de: PowerSystemResource
0..1	Measurements	0..*	Measurement	hérité de: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	hérité de: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	hérité de: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.3.8 Enumération BreakerConfiguration

Disposition de commutation pour Bay.

Le Tableau 87 présente tous les libellés de BreakerConfiguration.

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Tableau 87 – Libellés de Core::BreakerConfiguration

libellé	value	description
singleBreaker		Disjoncteur unique.
breakerAndAHalf		Disjoncteur et demi.
doubleBreaker		Double disjoncteur.
noBreaker		Aucun disjoncteur.

6.3.9 Enumération BusbarConfiguration

Disposition du jeu de barres pour Bay.

Le Tableau 88 présente tous les libellés de BusbarConfiguration.

Tableau 88 – Libellés de Core::BusbarConfiguration

libellé	value	description
singleBus		Barre de transfert unique.
doubleBus		Double barre de transfert.
mainWithTransfer		Barre de transfert principale avec barre de transfert.
ringBus		Barre de transfert en anneau.

6.3.10 ConductingEquipment

Parties du système de puissance à courant alternatif conçues pour transporter du courant ou connectées par des bornes de façon à assurer la conduction.

Le Tableau 89 présente tous les attributs de ConductingEquipment.

Tableau 89 – Attributs de Core::ConductingEquipment

nom	mult	type	description
aggregate	0..1	Boolean	hérité de: Equipment
inService	0..1	Boolean	hérité de: Equipment
networkAnalysisEnabled	0..1	Boolean	hérité de: Equipment
normallyInService	0..1	Boolean	hérité de: Equipment
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 90 présente toutes les extrémités d'association de ConductingEquipment avec d'autres classes.

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Tableau 90 – Extrémités d'association de Core::ConductingEquipment avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..*	BaseVoltage	0..1	BaseVoltage	Tension de base pour cet équipement conducteur. À n'utiliser que lorsqu'aucun conteneur de niveau de tension n'est utilisé et qu'une seule tension de base s'applique. Par exemple, n'est pas utilisée pour des transformateurs.
1..1	SvStatus	0..*	SvStatus	Variable d'état de statut associée à cet équipement conducteur.
0..*	ProtectionEquipments	0..*	ProtectionEquipment	Équipement de protection utilisé pour protéger un équipement conducteur spécifique.
1..1	Terminals	0..*	Terminal	L'équipement conducteur a des bornes qui peuvent être connectées à d'autres bornes d'un équipement conducteur à l'aide de nœuds de connectivité ou de nœuds topologiques.
0..1	OperationalLimitSet	0..*	OperationalLimitSet	hérité de: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	hérité de: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	hérité de: Equipment
0..1	Faults	0..*	Fault	hérité de: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	hérité de: Equipment
0..*	PSRType	0..1	PSRType	hérité de: PowerSystemResource
0..1	Controls	0..*	Control	hérité de: PowerSystemResource
0..1	Measurements	0..*	Measurement	hérité de: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	hérité de: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	hérité de: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.3.11 ConnectivityNode

Les Connectivity nodes (nœuds de connectivité) sont des points auxquels les bornes d'un équipement conducteur à courant alternatif sont raccordées ensemble avec une impédance nulle.

Le Tableau 91 présente tous les attributs de ConnectivityNode.

Tableau 91 – Attributs de Core::ConnectivityNode

nom	mult	type	description
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

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Le Tableau 92 présente toutes les extrémités d'association de ConnectivityNode avec d'autres classes.

Tableau 92 – Extrémités d'association de Core::ConnectivityNode avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..*	TopologicalNode	0..1	TopologicalNode	Nœud topologique auquel est affecté ce nœud de connectivité. Peut dépendre de l'état courant des commutateurs dans le réseau.
0..*	ConnectivityNodeContainer	1..1	ConnectivityNodeContainer	Conteneur de ce nœud de connectivité
0..1	Terminals	0..*	Terminal	Bornes interconnectées à impédance nulle à ce nœud de connectivité.
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.3.12 ConnectivityNodeContainer

Classe de base pour tous les objets qui peuvent contenir des nœuds de connectivité ou des nœuds topologiques.

Le Tableau 93 présente tous les attributs de ConnectivityNodeContainer.

Tableau 93 – Attributs de Core::ConnectivityNodeContainer

nom	mult	type	description
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 94 présente toutes les extrémités d'association de ConnectivityNodeContainer avec d'autres classes.

Tableau 94 – Extrémités d'association de Core::ConnectivityNodeContainer avec d'autres classes

mult à partir de	nom	mult vers	type	description
1..1	ConnectivityNodes	0..*	ConnectivityNode	Nœuds de connectivité qui appartiennent à ce conteneur de nœuds de connectivité.
0..1	TopologicalNode	0..*	TopologicalNode	Nœuds topologiques qui appartiennent à ce conteneur de nœuds de connectivité.
0..*	PSRType	0..1	PSRType	hérité de: PowerSystemResource
0..1	Controls	0..*	Control	hérité de: PowerSystemResource
0..1	Measurements	0..*	Measurement	hérité de: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	hérité de: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	hérité de: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

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6.3.13 Curve

Courbe d'usage général ou relation fonctionnelle entre une variable indépendante (axe X) et des variables dépendantes (axe Y).

Le Tableau 95 présente tous les attributs de Curve.

Tableau 95 – Attributs de Core::Curve

nom	mult	type	description
curveStyle	0..1	CurveStyle	Style ou forme de la courbe.
xMultiplier	0..1	UnitMultiplier	Multiplicateur pour l'axe X.
xUnit	0..1	UnitSymbol	Unités de mesure de l'axe X.
y1Multiplier	0..1	UnitMultiplier	Multiplicateur pour l'axe Y1.
y1Unit	0..1	UnitSymbol	Unités de mesure de l'axe Y1.
y2Multiplier	0..1	UnitMultiplier	Multiplicateur pour l'axe Y2.
y2Unit	0..1	UnitSymbol	Unités de mesure de l'axe Y2.
y3Multiplier	0..1	UnitMultiplier	Multiplicateur pour l'axe Y3.
y3Unit	0..1	UnitSymbol	Unités de mesure de l'axe Y3.
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 96 présente toutes les extrémités d'association de Curve avec d'autres classes.

Tableau 96 – Extrémités d'association de Core::Curve avec d'autres classes

mult à partir de	nom	mult vers	type	description
1..1	CurveDatas	0..*	CurveData	Valeurs de données du point définissant cette courbe.
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.3.14 Classe racine CurveData

Points de données d'usage général pour définir une courbe. L'utilisation de cette classe générique est déconseillée si une classe plus spécifique peut être utilisée pour spécifier les valeurs des axes X et Y ainsi que leurs types de données spécifiques.

Le Tableau 97 présente tous les attributs de CurveData.

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Tableau 97 – Attributs de Core::CurveData

nom	mult	type	description
xvalue	0..1	Float	Valeur de données de la variable de l'axe X, en fonction des unités de l'axe X.
y1value	0..1	Float	Valeur de données de la première variable de l'axe Y, en fonction des unités de l'axe Y.
y2value	0..1	Float	Valeur de données de la deuxième variable de l'axe Y (s'il y en a une), en fonction des unités de l'axe Y.
y3value	0..1	Float	Valeur de données de la troisième variable de l'axe Y (s'il y en a une), en fonction des unités de l'axe Y.

Le Tableau 98 présente toutes les extrémités d'association de CurveData avec d'autres classes.

Tableau 98 – Extrémités d'association de Core::CurveData avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..*	Curve	1..1	Curve	Courbe de ce point de données de courbe.

6.3.15 Enumération CurveStyle

Style ou forme de la courbe

Le Tableau 99 présente tous les libellés de CurveStyle.

Tableau 99 – Libellés de Core::CurveStyle

libellé	value	description
constantYValue		Les valeurs de l'axe Y sont par hypothèse constantes jusqu'au point suivant de courbe et avant le premier point de courbe.
straightLineYValues		Par hypothèse, les valeurs de l'axe Y forment une ligne droite entre les valeurs. Aussi appelé interpolation linéaire.

6.3.16 Equipment

Éléments d'un système de puissance qui sont des appareils matériels, électroniques ou mécaniques.

Le Tableau 100 présente tous les attributs de Equipment.

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Tableau 100 – Attributs de Core::Equipment

nom	mult	type	description
aggregate	0..1	Boolean	L'indicateur aggregate (agrégat) fournit une autre façon de représenter un élément agrégé (équivalent). Il s'applique lorsque les classes dédiées de l'équipement équivalent ne comportent pas tous les attributs nécessaires pour représenter le niveau de détail exigé. Lorsque l'indicateur est réglé sur " true " (vrai), l'instance unique de l'équipement représente plusieurs éléments d'équipement qui ont été modélisés ensemble comme un agrégat équivalent obtenu par une procédure de réduction de réseau. Des exemples de cela sont les transformateurs de puissance ou les machines synchrones fonctionnant en parallèle, modélisées comme un seul agrégat de transformateur de puissance ou agrégat de machine synchrone. L'attribut n'est pas utilisé pour EquivalentBranch, EquivalentShunt et EquivalentInjection.
inService	0..1	Boolean	Spécifie la disponibilité de l'équipement. True (vrai) signifie que l'équipement est disponible pour appliquer le traitement topologique qui détermine si l'équipement est sous tension ou non. False (faux) signifie que l'équipement est traité par des applications de réseau comme s'il était absent du modèle.
networkAnalysisEnabled	0..1	Boolean	L'équipement est activé pour participer à l'analyse du réseau. Si elle n'est pas spécifiée, la valeur est par hypothèse "true" (vrai).
normallyInService	0..1	Boolean	Spécifie la disponibilité de l'équipement dans des conditions de fonctionnement normal. True (vrai) signifie que l'équipement est disponible pour appliquer le traitement topologique qui détermine si l'équipement est sous tension ou non. False (faux) signifie que l'équipement est traité par des applications de réseau comme s'il était absent du modèle.
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 101 présente toutes les extrémités d'association de Equipment avec d'autres classes.

Tableau 101 – Extrémités d'association de Core::Equipment avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..1	OperationalLimitSet	0..*	OperationalLimitSet	Jeux de limites opérationnelles associés à cet équipement.
1..1	ContingencyEquipment	0..*	ContingencyEquipment	Équipements de contingence auxquels cet équipement participe.
0..*	EquipmentContainer	0..1	EquipmentContainer	Conteneur de cet équipement.
0..1	Faults	0..*	Fault	Tous les défauts présents sur cet équipement.
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	Conteneur d'équipement supplémentaire en plus du conteneur d'équipement principal. L'équipement est contenu dans un autre conteneur d'équipements, mais également groupé avec ce conteneur d'équipements.

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mult à partir de	nom	mult vers	type	description
0..*	PSRType	0..1	PSRType	hérité de: PowerSystemResource
0..1	Controls	0..*	Control	hérité de: PowerSystemResource
0..1	Measurements	0..*	Measurement	hérité de: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	hérité de: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	hérité de: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.3.17 EquipmentContainer

Un choix de modélisation pour proposer une classe racine qui regroupe des équipements.

Le Tableau 102 présente tous les attributs de EquipmentContainer.

Tableau 102 – Attributs de Core::EquipmentContainer

nom	mult	type	description
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 103 présente toutes les extrémités d'association de EquipmentContainer avec d'autres classes.

Tableau 103 – Extrémités d'association de Core::EquipmentContainer avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..1	Equipments	0..*	Equipment	Équipement contenu.
0..*	AdditionalGroupedEquipment	0..*	Equipment	Équipement contenu supplémentaire. L'équipement appartient au conteneur d'équipements. L'équipement est contenu dans un autre conteneur d'équipements, mais également groupé avec ce conteneur d'équipements. Par exemple, lorsqu'un commutateur contenu dans un poste est également groupé avec un conteneur de lignes ou lorsqu'un commutateur est inclus dans un poste secondaire et également groupé dans une ligne d'alimentation.
1..1	ConnectivityNodes	0..*	ConnectivityNode	hérité de: ConnectivityNodeContainer
0..1	TopologicalNode	0..*	TopologicalNode	hérité de: ConnectivityNodeContainer
0..*	PSRType	0..1	PSRType	hérité de: PowerSystemResource
0..1	Controls	0..*	Control	hérité de: PowerSystemResource
0..1	Measurements	0..*	Measurement	hérité de: PowerSystemResource

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mult à partir de	nom	mult vers	type	description
1..1	OperatingShare	0..*	OperatingShare	hérité de: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	hérité de: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.3.18 Feeder

Ensemble d'équipements pour les besoins organisationnels, utilisé pour grouper les ressources de distribution[5].

L'organisation d'une ligne d'alimentation ne reflète pas nécessairement la connectivité ou l'état de fonctionnement en cours.

Le Tableau 104 présente tous les attributs de Feeder.

Tableau 104 – Attributs de Core::Feeder

nom	mult	type	description
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 105 présente toutes les extrémités d'association de Feeder avec d'autres classes.

Tableau 105 – Extrémités d'association de Core::Feeder avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..*	NormalEnergizingSubstation	0..1	Substation	Le poste qui alimente de manière nominale la ligne d'alimentation. Également utilisé pour les besoins de la dénomination.
0..1	NamingSecondarySubstation	0..*	Substation	Les postes secondaires qui sont normalement alimentés par la ligne d'alimentation. Utilisés pour les besoins de la dénomination. Il convient que cela soit cohérent avec les autres associations pour la spécification d'alimentation de la borne et la spécification d'alimentation en énergie de la ligne d'alimentation.
0..1	NormalHeadTerminal	1..*	Terminal	Borne de hauteur de chute normale de la ligne d'alimentation.
0..*	NormalEnergizedSubstation	0..*	Substation	Les postes qui sont normalement alimentés par la ligne d'alimentation.
0..1	Equipments	0..*	Equipment	hérité de: EquipmentContainer

[5] Note du traducteur : on parle aussi de " départ " (out-going feeder ") ou d'arrivée (in-going feeder). Dans le texte il est utilisé le terme ligne d'alimentation.

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mult à partir de	nom	mult vers	type	description
0..*	AdditionalGroupedEquipment	0..*	Equipment	hérité de: EquipmentContainer
1..1	ConnectivityNodes	0..*	ConnectivityNode	hérité de: ConnectivityNodeContainer
0..1	TopologicalNode	0..*	TopologicalNode	hérité de: ConnectivityNodeContainer
0..*	PSRType	0..1	PSRType	hérité de: PowerSystemResource
0..1	Controls	0..*	Control	hérité de: PowerSystemResource
0..1	Measurements	0..*	Measurement	hérité de: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	hérité de: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	hérité de: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.3.19 GeographicalRegion

Région géographique d'un modèle de réseau de système de puissance.

Le Tableau 106 présente tous les attributs de GeographicalRegion.

Tableau 106 – Attributs de Core::GeographicalRegion

nom	mult	type	description
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 107 présente toutes les extrémités d'association de GeographicalRegion avec d'autres classes.

Tableau 107 – Extrémités d'association de Core::GeographicalRegion avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..1	Regions	0..*	SubGeographicalRegion	Toutes les sous-régions géographiques à l'intérieur de cette région géographique.
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.3.20 Classe racine IdentifiedObject

Il s'agit d'une classe racine qui fournit une identification commune pour toutes les classes nécessitant des attributs d'identification et de dénomination.

Le Tableau 108 présente tous les attributs de IdentifiedObject.

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Tableau 108 – Attributs de Core::IdentifiedObject

nom	mult	type	description
aliasName	0..1	String	L'aliasName est un nom de l'objet en texte lisible par l'homme en remplacement de IdentifiedObject.name. Il peut ne pas être unique et peut ne pas se corréler à une hiérarchie de dénomination. L'attribut aliasName a été retenu parce qu'il est compatible avec les précédentes versions du CIM. Il est cependant recommandé de remplacer aliasName par la classe Name puisqu'il est prévu de supprimer aliasName à l'avenir.
description	0..1	String	La description est un texte lisible par l'homme qui décrit ou nomme l'objet. Elle peut ne pas être unique et peut ne pas se corréler à une hiérarchie de dénomination.
mRID	0..1	String	Identificateur Master resource publié par une autorité de modèle. Le mRID (identificateur Master resource) est unique dans un contexte d'échange. Il est facile d'obtenir une unicité globale en utilisant un UUID tel que spécifié dans la RFC 4122 pour le mRID. L'utilisation d'un UUID est fortement recommandée. Pour des fichiers de données CIMXML en syntaxe RDF, conformément à l'IEC 61970-552, le mRID est mis en correspondance avec les attributs rdf:ID ou rdf:about qui identifient les éléments d'objet du CIM.
name	0..1	String	Le nom est un texte lisible par l'homme et, si possible, non unique, qui nomme l'objet.

Le Tableau 109 présente toutes les extrémités d'association de IdentifiedObject avec d'autres classes.

Tableau 109 – Extrémités d'association de Core::IdentifiedObject avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..1	DiagramObjects	0..*	DiagramObject	Objets de diagramme qui sont associés à l'objet de domaine.
1..1	Names	0..*	Name	Tous les noms de cet objet identifié.

6.3.21 IrregularIntervalSchedule

Le programme comporte plusieurs instants entre lesquels le temps varie.

Le Tableau 110 présente tous les attributs de IrregularIntervalSchedule.

Tableau 110 – Attributs de Core::IrregularIntervalSchedule

nom	mult	type	description
startTime	0..1	DateTime	hérité de: BasicIntervalSchedule
value1Multiplier	0..1	UnitMultiplier	hérité de: BasicIntervalSchedule
value1Unit	0..1	UnitSymbol	hérité de: BasicIntervalSchedule
value2Multiplier	0..1	UnitMultiplier	hérité de: BasicIntervalSchedule
value2Unit	0..1	UnitSymbol	hérité de: BasicIntervalSchedule
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject

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nom	mult	type	description
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 111 présente toutes les extrémités d'association de IrregularIntervalSchedule avec d'autres classes.

Tableau 111 – Extrémités d'association de Core::IrregularIntervalSchedule avec d'autres classes

mult à partir de	nom	mult vers	type	description
1..1	TimePoints	1..*	IrregularTimePoint	Valeurs de données du point définissant une courbe.
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.3.22 Classe racine IrregularTimePoint

Des TimePoints pour un programme dans lequel le temps entre les points varie.

Le Tableau 112 présente tous les attributs de IrregularTimePoint.

Tableau 112 – Attributs de Core::IrregularTimePoint

nom	mult	type	description
time	0..1	Seconds	Le temps est lié à l'instant où commence le programme.
value1	0..1	Float	Première valeur au temps indiqué. La signification de cette valeur est définie par le type dérivé du programme associé.
value2	0..1	Float	Deuxième valeur au temps indiqué. La signification de cette valeur est définie par le type dérivé du programme associé.

Le Tableau 113 présente toutes les extrémités d'association de IrregularTimePoint avec d'autres classes.

Tableau 113 – Extrémités d'association de Core::IrregularTimePoint avec d'autres classes

mult à partir de	nom	mult vers	type	description
1..*	IntervalSchedule	1..1	IrregularIntervalSchedule	Un IrregularTimePoint appartient à un IrregularIntervalSchedule.

6.3.23 Classe racine Name

La classe Name fournit les moyens de définir un nombre quelconque de noms lisibles par l'homme pour un objet. Un nom ne doit pas être utilisé pour définir des relations entre objets. Utiliser plutôt l'identification d'objet 'mRID' pour les relations entre objets.

Le Tableau 114 présente tous les attributs de Name.

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Tableau 114 – Attributs de Core::Name

nom	mult	type	description
name	0..1	String	Tout texte libre qui désigne l'objet.

Le Tableau 115 présente toutes les extrémités d'association de Name avec d'autres classes.

Tableau 115 – Extrémités d'association de Core::Name avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..*	IdentifiedObject	1..1	IdentifiedObject	Objet identifié que désigne ce nom.
0..*	NameType	1..1	NameType	Type de ce nom.

6.3.24 Classe racine NameType

Type de nom. Les valeurs possibles pour l'attribut 'name' dépendent de la mise en œuvre, mais des profils normatifs peuvent spécifier des types. Une entreprise peut avoir plusieurs systèmes informatiques dont chacun a son propre nom local pour le même objet, par exemple un système de planification peut utiliser d'autres noms qu'un système de gestion de l'énergie (EMS – Energy Management System). Un objet peut aussi avoir des noms différents dans le même système informatique, par exemple localName tel que le définit le CIM version 14. La définition du CIM14 est:

Le localName (nom local) est un nom de l'objet lisible par l'homme. C'est un nom en texte libre se trouvant à un nœud dans une hiérarchie de dénomination similaire à une structure de répertoire de fichiers. Une hiérarchie de dénomination relative à un système de puissance peut être la suivante: Substation, VoltageLevel, Equipment etc. Dans une telle hiérarchie, les enfants du même parent ont des noms qui sont généralement uniques les uns par rapport aux autres.

Le Tableau 116 présente tous les attributs de NameType.

Tableau 116 – Attributs de Core::NameType

nom	mult	type	description
name	0..1	String	Nom du type de nom.
description	0..1	String	Description du type de nom.

Le Tableau 117 présente toutes les extrémités d'association de NameType avec d'autres classes.

Tableau 117 – Extrémités d'association de Core::NameType avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..*	NameTypeAuthority	0..1	NameTypeAuthority	Autorité en charge de la gestion des noms de ce type.
1..1	Names	0..*	Name	Tous les noms de ce type.

6.3.25 Classe racine NameTypeAuthority

Autorité chargée de créer et de gérer les noms d'un type donné. Il s'agit en général d'une organisation ou d'un système d'entreprise.

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Le Tableau 118 présente tous les attributs de NameTypeAuthority.

Tableau 118 – Attributs de Core::NameTypeAuthority

nom	mult	type	description
name	0..1	String	Nom de l'autorité pour le type de nom.
description	0..1	String	Description de l'autorité pour le type de nom.

Le Tableau 119 présente toutes les extrémités d'association de NameTypeAuthority avec d'autres classes.

Tableau 119 – Extrémités d'association de Core::NameTypeAuthority avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..1	NameTypes	0..*	NameType	Tous les types de noms gérés par cette autorité.

6.3.26 OperatingParticipant

Opérateur de plusieurs objets de ressources de systèmes de puissance. Noter que plusieurs participants opérateurs peuvent exploiter le même objet de ressource de système de puissance. Cela peut être utilisé pour modéliser des unités détenues en copropriété dans lesquelles chaque propriétaire agit selon une quote-part contractuelle.

Le Tableau 120 présente tous les attributs de OperatingParticipant.

Tableau 120 – Attributs de Core::OperatingParticipant

nom	mult	type	description
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 121 présente toutes les extrémités d'association de OperatingParticipant avec d'autres classes.

Tableau 121 – Extrémités d'association de Core::OperatingParticipant avec d'autres classes

mult à partir de	nom	mult vers	type	description
1..1	OperatingShare	0..*	OperatingShare	Les quotes-parts d'exploitation d'un participant opérateur. Un participant opérateur peut être réutilisé pour un nombre quelconque de ressources du système de puissance.
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

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6.3.27 Classe racine OperatingShare

Spécifie les relations contractuelles d'exploitation entre une ressource de système de puissance et un participant au contrat.

Le Tableau 122 présente tous les attributs de OperatingShare.

Tableau 122 – Attributs de Core::OperatingShare

nom	mult	type	description
percentage	0..1	PerCent	Pourcentage de possession opérationnelle de la paire (ressource de système de puissance et participant opérateur) associée à cette quote-part. Il convient que la possession totale en pourcentage d'une ressource de système de puissance soit égale à 100 %.

Le Tableau 123 présente toutes les extrémités d'association de OperatingShare avec d'autres classes.

Tableau 123 – Extrémités d'association de Core::OperatingShare avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..*	OperatingParticipant	1..1	OperatingParticipant	Participant opérateur qui a cette quote-part avec la ressource de système de puissance associée.
0..*	PowerSystemResource	1..1	PowerSystemResource	Ressource de système de puissance à laquelle s'applique cette quote-part.

6.3.28 PSRType

Instances de classification de la même classe, par exemple, ACLineSegments (segments de ligne en courant alternatif) aériens et souterrains. Ce mécanisme de classification est destiné à procurer de la flexibilité au-delà du domaine d'application du présent document, c'est-à-dire à apporter une personnalisation qui n'est pas dans la norme.

Le Tableau 124 présente tous les attributs de PSRType.

Tableau 124 – Attributs de Core::PSRType

nom	mult	type	description
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 125 présente toutes les extrémités d'association de PSRType avec d'autres classes.

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Tableau 125 – Extrémités d'association de Core::PSRType avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..1	PowerSystemResources	0..*	PowerSystemResource	Ressources de système de puissance classées avec ce type de ressource de système de puissance.
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.3.29 Enumération PhaseCode

Enumération non ordonnée des identificateurs de phase. Permet de désigner des phases pour l'équipement, les circuits et les charges à la fois de transport et de distribution. Par nature, l'énumération ne décrit pas la manière dont les phases sont connectées ensemble ou reliées à la terre. La terre n'est pas explicitement indiquée comme étant une phase.

Les charges résidentielles et celles de petits commerces sont souvent fournies à partir de circuits secondaires monophasés, ou en phase auxiliaire. En prenant pour exemple s12N, les phases 1 et 2 se réfèrent à des fils chauds qui sont en décalage de phase de 180 degrés tandis que N se réfère au fil neutre. Par des connexions monophasées de transformateur, ces circuits secondaires peuvent être alimentés par une ou deux des phases primaires A, B et C. Pour des charges triphasées, utiliser les codes de phase A, B, C au lieu de s12N.

Les valeurs entières sont issues de l'IEC 61968-9 venant à l'appui des applications de comptage des recettes.

Le Tableau 126 présente tous les libellés de PhaseCode.

Tableau 126 – Libellés de Core::PhaseCode

libellé	value	description
ABCN	225	Phases A, B, C, et N.
ABC	224	Phases A, B et C.
ABN	193	Phases A, B et neutre.
ACN	41	Phases A, C et neutre.
BCN	97	Phases B, C et neutre.
AB	132	Phases A et B.
AC	96	Phases A et C.
BC	66	Phases B et C.
AN	129	Phases A et neutre.
BN	65	Phases B et neutre.
CN	33	Phases C et neutre.
A	128	Phase A.
B	64	Phase B.
C	32	Phase C.
N	16	Phase neutre.
s1N	528	Phase secondaire 1 et neutre.
s2N	272	Phase secondaire 2 et neutre.
s12N	784	Phases secondaires 1, 2 et neutre.

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libellé	value	description
s1	512	Phase secondaire 1.
s2	256	Phase secondaire 2.
s12	768	Phases secondaires 1 et 2.
none	0	Aucune phase spécifiée.
X	1024	Phase non neutre inconnue.
XY	3072	Deux phases non neutres inconnues.
XN	1040	Phase non neutre inconnue plus neutre.
XYN	3088	Deux phases non neutres inconnues plus neutre.

6.3.30 PowerSystemResource

Une ressource de système de puissance (PSR) peut être un élément d'équipement tel qu'un commutateur, un conteneur d'équipements contenant de nombreux éléments d'équipements individuels tel qu'un poste ou une entité opérationnelle telle qu'une sous-zone de réglage. Les ressources de système de puissance peuvent comporter des mesures associées.

Le Tableau 127 présente tous les attributs de PowerSystemResource.

Tableau 127 – Attributs de Core::PowerSystemResource

nom	mult	type	description
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 128 présente toutes les extrémités d'association de PowerSystemResource avec d'autres classes.

Tableau 128 – Extrémités d'association de Core::PowerSystemResource avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..*	PSRType	0..1	PSRType	Classification personnalisée pour cette ressource de système de puissance.
0..1	Controls	0..*	Control	Les sorties de commande utilisées pour commander effectivement un appareil de régulation, par exemple la magnétisation d'une machine synchrone ou l'actionneur disjoncteur d'une batterie de condensateurs.
0..1	Measurements	0..*	Measurement	Les mesures associées à cette ressource de système de puissance.
1..1	OperatingShare	0..*	OperatingShare	Quotes-parts d'exploitation de cette ressource de système de puissance.
0..*	ReportingGroup	0..*	ReportingGroup	Groupes de reporting auxquels appartient cette ressource de système de puissance.
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

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6.3.31 RegularIntervalSchedule

Le programme comporte plusieurs instants entre lesquels le temps est constant.

Le Tableau 129 présente tous les attributs de RegularIntervalSchedule.

Tableau 129 – Attributs de Core::RegularIntervalSchedule

nom	mult	type	description
endTime	0..1	DateTime	Heure du dernier instant (Time Point). La valeur peut être une heure du jour, pas une date particulière.
timeStep	0..1	Seconds	Temps entre chaque paire d'instants réguliers ultérieurs, en ordre séquentiel.
startTime	0..1	DateTime	hérité de: BasicIntervalSchedule
value1Multiplier	0..1	UnitMultiplier	hérité de: BasicIntervalSchedule
value1Unit	0..1	UnitSymbol	hérité de: BasicIntervalSchedule
value2Multiplier	0..1	UnitMultiplier	hérité de: BasicIntervalSchedule
value2Unit	0..1	UnitSymbol	hérité de: BasicIntervalSchedule
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 130 présente toutes les extrémités d'association de RegularIntervalSchedule avec d'autres classes.

Tableau 130 – Extrémités d'association de Core::RegularIntervalSchedule avec d'autres classes

mult à partir de	nom	mult vers	type	description
1..1	TimePoints	1..*	RegularTimePoint	Valeurs de données de l'instant d'intervalle régulier qui définissent ce programme.
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.3.32 Classe racine RegularTimePoint

Instant pour un programme, l'intervalle de temps entre les instants consécutifs étant constant.

Le Tableau 131 présente tous les attributs de RegularTimePoint.

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Tableau 131 – Attributs de Core::RegularTimePoint

nom	mult	type	description
sequenceNumber	0..1	Integer	Position du RegularTimePoint dans cette séquence. Noter que les Time Point ne doivent pas nécessairement être séquentiels, c'est-à-dire que des Time Point peuvent être omis. La durée réelle pour un RegularTimePoint est calculée en multipliant le pas de temps associé du programme à intervalle régulier par le numéro d'ordre de l'instant de l'intervalle régulier et en ajoutant l'heure de départ des programmes associés. Pour spécifier les valeurs de l'heure de départ, utiliser le numéro d'ordre 0. Le numéro d'ordre ne peut pas être négatif.
value1	0..1	Float	Première valeur au temps indiqué. La signification de cette valeur est définie par le type dérivé du programme associé.
value2	0..1	Float	Deuxième valeur au temps indiqué. La signification de cette valeur est définie par le type dérivé du programme associé.

Le Tableau 132 présente toutes les extrémités d'association de RegularTimePoint avec d'autres classes.

Tableau 132 – Extrémités d'association de Core::RegularTimePoint avec d'autres classes

mult à partir de	nom	mult vers	type	description
1..*	IntervalSchedule	1..1	RegularIntervalSchedule	Programme d'intervalle régulier contenant cet instant.

6.3.33 ReportingGroup

Un groupe de reporting est utilisé pour différents groupements ad-hoc utilisés pour le reporting.

Le Tableau 133 présente tous les attributs de ReportingGroup.

Tableau 133 – Attributs de Core::ReportingGroup

nom	mult	type	description
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 134 présente toutes les extrémités d'association de ReportingGroup avec d'autres classes.

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Tableau 134 – Extrémités d'association de Core::ReportingGroup avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..*	PowerSystemResource	0..*	PowerSystemResource	Ressources de système de puissance qui appartiennent à ce groupe de reporting.
0..*	ReportingSuperGroup	0..1	ReportingSuperGroup	Supergroupe de reporting auquel appartient ce groupe de reporting.
0..1	BusNameMarker	0..*	BusNameMarker	Marqueurs de nom du bus qui appartiennent à ce groupe de reporting.
0..1	TopologicalNode	0..*	TopologicalNode	Nœuds topologiques qui appartiennent au groupe de reporting.
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.3.34 ReportingSuperGroup

Un supergroupe de reporting regroupe des groupes de reporting pour un rapport de niveau plus haut.

Le Tableau 135 présente tous les attributs de ReportingSuperGroup.

Tableau 135 – Attributs de Core::ReportingSuperGroup

nom	mult	type	description
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 136 présente toutes les extrémités d'association de ReportingSuperGroup avec d'autres classes.

Tableau 136 – Extrémités d'association de Core::ReportingSuperGroup avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..1	ReportingGroup	0..*	ReportingGroup	Groupes de reporting qui sont regroupés sous ce supergroupe.
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.3.35 SubGeographicalRegion

Sous-ensemble d'une région géographique d'un modèle de réseau de système de puissance.

Le Tableau 137 présente tous les attributs de SubGeographicalRegion.

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Tableau 137 – Attributs de Core::SubGeographicalRegion

nom	mult	type	description
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 138 présente toutes les extrémités d'association de SubGeographicalRegion avec d'autres classes.

Tableau 138 – Extrémités d'association de Core::SubGeographicalRegion avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..1	Lines	0..*	Line	Les lignes dans cette sous-région géographique.
0..1	Substations	0..*	Substation	Postes de cette sous-région géographique.
0..*	Region	0..1	GeographicalRegion	Région géographique dans laquelle se trouve cette sous-région géographique.
0..1	DCLines	0..*	DCLine	Lignes de courant continu de cette sous-région géographique.
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.3.36 Substation

Ensemble d'équipements dans d'autres buts que la production ou l'utilisation, à travers lesquels passe de l'énergie électrique en vrac dans le but de commuter ou de modifier ses caractéristiques.

Le Tableau 139 présente tous les attributs de Substation.

Tableau 139 – Attributs de Core::Substation

nom	mult	type	description
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 140 présente toutes les extrémités d'association de Substation avec d'autres classes.

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Tableau 140 – Extrémités d'association de Core::Substation avec d'autres classes

mult à partir de	nom	mult vers	type	description
1..1	VoltageLevels	0..*	VoltageLevel	Niveaux de tension à l'intérieur de ce poste.
0..1	Bays	0..*	Bay	Cellules contenues dans ce poste.
0..1	NormalEnergizedFeeder	0..*	Feeder	Lignes d'alimentation normales sous tension du poste. Également utilisé pour les besoins de la dénomination.
0..*	NamingFeeder	0..1	Feeder	Ligne d'alimentation principale qui alimente normalement le poste secondaire. Utilisés pour les besoins de la dénomination. Il convient d'utiliser cette association ou le poste de la sous-région géographique pour la spécification d'emboîtement hiérarchique.
0..*	NormalEnergizingFeeder	0..*	Feeder	Lignes d'alimentation qui alimentent potentiellement le poste en aval. Il convient que cela soit cohérent avec les associations qui décrivent la hiérarchie de dénomination.
0..*	Region	0..1	SubGeographicalRegion	SubGeographicalRegion contenant ce poste.
0..1	DCConverterUnit	0..*	DCConverterUnit	Unité de convertisseur de courant continu appartenant au poste.
0..1	Equipments	0..*	Equipment	hérité de: EquipmentContainer
0..*	AdditionalGroupedEquipment	0..*	Equipment	hérité de: EquipmentContainer
1..1	ConnectivityNodes	0..*	ConnectivityNode	hérité de: ConnectivityNodeContainer
0..1	TopologicalNode	0..*	TopologicalNode	hérité de: ConnectivityNodeContainer
0..*	PSRType	0..1	PSRType	hérité de: PowerSystemResource
0..1	Controls	0..*	Control	hérité de: PowerSystemResource
0..1	Measurements	0..*	Measurement	hérité de: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	hérité de: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	hérité de: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.3.37 Terminal

Point de connexion électrique à courant alternatif à une partie d'un équipement conducteur. Les Terminals (bornes) sont connectées sur des points de connexion physiques appelés nœuds de connectivité (ConnectivityNode).

Le Tableau 141 présente tous les attributs de Terminal.

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Tableau 141 – Attributs de Core::Terminal

nom	mult	type	description
phases	0..1	PhaseCode	Représente la condition de phase normale du réseau. Si l'attribut est absent, trois phases (ABC) doivent être prises pour hypothèse, sauf pour les bornes de classes de mise à la terre (spécialisations de EarthFaultCompensator, GroundDisconnector~~, GroundSwitch~~ et Ground) qui sont, par hypothèse, N. Par conséquent, le code de phase ABCN est explicitement déclaré si nécessaire, par exemple, pour l'équipement de mise à la terre du point neutre. Le code de phase sur les bornes reliant le même ConnectivityNode ou le même TopologicalNode ainsi que pour l'équipement entre deux bornes doit être cohérent.
connected	0..1	Boolean	hérité de: ACDCTerminal
sequenceNumber	0..1	Integer	hérité de: ACDCTerminal
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 142 présente toutes les extrémités d'association de Terminal avec d'autres classes.

Tableau 142 – Extrémités d'association de Core::Terminal avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..*	ConductingEquipment	1..1	ConductingEquipment	Equipement conducteur de la borne. L'équipement conducteur a des bornes qui peuvent être connectées à d'autres bornes d'un équipement conducteur à l'aide de nœuds de connectivité ou de nœuds topologiques.
0..*	ConnectivityNode	0..1	ConnectivityNode	Nœud de connectivité auquel cette borne est connectée à impédance nulle.
0..*	TopologicalNode	0..1	TopologicalNode	Le nœud topologique associé à la borne. Il peut être utilisé comme remplacement d'un chemin de nœuds de connectivité allant jusqu'au nœud topologique, éliminant donc la nécessité de modéliser les nœuds de connectivité dans certains cas. Noter que si les nœuds de connectivité sont présents dans le modèle, cette association n'est probablement pas utilisée comme spécification d'entrée.
0..1	RegulatingControl	0..*	RegulatingControl	Les commandes qui régulent cette borne.
1..*	NormalHeadFeeder	0..1	Feeder	Ligne d'alimentation qui alimente normalement cette borne. Uniquement spécifiée pour les bornes au niveau de la hauteur de chute des lignes d'alimentation.
1..1	HasFirstMutualCoupling	0..*	MutualCoupling	Couplages mutuels associés avec la branche comme première branche.
0..1	TransformerEnd	0..*	TransformerEnd	Toutes les extrémités de transformateur connectées à cette borne.

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mult à partir de	nom	mult vers	type	description
1..1	BranchGroupTerminal	0..*	BranchGroupTerminal	Bornes orientées de groupe de branches pour lesquelles cette borne est surveillée.
1..1	SvPowerFlow	0..*	SvPowerFlow	Variable d'état de flux de puissance associée à la borne.
1..1	AuxiliaryEquipment	0..*	AuxiliaryEquipment	Equipement auxiliaire connecté à la borne.
1..1	HasSecondMutualCoupling	0..*	MutualCoupling	Couplages mutuels avec la branche associée comme première branche.
1..1	TieFlow	0..2	TieFlow	Flux d'interconnexion de zone de commande auxquels cette borne est associée.
0..1	EquipmentFaults	0..*	EquipmentFault	Les défauts d'équipement au niveau de cette borne.
0..1	ConverterDCSides	0..*	ACDCConverter	Tous les côtés à courant continu des convertisseurs liés à cette borne de point de couplage commun.
1..1	RemoteInputSignal	0..*	RemoteInputSignal	Signal entrant venant de cette borne.
1..*	BusNameMarker	0..1	BusNameMarker	hérité de: ACDCTerminal
0..1	OperationalLimitSet	0..*	OperationalLimitSet	hérité de: ACDCTerminal
0..1	Measurements	0..*	Measurement	hérité de: ACDCTerminal
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.3.38 VoltageLevel

Ensemble d'équipements à un même niveau de tension, constituant un appareillage de connexion. L'équipement consiste généralement en disjoncteurs, jeux de barres, appareils d'instrumentation, de commande, de régulation et de protection, de même que des regroupements de ce type de constituants.

Le Tableau 143 présente tous les attributs de VoltageLevel.

Tableau 143 – Attributs de Core::VoltageLevel

nom	mult	type	description
highVoltageLimit	0..1	Voltage	Limite de haute tension du jeu de barres La limite s'applique à tous les équipements et nœuds contenus dans un VoltageLevel donné. Il n'est pas exigé de l'échanger par paire avec lowVoltageLimit. Il est préférable d'utiliser la VoltageLimit opérationnelle qui prévaut si elle est présente.
lowVoltageLimit	0..1	Voltage	Limite de basse tension du jeu de barres. La limite s'applique à tous les équipements et nœuds contenus dans un VoltageLevel donné. Il n'est pas exigé de l'échanger par paire avec lowVoltageLimit. Il est préférable d'utiliser la VoltageLimit opérationnelle qui prévaut si elle est présente.
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

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Le Tableau 144 présente toutes les extrémités d'association de VoltageLevel avec d'autres classes.

Tableau 144 – Extrémités d'association de Core::VoltageLevel avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..*	BaseVoltage	1..1	BaseVoltage	Tension de base utilisée pour tout l'équipement dans le niveau de tension.
0..1	Bays	0..*	Bay	Cellules qui se trouvent à ce niveau de tension.
0..*	Substation	1..1	Substation	Poste du niveau de tension.
0..1	Equipments	0..*	Equipment	hérité de: EquipmentContainer
0..*	AdditionalGrouped Equipment	0..*	Equipment	hérité de: EquipmentContainer
1..1	ConnectivityNodes	0..*	ConnectivityNode	hérité de: ConnectivityNodeContainer
0..1	TopologicalNode	0..*	TopologicalNode	hérité de: ConnectivityNodeContainer
0..*	PSRType	0..1	PSRType	hérité de: PowerSystemResource
0..1	Controls	0..*	Control	hérité de: PowerSystemResource
0..1	Measurements	0..*	Measurement	hérité de: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	hérité de: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	hérité de: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.4 Paquetage Wires

6.4.1 Généralités

Extension des paquetages Core et Topology qui modélise les informations des caractéristiques électriques des réseaux Transport et Distribution. Ce paquetage est utilisé par des applications de réseau telles que State Estimation, Load Flow et Optimal Power Flow.

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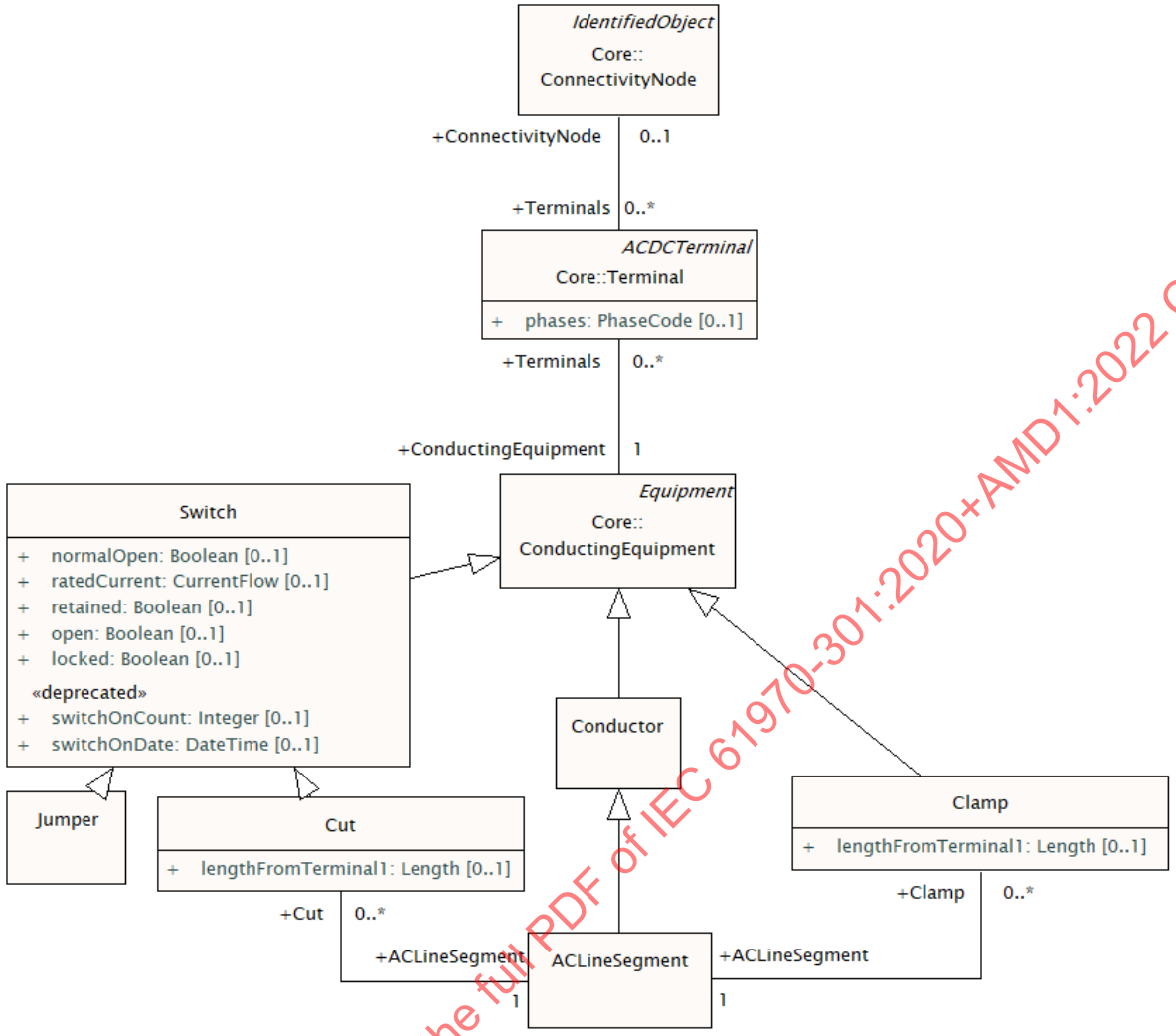


Figure 86 – Diagramme de classe Wires::CutsAndJumpers

Figure 86: Le diagramme représente le modèle de données des cuts et des cavaliers.

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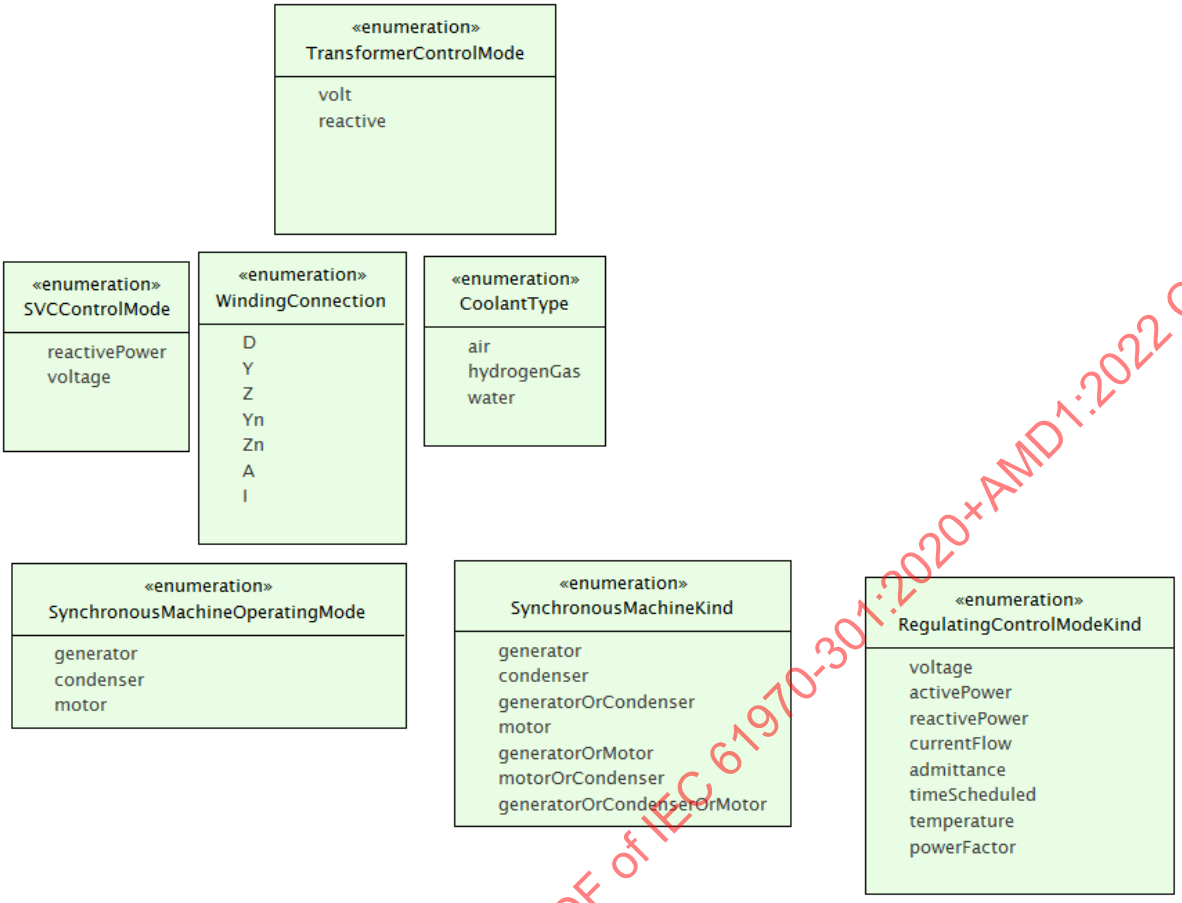


Figure 87 – Diagramme de classe Wires::Datatypes

Figure 87: Ce diagramme représente les types de données spécifiques au paquetage Wires.

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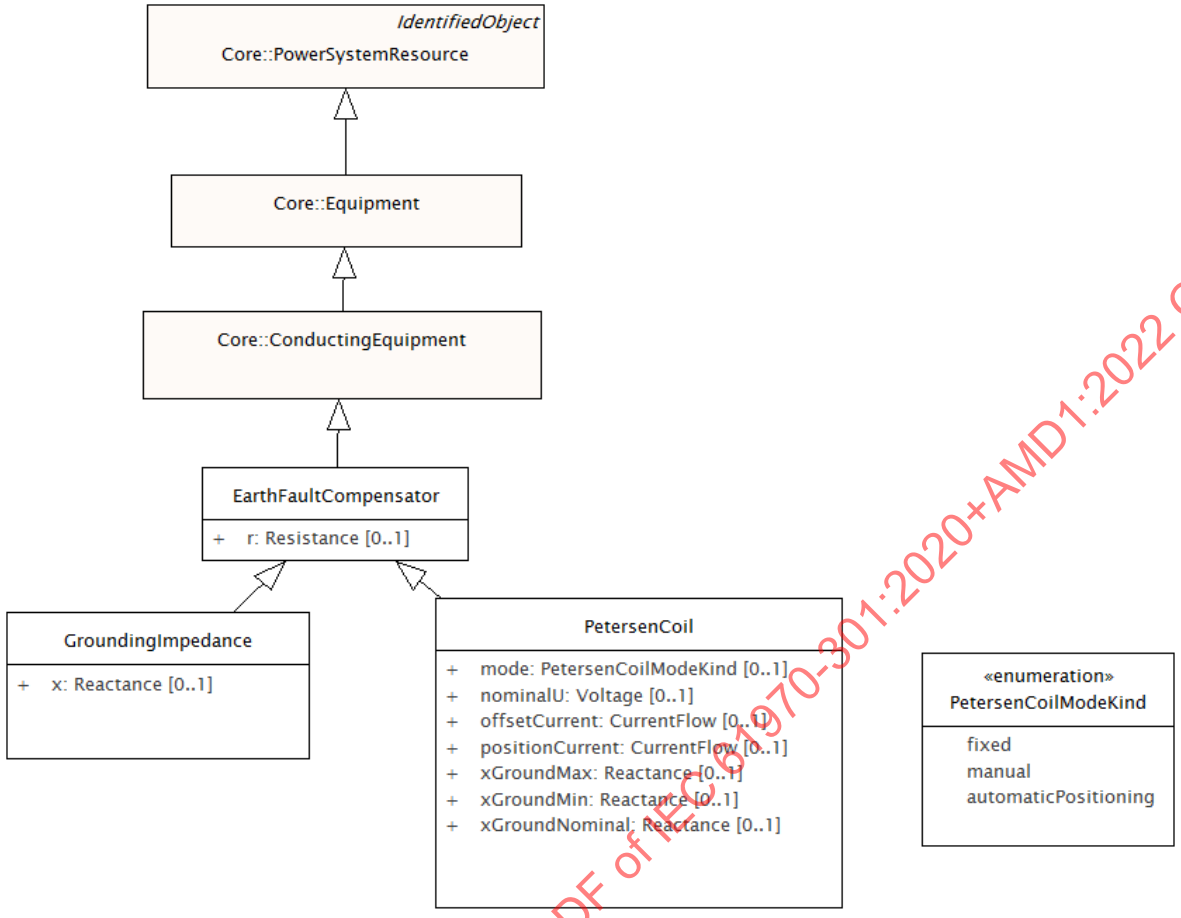
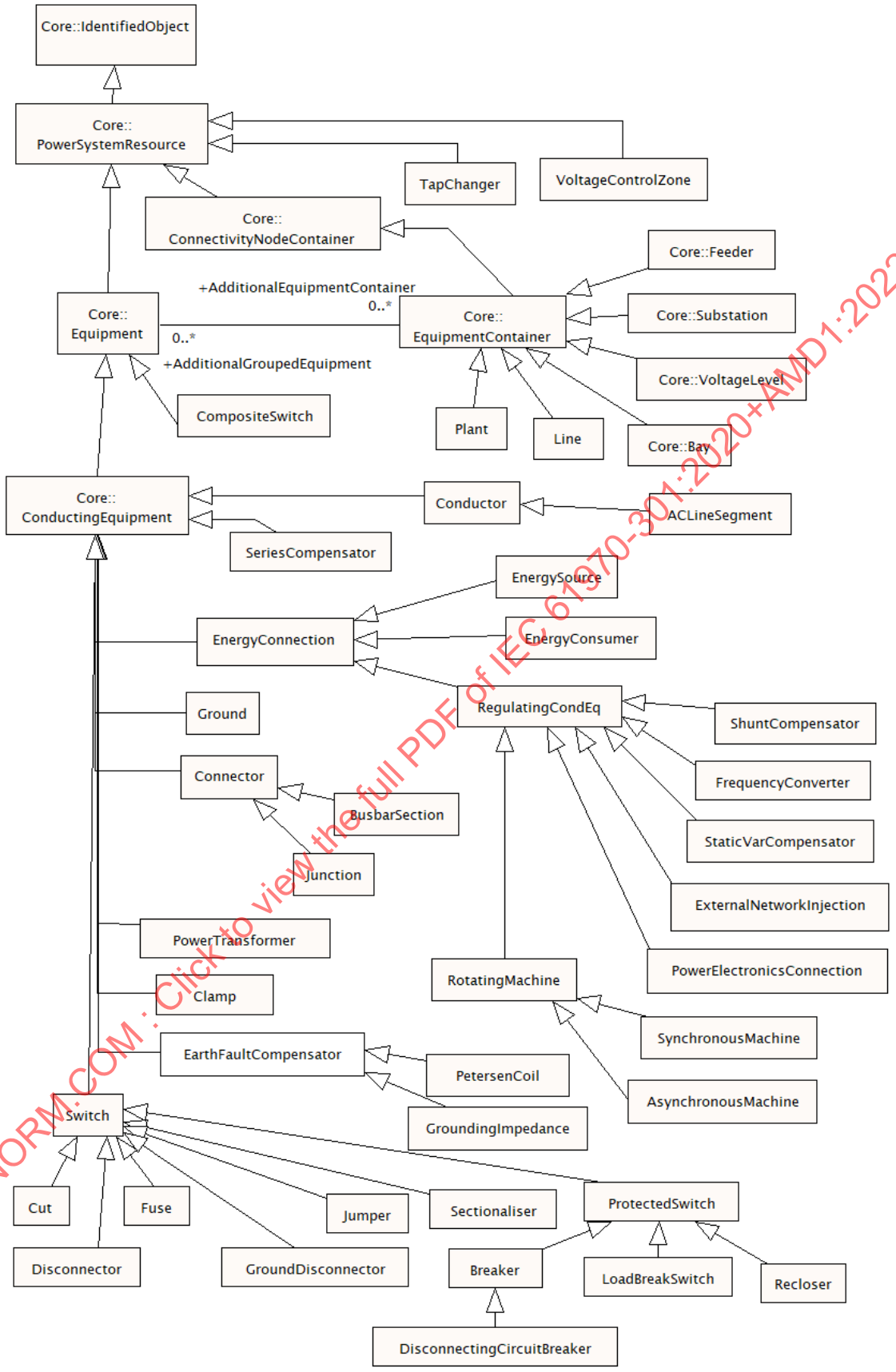


Figure 88 – Diagramme de classe Wires::EarthFaultCompensator

Figure 88: Représente les appareils de compensation de défaut à la terre.

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Figure 89 – Diagramme de classe Wires::InheritanceHierarchy

Figure 89: Ce diagramme décrit les relations d'héritage entre des classes du paquetage Wires ou liées à celui-ci.

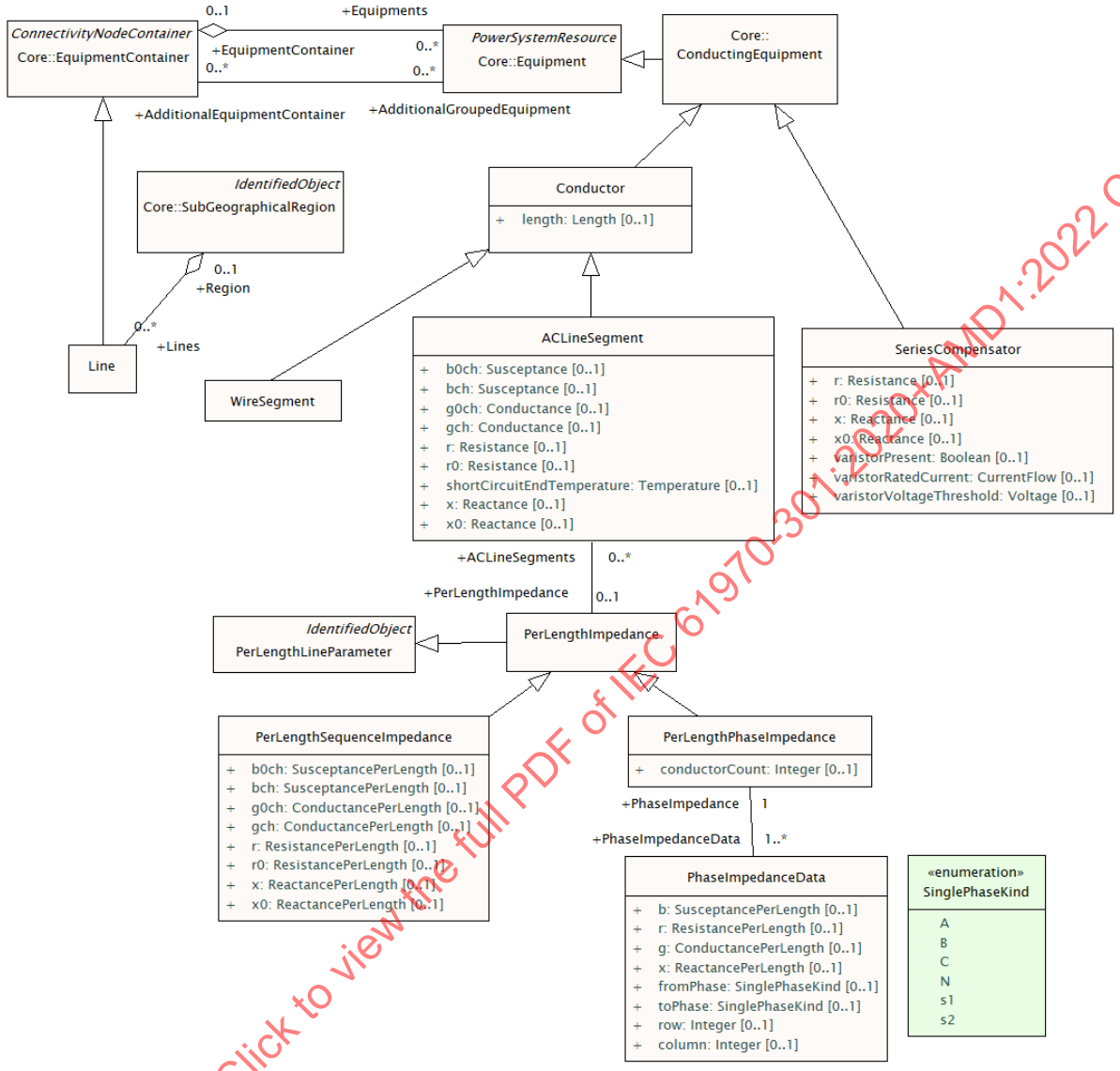


Figure 90 – Diagramme de classe Wires::LineModel

Figure 90: Ce diagramme représente toutes les classes liées au modèle de lignes de transport.

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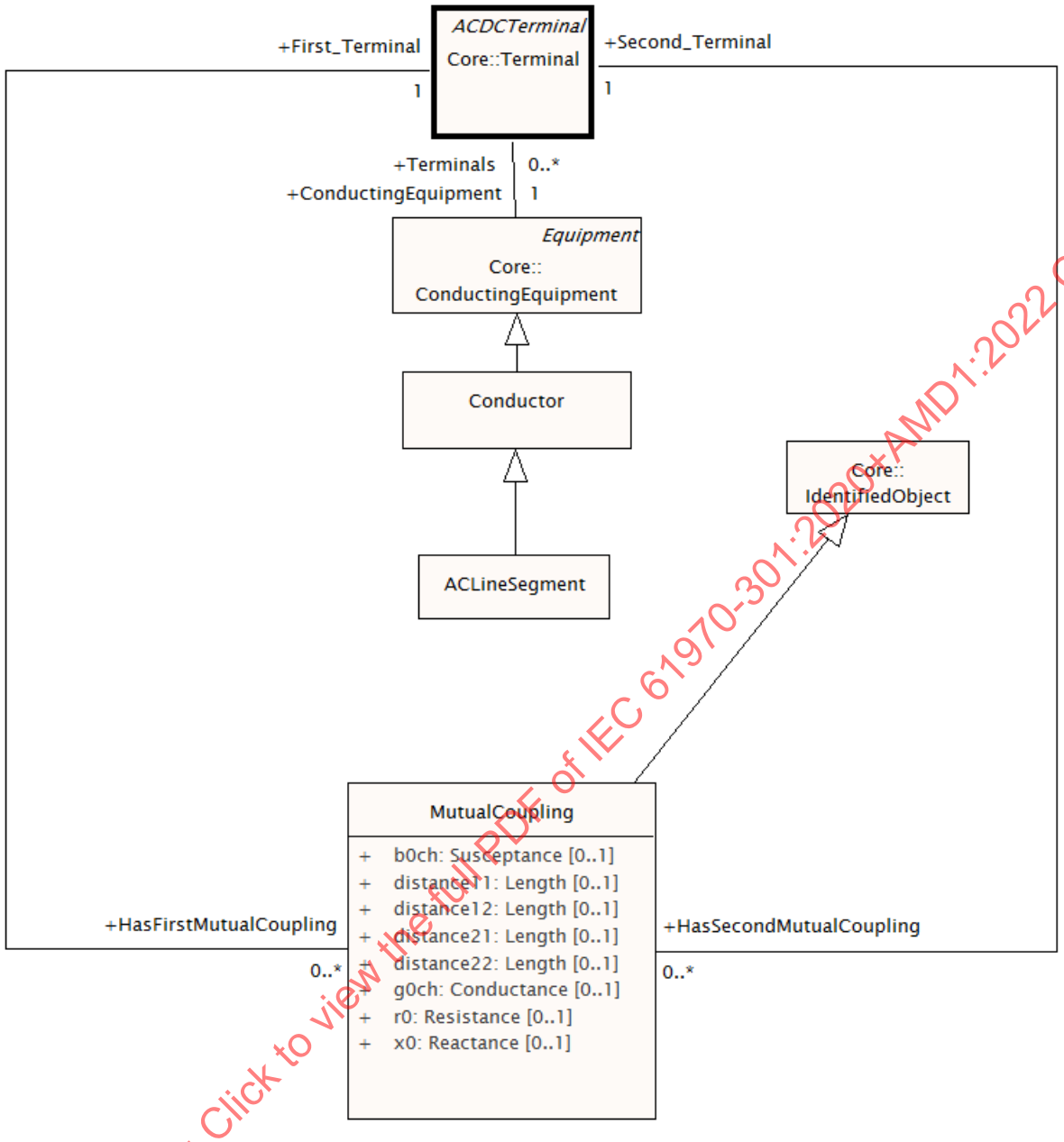
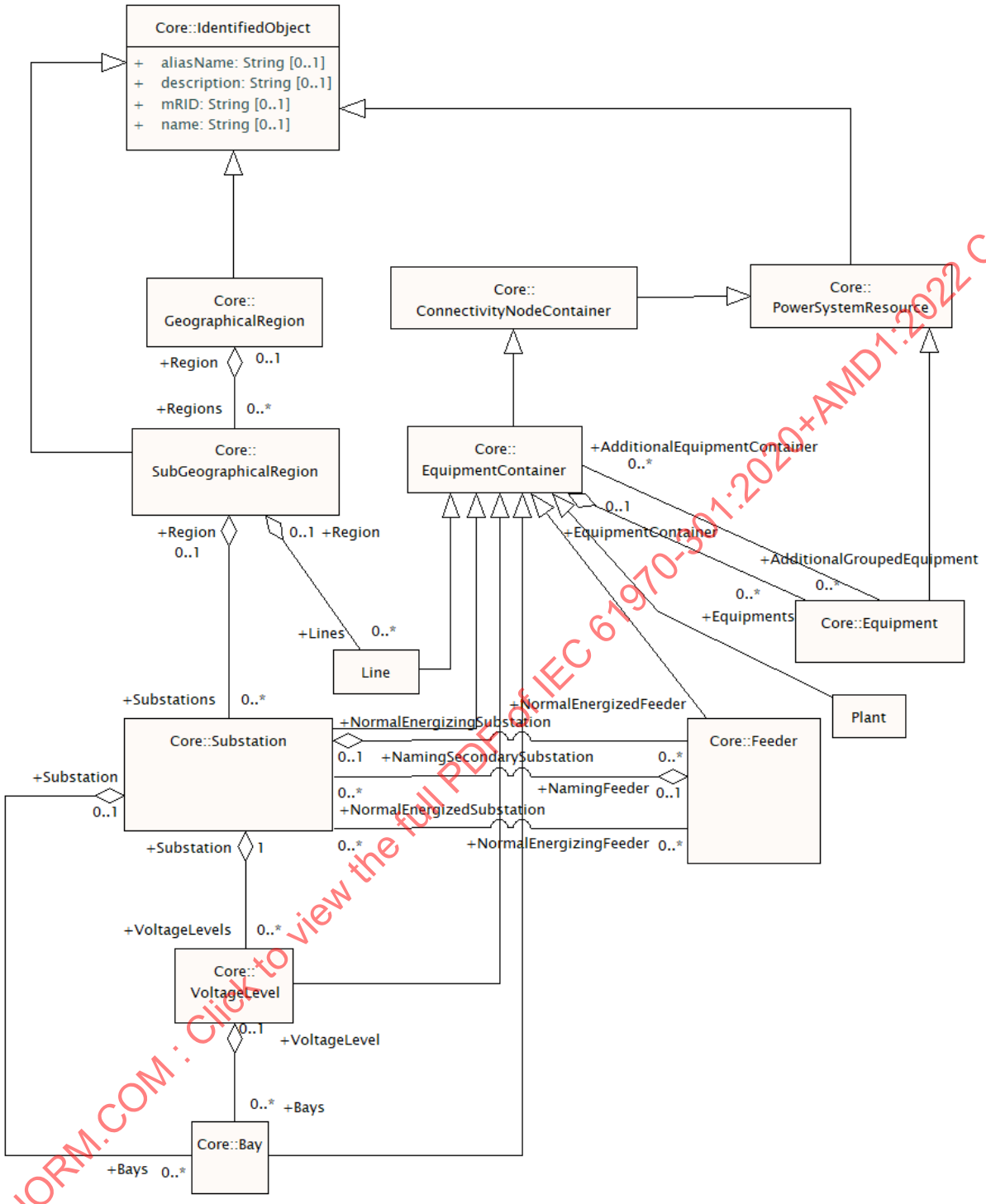


Figure 91 – Diagramme de classe Wires::MutualCoupling

Figure 91: Représente les modèles de couplage mutuel.

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Figure 92 – Diagramme de classe Wires::NamingHierarchyPart1

Figure 92: Le diagramme représente la partie supérieure de la hiérarchie de dénomination. La hiérarchie est une façon d'organiser et de nommer l'équipement. Par conséquent, elle est intimement liée à l'IdentifiedObject et à ses attributs. La classe Equipment est en outre spécialisée en de nombreux sous-types qui sont tous contenus par les sous-classes de EquipmentContainer.

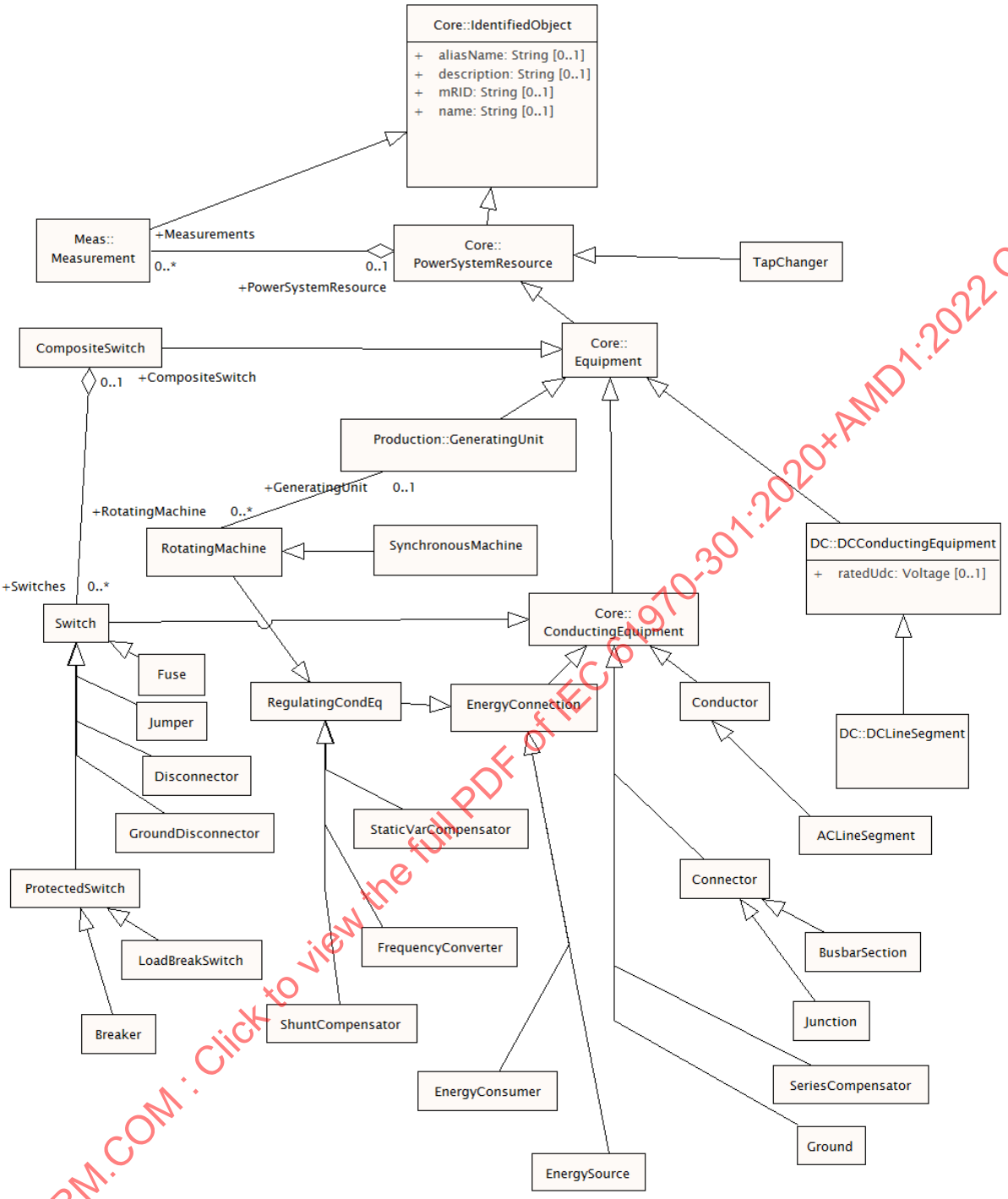


Figure 93 – Diagramme de classe Wires::NamingHierarchyPart2

Figure 93: Le diagramme représente la partie inférieure de la hiérarchie de dénomination. Il représente la façon dont la classe Equipment est en outre spécialisée en de nombreux sous-types qui sont tous contenus par les sous-classes de EquipmentContainer. Pour les sous-classes du conteneur d'équipements, se référer à la Figure 92.

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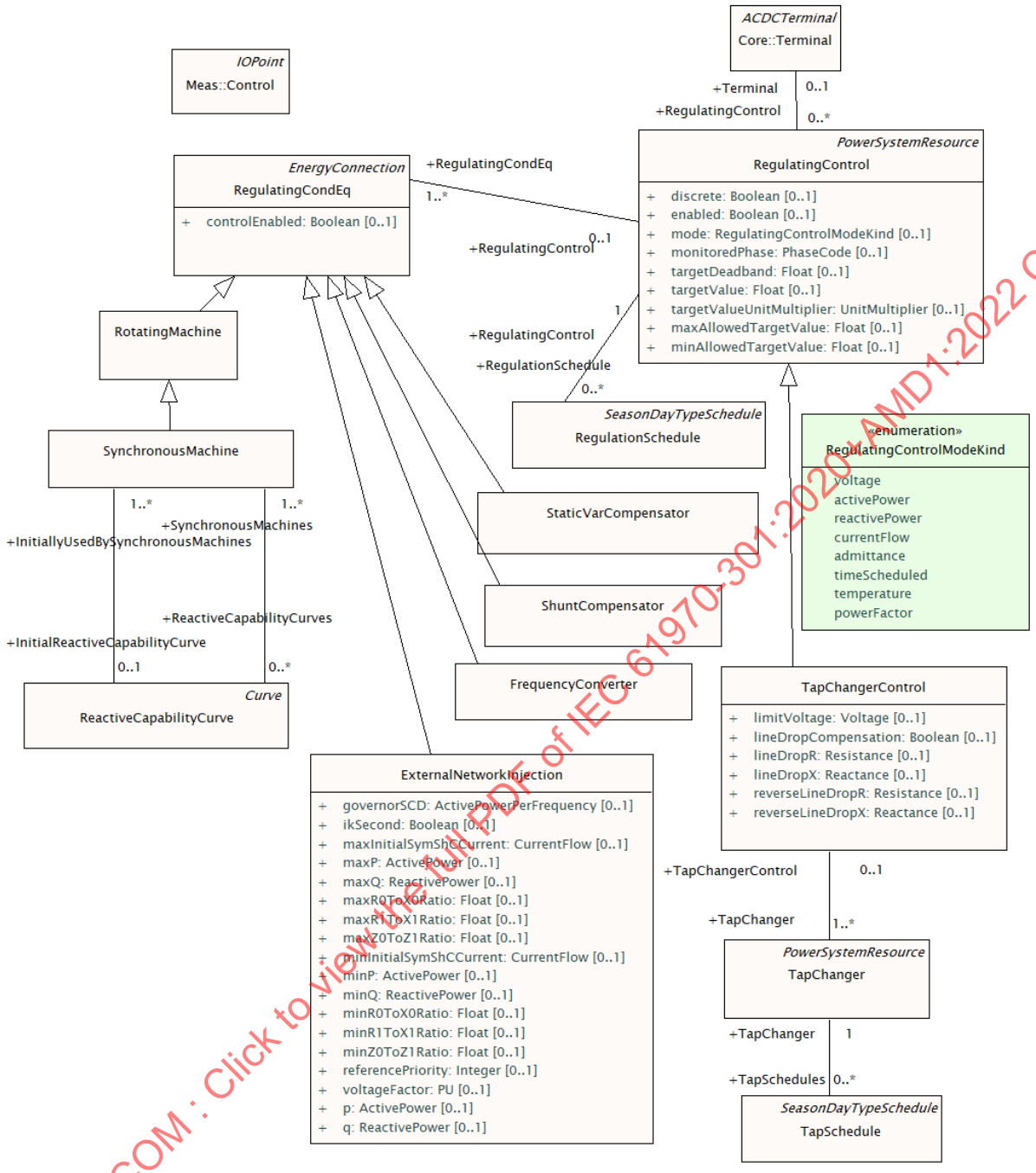


Figure 94 – Diagramme de classe Wires::RegulatingEquipment

Figure 94: Le diagramme représente toutes les classes liées à l'équipement de régulation et à la compensation de puissance réactive.

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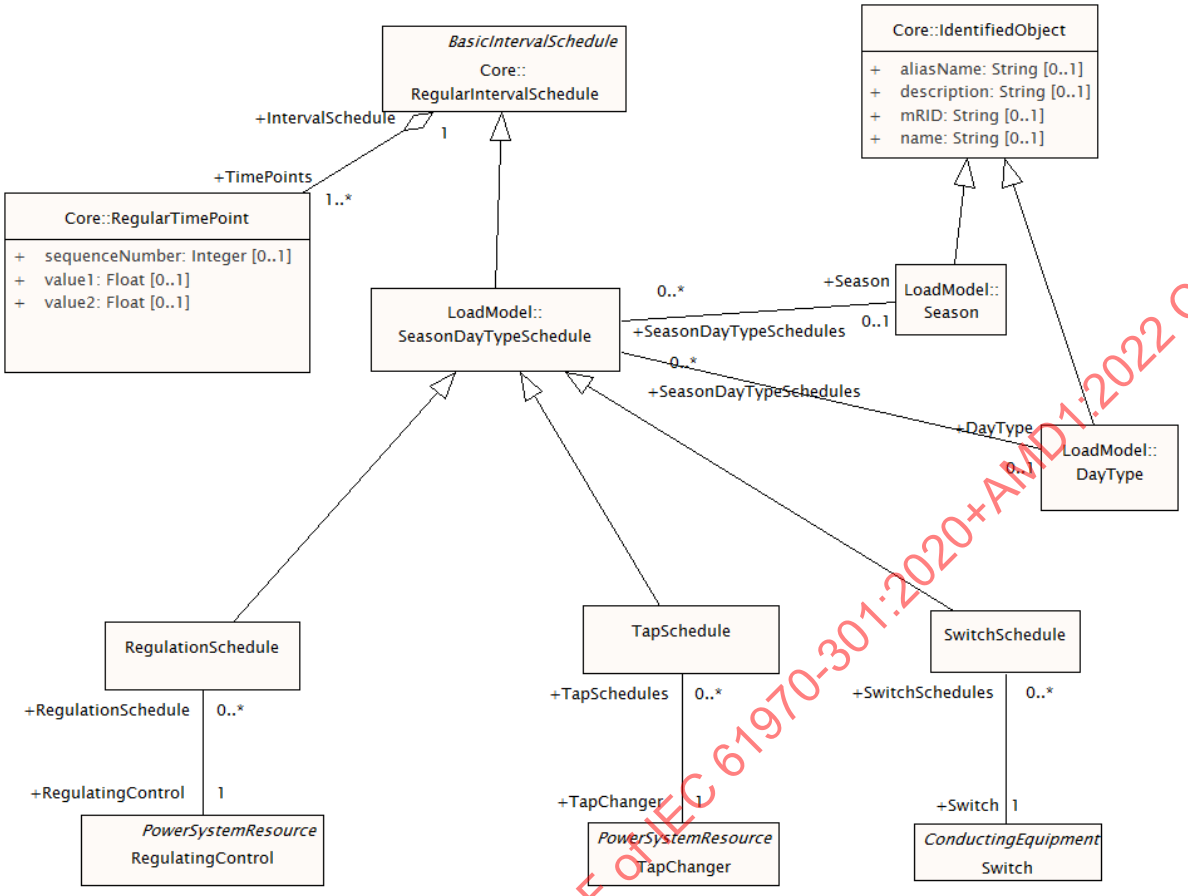


Figure 95 – Diagramme de classe Wires::Schedules

Figure 95: Représente les programmes du modèle de Wires.

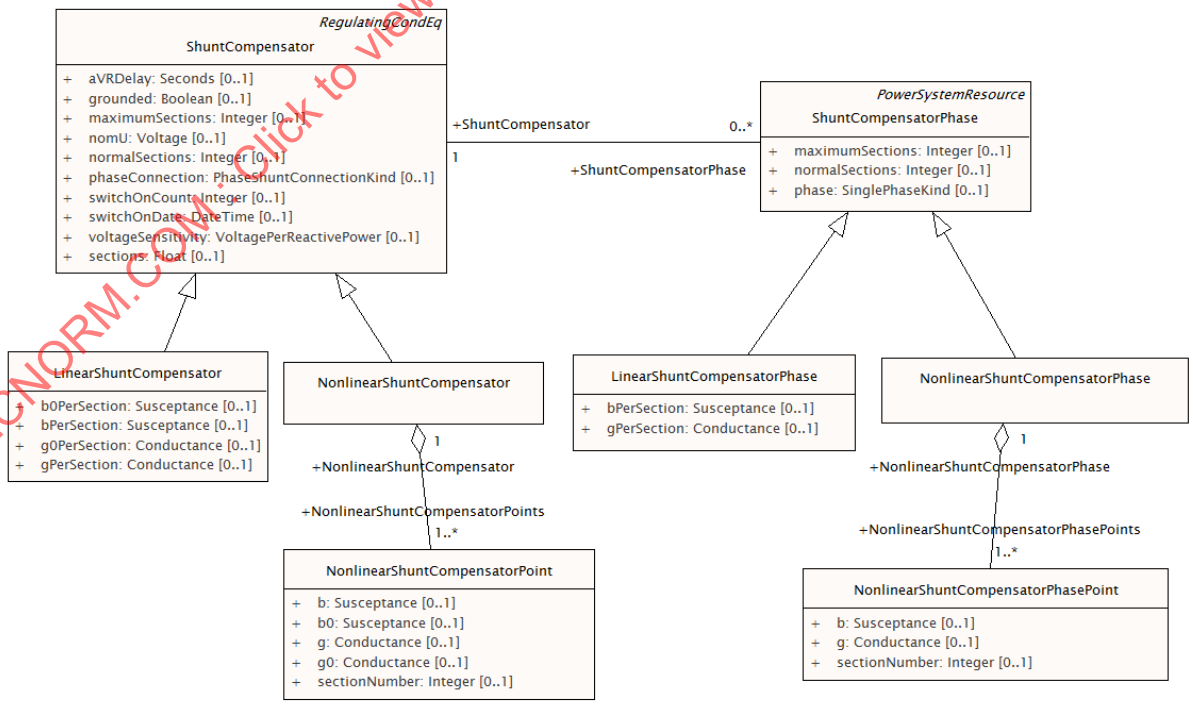


Figure 96 – Diagramme de classe Wires::ShuntCompensator

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Figure 96: Représente la structure d'héritage du compensateur shunt.

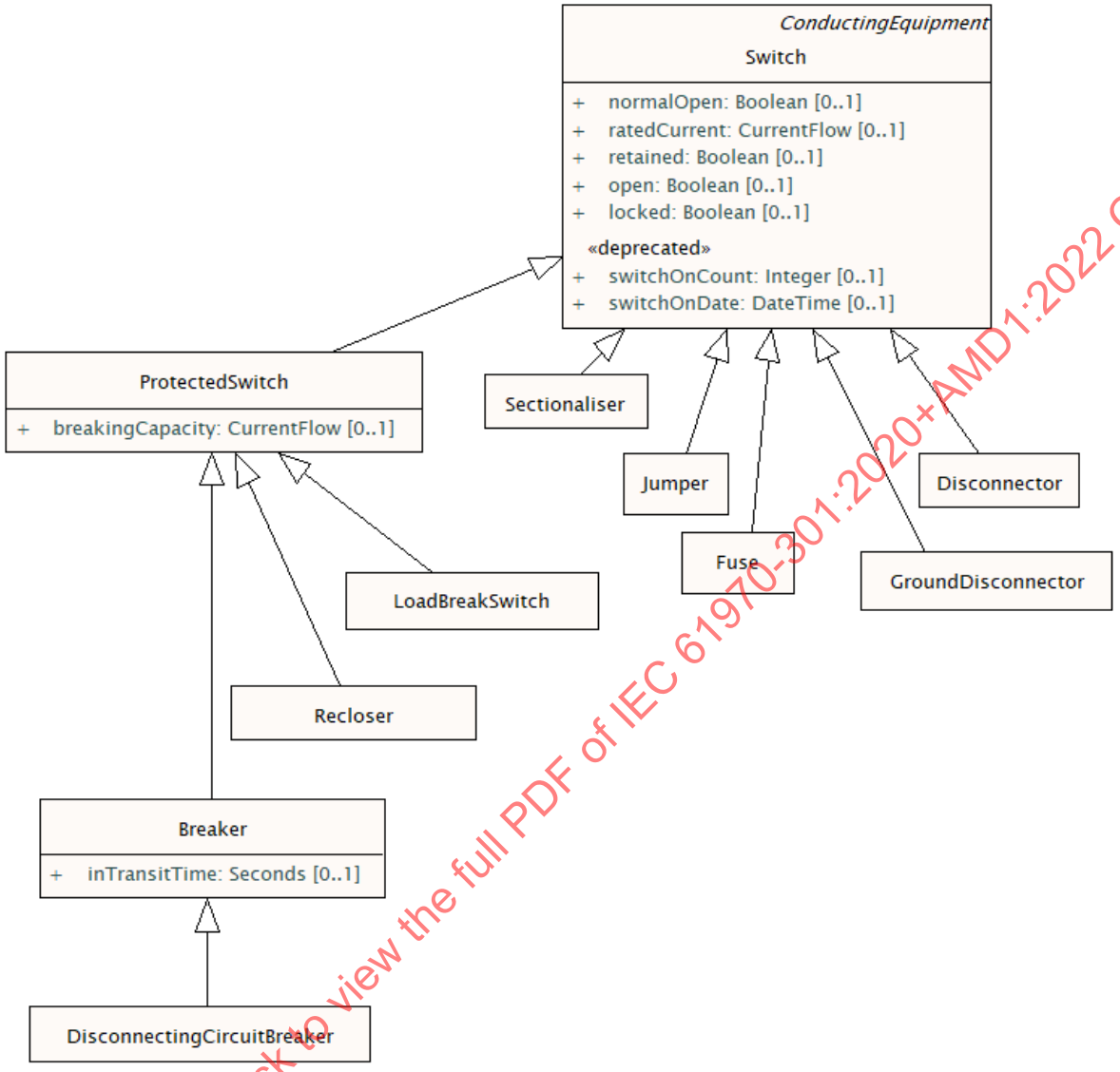
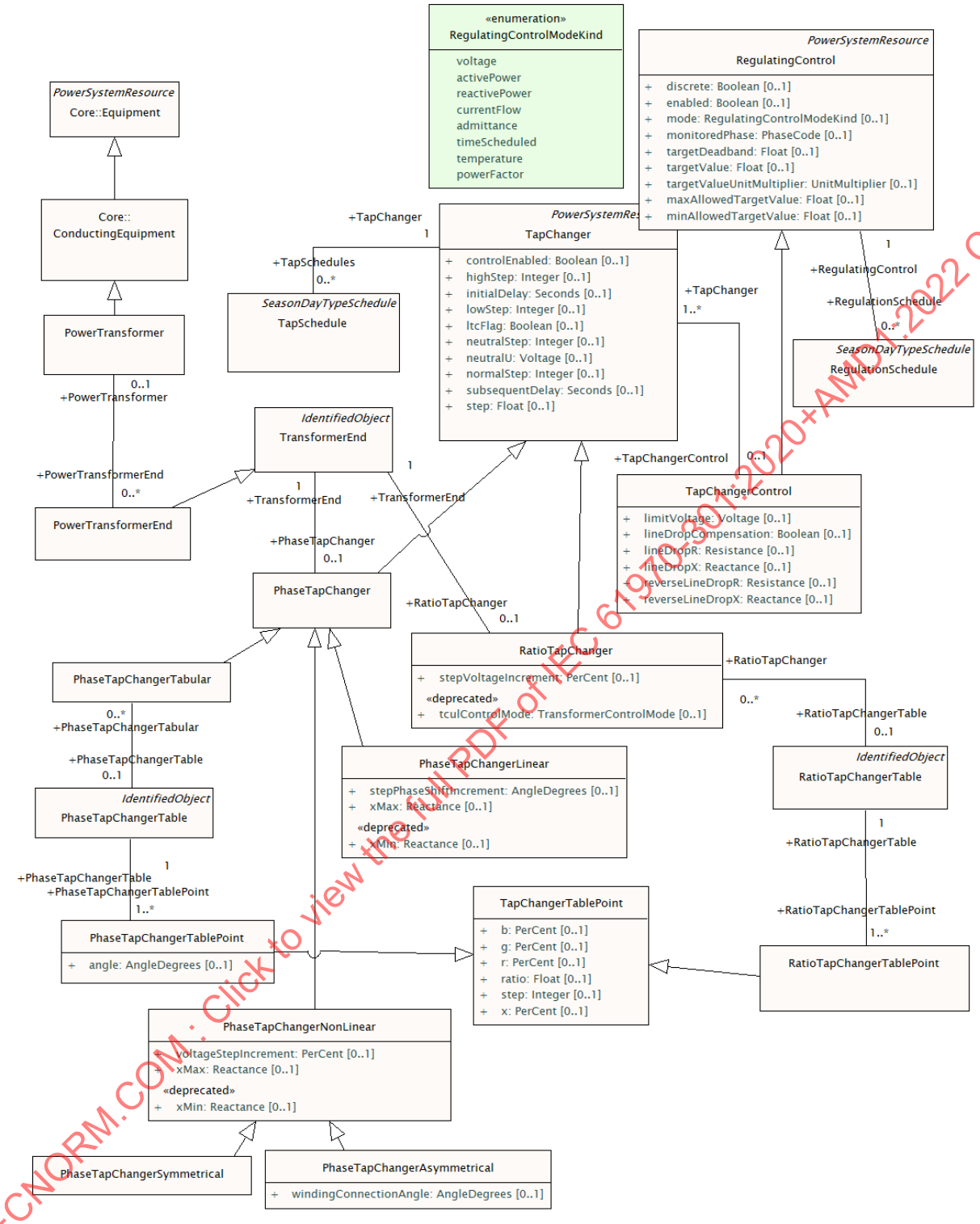


Figure 97 – Diagramme de classe Wires::SwitchingEquipment

Figure 97: Représente la structure d'héritage de SwitchingEquipment.

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Figure 98 – Diagramme de classe Wires::TapChanger

Figure 98: Ce diagramme représente toutes les classes liées au modèle de prise de transformateur.

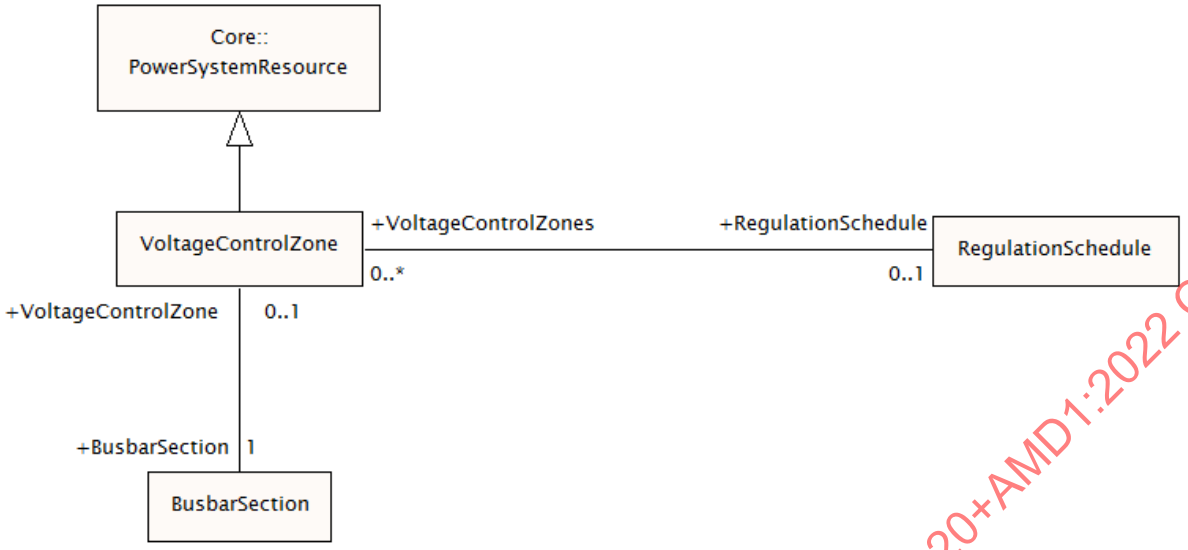
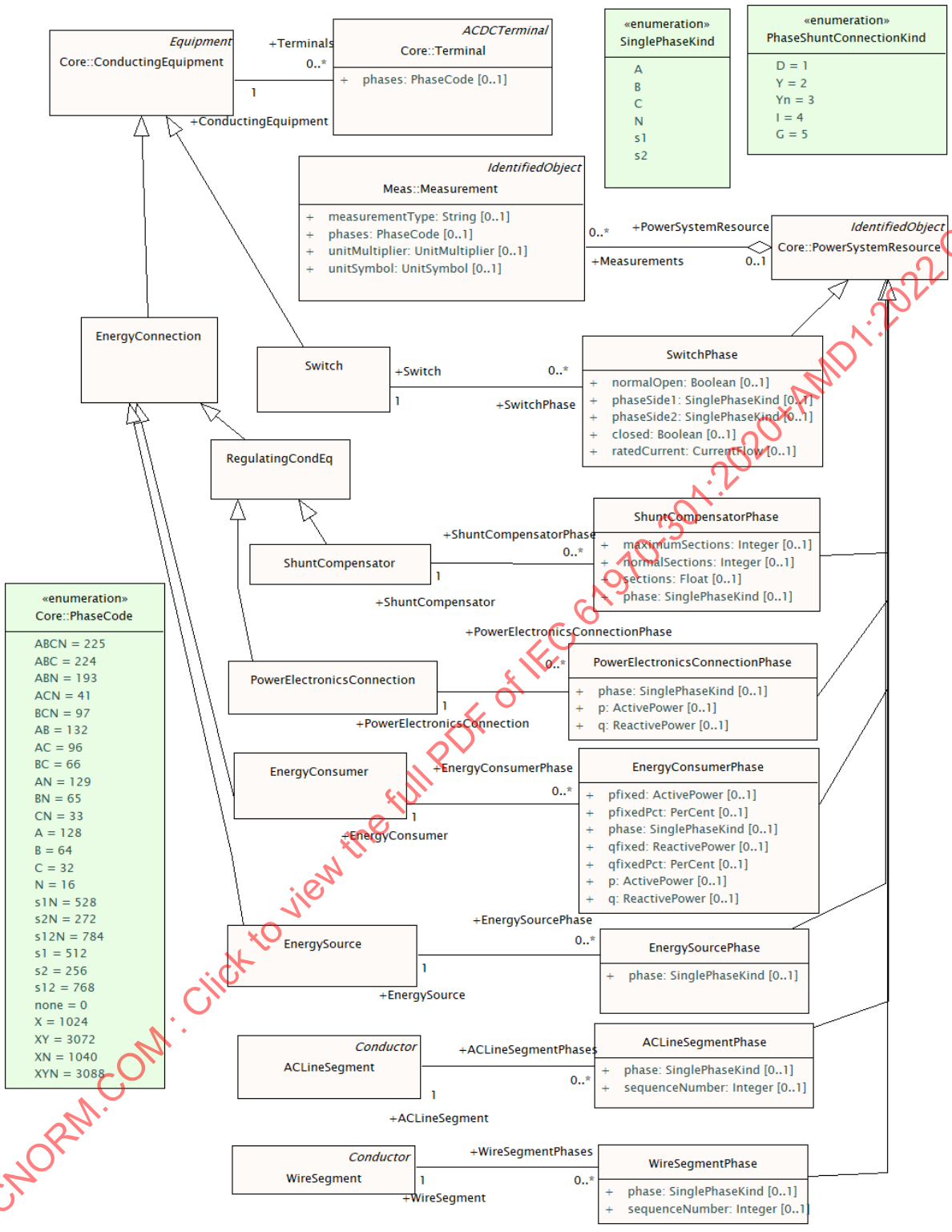


Figure 99 – Diagramme de classe Wires::VoltageControl

Figure 99: Ce diagramme représente toutes les classes liées à la régulation de tension de zone.

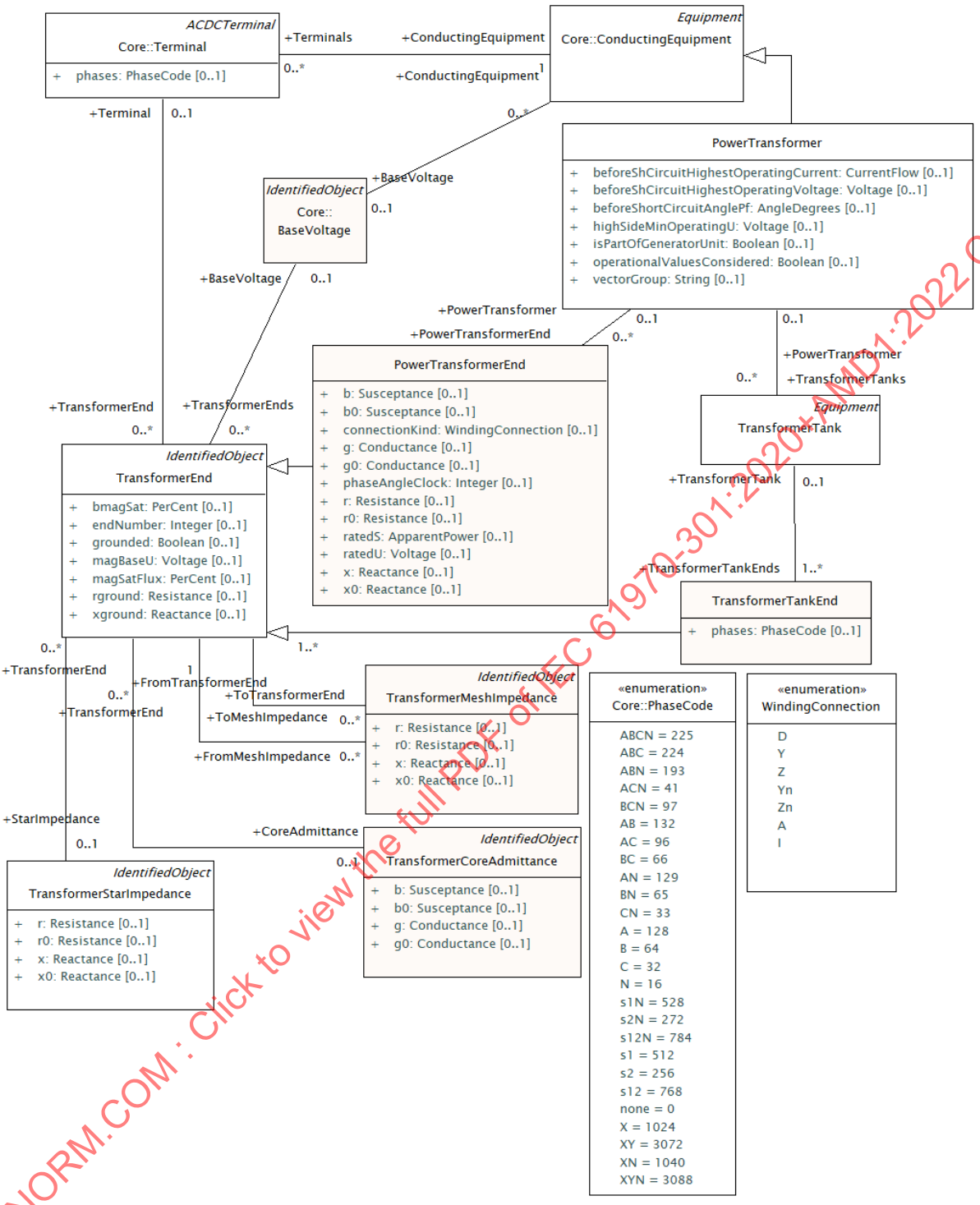
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Figure 100 – Diagramme de classe Wires::WiresPhaseModel

Figure 100: Représente en détail la connexion de phase quand les appareils sont modélisés jusqu'aux composants de phase à l'intérieur d'un équipement conducteur.



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Figure 101 – Diagramme de classe Wires::Transformer

Figure 101: Ce diagramme représente les classes relatives au modèle central de transformateur, mais ne représente pas en détail le changeur de prises.

6.4.2 Enumération AsynchronousMachineKind

Genre de machine asynchrone.

Le Tableau 145 présente tous les libellés de AsynchronousMachineKind.

Tableau 145 – Libellés de Wires::AsynchronousMachineKind

libellé	value	description
generator		La machine asynchrone (Asynchronous Machine) est un générateur.
motor		La machine asynchrone (Asynchronous Machine) est un moteur.

6.4.3 ACLineSegment

Fil ou une combinaison de fils ayant des caractéristiques électriques cohérentes, et formant un seul système de puissance, utilisé pour transporter du courant alternatif entre des points du réseau.

Pour les lignes triphasées transposées symétriques, il suffit d'utiliser les attributs du segment de ligne qui décrivent les impédances et les admittances pour la longueur totale du segment. Les impédances peuvent en outre être calculées en utilisant la longueur et les impédances associées par unité de longueur.

La BaseVoltage (tension de base) aux deux extrémités des ACLineSegments dans une Line (ligne) doit avoir la même BaseVoltage.nominalVoltage. Cependant, les lignes limites peuvent avoir des BaseVoltage.nominalVoltages légèrement inférieures et une variation est autorisée. Une différence de tension plus importante exige en général l'utilisation d'une branche équivalente.

Le Tableau 146 présente tous les attributs de ACLineSegment.

Tableau 146 – Attributs de Wires::ACLineSegment

nom	mult	type	description
b0ch	0..1	Susceptance	Susceptance shunt homopolaire (de chargement), uniformément répartie, de la section de ligne complète.
bch	0..1	Susceptance	Susceptance shunt directe (de chargement), uniformément répartie, de la section de ligne complète. Cette valeur représente le chargement total sur la longueur totale de la ligne.
g0ch	0..1	Conductance	Conductance shunt homopolaire (de chargement), uniformément répartie, de la section de ligne complète.
gch	0..1	Conductance	Conductance shunt directe (de chargement), uniformément répartie, de la section de ligne complète.
r	0..1	Resistance	Résistance série directe de la section de ligne complète.
r0	0..1	Resistance	Résistance série homopolaire de la section de ligne complète.
shortCircuitEndTemperature	0..1	Temperature	Température maximale autorisée à l'extrémité du convertisseur source pour le calcul des courants minimaux de court-circuit. Utilisé pour l'échange de données relatives à un court-circuit, conformément à l'IEC 60909.
x	0..1	Reactance	Réactance série directe de la section de ligne complète.
x0	0..1	Reactance	Réactance série homopolaire de la section de ligne complète.
length	0..1	Length	hérité de: Conductor
aggregate	0..1	Boolean	hérité de: Equipment

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nom	mult	type	description
inService	0..1	Boolean	hérité de: Equipment
networkAnalysisEnabled	0..1	Boolean	hérité de: Equipment
normallyInService	0..1	Boolean	hérité de: Equipment
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 147 présente toutes les extrémités d'association de ACLineSegment avec d'autres classes.

Tableau 147 – Extrémités d'association de Wires::ACLineSegment avec d'autres classes

mult à partir de	nom	mult vers	type	description
1..1	Clamp	0..*	Clamp	Les serre-fils reliés au tronçon de ligne.
0..*	PerLengthImpedance	0..1	PerLengthImpedance	Impédance par longueur de ce tronçon de ligne.
1..1	Cut	0..*	Cut	Cuts appliqués au segment de ligne.
0..1	LineFaults	0..*	LineFault	Les défauts de ligne du segment de ligne.
1..1	ACLineSegmentPhases	0..*	ACLineSegmentPhase	Phases du segment de ligne qui appartiennent aux segments de ligne.
0..*	BaseVoltage	0..1	BaseVoltage	hérité de: ConductingEquipment
1..1	Terminals	0..*	Terminal	hérité de: ConductingEquipment
1..1	SvStatus	0..*	SvStatus	hérité de: ConductingEquipment
0..*	ProtectionEquipments	0..*	ProtectionEquipment	hérité de: ConductingEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	hérité de: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	hérité de: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	hérité de: Equipment
0..1	Faults	0..*	Fault	hérité de: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	hérité de: Equipment
0..*	PSRType	0..1	PSRType	hérité de: PowerSystemResource
0..1	Controls	0..*	Control	hérité de: PowerSystemResource
0..1	Measurements	0..*	Measurement	hérité de: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	hérité de: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	hérité de: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.4.4 ACLineSegmentPhase

Représente un fil unique sur un segment de ligne à courant alternatif.

Le Tableau 148 présente tous les attributs de ACLineSegmentPhase.

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Tableau 148 – Attributs de Wires::ACLineSegmentPhase

nom	mult	type	description
phase	0..1	SinglePhaseKind	Connexion de phase du fil aux deux extrémités.
sequenceNumber	0..1	Integer	Désignation numérique de la phase de ce segment de ligne. Il convient que chaque phase de segment de ligne d'un segment de ligne n'ait qu'un seul numéro d'ordre. Cela permet à la modélisation déséquilibrée de lier le modèle mathématique (PhaseImpedanceData de PerLengthPhaseImpedance) au modèle de connectivité (cette classe) et au modèle physique (WirePosition) sans couplage serré.
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 149 présente toutes les extrémités d'association de ACLineSegmentPhase avec d'autres classes.

Tableau 149 – Extrémités d'association de Wires::ACLineSegmentPhase avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..*	ACLineSegment	1..1	ACLineSegment	Segment de ligne auquel appartient la phase.
0..*	PSRType	0..1	PSRType	hérité de: PowerSystemResource
0..1	Controls	0..*	Control	hérité de: PowerSystemResource
0..1	Measurements	0..*	Measurement	hérité de: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	hérité de: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	hérité de: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.4.5 AsynchronousMachine

Machine tournante dont l'arbre tourne de manière asynchrone par rapport au champ électrique. Aussi appelée machine à induction sans connexion externe aux enroulements du rotor, par exemple une machine à induction à cage d'écureuil.

Le Tableau 150 présente tous les attributs de AsynchronousMachine.

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Tableau 150 – Attributs de Wires::AsynchronousMachine

nom	mult	type	description
asynchronousMachineType	0..1	AsynchronousMachineKind	Indique le type de machine asynchrone (moteur ou générateur).
converterFedDrive	0..1	Boolean	Indique si la machine est un dispositif d'entraînement alimenté par convertisseur. Utilisé pour l'échange de données relatives à un court-circuit, conformément à l'IEC 60909.
efficiency	0..1	PerCent	Efficacité de la machine asynchrone en fonctionnement nominal, en pourcentage. Indicateur pour les moteurs entraînés par convertisseur. Utilisé pour l'échange de données relatives à un court-circuit, conformément à l'IEC 60909.
iaIrRatio	0..1	Float	Rapport courant à rotor bloqué sur courant assigné du moteur (Ia/Ir). Utilisé pour l'échange de données relatives à un court-circuit, conformément à l'IEC 60909.
nominalFrequency	0..1	Frequency	Données constructeur qui indiquent si la machine est une machine à 50 Hz ou à 60 Hz.
nominalSpeed	0..1	RotationSpeed	Données Nameplate (constructeur). Dépend du glissement et du nombre de paires polaires.
polePairNumber	0..1	Integer	Nombre de paires polaires du stator. Utilisé pour l'échange de données relatives à un court-circuit, conformément à l'IEC 60909.
ratedMechanicalPower	0..1	ActivePower	Puissance mécanique assignée (Pr dans l'IEC 60909-0). Utilisé pour l'échange de données relatives à un court-circuit, conformément à l'IEC 60909.
reversible	0..1	Boolean	Indique si la puissance des moteurs d'entraînement de convertisseurs peut être réversible. Utilisé pour l'échange de données relatives à un court-circuit, conformément à l'IEC 60909.
rr1	0..1	Resistance	Résistance de l'enroulement amortisseur 1 (Damper 1).
rr2	0..1	Resistance	Résistance de l'enroulement amortisseur 2 (Damper 1).
rxLockedRotorRatio	0..1	Float	Rapport de rotor verrouillé (R/X). Utilisé pour l'échange de données relatives à un court-circuit, conformément à l'IEC 60909.
tpo	0..1	Seconds	Constante de temps du rotor transitoire (supérieure à tppo).
tppo	0..1	Seconds	Constante de temps du rotor sous-transitoire (supérieure à 0).
xlr1	0..1	Reactance	Réactance de fuite de l'enroulement amortisseur 1 (Damper 1).
xlr2	0..1	Reactance	Réactance de fuite de l'enroulement amortisseur 2 (Damper 1).
xm	0..1	Reactance	Réactance magnétisante.
xp	0..1	Reactance	Réactance transitoire (non saturée) (supérieure ou égale à xxp).
xpp	0..1	Reactance	Réactance sous-transitoire (non saturée).
xs	0..1	Reactance	Réactance synchrone (supérieure à xp).
ratedPowerFactor	0..1	Float	hérité de: RotatingMachine
p	0..1	ActivePower	hérité de: RotatingMachine
ratedS	0..1	ApparentPower	hérité de: RotatingMachine
q	0..1	ReactivePower	hérité de: RotatingMachine

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nom	mult	type	description
ratedU	0..1	Voltage	hérité de: RotatingMachine
controlEnabled	0..1	Boolean	hérité de: RegulatingCondEq
aggregate	0..1	Boolean	hérité de: Equipment
inService	0..1	Boolean	hérité de: Equipment
networkAnalysisEnabled	0..1	Boolean	hérité de: Equipment
normallyInService	0..1	Boolean	hérité de: Equipment
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 151 présente toutes les extrémités d'association de AsynchronousMachine avec d'autres classes.

Tableau 151 – Extrémités d'association de Wires::AsynchronousMachine avec d'autres classes

mult à partir de	nom	mult vers	type	description
1..1	AsynchronousMachineDynamics	0..1	AsynchronousMachineDynamics	Modèle dynamique de machine asynchrone utilisé pour décrire le comportement dynamique de cette machine asynchrone.
1..1	HydroPump	0..1	HydroPump	hérité de: RotatingMachine
0..*	GeneratingUnit	0..1	GeneratingUnit	hérité de: RotatingMachine
0..*	RegulatingControl	0..1	RegulatingControl	hérité de: RegulatingCondEq
0..*	BaseVoltage	0..1	BaseVoltage	hérité de: ConductingEquipment
1..1	Terminals	0..*	Terminal	hérité de: ConductingEquipment
1..1	SvStatus	0..*	SvStatus	hérité de: ConductingEquipment
0..*	ProtectionEquipments	0..*	ProtectionEquipment	hérité de: ConductingEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	hérité de: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	hérité de: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	hérité de: Equipment
0..1	Faults	0..*	Fault	hérité de: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	hérité de: Equipment
0..*	PSRType	0..1	PSRType	hérité de: PowerSystemResource
0..1	Controls	0..*	Control	hérité de: PowerSystemResource
0..1	Measurements	0..*	Measurement	hérité de: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	hérité de: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	hérité de: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

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6.4.6 Breaker

Appareil de commutation mécanique capable d'établir, de transporter et d'interrompre des courants dans des conditions normales de circuit et aussi d'établir, de transporter pendant une durée déterminée et d'interrompre des courants dans des conditions anormales spécifiées de circuit, par exemple celles d'un court-circuit.

Le Tableau 152 présente tous les attributs de Breaker.

Tableau 152 – Attributs de Wires::Breaker

nom	mult	type	description
inTransitTime	0..1	Seconds	Temps de transition dans les positions ouverte et fermée.
breakingCapacity	0..1	CurrentFlow	hérité de: ProtectedSwitch
normalOpen	0..1	Boolean	hérité de: Switch
ratedCurrent	0..1	CurrentFlow	hérité de: Switch
switchOnCount	0..1	Integer	(déconseillé) hérité de: Switch
switchOnDate	0..1	DateTime	(déconseillé) hérité de: Switch
retained	0..1	Boolean	hérité de: Switch
open	0..1	Boolean	hérité de: Switch
locked	0..1	Boolean	hérité de: Switch
aggregate	0..1	Boolean	hérité de: Equipment
inService	0..1	Boolean	hérité de: Equipment
networkAnalysisEnabled	0..1	Boolean	hérité de: Equipment
normallyInService	0..1	Boolean	hérité de: Equipment
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 153 présente toutes les extrémités d'association de Breaker avec d'autres classes.

Tableau 153 – Extrémités d'association de Wires::Breaker avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..*	OperatedByProtectionEquipment	0..*	ProtectionEquipment	hérité de: ProtectedSwitch
1..1	RecloseSequences	0..*	RecloseSequence	hérité de: ProtectedSwitch
1..1	SwitchPhase	0..*	SwitchPhase	hérité de: Switch
1..1	SwitchSchedules	0..*	SwitchSchedule	hérité de: Switch
0..*	CompositeSwitch	0..1	CompositeSwitch	hérité de: Switch
1..1	SvSwitch	0..*	SvSwitch	hérité de: Switch
0..*	BaseVoltage	0..1	BaseVoltage	hérité de: ConductingEquipment
1..1	SvStatus	0..*	SvStatus	hérité de: ConductingEquipment
0..*	ProtectionEquipments	0..*	ProtectionEquipment	hérité de: ConductingEquipment
1..1	Terminals	0..*	Terminal	hérité de: ConductingEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	hérité de: Equipment

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mult à partir de	nom	mult vers	type	description
1..1	ContingencyEquipment	0..*	ContingencyEquipment	hérité de: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	hérité de: Equipment
0..1	Faults	0..*	Fault	hérité de: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	hérité de: Equipment
0..*	PSRType	0..1	PSRType	hérité de: PowerSystemResource
0..1	Controls	0..*	Control	hérité de: PowerSystemResource
0..1	Measurements	0..*	Measurement	hérité de: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	hérité de: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	hérité de: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.4.7 BusbarSection

Conducteur, ou groupe de conducteurs, ayant une impédance négligeable, servant à connecter un autre équipement conducteur au sein d'un seul poste.

Les mesures de tension sont habituellement obtenues à partir des transformateurs de tension connectés à des sections de jeu de barres. Une section de jeu de barres peut avoir plusieurs bornes physiques mais, pour l'analyse, elle est modélisée avec une seule borne logique.

Le Tableau 154 présente tous les attributs de BusbarSection.

Tableau 154 – Attributs de Wires::BusbarSection

nom	mult	type	description
ipMax	0..1	CurrentFlow	Valeur de crête maximale autorisée du courant de court-circuit du jeu de barres (Ipmax dans l'IEC 60909-0). Limite mécanique du jeu de barres dans le poste lui-même. Utilisé pour l'échange de données relatives à un court-circuit, conformément à l'IEC 60909.
aggregate	0..1	Boolean	hérité de: Equipment
inService	0..1	Boolean	hérité de: Equipment
networkAnalysisEnabled	0..1	Boolean	hérité de: Equipment
normallyInService	0..1	Boolean	hérité de: Equipment
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 155 présente toutes les extrémités d'association de BusbarSection avec d'autres classes.

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Tableau 155 – Extrémités d'association de Wires::BusbarSection avec d'autres classes

mult à partir de	nom	mult vers	type	description
1..1	VoltageControlZone	0..1	VoltageControlZone	Une VoltageControlZone (zone de réglage de la tension) est commandée par une BusbarSection (section de jeu de barres) déterminée.
0..*	BaseVoltage	0..1	BaseVoltage	hérité de: ConductingEquipment
1..1	Terminals	0..*	Terminal	hérité de: ConductingEquipment
1..1	SvStatus	0..*	SvStatus	hérité de: ConductingEquipment
0..*	ProtectionEquipments	0..*	ProtectionEquipment	hérité de: ConductingEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	hérité de: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	hérité de: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	hérité de: Equipment
0..1	Faults	0..*	Fault	hérité de: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	hérité de: Equipment
0..*	PSRType	0..1	PSRType	hérité de: PowerSystemResource
0..1	Controls	0..*	Control	hérité de: PowerSystemResource
0..1	Measurements	0..*	Measurement	hérité de: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	hérité de: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	hérité de: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.4.8 Clamp

Un Clamp (serre-fil) est une connexion galvanique à un segment de ligne où est connecté l'autre équipement. Un Clamp ne coupe pas le segment de ligne.

Un Clamp est un ConductingEquipment et a une borne (Terminal) comportant un ConnectivityNode. Tout autre ConductingEquipment peut être connecté au Clamp ConnectivityNode.

Le Tableau 156 présente tous les attributs de Clamp.

Tableau 156 – Attributs de Wires::Clamp

nom	mult	type	description
lengthFromTerminal1	0..1	Length	Longueur à l'endroit où se trouve le serre-fil, en partant d'un côté du segment de ligne, c'est-à-dire de la borne de segment de ligne dont le numéro d'ordre est 1.
aggregate	0..1	Boolean	hérité de: Equipment
inService	0..1	Boolean	hérité de: Equipment
networkAnalysisEnabled	0..1	Boolean	hérité de: Equipment
normallyInService	0..1	Boolean	hérité de: Equipment
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

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Le Tableau 157 présente toutes les extrémités d'association de Clamp avec d'autres classes.

Tableau 157 – Extrémités d'association de Wires::Clamp avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..*	ACLineSegment	1..1	ACLineSegment	Segment de ligne auquel appartient le serre-fil.
0..*	BaseVoltage	0..1	BaseVoltage	hérité de: ConductingEquipment
1..1	Terminals	0..*	Terminal	hérité de: ConductingEquipment
1..1	SvStatus	0..*	SvStatus	hérité de: ConductingEquipment
0..*	ProtectionEquipments	0..*	ProtectionEquipment	hérité de: ConductingEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	hérité de: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	hérité de: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	hérité de: Equipment
0..1	Faults	0..*	Fault	hérité de: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	hérité de: Equipment
0..*	PSRType	0..1	PSRType	hérité de: PowerSystemResource
0..1	Controls	0..*	Control	hérité de: PowerSystemResource
0..1	Measurements	0..*	Measurement	hérité de: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	hérité de: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	hérité de: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.4.9 CompositeSwitch

Modèle d'un ensemble de Switchs (commutateurs) individuels normalement compris dans la même armoire et, si possible, avec des verrouillages qui restreignent la combinaison des positions de commutation. Ils se trouvent généralement dans des réseaux électriques de distribution en moyenne tension.

Un CompositeSwitch peut représenter un Ring-Main-Unit (RMU) ou un appareillage de commutation monté par bloc, avec des appareils internes primaires tels qu'un jeu de barres interne plus 3 ou 4 commutateurs internes qui peuvent être individuellement ouverts ou fermés. Un CompositeSwitch et un ensemble de Switchs qu'il contient peuvent aussi être utilisés pour représenter un commutateur à plusieurs positions, par exemple un commutateur qui peut connecter un circuit à la terre (Ground), à l'air (Open) ou à un jeu de barres (Busbar).

Le Tableau 158 présente tous les attributs de CompositeSwitch.

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Tableau 158 – Attributs de Wires::CompositeSwitch

nom	mult	type	description
compositeSwitchType	0..1	String	Code alphanumérique qui peut être utilisé pour faire référence à des informations supplémentaires telles que la description du schéma de verrouillage, le cas échéant.
aggregate	0..1	Boolean	hérité de: Equipment
inService	0..1	Boolean	hérité de: Equipment
networkAnalysisEnabled	0..1	Boolean	hérité de: Equipment
normallyInService	0..1	Boolean	hérité de: Equipment
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 159 présente toutes les extrémités d'association de CompositeSwitch avec d'autres classes.

Tableau 159 – Extrémités d'association de Wires::CompositeSwitch avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..1	Switches	0..*	Switch	Commutateurs contenus dans ce CompositeSwitch.
0..1	OperationalLimitSet	0..*	OperationalLimitSet	hérité de: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	hérité de: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	hérité de: Equipment
0..1	Faults	0..*	Fault	hérité de: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	hérité de: Equipment
0..*	PSRType	0..1	PSRType	hérité de: PowerSystemResource
0..1	Controls	0..*	Control	hérité de: PowerSystemResource
0..1	Measurements	0..*	Measurement	hérité de: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	hérité de: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	hérité de: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

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6.4.10 Conductor

Combinaison de matériaux conducteurs ayant des caractéristiques électriques cohérentes et formant un seul système de puissance, utilisé pour transporter du courant entre des points dans le système de puissance.

Le Tableau 160 présente tous les attributs de Conductor.

Tableau 160 – Attributs de Wires::Conductor

nom	mult	type	description
length	0..1	Length	Longueur du segment pour calculer les capacités d'une section de ligne.
aggregate	0..1	Boolean	hérité de: Equipment
inService	0..1	Boolean	hérité de: Equipment
networkAnalysisEnabled	0..1	Boolean	hérité de: Equipment
normallyInService	0..1	Boolean	hérité de: Equipment
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 161 présente toutes les extrémités d'association de Conductor avec d'autres classes.

Tableau 161 – Extrémités d'association de Wires::Conductor avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..*	BaseVoltage	0..1	BaseVoltage	hérité de: ConductingEquipment
1..1	SvStatus	0..*	SvStatus	hérité de: ConductingEquipment
0..*	ProtectionEquipments	0..*	ProtectionEquipment	hérité de: ConductingEquipment
1..1	Terminals	0..*	Terminal	hérité de: ConductingEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	hérité de: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	hérité de: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	hérité de: Equipment
0..1	Faults	0..*	Fault	hérité de: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	hérité de: Equipment
0..*	PSRType	0..1	PSRType	hérité de: PowerSystemResource
0..1	Controls	0..*	Control	hérité de: PowerSystemResource
0..1	Measurements	0..*	Measurement	hérité de: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	hérité de: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	hérité de: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

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6.4.11 Connector

Conducteur, ou groupe de conducteurs, d'une impédance négligeable, servant à connecter un autre équipement conducteur au sein d'un seul poste et qui sont modélisés avec une seule borne logique.

Le Tableau 162 présente tous les attributs de Connector.

Tableau 162 – Attributs de Wires::Connector

nom	mult	type	description
aggregate	0..1	Boolean	hérité de: Equipment
inService	0..1	Boolean	hérité de: Equipment
networkAnalysisEnabled	0..1	Boolean	hérité de: Equipment
normallyInService	0..1	Boolean	hérité de: Equipment
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 163 présente toutes les extrémités d'association de Connector avec d'autres classes.

Tableau 163 – Extrémités d'association de Wires::Connector avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..*	BaseVoltage	0..1	BaseVoltage	hérité de: ConductingEquipment
1..1	SvStatus	0..*	SvStatus	hérité de: ConductingEquipment
0..*	ProtectionEquipments	0..*	ProtectionEquipment	hérité de: ConductingEquipment
1..1	Terminals	0..*	Terminal	hérité de: ConductingEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	hérité de: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	hérité de: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	hérité de: Equipment
0..1	Faults	0..*	Fault	hérité de: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	hérité de: Equipment
0..*	PSRType	0..1	PSRType	hérité de: PowerSystemResource
0..1	Controls	0..*	Control	hérité de: PowerSystemResource
0..1	Measurements	0..*	Measurement	hérité de: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	hérité de: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	hérité de: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.4.12 Enumération CoolantType

Méthode de refroidissement d'une machine.

Le Tableau 164 présente tous les libellés de CoolantType.

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Tableau 164 – Libellés de Wires::CoolantType

libellé	value	description
air		Air.
hydrogenGas		Gaz hydrogène.
water		Eau.

6.4.13 Cut

Un cut sépare en deux parties un segment de ligne. Le cut se présente comme un commutateur qui est inséré entre ces deux parties et les connecte l'une à l'autre. Comme le cut est normalement ouvert, il n'y a pas de connexion galvanique entre les deux parties du segment de ligne. Il est cependant possible de fermer le cut pour obtenir une connexion galvanique.

Les bornes du cut sont orientées vers les bornes du segment de ligne qui ont le même numéro d'ordre. La borne de cut dont le numéro d'ordre est égal à 1 est, par conséquent, orientée vers la borne du segment de ligne dont le numéro d'ordre est égal à 1.

Les bornes du cut ont aussi une fonction de point de connexion pour des cavaliers et d'autres équipements, par exemple un générateur mobile. Pour y parvenir, des nœuds de connectivité sont placés aux bornes du cut. Une fois que les nœuds de connectivité sont en place, il est possible d'y connecter n'importe quel équipement.

Le Tableau 165 présente tous les attributs de Cut.

Tableau 165 – Attributs de Wires::Cut

nom	mult	type	description
lengthFromTerminal1	0..1	Length	Longueur à l'endroit où se trouve le cut, en partant d'un côté du segment de ligne du cut, c'est-à-dire de la borne (Terminal) de segment de ligne dont le numéro d'ordre est 1.
normalOpen	0..1	Boolean	hérité de: Switch
ratedCurrent	0..1	CurrentFlow	hérité de: Switch
switchOnCount	0..1	Integer	(déconseillé) hérité de: Switch
switchOnDate	0..1	DateTime	(déconseillé) hérité de: Switch
retained	0..1	Boolean	hérité de: Switch
open	0..1	Boolean	hérité de: Switch
locked	0..1	Boolean	hérité de: Switch
aggregate	0..1	Boolean	hérité de: Equipment
inService	0..1	Boolean	hérité de: Equipment
networkAnalysisEnabled	0..1	Boolean	hérité de: Equipment
normallyInService	0..1	Boolean	hérité de: Equipment
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 166 présente toutes les extrémités d'association de Cut avec d'autres classes.

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Tableau 166 – Extrémités d'association de Wires::Cut avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..*	ACLineSegment	1..1	ACLineSegment	Segment de ligne auquel est appliqué le cut.
1..1	SwitchPhase	0..*	SwitchPhase	hérité de: Switch
1..1	SwitchSchedules	0..*	SwitchSchedule	hérité de: Switch
0..*	CompositeSwitch	0..1	CompositeSwitch	hérité de: Switch
1..1	SvSwitch	0..*	SvSwitch	hérité de: Switch
0..*	BaseVoltage	0..1	BaseVoltage	hérité de: ConductingEquipment
1..1	SvStatus	0..*	SvStatus	hérité de: ConductingEquipment
0..*	ProtectionEquipments	0..*	ProtectionEquipment	hérité de: ConductingEquipment
1..1	Terminals	0..*	Terminal	hérité de: ConductingEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	hérité de: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	hérité de: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	hérité de: Equipment
0..1	Faults	0..*	Fault	hérité de: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	hérité de: Equipment
0..*	PSRType	0..1	PSRType	hérité de: PowerSystemResource
0..1	Controls	0..*	Control	hérité de: PowerSystemResource
0..1	Measurements	0..*	Measurement	hérité de: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	hérité de: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	hérité de: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.4.14 Disconnector

Appareil de commutation mécanique exploité manuellement ou par un moteur utilisé pour modifier les connexions dans un circuit ou pour isoler un circuit ou un équipement d'une source d'électricité. Les circuits doivent être ouverts ou fermés quand un courant négligeable est interrompu ou produit.

Le Tableau 167 présente tous les attributs de Disconnector.

Tableau 167 – Attributs de Wires::Disconnector

nom	mult	type	description
normalOpen	0..1	Boolean	hérité de: Switch
ratedCurrent	0..1	CurrentFlow	hérité de: Switch
switchOnCount	0..1	Integer	hérité de: Switch
switchOnDate	0..1	DateTime	hérité de: Switch
retained	0..1	Boolean	hérité de: Switch
open	0..1	Boolean	hérité de: Switch
locked	0..1	Boolean	hérité de: Switch
aggregate	0..1	Boolean	hérité de: Equipment

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nom	mult	type	description
inService	0..1	Boolean	hérité de: Equipment
networkAnalysisEnabled	0..1	Boolean	hérité de: Equipment
normallyInService	0..1	Boolean	hérité de: Equipment
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 168 présente toutes les extrémités d'association de Disconnector avec d'autres classes.

Tableau 168 – Extrémités d'association de Wires::Disconnector avec d'autres classes

mult à partir de	nom	mult vers	type	description
1..1	SwitchPhase	0..*	SwitchPhase	hérité de: Switch
1..1	SwitchSchedules	0..*	SwitchSchedule	hérité de: Switch
0..*	CompositeSwitch	0..1	CompositeSwitch	hérité de: Switch
1..1	SvSwitch	0..*	SvSwitch	hérité de: Switch
0..*	BaseVoltage	0..1	BaseVoltage	hérité de: ConductingEquipment
1..1	SvStatus	0..*	SvStatus	hérité de: ConductingEquipment
0..*	ProtectionEquipments	0..*	ProtectionEquipment	hérité de: ConductingEquipment
1..1	Terminals	0..*	Terminal	hérité de: ConductingEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	hérité de: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	hérité de: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	hérité de: Equipment
0..1	Faults	0..*	Fault	hérité de: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	hérité de: Equipment
0..*	PSRType	0..1	PSRType	hérité de: PowerSystemResource
0..1	Controls	0..*	Control	hérité de: PowerSystemResource
0..1	Measurements	0..*	Measurement	hérité de: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	hérité de: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	hérité de: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

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6.4.15 DisconnectingCircuitBreaker

Disjoncteur intégrant une fonction de déconnexion, ce qui évite d'utiliser des sectionneurs séparés.

Le Tableau 169 présente tous les attributs de DisconnectingCircuitBreaker.

Tableau 169 – Attributs de Wires::DisconnectingCircuitBreaker

nom	mult	type	description
inTransitTime	0..1	Seconds	hérité de: Breaker
breakingCapacity	0..1	CurrentFlow	hérité de: ProtectedSwitch
normalOpen	0..1	Boolean	hérité de: Switch
ratedCurrent	0..1	CurrentFlow	hérité de: Switch
switchOnCount	0..1	Integer	(déconseillé) hérité de: Switch
switchOnDate	0..1	DateTime	(déconseillé) hérité de: Switch
retained	0..1	Boolean	hérité de: Switch
open	0..1	Boolean	hérité de: Switch
locked	0..1	Boolean	hérité de: Switch
aggregate	0..1	Boolean	hérité de: Equipment
inService	0..1	Boolean	hérité de: Equipment
networkAnalysisEnabled	0..1	Boolean	hérité de: Equipment
normallyInService	0..1	Boolean	hérité de: Equipment
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 170 présente toutes les extrémités d'association de DisconnectingCircuitBreaker avec d'autres classes.

Tableau 170 – Extrémités d'association de ExtEuWires::DisconnectingCircuitBreaker avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..*	OperatedByProtectionEquipment	0..*	ProtectionEquipment	hérité de: ProtectedSwitch
1..1	RecloseSequences	0..*	RecloseSequence	hérité de: ProtectedSwitch
1..1	SwitchSchedules	0..*	SwitchSchedule	hérité de: Switch
1..1	SwitchPhase	0..*	SwitchPhase	hérité de: Switch
0..*	CompositeSwitch	0..1	CompositeSwitch	hérité de: Switch
1..1	SvSwitch	0..*	SvSwitch	hérité de: Switch
0..*	BaseVoltage	0..1	BaseVoltage	hérité de: ConductingEquipment
1..1	SvStatus	0..*	SvStatus	hérité de: ConductingEquipment
0..*	ProtectionEquipments	0..*	ProtectionEquipment	hérité de: ConductingEquipment
1..1	Terminals	0..*	Terminal	hérité de: ConductingEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	hérité de: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	hérité de: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	hérité de: Equipment
0..1	Faults	0..*	Fault	hérité de: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	hérité de: Equipment

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mult à partir de	nom	mult vers	type	description
0..*	PSRType	0..1	PSRType	hérité de: PowerSystemResource
0..1	Controls	0..*	Control	hérité de: PowerSystemResource
0..1	Measurements	0..*	Measurement	hérité de: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	hérité de: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	hérité de: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.4.16 EarthFaultCompensator

Équipement conducteur utilisé pour représenter une connexion à la terre qui est généralement utilisée pour compenser les défauts de terre. Un appareil de compensation de défaut de terre modélisé avec une seule borne implique une deuxième borne solidement raccordée à la terre. Si deux bornes sont modélisées, la terre n'est pas prise en compte et les règles de connexion normale s'appliquent.

Le Tableau 171 présente tous les attributs de EarthFaultCompensator.

Tableau 171 – Attributs de Wires::EarthFaultCompensator

nom	mult	type	description
r	0..1	Resistance	Résistance nominale de l'appareil.
aggregate	0..1	Boolean	hérité de: Equipment
inService	0..1	Boolean	hérité de: Equipment
networkAnalysisEnabled	0..1	Boolean	hérité de: Equipment
normallyInService	0..1	Boolean	hérité de: Equipment
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 172 présente toutes les extrémités d'association de EarthFaultCompensator avec d'autres classes.

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Tableau 172 – Extrémités d'association de Wires::EarthFaultCompensator avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..*	BaseVoltage	0..1	BaseVoltage	hérité de: ConductingEquipment
1..1	SvStatus	0..*	SvStatus	hérité de: ConductingEquipment
0..*	ProtectionEquipments	0..*	ProtectionEquipment	hérité de: ConductingEquipment
1..1	Terminals	0..*	Terminal	hérité de: ConductingEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	hérité de: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	hérité de: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	hérité de: Equipment
0..1	Faults	0..*	Fault	hérité de: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	hérité de: Equipment
0..*	PSRType	0..1	PSRType	hérité de: PowerSystemResource
0..1	Controls	0..*	Control	hérité de: PowerSystemResource
0..1	Measurements	0..*	Measurement	hérité de: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	hérité de: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	hérité de: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.4.17 EnergyConnection

Connexion de la génération ou la consommation d'énergie sur le modèle de système de puissance.

Le Tableau 173 présente tous les attributs de EnergyConnection.

Tableau 173 – Attributs de Wires::EnergyConnection

nom	mult	type	description
aggregate	0..1	Boolean	hérité de: Equipment
inService	0..1	Boolean	hérité de: Equipment
networkAnalysisEnabled	0..1	Boolean	hérité de: Equipment
normallyInService	0..1	Boolean	hérité de: Equipment
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 174 présente toutes les extrémités d'association de EnergyConnection avec d'autres classes.

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Tableau 174 – Extrémités d'association de Wires::EnergyConnection avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..*	BaseVoltage	0..1	BaseVoltage	hérité de: ConductingEquipment
1..1	SvStatus	0..*	SvStatus	hérité de: ConductingEquipment
0..*	ProtectionEquipments	0..*	ProtectionEquipment	hérité de: ConductingEquipment
1..1	Terminals	0..*	Terminal	hérité de: ConductingEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	hérité de: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	hérité de: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	hérité de: Equipment
0..1	Faults	0..*	Fault	hérité de: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	hérité de: Equipment
0..*	PSRType	0..1	PSRType	hérité de: PowerSystemResource
0..1	Controls	0..*	Control	hérité de: PowerSystemResource
0..1	Measurements	0..*	Measurement	hérité de: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	hérité de: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	hérité de: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.4.18 EnergyConsumer

Consommateur générique d'énergie – point de consommation sur le modèle de système de puissance.

EnergyConsumer.pfixed, .qfixed, .pfixedPct et .qfixedPct n'ont une signification qu'en l'absence de LoadResponseCharacteristic associé à EnergyConsumer ou si LoadResponseCharacteristic.exponentModel est réglé à False

Le Tableau 175 présente tous les attributs de EnergyConsumer.

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Tableau 175 – Attributs de Wires::EnergyConsumer

nom	mult	type	description
customerCount	0..1	Integer	Nombre de clients individuels représentés par cette demande.
grounded	0..1	Boolean	Utilisée pour des connexions Yn et Zn. Vrai si le neutre est solidement mis à la terre.
pfixed	0..1	ActivePower	Puissance active de la charge dont la grandeur est fixe et ne varie pas selon la variation de la valeur de groupe de charge. La convention de signe charge est utilisée, c'est-à-dire que le signe positif signifie un flux à partir d'un nœud.
pfixedPct	0..1	PerCent	Puissance active fixe exprimée en pourcentage de la puissance active fixe du groupe de charge. Utilisée pour représenter les composantes variables dans le temps. La convention de signe charge est utilisée, c'est-à-dire que le signe positif signifie un flux à partir d'un nœud.
phaseConnection	0..1	PhaseShuntConnectionKind	Type de connexion de phase, par exemple montage en étoile ou en triangle.
qfixed	0..1	ReactivePower	Puissance réactive de la charge dont la grandeur est fixe et ne varie pas selon la variation de la valeur de groupe de charge. La convention de signe charge est utilisée, c'est-à-dire que le signe positif signifie un flux à partir d'un nœud.
qfixedPct	0..1	PerCent	Puissance réactive fixe exprimée en pourcentage de la puissance réactive fixe du groupe de charge. Utilisée pour représenter les composantes variables dans le temps. La convention de signe charge est utilisée, c'est-à-dire que le signe positif signifie un flux à partir d'un nœud.
p	0..1	ActivePower	Puissance active de la charge. La convention de signe charge est utilisée, c'est-à-dire que le signe positif signifie un flux à partir d'un nœud. Pour les charges qui dépendent de la tension, la valeur est celle de la tension assignée. Valeur de départ pour une solution en régime établi.
q	0..1	ReactivePower	Puissance réactive de la charge. La convention de signe charge est utilisée, c'est-à-dire que le signe positif signifie un flux à partir d'un nœud. Pour les charges qui dépendent de la tension, la valeur est celle de la tension assignée. Valeur de départ pour une solution en régime établi.
aggregate	0..1	Boolean	hérité de: Equipment
inService	0..1	Boolean	hérité de: Equipment
networkAnalysisEnabled	0..1	Boolean	hérité de: Equipment
normallyInService	0..1	Boolean	hérité de: Equipment
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 176 présente toutes les extrémités d'association de EnergyConsumer avec d'autres classes.

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Tableau 176 – Extrémités d'association de Wires::EnergyConsumer avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..*	LoadResponse	0..1	LoadResponseCharacteristic	Caractéristique de réponse de charge pour cette charge. Si elle manque, cette charge est considérée comme une puissance constante.
1..1	EnergyConsumerPhase	0..*	EnergyConsumerPhase	Modèles individuels de phase pour ce consommateur d'énergie.
1..*	PowerCutZone	0..1	PowerCutZone	Le consommateur d'énergie est affecté à cette zone de coupure de puissance.
0..*	LoadDynamics	0..1	LoadDynamics	Modèle dynamique de charge utilisé pour décrire le comportement dynamique de ce consommateur d'énergie.
0..*	BaseVoltage	0..1	BaseVoltage	hérité de: ConductingEquipment
1..1	SvStatus	0..*	SvStatus	hérité de: ConductingEquipment
1..1	Terminals	0..*	Terminal	hérité de: ConductingEquipment
0..*	ProtectionEquipments	0..*	ProtectionEquipment	hérité de: ConductingEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	hérité de: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	hérité de: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	hérité de: Equipment
0..1	Faults	0..*	Fault	hérité de: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	hérité de: Equipment
0..*	PSRType	0..1	PSRType	hérité de: PowerSystemResource
0..1	Controls	0..*	Control	hérité de: PowerSystemResource
0..1	Measurements	0..*	Measurement	hérité de: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	hérité de: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	hérité de: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.4.19 EnergyConsumerPhase

Phase unique d'un consommateur d'énergie.

Le Tableau 177 présente tous les attributs de EnergyConsumerPhase.

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Tableau 177 – Attributs de Wires::EnergyConsumerPhase

nom	mult	type	description
pfixed	0..1	ActivePower	Puissance active de la charge dont la grandeur est fixe. La convention de signe charge est utilisée, c'est-à-dire que le signe positif signifie un flux à partir d'un nœud.
pfixedPct	0..1	PerCent	Puissance active fixe exprimée en pourcentage de la puissance active fixe du groupe de charge. La convention de signe charge est utilisée, c'est-à-dire que le signe positif signifie un flux à partir d'un nœud.
phase	0..1	SinglePhaseKind	Phase de ce composant consommateur d'énergie. Si le consommateur d'énergie est connecté en étoile, la connexion va de la phase indiquée à la terre centrale ou au point neutre. Si le consommateur d'énergie est connecté en triangle, la phase indique qu'un consommateur d'énergie est connecté de la phase indiquée à la phase logique suivante non neutre.
qfixed	0..1	ReactivePower	Puissance réactive de la charge dont la grandeur est fixe. La convention de signe charge est utilisée, c'est-à-dire que le signe positif signifie un flux à partir d'un nœud.
qfixedPct	0..1	PerCent	Puissance réactive fixe exprimée en pourcentage de la puissance réactive fixe du groupe de charge. La convention de signe charge est utilisée, c'est-à-dire que le signe positif signifie un flux à partir d'un nœud.
p	0..1	ActivePower	Puissance active de la charge. La convention de signe charge est utilisée, c'est-à-dire que le signe positif signifie un flux à partir d'un nœud. Pour les charges qui dépendent de la tension, la valeur est celle de la tension assignée. Valeur de départ pour une solution en régime établi.
q	0..1	ReactivePower	Puissance réactive de la charge. La convention de signe charge est utilisée, c'est-à-dire que le signe positif signifie un flux à partir d'un nœud. Pour les charges qui dépendent de la tension, la valeur est celle de la tension assignée. Valeur de départ pour une solution en régime établi.
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 178 présente toutes les extrémités d'association de EnergyConsumerPhase avec d'autres classes.

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Tableau 178 – Extrémités d'association de Wires::EnergyConsumerPhase avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..*	EnergyConsumer	1..1	EnergyConsumer	Consommateur d'énergie auquel appartient cette phase.
0..*	PSRType	0..1	PSRType	hérité de: PowerSystemResource
0..1	Controls	0..*	Control	hérité de: PowerSystemResource
0..1	Measurements	0..*	Measurement	hérité de: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	hérité de: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	hérité de: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.4.20 EnergySchedulingType

Utilisé pour définir le type de production à des fins de programmation.

Le Tableau 179 présente tous les attributs de EnergySchedulingType.

Tableau 179 – Attributs de Wires::EnergySchedulingType

nom	mult	type	description
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 180 présente toutes les extrémités d'association de EnergySchedulingType avec d'autres classes.

Tableau 180 – Extrémités d'association de Wires::EnergySchedulingType avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..1	EnergySource	0..*	EnergySource	Source d'énergie (Energy Source) d'un type particulier de programmation d'énergie (Energy Scheduling Type)/
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.4.21 EnergySource

Équivalent générique pour un fournisseur d'énergie sur un niveau de tension de transport ou de distribution.

Le Tableau 181 présente tous les attributs de EnergySource.

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Tableau 181 – Attributs de Wires::EnergySource

nom	mult	type	description
activePower	0..1	ActivePower	Injection active de source haute tension. La convention de signe charge est utilisée, c'est-à-dire que le signe positif signifie un flux à partir d'un nœud. Valeur de départ pour des solutions en régime établi.
reactivePower	0..1	ReactivePower	Injection réactive de source haute tension. La convention de signe charge est utilisée, c'est-à-dire que le signe positif signifie un flux à partir d'un nœud. Valeur de départ pour des solutions en régime établi.
nominalVoltage	0..1	Voltage	Tension nominale phase à phase.
r	0..1	Resistance	Résistance directe de Thevenin.
r0	0..1	Resistance	Résistance homopolaire de Thevenin.
rn	0..1	Resistance	Résistance inverse de Thevenin.
voltageAngle	0..1	AngleRadians	Angle de phase d'un circuit à phase ouvert utilisé lorsqu'il est nécessaire d'imposer des caractéristiques de tension au niveau du noeud associé à la borne de la source d'énergie (lorsque les tensions et les angles provenant du niveau de transport sont utilisés comme entrée dans le réseau de distribution, par exemple). L'attribut doit avoir une valeur positive ou égale à zéro.
voltageMagnitude	0..1	Voltage	Valeur de la tension phase à phase d'un circuit ouvert utilisé lorsqu'il est nécessaire d'imposer des caractéristiques de tension au niveau du noeud associé à la borne de la source d'énergie (lorsque les tensions et les angles provenant du niveau de transport sont utilisés comme entrée dans le réseau de distribution, par exemple). L'attribut doit avoir une valeur positive ou égale à zéro.
x	0..1	Reactance	Réactance directe de Thevenin.
x0	0..1	Reactance	Réactance homopolaire de Thevenin.
xn	0..1	Reactance	Réactance inverse de Thevenin.
pMin	0..1	ActivePower	Il s'agit de la puissance active minimale qui peut être produite par la source. La convention de signe charge est utilisée, c'est-à-dire que le signe positif signifie un flux à partir d'un TopologicalNode (bus) vers l'équipement conducteur.
pMax	0..1	ActivePower	Il s'agit de la puissance active maximale qui peut être produite par la source. La convention de signe charge est utilisée, c'est-à-dire que le signe positif signifie un flux à partir d'un TopologicalNode (bus) vers l'équipement conducteur.
aggregate	0..1	Boolean	hérité de: Equipment
inService	0..1	Boolean	hérité de: Equipment
networkAnalysisEnabled	0..1	Boolean	hérité de: Equipment
normallyInService	0..1	Boolean	hérité de: Equipment
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 182 présente toutes les extrémités d'association de EnergySource avec d'autres classes.

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Tableau 182 – Extrémités d'association de Wires::EnergySource avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..*	EnergySchedulingType	0..1	EnergySchedulingType	Type de planification d'énergie d'une source d'énergie.
1..1	EnergySourcePhase	0..*	EnergySourcePhase	Informations de phase individuelles de la source d'énergie.
0..*	BaseVoltage	0..1	BaseVoltage	hérité de: ConductingEquipment
1..1	SvStatus	0..*	SvStatus	hérité de: ConductingEquipment
0..*	ProtectionEquipments	0..*	ProtectionEquipment	hérité de: ConductingEquipment
1..1	Terminals	0..*	Terminal	hérité de: ConductingEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	hérité de: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	hérité de: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	hérité de: Equipment
0..1	Faults	0..*	Fault	hérité de: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	hérité de: Equipment
0..*	PSRType	0..1	PSRType	hérité de: PowerSystemResource
0..1	Controls	0..*	Control	hérité de: PowerSystemResource
0..1	Measurements	0..*	Measurement	hérité de: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	hérité de: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	hérité de: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.4.22 EnergySourcePhase

Représente les informations de phase individuelles d'une source d'énergie déséquilibrée.

Le Tableau 183 présente tous les attributs de EnergySourcePhase.

Tableau 183 – Attributs de Wires::EnergySourcePhase

nom	mult	type	description
phase	0..1	SinglePhaseKind	Phase de ce composant source d'énergie. Si la source d'énergie est connectée en étoile, la connexion va de la phase indiquée à la terre centrale ou au point neutre. Si la source d'énergie est connectée en triangle, la phase indique qu'une source d'énergie est connectée de la phase indiquée à la phase logique suivante non neutre.
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 184 présente toutes les extrémités d'association de EnergySourcePhase avec d'autres classes.

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Tableau 184 – Extrémités d'association de Wires::EnergySourcePhase avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..*	EnergySource	1..1	EnergySource	Source d'énergie auquel appartient la phase.
0..*	PSRType	0..1	PSRType	hérité de: PowerSystemResource
0..1	Controls	0..*	Control	hérité de: PowerSystemResource
0..1	Measurements	0..*	Measurement	hérité de: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	hérité de: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	hérité de: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.4.23 ExternalNetworkInjection

Cette classe représente le réseau externe et est utilisée pour les calculs de l'IEC 60909.

Le Tableau 185 présente tous les attributs de ExternalNetworkInjection.

Tableau 185 – Attributs de Wires::ExternalNetworkInjection

nom	mult	type	description
governorSCD	0..1	ActivePowerPerFrequency	Polarisation de la fréquence industrielle. Il s'agit de la variation de l'injection de puissance divisée par la variation de la fréquence et changée de signe. Une valeur positive de la polarisation de la fréquence industrielle fournit une injection de puissance additive par suite d'une chute de fréquence.
ikSecond	0..1	Boolean	Indique si le courant de court-circuit initial symétrique et la puissance ont été calculés conformément à l'IEC (Ik"). Utilisé uniquement si les calculs de court-circuit sont réalisés selon la méthode de superposition.
maxInitialSymShCCurrent	0..1	CurrentFlow	Courants maximaux de court-circuit initiaux symétriques (Ik" max), en ampères (Ik" = Sk"/(SQRT(3) Un)). Utilisé pour l'échange de données relatives à un court-circuit, conformément à l'IEC 60909.
maxP	0..1	ActivePower	Puissance active maximale de l'injection.
maxQ	0..1	ReactivePower	Limite de puissance réactive maximale.. Elle est utilisée pour la modélisation d'alimentation pour l'échange de flux de charge et pas pour la modélisation de courts-circuits.
maxR0ToX0Ratio	0..1	Float	Rapport minimal de la résistance homopolaire du Network Feeder (réseau d'alimentation) sur sa réactance homopolaire (R(0)/X(0) max). Utilisé pour l'échange de données relatives à un court-circuit, conformément à l'IEC 60909.
maxR1ToX1Ratio	0..1	Float	Rapport maximal de la résistance directe du Network Feeder (réseau d'alimentation) sur sa réactance directe (R(1)/X(1) max). Utilisé pour l'échange de données relatives à un court-circuit, conformément à l'IEC 60909.
maxZ0ToZ1Ratio	0..1	Float	Rapport maximal de l'impédance homopolaire sur l'impédance directe (Z(0)/Z(1) max). Utilisé pour l'échange de données relatives à un court-circuit, conformément à l'IEC 60909.

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nom	mult	type	description
minInitialSymShCCurrent	0..1	CurrentFlow	Courants minimaux de court-circuit initiaux symétriques (Ik" min), en ampères (Ik" = Sk"/(SQRT(3) Un)). Utilisé pour l'échange de données relatives à un court-circuit, conformément à l'IEC 60909.
minP	0..1	ActivePower	Puissance active minimale de l'injection.
minQ	0..1	ReactivePower	Limite de puissance réactive minimale Elle est utilisée pour la modélisation d'alimentation pour l'échange de flux de charge et pas pour la modélisation de courts-circuits.
minR0ToX0Ratio	0..1	Float	Indique si le courant de court-circuit initial symétrique et la puissance ont été calculés conformément à l'IEC (Ik"). Utilisé pour l'échange de données relatives à un court-circuit, conformément à l'IEC 6090.
minR1ToX1Ratio	0..1	Float	Rapport minimal de la résistance directe du Network Feeder (réseau d'alimentation) sur sa réactance directe (R(1)/X(1) min). Utilisé pour l'échange de données relatives à un court-circuit, conformément à l'IEC 60909.
minZ0ToZ1Ratio	0..1	Float	Rapport minimal de l'impédance homopolaire sur l'impédance directe (Z(0)/Z(1) min). Utilisé pour l'échange de données relatives à un court-circuit, conformément à l'IEC 60909.
referencePriority	0..1	Integer	Priorité de l'unité pour une utilisation comme sélection de bus de référence pour l'angle de phase de la tension du flux de puissance. 0 = don't care (peu importe, valeur par défaut) 1 = plus haute priorité. 2 est moins que 1 et ainsi de suite.
voltageFactor	0..1	PU	Facteur de tension, en pu, qui a été utilisé pour calculer le courant de court-circuit Ik" et la puissance Sk". Utilisé uniquement si les calculs de court-circuit sont réalisés selon la méthode de superposition.
p	0..1	ActivePower	Injection de puissance active. La convention de signe charge est utilisée, c'est-à-dire que le signe positif signifie un flux à partir d'un nœud. Valeur de départ pour des solutions en régime établi.
q	0..1	ReactivePower	Injection de puissance réactive. La convention de signe charge est utilisée, c'est-à-dire que le signe positif signifie un flux à partir d'un nœud. Valeur de départ pour des solutions en régime établi.
controlEnabled	0..1	Boolean	hérité de: RegulatingCondEq
aggregate	0..1	Boolean	hérité de: Equipment
inService	0..1	Boolean	hérité de: Equipment
networkAnalysisEnabled	0..1	Boolean	hérité de: Equipment
normallyInService	0..1	Boolean	hérité de: Equipment
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

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Le Tableau 186 présente toutes les extrémités d'association de ExternalNetworkInjection avec d'autres classes.

Tableau 186 – Extrémités d'association de Wires::ExternalNetworkInjection avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..*	RegulatingControl	0..1	RegulatingControl	hérité de: RegulatingCondEq
0..*	BaseVoltage	0..1	BaseVoltage	hérité de: ConductingEquipment
1..1	SvStatus	0..*	SvStatus	hérité de: ConductingEquipment
0..*	ProtectionEquipments	0..*	ProtectionEquipment	hérité de: ConductingEquipment
1..1	Terminals	0..*	Terminal	hérité de: ConductingEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	hérité de: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	hérité de: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	hérité de: Equipment
0..1	Faults	0..*	Fault	hérité de: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	hérité de: Equipment
0..*	PSRType	0..1	PSRType	hérité de: PowerSystemResource
0..1	Controls	0..*	Control	hérité de: PowerSystemResource
0..1	Measurements	0..*	Measurement	hérité de: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	hérité de: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	hérité de: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.4.24 FrequencyConverter

Un appareil servant à convertir une fréquence en une autre (par exemple, fréquence F1 en F2) comprend une paire d'instances FrequencyConverter. L'une convertit de F1 en courant continu, l'autre de courant continu en F2.

Le Tableau 187 présente tous les attributs de FrequencyConverter.

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Tableau 187 – Attributs de Wires::FrequencyConverter

nom	mult	type	description
frequency	0..1	Frequency	Fréquence du côté courant alternatif.
maxP	0..1	ActivePower	Puissance active maximale du côté courant continu à laquelle il convient que le convertisseur de fréquence fonctionne.
maxU	0..1	Voltage	Tension maximale du côté courant continu à laquelle il convient que le convertisseur de fréquence fonctionne.
minP	0..1	ActivePower	Puissance active minimale du côté courant continu à laquelle il convient que le convertisseur de fréquence fonctionne.
minU	0..1	Voltage	Tension minimale du côté courant continu à laquelle il convient que le convertisseur de fréquence fonctionne.
controlEnabled	0..1	Boolean	hérité de: RegulatingCondEq
aggregate	0..1	Boolean	hérité de: Equipment
inService	0..1	Boolean	hérité de: Equipment
networkAnalysisEnabled	0..1	Boolean	hérité de: Equipment
normallyInService	0..1	Boolean	hérité de: Equipment
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 188 présente toutes les extrémités d'association de FrequencyConverter avec d'autres classes.

Tableau 188 – Extrémités d'association de Wires::FrequencyConverter avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..*	RegulatingControl	0..1	RegulatingControl	hérité de: RegulatingCondEq
0..*	BaseVoltage	0..1	BaseVoltage	hérité de: ConductingEquipment
1..1	SvStatus	0..*	SvStatus	hérité de: ConductingEquipment
0..*	ProtectionEquipments	0..*	ProtectionEquipment	hérité de: ConductingEquipment
1..1	Terminals	0..*	Terminal	hérité de: ConductingEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	hérité de: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	hérité de: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	hérité de: Equipment
0..1	Faults	0..*	Fault	hérité de: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	hérité de: Equipment
0..*	PSRType	0..1	PSRType	hérité de: PowerSystemResource
0..1	Controls	0..*	Control	hérité de: PowerSystemResource
0..1	Measurements	0..*	Measurement	hérité de: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	hérité de: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	hérité de: PowerSystemResource

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mult à partir de	nom	mult vers	type	description
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.4.25 Fuse

Appareil de protection contre les surintensités avec un fusible à ouverture de circuit qui est chauffé et rompu quand une surintensité le traverse. Un fusible est considéré comme un dispositif de commutation parce qu'il interrompt le courant.

Le Tableau 189 présente tous les attributs de Fuse.

Tableau 189 – Attributs de Wires::Fuse

nom	mult	type	description
normalOpen	0..1	Boolean	hérité de: Switch
ratedCurrent	0..1	CurrentFlow	hérité de: Switch
switchOnCount	0..1	Integer	hérité de: Switch
switchOnDate	0..1	DateTime	hérité de: Switch
retained	0..1	Boolean	hérité de: Switch
open	0..1	Boolean	hérité de: Switch
locked	0..1	Boolean	hérité de: Switch
aggregate	0..1	Boolean	hérité de: Equipment
inService	0..1	Boolean	hérité de: Equipment
networkAnalysisEnabled	0..1	Boolean	hérité de: Equipment
normallyInService	0..1	Boolean	hérité de: Equipment
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 190 présente toutes les extrémités d'association de Fuse avec d'autres classes.

Tableau 190 – Extrémités d'association de Wires::Fuse avec d'autres classes

mult à partir de	nom	mult vers	type	description
1..1	SwitchPhase	0..*	SwitchPhase	hérité de: Switch
1..1	SwitchSchedules	0..*	SwitchSchedule	hérité de: Switch
0..*	CompositeSwitch	0..1	CompositeSwitch	hérité de: Switch
1..1	SvSwitch	0..*	SvSwitch	hérité de: Switch
0..*	BaseVoltage	0..1	BaseVoltage	hérité de: ConductingEquipment
1..1	SvStatus	0..*	SvStatus	hérité de: ConductingEquipment
0..*	ProtectionEquipments	0..*	ProtectionEquipment	hérité de: ConductingEquipment
1..1	Terminals	0..*	Terminal	hérité de: ConductingEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	hérité de: Equipment

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mult à partir de	nom	mult vers	type	description
1..1	ContingencyEquipment	0..*	ContingencyEquipment	hérité de: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	hérité de: Equipment
0..1	Faults	0..*	Fault	hérité de: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	hérité de: Equipment
0..*	PSRType	0..1	PSRType	hérité de: PowerSystemResource
0..1	Controls	0..*	Control	hérité de: PowerSystemResource
0..1	Measurements	0..*	Measurement	hérité de: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	hérité de: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	hérité de: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.4.26 Ground

Point au niveau duquel le système est mis à la terre pour raccorder l'équipement conducteur à la terre. Le modèle de système de puissance peut avoir un nombre quelconque de terres.

Le Tableau 191 présente tous les attributs de Ground.

Tableau 191 – Attributs de Wires::Ground

nom	mult	type	description
aggregate	0..1	Boolean	hérité de: Equipment
inService	0..1	Boolean	hérité de: Equipment
networkAnalysisEnabled	0..1	Boolean	hérité de: Equipment
normallyInService	0..1	Boolean	hérité de: Equipment
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 192 présente toutes les extrémités d'association de Ground avec d'autres classes.

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Tableau 192 – Extrémités d'association de Wires::Ground avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..*	BaseVoltage	0..1	BaseVoltage	hérité de: ConductingEquipment
1..1	SvStatus	0..*	SvStatus	hérité de: ConductingEquipment
0..*	ProtectionEquipments	0..*	ProtectionEquipment	hérité de: ConductingEquipment
1..1	Terminals	0..*	Terminal	hérité de: ConductingEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	hérité de: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	hérité de: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	hérité de: Equipment
0..1	Faults	0..*	Fault	hérité de: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	hérité de: Equipment
0..*	PSRType	0..1	PSRType	hérité de: PowerSystemResource
0..1	Controls	0..*	Control	hérité de: PowerSystemResource
0..1	Measurements	0..*	Measurement	hérité de: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	hérité de: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	hérité de: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.4.27 GroundingImpedance

Appareil à impédance fixe utilisé pour la mise à la terre.

Le Tableau 193 présente tous les attributs de GroundingImpedance.

Tableau 193 – Attributs de Wires::GroundingImpedance

nom	mult	type	description
x	0..1	Reactance	Réactance de l'appareil.
r	0..1	Resistance	hérité de: EarthFaultCompensator
aggregate	0..1	Boolean	hérité de: Equipment
inService	0..1	Boolean	hérité de: Equipment
networkAnalysisEnabled	0..1	Boolean	hérité de: Equipment
normallyInService	0..1	Boolean	hérité de: Equipment
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 194 présente toutes les extrémités d'association de GroundingImpedance avec d'autres classes.

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Tableau 194 – Extrémités d'association de Wires::GroundingImpedance avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..*	BaseVoltage	0..1	BaseVoltage	hérité de: ConductingEquipment
1..1	SvStatus	0..*	SvStatus	hérité de: ConductingEquipment
0..*	ProtectionEquipments	0..*	ProtectionEquipment	hérité de: ConductingEquipment
1..1	Terminals	0..*	Terminal	hérité de: ConductingEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	hérité de: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	hérité de: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	hérité de: Equipment
0..1	Faults	0..*	Fault	hérité de: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	hérité de: Equipment
0..*	PSRType	0..1	PSRType	hérité de: PowerSystemResource
0..1	Controls	0..*	Control	hérité de: PowerSystemResource
0..1	Measurements	0..*	Measurement	hérité de: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	hérité de: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	hérité de: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.4.28 GroundDisconnector

Appareil mécanique de commutation, exploité manuellement ou par un moteur, utilisé pour isoler un circuit ou un équipement de la terre.

Le Tableau 195 présente tous les attributs de GroundDisconnector.

Tableau 195 – Attributs de Wires::GroundDisconnector

nom	mult	type	description
normalOpen	0..1	Boolean	hérité de: Switch
ratedCurrent	0..1	CurrentFlow	hérité de: Switch
switchOnCount	0..1	Integer	(déconseillé) hérité de: Switch
switchOnDate	0..1	DateTime	(déconseillé) hérité de: Switch
retained	0..1	Boolean	hérité de: Switch
open	0..1	Boolean	hérité de: Switch
locked	0..1	Boolean	hérité de: Switch
aggregate	0..1	Boolean	hérité de: Equipment
inService	0..1	Boolean	hérité de: Equipment
networkAnalysisEnabled	0..1	Boolean	hérité de: Equipment
normallyInService	0..1	Boolean	hérité de: Equipment
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject

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nom	mult	type	description
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 196 présente toutes les extrémités d'association de GroundDisconnector avec d'autres classes.

Tableau 196 – Extrémités d'association de Wires::GroundDisconnector avec d'autres classes

mult à partir de	nom	mult vers	type	description
1..1	SwitchPhase	0..*	SwitchPhase	hérité de: Switch
1..1	SwitchSchedules	0..*	SwitchSchedule	hérité de: Switch
0..*	CompositeSwitch	0..1	CompositeSwitch	hérité de: Switch
1..1	SvSwitch	0..*	SvSwitch	hérité de: Switch
0..*	BaseVoltage	0..1	BaseVoltage	hérité de: ConductingEquipment
1..1	SvStatus	0..*	SvStatus	hérité de: ConductingEquipment
0..*	ProtectionEquipments	0..*	ProtectionEquipment	hérité de: ConductingEquipment
1..1	Terminals	0..*	Terminal	hérité de: ConductingEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	hérité de: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	hérité de: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	hérité de: Equipment
0..1	Faults	0..*	Fault	hérité de: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	hérité de: Equipment
0..*	PSRType	0..1	PSRType	hérité de: PowerSystemResource
0..1	Controls	0..*	Control	hérité de: PowerSystemResource
0..1	Measurements	0..*	Measurement	hérité de: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	hérité de: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	hérité de: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.4.29 Jumper

Courte section de conducteur avec une impédance négligeable pouvant être enlevée et remplacée manuellement si le circuit n'est plus alimenté. Noter que les branches à impédance nulle peuvent être potentiellement modélisées par d'autres types d'équipements.

Le Tableau 197 présente tous les attributs de Jumper.

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Tableau 197 – Attributs de Wires::Jumper

nom	mult	type	description
normalOpen	0..1	Boolean	hérité de: Switch
ratedCurrent	0..1	CurrentFlow	hérité de: Switch
switchOnCount	0..1	Integer	(déconseillé) hérité de: Switch
switchOnDate	0..1	DateTime	(déconseillé) hérité de: Switch
retained	0..1	Boolean	hérité de: Switch
open	0..1	Boolean	hérité de: Switch
locked	0..1	Boolean	hérité de: Switch
aggregate	0..1	Boolean	hérité de: Equipment
inService	0..1	Boolean	hérité de: Equipment
networkAnalysisEnabled	0..1	Boolean	hérité de: Equipment
normallyInService	0..1	Boolean	hérité de: Equipment
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 198 présente toutes les extrémités d'association de Jumper avec d'autres classes.

Tableau 198 – Extrémités d'association de Wires::Jumper avec d'autres classes

mult à partir de	nom	mult vers	type	description
1..1	SwitchPhase	0..*	SwitchPhase	hérité de: Switch
1..1	SwitchSchedules	0..*	SwitchSchedule	hérité de: Switch
0..*	CompositeSwitch	0..1	CompositeSwitch	hérité de: Switch
1..1	SvSwitch	0..*	SvSwitch	hérité de: Switch
0..*	BaseVoltage	0..1	BaseVoltage	hérité de: ConductingEquipment
1..1	SvStatus	0..*	SvStatus	hérité de: ConductingEquipment
0..*	ProtectionEquipments	0..*	ProtectionEquipment	hérité de: ConductingEquipment
1..1	Terminals	0..*	Terminal	hérité de: ConductingEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	hérité de: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	hérité de: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	hérité de: Equipment
0..1	Faults	0..*	Fault	hérité de: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	hérité de: Equipment
0..*	PSRType	0..1	PSRType	hérité de: PowerSystemResource
0..1	Controls	0..*	Control	hérité de: PowerSystemResource
0..1	Measurements	0..*	Measurement	hérité de: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	hérité de: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	hérité de: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

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6.4.30 Junction

Point auquel un ou plusieurs équipements conducteurs sont connectés avec une résistance homopolaire.

Le Tableau 199 présente tous les attributs de Junction.

Tableau 199 – Attributs de Wires::Junction

nom	mult	type	description
aggregate	0..1	Boolean	hérité de: Equipment
inService	0..1	Boolean	hérité de: Equipment
networkAnalysisEnabled	0..1	Boolean	hérité de: Equipment
normallyInService	0..1	Boolean	hérité de: Equipment
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 200 présente toutes les extrémités d'association de Junction avec d'autres classes.

Tableau 200 – Extrémités d'association de Wires::Junction avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..*	BaseVoltage	0..1	BaseVoltage	hérité de: ConductingEquipment
1..1	SvStatus	0..*	SvStatus	hérité de: ConductingEquipment
0..*	ProtectionEquipments	0..*	ProtectionEquipment	hérité de: ConductingEquipment
1..1	Terminals	0..*	Terminal	hérité de: ConductingEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	hérité de: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	hérité de: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	hérité de: Equipment
0..1	Faults	0..*	Fault	hérité de: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	hérité de: Equipment
0..*	PSRType	0..1	PSRType	hérité de: PowerSystemResource
0..1	Controls	0..*	Control	hérité de: PowerSystemResource
0..1	Measurements	0..*	Measurement	hérité de: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	hérité de: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	hérité de: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.4.31 Line

Contient des équipements au-delà du poste appartenant à une ligne de transport d'énergie électrique.

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Le Tableau 201 présente tous les attributs de Line.

Tableau 201 – Attributs de Wires::Line

nom	mult	type	description
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 202 présente toutes les extrémités d'association de Line avec d'autres classes.

Tableau 202 – Extrémités d'association de Wires::Line avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..*	Region	0..1	SubGeographicalRegion	Sous-région géographique de la ligne.
0..1	Equipments	0..*	Equipment	hérité de: EquipmentContainer
0..*	AdditionalGrouped Equipment	0..*	Equipment	hérité de: EquipmentContainer
1..1	ConnectivityNodes	0..*	ConnectivityNode	hérité de: ConnectivityNodeContainer
0..1	TopologicalNode	0..*	TopologicalNode	hérité de: ConnectivityNodeContainer
0..*	PSRType	0..1	PSRType	hérité de: PowerSystemResource
0..1	Controls	0..*	Control	hérité de: PowerSystemResource
0..1	Measurements	0..*	Measurement	hérité de: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	hérité de: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	hérité de: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.4.32 LinearShuntCompensator

Le compensateur shunt linéaire a des batteries ou des sections ayant des valeurs égales d'admittance.

Le Tableau 203 présente tous les attributs de LinearShuntCompensator.

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Tableau 203 – Attributs de Wires::LinearShuntCompensator

nom	mult	type	description
b0PerSection	0..1	Susceptance	Susceptance shunt homopolaire (de chargement) par section.
bPerSection	0..1	Susceptance	Susceptance shunt directe (de chargement) par section.
g0PerSection	0..1	Conductance	Conductance shunt homopolaire (de chargement) par section.
gPerSection	0..1	Conductance	Conductance shunt directe (de chargement) par section.
aVRDelay	0..1	Seconds	hérité de: ShuntCompensator
grounded	0..1	Boolean	hérité de: ShuntCompensator
maximumSections	0..1	Integer	hérité de: ShuntCompensator
nomU	0..1	Voltage	hérité de: ShuntCompensator
normalSections	0..1	Integer	hérité de: ShuntCompensator
phaseConnection	0..1	PhaseShuntConnectionKind	hérité de: ShuntCompensator
switchOnCount	0..1	Integer	hérité de: ShuntCompensator
switchOnDate	0..1	DateTime	hérité de: ShuntCompensator
voltageSensitivity	0..1	VoltagePerReactivePower	hérité de: ShuntCompensator
sections	0..1	Float	hérité de: ShuntCompensator
controlEnabled	0..1	Boolean	hérité de: RegulatingCondEq
aggregate	0..1	Boolean	hérité de: Equipment
inService	0..1	Boolean	hérité de: Equipment
networkAnalysisEnabled	0..1	Boolean	hérité de: Equipment
normallyInService	0..1	Boolean	hérité de: Equipment
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 204 présente toutes les extrémités d'association de LinearShuntCompensator avec d'autres classes.

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Tableau 204 – Extrémités d'association de Wires::LinearShuntCompensator avec d'autres classes

mult à partir de	nom	mult vers	type	description
1..1	ShuntCompensatorPhase	0..*	ShuntCompensatorPhase	hérité de: ShuntCompensator
1..1	SvShuntCompensatorSections	0..*	SvShuntCompensatorSections	hérité de: ShuntCompensator
0..*	RegulatingControl	0..1	RegulatingControl	hérité de: RegulatingCondEq
0..*	BaseVoltage	0..1	BaseVoltage	hérité de: ConductingEquipment
1..1	SvStatus	0..*	SvStatus	hérité de: ConductingEquipment
0..*	ProtectionEquipments	0..*	ProtectionEquipment	hérité de: ConductingEquipment
1..1	Terminals	0..*	Terminal	hérité de: ConductingEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	hérité de: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	hérité de: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	hérité de: Equipment
0..1	Faults	0..*	Fault	hérité de: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	hérité de: Equipment
0..*	PSRType	0..1	PSRType	hérité de: PowerSystemResource
0..1	Controls	0..*	Control	hérité de: PowerSystemResource
0..1	Measurements	0..*	Measurement	hérité de: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	hérité de: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	hérité de: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.4.33 LinearShuntCompensatorPhase

Un compensateur shunt linéaire par phase a des batteries ou des sections ayant des valeurs égales d'admittance.

Le Tableau 205 présente tous les attributs de LinearShuntCompensatorPhase.

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Tableau 205 – Attributs de Wires::LinearShuntCompensatorPhase

nom	mult	type	description
bPerSection	0..1	Susceptance	Susceptance par section de la phase si le compensateur shunt est monté en étoile. Susceptance par section phase – phase si le compensateur shunt est monté en triangle.
gPerSection	0..1	Conductance	Conductance par section de cette phase si le compensateur shunt est monté en étoile. Conductance par section phase – phase si le compensateur shunt est monté en triangle.
maximumSections	0..1	Integer	hérité de: ShuntCompensatorPhase
normalSections	0..1	Integer	hérité de: ShuntCompensatorPhase
sections	0..1	Float	hérité de: ShuntCompensatorPhase
phase	0..1	SinglePhaseKind	hérité de: ShuntCompensatorPhase
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 206 présente toutes les extrémités d'association de LinearShuntCompensatorPhase avec d'autres classes.

Tableau 206 – Extrémités d'association de Wires::LinearShuntCompensatorPhase avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..*	ShuntCompensator	1..1	ShuntCompensator	hérité de: ShuntCompensatorPhase
0..*	PSRType	0..1	PSRType	hérité de: PowerSystemResource
0..1	Controls	0..*	Control	hérité de: PowerSystemResource
0..1	Measurements	0..*	Measurement	hérité de: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	hérité de: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	hérité de: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.4.34 LoadBreakSwitch

Dispositif de commutation mécanique capable de produire, transporter et interrompre des courants en conditions normales de fonctionnement.

Le Tableau 207 présente tous les attributs de LoadBreakSwitch.

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Tableau 207 – Attributs de Wires::LoadBreakSwitch

nom	mult	type	description
breakingCapacity	0..1	CurrentFlow	hérité de: ProtectedSwitch
normalOpen	0..1	Boolean	hérité de: Switch
ratedCurrent	0..1	CurrentFlow	hérité de: Switch
switchOnCount	0..1	Integer	(déconseillé) hérité de: Switch
switchOnDate	0..1	DateTime	(déconseillé) hérité de: Switch
retained	0..1	Boolean	hérité de: Switch
open	0..1	Boolean	hérité de: Switch
loacked	0..1	Boolean	hérité de: Switch
aggregate	0..1	Boolean	hérité de: Equipment
inService	0..1	Boolean	hérité de: Equipment
networkAnalysisEnabled	0..1	Boolean	hérité de: Equipment
normallyInService	0..1	Boolean	hérité de: Equipment
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 208 présente toutes les extrémités d'association de LoadBreakSwitch avec d'autres classes.

Tableau 208 – Extrémités d'association de Wires::LoadBreakSwitch avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..*	OperatedByProtectionEquipment	0..*	ProtectionEquipment	hérité de: ProtectedSwitch
1..1	RecloseSequences	0..*	RecloseSequence	hérité de: ProtectedSwitch
1..1	SwitchPhase	0..*	SwitchPhase	hérité de: Switch
1..1	SwitchSchedules	0..*	SwitchSchedule	hérité de: Switch
0..*	CompositeSwitch	0..1	CompositeSwitch	hérité de: Switch
1..1	SvSwitch	0..*	SvSwitch	hérité de: Switch
0..*	BaseVoltage	0..1	BaseVoltage	hérité de: ConductingEquipment
1..1	SvStatus	0..*	SvStatus	hérité de: ConductingEquipment
0..*	ProtectionEquipments	0..*	ProtectionEquipment	hérité de: ConductingEquipment
1..1	Terminals	0..*	Terminal	hérité de: ConductingEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	hérité de: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	hérité de: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	hérité de: Equipment
0..1	Faults	0..*	Fault	hérité de: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	hérité de: Equipment
0..*	PSRType	0..1	PSRType	hérité de: PowerSystemResource
0..1	Controls	0..*	Control	hérité de: PowerSystemResource

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mult à partir de	nom	mult vers	type	description
0..1	Measurements	0..*	Measurement	hérité de: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	hérité de: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	hérité de: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.4.35 MutualCoupling

Cette classe représente le couplage mutuel de ligne homopolaire.

Le Tableau 209 présente tous les attributs de MutualCoupling.

Tableau 209 – Attributs de Wires::MutualCoupling

nom	mult	type	description
b0ch	0..1	Susceptance	Susceptance shunt de couplage mutuel homopolaire (de chargement), uniformément répartie, du segment de ligne complet.
distance11	0..1	Length	Distance par rapport au début de la région couplée à partir de la première borne de la ligne dont le numéro d'ordre est égal à 1.
distance12	0..1	Length	Distance par rapport à la fin de la région couplée à partir de la première borne de la ligne dont le numéro d'ordre est égal à 1.
distance21	0..1	Length	Distance par rapport au début de la région couplée à partir de la deuxième borne de la ligne dont le numéro d'ordre est égal à 1.
distance22	0..1	Length	Distance par rapport à la fin de la région couplée à partir de la deuxième borne de la ligne dont le numéro d'ordre est égal à 1.
g0ch	0..1	Conductance	Conductance shunt de couplage mutuel homopolaire (de chargement), uniformément répartie, du segment de ligne complet.
r0	0..1	Resistance	Couplage d'impédance mutuel homopolaire entre branches, résistance.
x0	0..1	Reactance	Couplage d'impédance mutuel homopolaire entre branches, réactance.
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 210 présente toutes les extrémités d'association de MutualCoupling avec d'autres classes.

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Tableau 210 – Extrémités d'association de Wires::MutualCoupling avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..*	First_Terminal	1..1	Terminal	Borne de départ pour le calcul des distances le long de la première branche du couplage mutuel. Normalement, le couplage mutuel MutualCoupling n'est utilisé que pour des bornes de segments de ligne à courant alternatif. Il convient que les première et deuxième bornes d'un couplage mutuel pointent vers des segments de ligne à courant alternatif différents.
0..*	Second_Terminal	1..1	Terminal	Borne de départ pour le calcul des distances le long de la deuxième branche du couplage mutuel.
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.4.36 NonlinearShuntCompensator

Un compensateur shunt non linéaire a des valeurs d'admittance de batterie ou de section qui diffèrent. Les attributs g, b, g0 et b0 du NonlinearShuntCompensatorPoint associé décrivent la conductance et l'admittance totales d'un NonlinearShuntCompensatorPoint au niveau d'un numéro de section spécifié par NonlinearShuntCompensatorPoint.sectionNumber.

Le Tableau 211 présente tous les attributs de NonlinearShuntCompensator.

Tableau 211 – Attributs de Wires::NonlinearShuntCompensator

nom	mult	type	description
aVRDelay	0..1	Seconds	hérité de: ShuntCompensator
grounded	0..1	Boolean	hérité de: ShuntCompensator
maximumSections	0..1	Integer	hérité de: ShuntCompensator
nomU	0..1	Voltage	hérité de: ShuntCompensator
normalSections	0..1	Integer	hérité de: ShuntCompensator
phaseConnection	0..1	PhaseShuntConnectionKind	hérité de: ShuntCompensator
switchOnCount	0..1	Integer	(déconseillé) hérité de: ShuntCompensator
switchOnDate	0..1	DateTime	(déconseillé) hérité de: ShuntCompensator
voltageSensitivity	0..1	VoltagePerReactivePower	hérité de: ShuntCompensator
sections	0..1	Float	hérité de: ShuntCompensator
controlEnabled	0..1	Boolean	hérité de: RegulatingCondEq
aggregate	0..1	Boolean	hérité de: Equipment
inService	0..1	Boolean	hérité de: Equipment
networkAnalysisEnabled	0..1	Boolean	hérité de: Equipment
normallyInService	0..1	Boolean	hérité de: Equipment
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

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Le Tableau 212 présente toutes les extrémités d'association de NonlinearShuntCompensator avec d'autres classes.

Tableau 212 – Extrémités d'association de Wires::NonlinearShuntCompensator avec d'autres classes

mult à partir de	nom	mult vers	type	description
1..1	NonlinearShuntCompensatorPoints	1..*	NonlinearShuntCompensatorPoint	Tous les points du compensateur shunt non linéaire.
1..1	ShuntCompensatorPhase	0..*	ShuntCompensatorPhase	hérité de: ShuntCompensator
1..1	SvShuntCompensatorSections	0..*	SvShuntCompensatorSections	hérité de: ShuntCompensator
0..*	RegulatingControl	0..1	RegulatingControl	hérité de: RegulatingCondEq
0..*	BaseVoltage	0..1	BaseVoltage	hérité de: ConductingEquipment
1..1	SvStatus	0..*	SvStatus	hérité de: ConductingEquipment
0..*	ProtectionEquipments	0..*	ProtectionEquipment	hérité de: ConductingEquipment
1..1	Terminals	0..*	Terminal	hérité de: ConductingEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	hérité de: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	hérité de: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	hérité de: Equipment
0..1	Faults	0..*	Fault	hérité de: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	hérité de: Equipment
0..*	PSRType	0..1	PSRType	hérité de: PowerSystemResource
0..1	Controls	0..*	Control	hérité de: PowerSystemResource
0..1	Measurements	0..*	Measurement	hérité de: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	hérité de: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	hérité de: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.4.37 NonlinearShuntCompensatorPhase

Un compensateur shunt non linéaire par phase a des valeurs d'admittance de batterie ou de section qui diffèrent. Les attributs g et b du NonlinearShuntCompensatorPhasePoint associé décrivent la conductance et l'admittance totales d'un NonlinearShuntCompensatorPhasePoint au niveau d'un numéro de section spécifié par NonlinearShuntCompensatorPhasePoint.sectionNumber

Le Tableau 213 présente tous les attributs de NonlinearShuntCompensatorPhase.

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Tableau 213 – Attributs de Wires::NonlinearShuntCompensatorPhase

nom	mult	type	description
maximumSections	0..1	Integer	hérité de: ShuntCompensatorPhase
normalSections	0..1	Integer	hérité de: ShuntCompensatorPhase
Section	0..1	Float	hérité de: ShuntCompensatorPhase
phase	0..1	SinglePhaseKind	hérité de: ShuntCompensatorPhase
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 214 présente toutes les extrémités d'association de NonlinearShuntCompensatorPhase avec d'autres classes.

Tableau 214 – Extrémités d'association de Wires::NonlinearShuntCompensatorPhase avec d'autres classes

mult à partir de	nom	mult vers	type	description
1..1	NonlinearShuntCompensatorPhasePoints	1..*	NonlinearShuntCompensatorPhasePoint	Tous les points de la phase du compensateur shunt non linéaire.
0..*	ShuntCompensator	1..1	ShuntCompensator	hérité de: ShuntCompensatorPhase
0..*	PSRType	0..1	PSRType	hérité de: PowerSystemResource
0..1	Controls	0..*	Control	hérité de: PowerSystemResource
0..1	Measurements	0..*	Measurement	hérité de: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	hérité de: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	hérité de: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.4.38 NonlinearShuntCompensatorPhasePoint root class

Valeur d'admittance de batterie ou de section d'un compensateur shunt non linéaire par phase. Le nombre d'instances NonlinearShuntCompenstorPhasePoint associées à un NonlinearShuntCompensatorPhase doit être égal aux ShuntCompensatorPhase.maximumSections. Les ShuntCompensator.sections ne doivent être réglées que sur un des NonlinearShuntCompenstorPhasePoint.sectionNumber. Il n'existe aucune interpolation entre les NonlinearShuntCompenstorPhasePoint-s.

Le Tableau 215 présente tous les attributs de NonlinearShuntCompensatorPhasePoint.

Tableau 215 – Attributs de Wires::NonlinearShuntCompensatorPhasePoint

nom	mult	type	description
b	0..1	Susceptance	Susceptance shunt directe (de chargement) par section.
g	0..1	Conductance	Conductance shunt directe (de chargement) par section.
sectionNumber	0..1	Integer	Numéro de la section.

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Le Tableau 216 présente toutes les extrémités d'association de NonlinearShuntCompensatorPhasePoint avec d'autres classes.

Tableau 216 – Extrémités d'association de Wires::NonlinearShuntCompensatorPhasePoint avec d'autres classes

mult à partir de	nom	mult vers	type	description
1..*	NonlinearShuntCompensatorPhase	1..1	NonlinearShuntCompensatorPhase	Phase de compensateur shunt non linéaire qui possède ce point.

6.4.39 Classe racine NonlinearShuntCompensatorPoint

Valeur d'admittance de batterie ou de section d'un compensateur shunt non linéaire. Le nombre d'instances NonlinearShuntCompenstorPhasePoint associées à un NonlinearShuntCompensator doit être égal aux ShuntCompensator.maximumSections. Les ShuntCompensator.sections ne doivent être réglées que sur un des NonlinearShuntCompenstorPoint.sectionNumber. Il n'existe aucune interpolation entre les NonlinearShuntCompenstorPoint-s.

Le Tableau 217 présente tous les attributs de NonlinearShuntCompensatorPoint.

Tableau 217 – Attributs de Wires::NonlinearShuntCompensatorPoint

nom	mult	type	description
b	0..1	Susceptance	Susceptance shunt directe (de chargement) par section.
b0	0..1	Susceptance	Susceptance shunt homopolaire (de chargement) par section.
g	0..1	Conductance	Conductance shunt directe (de chargement) par section.
g0	0..1	Conductance	Conductance shunt homopolaire (de chargement) par section.
sectionNumber	0..1	Integer	Numéro de la section.

Le Tableau 218 présente toutes les extrémités d'association de NonlinearShuntCompensatorPoint avec d'autres classes.

Tableau 218 – Extrémités d'association de Wires::NonlinearShuntCompensatorPoint avec d'autres classes

mult à partir de	nom	mult vers	type	description
1..*	NonlinearShuntCompensator	1..1	NonlinearShuntCompensator	Compensateur shunt non linéaire qui possède ce point.

6.4.40 PerLengthImpedance

Type commun pour des catalogues électriques d'impédance par unité de longueur.

Le Tableau 219 présente tous les attributs de PerLengthImpedance.

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Tableau 219 – Attributs de Wires::PerLengthImpedance

nom	mult	type	description
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 220 présente toutes les extrémités d'association de PerLengthImpedance avec d'autres classes.

Tableau 220 – Extrémités d'association de Wires::PerLengthImpedance avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..1	ACLineSegments	0..*	ACLineSegment	Tous les segments de ligne décrits par cette impédance par unité de longueur.
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.4.41 PerLengthLineParameter

Type commun pour des catalogues électriques par unité de longueur qui décrit les paramètres de ligne.

Le Tableau 221 présente tous les attributs de PerLengthLineParameter.

Tableau 221 – Attributs de Wires::PerLengthLineParameter

nom	mult	type	description
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 222 présente toutes les extrémités d'association de PerLengthLineParameter avec d'autres classes.

Tableau 222 – Extrémités d'association de Wires::PerLengthLineParameter avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.4.42 PerLengthPhaseImpedance

Paramètres linéiques d'impédance et d'admittance pour les lignes à n fils déséquilibrées, sous forme de matrice.

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Le Tableau 223 présente tous les attributs de PerLengthPhaseImpedance.

Tableau 223 – Attributs de Wires::PerLengthPhaseImpedance

nom	mult	type	description
conductorCount	0..1	Integer	Nombre de phases, neutres et autres fils retenus. Contraint le nombre d'éléments de matrice et les codes de phase pouvant être utilisés avec cette matrice.
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 224 présente toutes les extrémités d'association de PerLengthPhaseImpedance avec les autres classes.

Tableau 224 – Extrémités d'association de Wires::PerLengthPhaseImpedance avec d'autres classes

mult à partir de	nom	mult vers	type	description
1..1	PhaseImpedanceData	1..*	PhaseImpedanceData	Toutes les données qui appartiennent à cette impédance de phase de conducteur.
0..1	ACLineSegments	0..*	ACLineSegment	hérité de: PerLengthImpedance
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.4.43 PerLengthSequenceImpedance

Paramètres linéiques d'impédance et d'admittance en séquence, pour les lignes transposées monophasées, diphasées ou triphasées. Pour les lignes monophasées, définir x=x0=xself. Pour les lignes diphasées, définir x=xs-xm et x0=xs+xm.

Le Tableau 225 présente tous les attributs de PerLengthSequenceImpedance.

Tableau 225 – Attributs de Wires::PerLengthSequenceImpedance

nom	mult	type	description
b0ch	0..1	SusceptancePerLength	Susceptance shunt homopolaire (de chargement), par unité de longueur.
bch	0..1	SusceptancePerLength	Susceptance shunt directe (de chargement), par unité de longueur.
g0ch	0..1	ConductancePerLength	Conductance shunt homopolaire (de chargement), par unité de longueur.
gch	0..1	ConductancePerLength	Conductance shunt directe (de chargement), par unité de longueur.
r	0..1	ResistancePerLength	Résistance série directe, par unité de longueur.
r0	0..1	ResistancePerLength	Résistance série homopolaire, par unité de longueur.
x	0..1	ReactancePerLength	Réactance série directe, par unité de longueur.

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nom	mult	type	description
x0	0..1	ReactancePerLength	Réactance série homopolaire, par unité de longueur.
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 226 présente toutes les extrémités d'association de PerLengthSequenceImpedance avec les autres classes.

Tableau 226 – Extrémités d'association de Wires::PerLengthSequenceImpedance avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..1	ACLineSegments	0..*	ACLineSegment	hérité de: PerLengthImpedance
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.4.44 PetersenCoil

Appareil à impédance variable normalement utilisé pour décaler le chargement de la ligne au cours des défauts uniques de la ligne dans une section non mise à la terre du réseau.

Le Tableau 227 présente tous les attributs de PetersenCoil.

Tableau 227 – Attributs de Wires::PetersenCoil

nom	mult	type	description
mode	0..1	PetersenCoilModeKind	Mode de fonctionnement de la bobine Petersen.
nominalU	0..1	Voltage	Tension nominale pour laquelle la bobine a été conçue.
offsetCurrent	0..1	CurrentFlow	Le courant décalé que le régulateur de la bobine Petersen fait fonctionner à partir du point de résonance. Il s'agit normalement d'une grandeur fixe pour laquelle le régulateur est configuré et qui peut être positive ou négative. Généralement entre 0 et 60 A selon la tension et les conditions de résonance.
positionCurrent	0..1	CurrentFlow	Courant de commande utilisé pour commander la bobine Petersen, aussi appelé "courant de position". Généralement compris entre 20 mA et 200 mA.
xGroundMax	0..1	Reactance	Réactance maximale.
xGroundMin	0..1	Reactance	Réactance minimale.
xGroundNominal	0..1	Reactance	Réactance nominale. Il s'agit du point de fonctionnement (normalement pendant la compensation) qui est défini d'après le point de résonance en conditions saines du réseau. L'impédance est calculée d'après la tension nominale divisée par le courant de position.
r	0..1	Resistance	hérité de: EarthFaultCompensator
aggregate	0..1	Boolean	hérité de: Equipment

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nom	mult	type	description
inService	0..1	Boolean	hérité de: Equipment
networkAnalysisEnabled	0..1	Boolean	hérité de: Equipment
normallyInService	0..1	Boolean	hérité de: Equipment
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 228 présente toutes les extrémités d'association de PetersenCoil avec d'autres classes.

Tableau 228 – Extrémités d'association de Wires::PetersenCoil avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..*	BaseVoltage	0..1	BaseVoltage	hérité de: ConductingEquipment
1..1	Terminals	0..*	Terminal	hérité de: ConductingEquipment
1..1	SvStatus	0..*	SvStatus	hérité de: ConductingEquipment
0..*	ProtectionEquipments	0..*	ProtectionEquipment	hérité de: ConductingEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	hérité de: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	hérité de: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	hérité de: Equipment
0..1	Faults	0..*	Fault	hérité de: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	hérité de: Equipment
0..*	PSRType	0..1	PSRType	hérité de: PowerSystemResource
0..1	Controls	0..*	Control	hérité de: PowerSystemResource
0..1	Measurements	0..*	Measurement	hérité de: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	hérité de: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	hérité de: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.4.45 Enumération PetersenCoilModeKind

Mode de fonctionnement d'une bobine Petersen.

Le Tableau 229 présente tous les libellés de PetersenCoilModeKind.

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Tableau 229 – Libellés de Wires::PetersenCoilModeKind

libellé	value	description
fixed		Position fixe.
manual		Positionnement manuel.
automaticPositioning		Positionnement automatique.

6.4.46 Classe racine PhaseImpedanceData

Valeurs d'élément de matrice de l'impédance et de la conductance.

Les éléments diagonaux sont décrits par les éléments ayant les mêmes valeurs toPhase et fromPhase, et les éléments hors de la diagonale ont des valeurs toPhase et fromPhase différentes. La matrice peut également être stockée dans un format triangulaire inférieur symétrique utilisant les attributs row (ligne) et column (colonne), qui mettent en correspondance avec ACLineSegmentPhase.sequenceNumber.

Le Tableau 230 présente tous les attributs de PhaseImpedanceData.

Tableau 230 – Attributs de Wires::PhaseImpedanceData

nom	mult	type	description
b	0..1	SusceptancePerLength	Valeur d'élément de la matrice des susceptances, par unité de longueur.
r	0..1	ResistancePerLength	Valeur d'élément de la matrice des résistances, par unité de longueur.
g	0..1	ConductancePerLength	Valeur d'élément de la matrice des conductances, par unité de longueur.
x	0..1	ReactancePerLength	Valeur d'élément de la matrice des réactances, par unité de longueur.
fromPhase	0..1	SinglePhaseKind	Voir la description de classe.
toPhase	0..1	SinglePhaseKind	Voir la description de classe.
row	0..1	Integer	Numéro de ligne de l'élément de la matrice, dans la ligne 1 pour PerLengthPhaseImpedance.conductorCount. Seul le triangle inférieur peut être stocké. Ce numéro de ligne correspond à ACLineSegmentPhase.sequenceNumber.
column	0..1	Integer	Numéro de colonne de l'élément de la matrice, dans la plage 1 vers la ligne. Seul le triangle inférieur peut être stocké. Ce numéro de colonne correspond à ACLineSegmentPhase.sequenceNumber.

Le Tableau 231 présente toutes les extrémités d'association de PhaseImpedanceData avec les autres classes.

Tableau 231 – Extrémités d'association de Wires::PhaseImpedanceData avec d'autres classes

mult à partir de	nom	mult vers	type	description
1..*	PhaseImpedance	1..1	PerLengthPhaseImpedance	Impédance de phase de conducteur à laquelle ces données appartiennent.

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6.4.47 Enumération PhaseShuntConnectionKind

La configuration des connexions de phase pour un appareil à une seule borne comme une charge ou un condensateur.

Le Tableau 232 présente tous les libellés de PhaseShuntConnectionKind.

Tableau 232 – Libellés de Wires::PhaseShuntConnectionKind

libellé	value	description
D	1	Montage en triangle.
Y	2	Montage en étoile.
Yn	3	Wye (c'est-à-dire I grec, montage en étoile), avec neutre sorti pour la mise à la terre.
I	4	Enroulement indépendant, pour connexions monophasées.
G	5	Connexion de terre. Utilisée lorsqu'il est nécessaire d'exprimer la connexion explicite à la terre en combinaison avec le code de phase, comme pour les fils/câbles électriques ou les appareils de mesure.

6.4.48 PhaseTapChanger

Modèle de changeur de prises déphaseur pour transformateur, lequel commande la différence d'angle de phase aux bornes du transformateur de puissance et potentiellement le flux de puissance active aux bornes du transformateur de puissance. Ce modèle de prise pour phase peut aussi avoir un effet sur la valeur de la tension.

Le Tableau 233 présente tous les attributs de PhaseTapChanger.

Tableau 233 – Attributs de Wires::PhaseTapChanger

nom	mult	type	description
controlEnabled	0..1	Boolean	hérité de: TapChanger
highStep	0..1	Integer	hérité de: TapChanger
initialDelay	0..1	Seconds	hérité de: TapChanger
lowStep	0..1	Integer	hérité de: TapChanger
ltcFlag	0..1	Boolean	hérité de: TapChanger
neutralStep	0..1	Integer	hérité de: TapChanger
neutralU	0..1	Voltage	hérité de: TapChanger
normalStep	0..1	Integer	hérité de: TapChanger
subsequentDelay	0..1	Seconds	hérité de: TapChanger
step	0..1	Float	hérité de: TapChanger
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 234 présente toutes les extrémités d'association de PhaseTapChanger avec d'autres classes.

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Tableau 234 – Extrémités d'association de Wires::PhaseTapChanger avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..1	TransformerEnd	1..1	TransformerEnd	Extrémité de transformateur à laquelle appartient ce changeur de prises pour phase.
0..*	TapChangerControl	0..1	TapChangerControl	hérité de: TapChanger
1..1	SvTapStep	0..1	SvTapStep	hérité de: TapChanger
1..1	TapSchedules	0..*	TapSchedule	hérité de: TapChanger
0..*	PSRType	0..1	PSRType	hérité de: PowerSystemResource
0..1	Controls	0..*	Control	hérité de: PowerSystemResource
0..1	Measurements	0..*	Measurement	hérité de: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	hérité de: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	hérité de: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.4.49 PhaseTapChangerAsymmetrical

Décrit le modèle de prise pour un transformateur déphaseur asymétrique dans lequel le vecteur de tension de différence s'ajoute à l'enroulement en phase. L'enroulement en discordance de phases est l'extrémité du transformateur où se situe le changeur de prises. L'angle entre l'enroulement en phase et l'enroulement en discordance de phases est appelé angle de connexion d'enroulement. Le déphasage dépend à la fois de la valeur de la tension de différence et de l'angle de connexion d'enroulement.

Le Tableau 235 présente tous les attributs de PhaseTapChangerAsymmetrical.

Tableau 235 – Attributs de Wires::PhaseTapChangerAsymmetrical

nom	mult	type	description
windingConnectionAngle	0..1	AngleDegrees	Angle de phase entre l'enroulement en phase et l'enroulement en discordance de phases utilisé pour créer le déphasage. L'enroulement en discordance de phases produit ce qui est appelé la tension de différence. Attribuer 90 degrés à cet angle n'est pas identique à un transformateur symétrique. L'attribut ne peut être constitué que de multiples de 30 degrés. La plage admise est comprise entre -150 degrés et 150 degrés, sauf 0
voltageStepIncrement	0..1	PerCent	hérité de: PhaseTapChangerNonLinear
xMax	0..1	Reactance	hérité de: PhaseTapChangerNonLinear
xMin	0..1	Reactance	(déconseillé) hérité de: PhaseTapChangerNonLinear
controlEnabled	0..1	Boolean	hérité de: TapChanger
highStep	0..1	Integer	hérité de: TapChanger
initialDelay	0..1	Seconds	hérité de: TapChanger
lowStep	0..1	Integer	hérité de: TapChanger
ltcFlag	0..1	Boolean	hérité de: TapChanger
neutralStep	0..1	Integer	hérité de: TapChanger
neutralU	0..1	Voltage	hérité de: TapChanger

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nom	mult	type	description
normalStep	0..1	Integer	hérité de: TapChanger
subsequentDelay	0..1	Seconds	hérité de: TapChanger
step	0..1	Float	hérité de: TapChanger
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 236 présente toutes les extrémités d'association de PhaseTapChangerAsymmetrical avec d'autres classes.

Tableau 236 – Extrémités d'association de Wires::PhaseTapChangerAsymmetrical avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..1	TransformerEnd	1..1	TransformerEnd	hérité de: PhaseTapChanger
0..*	TapChangerControl	0..1	TapChangerControl	hérité de: TapChanger
1..1	SvTapStep	0..1	SvTapStep	hérité de: TapChanger
1..1	TapSchedules	0..*	TapSchedule	hérité de: TapChanger
0..*	PSRType	0..1	PSRType	hérité de: PowerSystemResource
0..1	Controls	0..*	Control	hérité de: PowerSystemResource
0..1	Measurements	0..*	Measurement	hérité de: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	hérité de: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	hérité de: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.4.50 PhaseTapChangerLinear

Décrit un changeur de prises dont la relation est linéaire entre l'échelon de prise et la différence d'angle de phase aux bornes du transformateur. Il s'agit d'un modèle mathématique qui est une approximation pour un changeur de prises pour phase réelle.

L'angle de phase se calcule: stepPhaseShiftIncrement fois la position de prise.

La valeur de la tension des deux côtés est la même.

Le Tableau 237 présente tous les attributs de PhaseTapChangerLinear.

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Tableau 237 – Attributs de Wires::PhaseTapChangerLinear

nom	mult	type	description
stepPhaseShiftIncrement	0..1	AngleDegrees	Déphasage par position de régleur. Une valeur positive indique une variation positive d'angle depuis la Terminal au niveau de PowerTransformerEnd où la TapChanger est située dans le transformateur. L'incrément de déphasage réel peut être calculé plus précisément à partir des modèles symétriques ou asymétriques ou à partir d'une consultation de la table des échelons de prise si ceux-ci sont disponibles.
xMax	0..1	Reactance	La réactance dépend de la position de prise, conformément à une courbe en forme de "u". La réactance maximale (xMax) apparaît dans les positions de prise haute et basse. En fonction de la courbe en " u ", l'attribut peut être supérieur ou inférieur à PowerTransformerEnd.x.
xMin	0..1	Reactance	(déconseillé) La réactance dépend de la position de prise, conformément à une courbe en forme de "u". La réactance minimale (xMin) apparaît en position de prise moyenne. PowerTransformerEnd.x doit être cohérent avec PhaseTapChangerLinear.xMin et PhaseTapChangerNonLinear.xMin. En cas d'incohérence, PowerTransformerEnd.x doit être utilisé.
controlEnabled	0..1	Boolean	hérité de: TapChanger
highStep	0..1	Integer	hérité de: TapChanger
initialDelay	0..1	Seconds	hérité de: TapChanger
lowStep	0..1	Integer	hérité de: TapChanger
ltcFlag	0..1	Boolean	hérité de: TapChanger
neutralStep	0..1	Integer	hérité de: TapChanger
neutralU	0..1	Voltage	hérité de: TapChanger
normalStep	0..1	Integer	hérité de: TapChanger
subsequentDelay	0..1	Seconds	hérité de: TapChanger
step	0..1	Float	hérité de: TapChanger
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 238 présente toutes les extrémités d'association de PhaseTapChangerLinear avec d'autres classes.

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Tableau 238 – Extrémités d'association de Wires::PhaseTapChangerLinear avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..1	TransformerEnd	1..1	TransformerEnd	hérité de: PhaseTapChanger
0..*	TapChangerControl	0..1	TapChangerControl	hérité de: TapChanger
1..1	SvTapStep	0..1	SvTapStep	hérité de: TapChanger
1..1	TapSchedules	0..*	TapSchedule	hérité de: TapChanger
0..*	PSRType	0..1	PSRType	hérité de: PowerSystemResource
0..1	Controls	0..*	Control	hérité de: PowerSystemResource
0..1	Measurements	0..*	Measurement	hérité de: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	hérité de: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	hérité de: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.4.51 PhaseTapChangerNonLinear

Le changeur de prises pour phase non linéaire décrit le comportement non linéaire d'un changeur de prises pour phase. Il s'agit d'une classe de base pour les modèles de changeur de prises pour phase symétrique et asymétrique. Ces modèles sont présentés en détail dans l'IEC 61970-301.

Le Tableau 239 présente tous les attributs de PhaseTapChangerNonLinear.

Tableau 239 – Attributs de Wires::PhaseTapChangerNonLinear

nom	mult	type	description
voltageStepIncrement	0..1	PerCent	Augmentation d'un pas de la tension sur l'enroulement en discordance de phases (la PowerTransformerEnd où est située la TapChanger) spécifié en pourcentage de la tension assignée de PowerTransformerEnd. Une valeur positive indique une variation positive d'angle depuis la Terminal au niveau de PowerTransformerEnd où la TapChanger est située dans le transformateur. Si l'incrément est négatif, la tension diminue lorsque l'échelon de prise augmente.
xMax	0..1	Reactance	La réactance dépend de la position de prise, conformément à une courbe en forme de "u". La réactance maximale (xMax) apparaît dans les positions de prise haute et basse. En fonction de la courbe en " u ", l'attribut peut être supérieur ou inférieur à PowerTransformerEnd.x.
xMin	0..1	Reactance	(déconseillé) La réactance dépend de la position de prise, conformément à une courbe en forme de "u". La réactance minimale (xMin) apparaît en position de prise moyenne. PowerTransformerEnd.x doit être cohérent avec PhaseTapChangerLinear.xMin et PhaseTapChangerNonLinear.xMin. En cas d'incohérence, PowerTransformerEnd.x doit être utilisé.
controlEnabled	0..1	Boolean	hérité de: TapChanger
highStep	0..1	Integer	hérité de: TapChanger
initialDelay	0..1	Seconds	hérité de: TapChanger
lowStep	0..1	Integer	hérité de: TapChanger
ltcFlag	0..1	Boolean	hérité de: TapChanger

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nom	mult	type	description
neutralStep	0..1	Integer	hérité de: TapChanger
neutralU	0..1	Voltage	hérité de: TapChanger
normalStep	0..1	Integer	hérité de: TapChanger
subsequentDelay	0..1	Seconds	hérité de: TapChanger
step	0..1	Float	hérité de: TapChanger
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 240 présente toutes les extrémités d'association de PhaseTapChangerNonLinear avec d'autres classes.

Tableau 240 – Extrémités d'association de Wires::PhaseTapChangerNonLinear avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..1	TransformerEnd	1..1	TransformerEnd	hérité de: PhaseTapChanger
0..*	TapChangerControl	0..1	TapChangerControl	hérité de: TapChanger
1..1	SvTapStep	0..1	SvTapStep	hérité de: TapChanger
1..1	TapSchedules	0..*	TapSchedule	hérité de: TapChanger
0..*	PSRType	0..1	PSRType	hérité de: PowerSystemResource
0..1	Controls	0..*	Control	hérité de: PowerSystemResource
0..1	Measurements	0..*	Measurement	hérité de: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	hérité de: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	hérité de: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.4.52 PhaseTapChangerSymmetrical

Décrit un modèle de prise de transformateur déphaseur symétrique dans lequel la valeur de tension est la même des deux côtés. La valeur de la tension de différence est la base d'un triangle équilatéral dans lequel les côtés correspondent aux tensions primaire et secondaire. La différence d'angle de phase correspond à l'angle supérieur et peut être exprimée comme le double de l'arc tangent de la moitié de la tension totale de différence.

Le Tableau 241 présente tous les attributs de PhaseTapChangerSymmetrical.

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Tableau 241 – Attributs de Wires::PhaseTapChangerSymmetrical

nom	mult	type	description
voltageStepIncrement	0..1	PerCent	hérité de: PhaseTapChangerNonLinear
xMax	0..1	Reactance	hérité de: PhaseTapChangerNonLinear
xMin	0..1	Reactance	(déconseillé) hérité de: PhaseTapChangerNonLinear
controlEnabled	0..1	Boolean	hérité de: TapChanger
highStep	0..1	Integer	hérité de: TapChanger
initialDelay	0..1	Seconds	hérité de: TapChanger
lowStep	0..1	Integer	hérité de: TapChanger
ltcFlag	0..1	Boolean	hérité de: TapChanger
neutralStep	0..1	Integer	hérité de: TapChanger
neutralU	0..1	Voltage	hérité de: TapChanger
normalStep	0..1	Integer	hérité de: TapChanger
subsequentDelay	0..1	Seconds	hérité de: TapChanger
step	0..1	Float	hérité de: TapChanger
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 242 présente toutes les extrémités d'association de PhaseTapChangerSymmetrical avec d'autres classes.

Tableau 242 – Extrémités d'association de Wires::PhaseTapChangerSymmetrical avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..1	TransformerEnd	1..1	TransformerEnd	hérité de: PhaseTapChanger
0..*	TapChangerControl	0..1	TapChangerControl	hérité de: TapChanger
1..1	SvTapStep	0..1	SvTapStep	hérité de: TapChanger
1..1	TapSchedules	0..*	TapSchedule	hérité de: TapChanger
0..*	PSRType	0..1	PSRType	hérité de: PowerSystemResource
0..1	Controls	0..*	Control	hérité de: PowerSystemResource
0..1	Measurements	0..*	Measurement	hérité de: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	hérité de: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	hérité de: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.4.53 PhaseTapChangerTable

Décrit une courbe tabulaire qui représente la façon dont la différence de l'angle de phase et l'impédance varient avec l'échelon de prise.

Le Tableau 243 présente tous les attributs de PhaseTapChangerTable.

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Tableau 243 – Attributs de Wires::PhaseTapChangerTable

nom	mult	type	description
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 244 présente toutes les extrémités d'association de PhaseTapChangerTable avec d'autres classes.

Tableau 244 – Extrémités d'association de Wires::PhaseTapChangerTable avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..1	PhaseTapChangerTabular	0..*	PhaseTapChangerTabular	Changeurs de prises pour phase auxquels s'applique ce tableau de prise pour phase.
1..1	PhaseTapChangerTablePoint	1..*	PhaseTapChangerTablePoint	Points de ce tableau.
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.4.54 PhaseTapChangerTablePoint

Décrit chaque échelon de prise de la courbe tabulaire du changeur de prises pour phase.

Le Tableau 245 présente tous les attributs de PhaseTapChangerTablePoint.

Tableau 245 – Attributs de Wires::PhaseTapChangerTablePoint

nom	mult	type	description
angle	0..1	AngleDegrees	Différence d'angle en degrés. Une valeur positive indique une variation positive d'angle depuis la Terminal au niveau de PowerTransformerEnd où la TapChanger est située dans le transformateur.
b	0..1	PerCent	hérité de: TapChangerTablePoint
g	0..1	PerCent	hérité de: TapChangerTablePoint
r	0..1	PerCent	hérité de: TapChangerTablePoint
ratio	0..1	Float	hérité de: TapChangerTablePoint
step	0..1	Integer	hérité de: TapChangerTablePoint
x	0..1	PerCent	hérité de: TapChangerTablePoint

Le Tableau 246 présente toutes les extrémités d'association de PhaseTapChangerTablePoint avec d'autres classes.

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Tableau 246 – Extrémités d'association de Wires::PhaseTapChangerTablePoint avec d'autres classes

mult à partir de	nom	mult vers	type	description
1..*	PhaseTapChanger Table	1..1	PhaseTapChangerTable	Tableau de ce point.

6.4.55 PhaseTapChangerTabular

Décrit un changeur de prises avec un tableau qui définit la relation est linéaire entre l'échelon de prise et la différence d'angle de phase aux bornes du transformateur.

Le Tableau 247 présente tous les attributs de PhaseTapChangerTabular.

Tableau 247 – Attributs de Wires::PhaseTapChangerTabular

nom	mult	type	description
controlEnabled	0..1	Boolean	hérité de: TapChanger
highStep	0..1	Integer	hérité de: TapChanger
initialDelay	0..1	Seconds	hérité de: TapChanger
lowStep	0..1	Integer	hérité de: TapChanger
ltcFlag	0..1	Boolean	hérité de: TapChanger
neutralStep	0..1	Integer	hérité de: TapChanger
neutralU	0..1	Voltage	hérité de: TapChanger
normalStep	0..1	Integer	hérité de: TapChanger
subsequentDelay	0..1	Seconds	hérité de: TapChanger
step	0..1	Float	hérité de: TapChanger
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 248 présente toutes les extrémités d'association de PhaseTapChangerTabular avec d'autres classes.

Tableau 248 – Extrémités d'association de Wires::PhaseTapChangerTabular avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..*	PhaseTapChanger Table	0..1	PhaseTapChangerTable	Tableau du changeur de prises pour phase pour ce changeur de prises déphaseur.
0..1	TransformerEnd	1..1	TransformerEnd	hérité de: PhaseTapChanger
0..*	TapChangerControl	0..1	TapChangerControl	hérité de: TapChanger
1..1	SvTapStep	0..1	SvTapStep	hérité de: TapChanger
1..1	TapSchedules	0..*	TapSchedule	hérité de: TapChanger
0..*	PSRType	0..1	PSRType	hérité de: PowerSystemResource
0..1	Controls	0..*	Control	hérité de: PowerSystemResource
0..1	Measurements	0..*	Measurement	hérité de: PowerSystemResource

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mult à partir de	nom	mult vers	type	description
1..1	OperatingShare	0..*	OperatingShare	hérité de: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	hérité de: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.4.56 Plant

Une Plant (centrale) est un ensemble d'équipements utilisés à des fins de production.

Le Tableau 249 présente tous les attributs de Plant.

Tableau 249 – Attributs de Wires::Plant

nom	mult	type	description
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 250 présente toutes les extrémités d'association de Plant avec d'autres classes.

Tableau 250 – Extrémités d'association de Wires::Plant avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..1	Equipments	0..*	Equipment	hérité de: EquipmentContainer
0..*	AdditionalGrouped Equipment	0..*	Equipment	hérité de: EquipmentContainer
1..1	ConnectivityNodes	0..*	ConnectivityNode	hérité de: ConnectivityNodeContainer
0..1	TopologicalNode	0..*	TopologicalNode	hérité de: ConnectivityNodeContainer
0..*	PSRType	0..1	PSRType	hérité de: PowerSystemResource
0..1	Controls	0..*	Control	hérité de: PowerSystemResource
0..1	Measurements	0..*	Measurement	hérité de: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	hérité de: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	hérité de: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.4.57 PowerElectronicsConnection

Connexion au réseau à courant alternatif pour la production ou la consommation d'énergie qui utilise l'électronique de puissance plutôt que des machines tournantes.

Le Tableau 251 présente tous les attributs de PowerElectronicsConnection.

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Tableau 251 – Attributs de Wires::PowerElectronicsConnection

nom	mult	type	description
maxQ	0..1	ReactivePower	Limite maximale de la puissance réactive. Il s'agit de la limite maximale (constructeur) de l'unité.
minQ	0..1	ReactivePower	Limite de puissance réactive minimale de la tranche. Il s'agit de la limite minimale (constructeur) de l'unité.
ratedS	0..1	ApparentPower	Puissance apparente assignée constructeur de la tranche. L'attribut doit avoir une valeur positive.
ratedU	0..1	Voltage	Tension assignée (données constructeur, Ur dans l'IEC 60909-0). Utilisé principalement pour l'échange de données relatives à un court-circuit, conformément à l'IEC 60909. La valeur de l'attribut doit être positive.
p	0..1	ActivePower	Injection de puissance active. La convention de signe charge est utilisée, c'est-à-dire que le signe positif signifie un flux à partir d'un nœud. Valeur de départ pour une solution en régime établi.
q	0..1	ReactivePower	Injection de puissance réactive. La convention de signe charge est utilisée, c'est-à-dire que le signe positif signifie un flux à partir d'un nœud. Valeur de départ pour une solution en régime établi.
r	0..1	Resistance	(déconseillé) Résistance équivalente (RG) du générateur. RG est prise en compte pour le calcul de tous les courants, à l'exception du calcul du courant de crête, ip. Utilisé pour l'échange de données relatives à un court-circuit, conformément à l'IEC 60909.
r0	0..1	Resistance	(déconseillé) Résistance homopolaire de la machine synchrone.
rn	0..1	Resistance	(déconseillé) Résistance inverse de Thevenin.
x	0..1	Reactance	(déconseillé) Réactance directe de Thevenin.
x0	0..1	Reactance	(déconseillé) Réactance homopolaire de Thevenin.
xn	0..1	Reactance	(déconseillé) Résistance inverse de Thevenin.
maxIFault	0..1	PU	Courant de défaut maximal auquel participe cet appareil, exprimé par unité de courant assigné, avant que la protection du convertisseur ne se déclenche ou ne soit contournée.
controlEnabled	0..1	Boolean	hérité de: RegulatingCondEq
aggregate	0..1	Boolean	hérité de: Equipment
inService	0..1	Boolean	hérité de: Equipment
networkAnalysisEnabled	0..1	Boolean	hérité de: Equipment
normallyInService	0..1	Boolean	hérité de: Equipment
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 252 présente toutes les extrémités d'association de PowerElectronicsConnection avec d'autres classes.

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Tableau 252 – Extrémités d'association de Wires::PowerElectronicsConnection avec d'autres classes

mult à partir de	nom	mult vers	type	description
1..1	PowerElectronicsUnit	0..*	PowerElectronicsUnit	Une connexion de réseau à courant alternatif peut avoir plusieurs unités d'électronique de puissance qui lui sont raccordées.
1..1	PowerElectronicsConnectionPhase	0..*	PowerElectronicsConnectionPhase	Modèles de phases individuels pour la connexion d'électronique de puissance.
1..1	WindTurbineType3or4Dynamics	0..1	WindTurbineType3or4Dynamics	Modèle dynamique d'éolienne de type 3 ou de type 4 associé à la connexion d'électronique de puissance.
0..*	RegulatingControl	0..1	RegulatingControl	hérité de: RegulatingCondEq
0..*	BaseVoltage	0..1	BaseVoltage	hérité de: ConductingEquipment
1..1	SvStatus	0..*	SvStatus	hérité de: ConductingEquipment
0..*	ProtectionEquipments	0..*	ProtectionEquipment	hérité de: ConductingEquipment
1..1	Terminals	0..*	Terminal	hérité de: ConductingEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	hérité de: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	hérité de: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	hérité de: Equipment
0..1	Faults	0..*	Fault	hérité de: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	hérité de: Equipment
0..*	PSRType	0..1	PSRType	hérité de: PowerSystemResource
0..1	Controls	0..*	Control	hérité de: PowerSystemResource
0..1	Measurements	0..*	Measurement	hérité de: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	hérité de: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	hérité de: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.4.58 PowerElectronicsConnectionPhase

Phase simple d'une connexion d'électronique de puissance.

Le Tableau 253 présente tous les attributs de PowerElectronicsConnectionPhase.

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Tableau 253 – Attributs de Wires::PowerElectronicsConnectionPhase

nom	mult	type	description
phase	0..1	SinglePhaseKind	Phase de ce composant producteur d'énergie. Si le producteur d'énergie est connecté en étoile, la connexion va de la phase indiquée à la terre centrale ou au point neutre. Si le producteur d'énergie est connecté en triangle, la phase indique qu'un producteur d'énergie est connecté de la phase indiquée à la phase logique suivante non neutre.
p	0..1	ActivePower	Injection de puissance active. La convention de signe charge est utilisée, c'est-à-dire que le signe positif signifie un flux dans l'équipement provenant du réseau.
q	0..1	ReactivePower	Injection de puissance réactive. La convention de signe charge est utilisée, c'est-à-dire que le signe positif signifie un flux dans l'équipement provenant du réseau.
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 254 présente toutes les extrémités d'association de PowerElectronicsConnectionPhase avec d'autres classes.

Tableau 254 – Extrémités d'association de Wires::PowerElectronicsConnectionPhase avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..*	PowerElectronicsConnection	1..1	PowerElectronicsConnection	Connexion d'électronique de puissance de la phase de connexion d'électronique de puissance.
0..*	PSRType	0..1	PSRType	hérité de: PowerSystemResource
0..1	Controls	0..*	Control	hérité de: PowerSystemResource
0..1	Measurements	0..*	Measurement	hérité de: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	hérité de: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	hérité de: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.4.59 PowerTransformer

Appareil électrique constitué de deux enroulements couplés ou plus, avec ou sans noyau magnétique, destiné à introduire un couplage mutuel entre les circuits électriques. Les transformateurs peuvent être utilisés pour commander la tension et le déplacement de phase (flux de puissance active).

Un transformateur de puissance peut être composé de cuves distinctes de transformateur qui ne sont pas nécessairement identiques.

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Un transformateur de puissance peut être modélisé avec ou sans cuve. Il est prévu pour être utilisé à la fois dans une représentation équilibrée et une représentation déséquilibrée. Un transformateur de puissance a généralement deux bornes, mais il peut en avoir une (terre), trois ou davantage.

Il convient de ne pas utiliser l'association héritée ConductingEquipment.BaseVoltage. Il convient d'utiliser l'association de TransformerEnd à BaseVoltage à la place.

Le Tableau 255 présente tous les attributs de PowerTransformer.

Tableau 255 – Attributs de Wires::PowerTransformer

nom	mult	type	description
beforeShCircuitHighestOperatingCurrent	0..1	CurrentFlow	Courant de fonctionnement le plus élevé (Ib dans l'IEC 60909-0) avant le court-circuit (en fonction de la configuration du réseau et de la philosophie pertinente concernant la fiabilité). Il est utilisé pour calculer le facteur de correction d'impédance KT défini dans l'IEC 60909-0.
beforeShCircuitHighestOperatingVoltage	0..1	Voltage	Tension de fonctionnement la plus élevée (Ub dans l'IEC 60909-0) avant le court-circuit. Il est utilisé pour calculer le facteur de correction d'impédance KT défini dans l'IEC 60909-0. Il s'agit de la tension du cas le plus défavorable du côté inférieur de l'enroulement (3.7.1 de l'IEC 60909:2001). Utilisée pour définir les conditions de fonctionnement.
beforeShortCircuitAnglePf	0..1	AngleDegrees	Angle du facteur de puissance avant le court-circuit (phib dans l'IEC 60909-0). Il est utilisé pour calculer le facteur de correction d'impédance KT défini dans l'IEC 60909-0. Il s'agit du facteur de puissance du cas le plus défavorable. Utilisée pour définir les conditions de fonctionnement.
highSideMinOperatingU	0..1	Voltage	Tension minimale de fonctionnement (uQmin dans l'IEC 60909-0) côté haute tension (côté Q) du transformateur de groupe du groupe de production. Valeur bien établie à partir de l'expérience de fonctionnement à long terme du système. Elle est utilisée pour calculer le facteur de correction d'impédance KG défini dans l'IEC 60909-0.
isPartOfGeneratorUnit	0..1	Boolean	Indique si la machine fait partie d'un groupe de production. Utilisé pour l'échange de données relatives à un court-circuit, conformément à l'IEC 60909. Il a un impact sur la manière de calculer les facteurs de correction des transformateurs, étant donné que le transformateur ne fait pas nécessairement partie intégrante d'une machine synchrone et d'une unité de production. Cette information ne peut pas toujours être déduite du modèle. C'est la raison pour laquelle l'attribut est nécessaire.
operationalValuesConsidered	0..1	Boolean	Utilisé pour définir si les données (autres attributs liés à l'échange de données relatives à un court-circuit) définissent les conditions de fonctionnement à long terme. Utilisé pour l'échange de données relatives à un court-circuit, conformément à l'IEC 60909.

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nom	mult	type	description
vectorGroup	0..1	String	Groupe vectoriel du transformateur pour le relayage protecteur, par exemple Dyn1. Pour les transformateurs déséquilibrés, cela peut ne pas être déterminé simplement à partir des connexions constitutives d'enroulements et des déplacements d'angle de phase. La chaîne vectorGroup comporte les composants suivants dans l'ordre de l'énumération: connexion d'enroulement haute tension, connexion d'enroulement moyenne tension (pour des transformateurs à trois enroulements), numéro de position de déphasage de 0 à 11, connexion d'enroulement basse tension numéro de position de déphasage de 0 à 11 (position d'horloge). Les connexions d'enroulement sont D (triangle), Y (étoile), YN (étoile avec neutre), Z (zigzag), ZN (zigzag avec neutre), A (autotransformateur). Les majuscules indiquent la haute tension, les minuscules la basse ou moyenne tension. L'enroulement haute tension a toujours pour position 0. Il n'est pas compris dans la chaîne de groupe vectoriel. Quelques exemples: YNy0 (deux enroulements étoile à étoile, sans déphasage), YNd11 (deux enroulements étoile à triangle avec un déphasage de 330 degrés), YNyn0d5 (trois enroulements transformateurs étoile à haute tension neutre, étoile à moyenne tension neutre sans déphasage, triangle basse tension à déphasage de 150 degrés). Le déphasage est défini comme l'écart angulaire entre les phaseurs représentant les tensions entre le point neutre (réel ou fictif) et les bornes homologues de deux enroulements lorsqu'un système de tension direct est appliqué aux bornes de l'enroulement à haute tension dans l'ordre de séquence alphabétique de ces bornes si elles sont repérées par des lettres, ou dans leur ordre de séquence numérique si elles sont repérées par des chiffres: les phaseurs sont réputés tourner en sens inverse des aiguilles d'une horloge.
aggregate	0..1	Boolean	hérité de: Equipment
inService	0..1	Boolean	hérité de: Equipment
networkAnalysisEnabled	0..1	Boolean	hérité de: Equipment
normallyInService	0..1	Boolean	hérité de: Equipment
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 256 présente toutes les extrémités d'association de PowerTransformer avec d'autres classes.

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Tableau 256 – Extrémités d'association de Wires::PowerTransformer avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..1	PowerTransformerEnd	0..*	PowerTransformerEnd	Extrémités de ce transformateur de puissance.
0..1	TransformerTanks	0..*	TransformerTank	Tous les transformateurs qui appartiennent à cette batterie.
0..*	BaseVoltage	0..1	BaseVoltage	hérité de: ConductingEquipment
1..1	SvStatus	0..*	SvStatus	hérité de: ConductingEquipment
0..*	ProtectionEquipments	0..*	ProtectionEquipment	hérité de: ConductingEquipment
1..1	Terminals	0..*	Terminal	hérité de: ConductingEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	hérité de: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	hérité de: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	hérité de: Equipment
0..1	Faults	0..*	Fault	hérité de: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	hérité de: Equipment
0..*	PSRType	0..1	PSRType	hérité de: PowerSystemResource
0..1	Controls	0..*	Control	hérité de: PowerSystemResource
0..1	Measurements	0..*	Measurement	hérité de: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	hérité de: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	hérité de: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.4.60 PowerTransformerEnd

Un PowerTransformerEnd est associé à chaque Terminal d'un PowerTransformer.

Les valeurs d'impédance r, r0, x et x0 d'une PowerTransformerEnd représentent un équivalent étoile de la manière suivante.

1) Pour un PowerTransformer à deux Terminals (bornes), le PowerTransformerEnd haute tension (TransformerEnd.endNumber=1) a des valeurs non nulles pour r, r0, x et x0 tandis que le PowerTransformerEnd basse tension (TransformerEnd.endNumber=2) a des valeurs nulles pour r, r0, x et x0. Les paramètres sont toujours indiqués, même si les PowerTransformerEnds ont la même tension assignée. Dans ce cas, les paramètres sont indiqués au niveau de la PowerTransformerEnd dont le TransformerEnd.endNumber est égal à 1.
2) Pour un PowerTransformer à trois Terminals (bornes), les trois PowerTransformerEnds représentent un équivalent étoile dont chaque branche de l'étoile est représentée par les valeurs r, r0, x et x0.
3) Pour un transformateur à trois Terminals (bornes), chaque PowerTransformerEnd doit avoir des valeurs pour g, g0, b et b0 correspondant à des pertes à vide réparties sur les trois PowerTransformerEnds. Les impédances shunt totales de perte à vide peuvent également être placées au niveau d'une des PowerTransformerEnds, l'extrémité numéro 1 ayant les valeurs de shunt sur l'extrémité 1. Il s'agit de la manière préférentielle.
4) Pour un PowerTransformer à plus de trois Terminals (bornes), les valeurs d'impédance de PowerTransformerEnd ne peuvent pas être utilisées. Utiliser dans ce cas TransformerMeshImpedance ou diviser le transformateur en plusieurs PowerTransformers.

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Chaque PowerTransformerEnd doit être contenue par un PowerTransformer. Étant donné qu'une PowerTransformerEnd (ou un autre objet) ne peut pas être contenue par plusieurs parents, une PowerTransformerEnd ne peut pas avoir d'association à un EquipmentContainer (Substation, VoltageLevel, etc).

Le Tableau 257 présente tous les attributs de PowerTransformerEnd.

Tableau 257 – Attributs de Wires::PowerTransformerEnd

nom	mult	type	description
b	0..1	Susceptance	Susceptance de branche magnétique (B mag). La valeur peut être positive ou négative.
b0	0..1	Susceptance	Susceptance de branche magnétique homopolaire.
connectionKind	0..1	WindingConnection	Sorte de connexion.
g	0..1	Conductance	Conductance de la branche magnétisante.
g0	0..1	Conductance	Conductance homopolaire de la branche magnétisante (modèle en étoile).
phaseAngleClock	0..1	Integer	Déplacement de l'angle de phase de tension aux bornes où les heures d'une horloge représentent les 360 degrés. Les valeurs valides vont de 0 à 11. Par exemple pour l'extrémité côté secondaire d'un transformateur dont le code de groupe vectoriel est 'Dyn11', spécifier le type de connexion sous forme étoile avec neutre et spécifier l'angle de phase 11 d'après l'horloge. La valeur de position pour le numéro d'extrémité spécifié 1 du transformateur est par hypothèse zéro. Noter que, par hypothèse, le numéro d'extrémité du transformateur n'est pas identique au numéro d'ordre de la borne.
r	0..1	Resistance	Résistance (modèle en étoile) de l'extrémité du transformateur. L'attribut doit être supérieur ou égal à zéro pour les transformateurs non équivalents.
r0	0..1	Resistance	Résistance série homopolaire (modèle en étoile) de l'extrémité du transformateur.
ratedS	0..1	ApparentPower	Caractéristique assignée de puissance apparente normale. L'attribut doit être une valeur positive. Pour un transformateur à deux enroulements, les valeurs pour les côtés haute et basse tension doivent être identiques.
ratedU	0..1	Voltage	Tension assignée: entre phases pour les enroulements triphasés et soit entre phases, soit entre phase et neutre pour les enroulements monophasés. Un côté haute tension, comme dans le cas de TransformerEnd.endNumber, doit avoir un ratedU supérieur ou égal au ratedU pour les côtés de tension inférieure. La valeur de l'attribut doit être positive.
x	0..1	Reactance	Réactance série directe (modèle en étoile) de l'extrémité du transformateur.
x0	0..1	Reactance	Réactance série homopolaire de l'extrémité du transformateur.
bmagSat	0..1	PerCent	hérité de: TransformerEnd
endNumber	0..1	Integer	hérité de: TransformerEnd
grounded	0..1	Boolean	hérité de: TransformerEnd
magBaseU	0..1	Voltage	hérité de: TransformerEnd

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nom	mult	type	description
magSatFlux	0..1	PerCent	hérité de: TransformerEnd
rground	0..1	Resistance	hérité de: TransformerEnd
xground	0..1	Reactance	hérité de: TransformerEnd
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 258 présente toutes les extrémités d'association de PowerTransformerEnd avec d'autres classes.

Tableau 258 – Extrémités d'association de Wires::PowerTransformerEnd avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..*	PowerTransformer	0..1	PowerTransformer	Transformateur de puissance de cette extrémité du transformateur de puissance.
0..*	BaseVoltage	0..1	BaseVoltage	hérité de: TransformerEnd
0..*	Terminal	0..1	Terminal	hérité de: TransformerEnd
1..1	PhaseTapChanger	0..1	PhaseTapChanger	hérité de: TransformerEnd
1..1	RatioTapChanger	0..1	RatioTapChanger	hérité de: TransformerEnd
0..*	StarImpedance	0..1	TransformerStarImpedance	hérité de: TransformerEnd
0..*	CoreAdmittance	0..1	TransformerCoreAdmittance	hérité de: TransformerEnd
1..*	ToMeshImpedance	0..*	TransformerMeshImpedance	hérité de: TransformerEnd
1..1	FromMeshImpedance	0..*	TransformerMeshImpedance	hérité de: TransformerEnd
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.4.61 ProtectedSwitch

Un ProtectedSwitch (commutateur protégé) est un dispositif de commutation qui peut être actionné par un ProtectionEquipment (équipement de protection).

Le Tableau 259 présente tous les attributs de ProtectedSwitch.

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Tableau 259 – Attributs de Wires::ProtectedSwitch

nom	mult	type	description
breakingCapacity	0..1	CurrentFlow	Courant de défaut maximal qu'un dispositif de coupure peut couper en toute sécurité dans les conditions prévues d'utilisation.
normalOpen	0..1	Boolean	hérité de: Switch
ratedCurrent	0..1	CurrentFlow	hérité de: Switch
switchOnCount	0..1	Integer	hérité de: Switch
switchOnDate	0..1	DateTime	hérité de: Switch
retained	0..1	Boolean	hérité de: Switch
open	0..1	Boolean	hérité de: Switch
locked	0..1	Boolean	hérité de: Switch
aggregate	0..1	Boolean	hérité de: Equipment
inService	0..1	Boolean	hérité de: Equipment
networkAnalysisEnabled	0..1	Boolean	hérité de: Equipment
normallyInService	0..1	Boolean	hérité de: Equipment
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 260 présente toutes les extrémités d'association de ProtectedSwitch avec d'autres classes.

Tableau 260 – Extrémités d'association de Wires::ProtectedSwitch avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..*	OperatedByProtectionEquipment	0..*	ProtectionEquipment	Équipements de protection qui utilisent ce ProtectedSwitch.
1..1	RecloseSequences	0..*	RecloseSequence	Un disjoncteur peut avoir zéro ou plusieurs réenclenchements automatiques après un déclenchement.
1..1	SwitchPhase	0..*	SwitchPhase	hérité de: Switch
1..1	SwitchSchedules	0..*	SwitchSchedule	hérité de: Switch
0..*	CompositeSwitch	0..1	CompositeSwitch	hérité de: Switch
1..1	SvSwitch	0..*	SvSwitch	hérité de: Switch
0..*	BaseVoltage	0..1	BaseVoltage	hérité de: ConductingEquipment
1..1	SvStatus	0..*	SvStatus	hérité de: ConductingEquipment
0..*	ProtectionEquipments	0..*	ProtectionEquipment	hérité de: ConductingEquipment
1..1	Terminals	0..*	Terminal	hérité de: ConductingEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	hérité de: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	hérité de: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	hérité de: Equipment
0..1	Faults	0..*	Fault	hérité de: Equipment

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mult à partir de	nom	mult vers	type	description
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	hérité de: Equipment
0..*	PSRType	0..1	PSRType	hérité de: PowerSystemResource
0..1	Controls	0..*	Control	hérité de: PowerSystemResource
0..1	Measurements	0..*	Measurement	hérité de: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	hérité de: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	hérité de: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.4.62 RatioTapChanger

Changeur de prises qui change le rapport de tensions ayant un impact sur la valeur de la tension, mais pas sur l'angle de phase aux bornes du transformateur.

Convention de signe d'angle (générale): Une valeur positive indique un déphasage positif depuis l'enroulement où la prise est située jusqu'à l'autre enroulement (pour un transformateur à deux enroulements).

Le Tableau 261 présente tous les attributs de RatioTapChanger.

Tableau 261 – Attributs de Wires::RatioTapChanger

nom	mult	type	description
stepVoltageIncrement	0..1	PerCent	Augmentation d'un pas de prise du changeur, exprimée en pourcentage de la tension assignée de l'extrémité du transformateur de puissance, par position de régleur. Si l'incrément est négatif, la tension diminue lorsque l'échelon de prise augmente.
tculControlMode	0..1	TransformerControlMode	(déconseillé) Spécifie le mode de commande de régulation (tension ou puissance réactive) du RatioTapChanger.
controlEnabled	0..1	Boolean	hérité de: TapChanger
highStep	0..1	Integer	hérité de: TapChanger
initialDelay	0..1	Seconds	hérité de: TapChanger
lowStep	0..1	Integer	hérité de: TapChanger
ltcFlag	0..1	Boolean	hérité de: TapChanger
neutralStep	0..1	Integer	hérité de: TapChanger
neutralU	0..1	Voltage	hérité de: TapChanger
normalStep	0..1	Integer	hérité de: TapChanger
subsequentDelay	0..1	Seconds	hérité de: TapChanger
step	0..1	Float	hérité de: TapChanger
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

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Le Tableau 262 présente toutes les extrémités d'association de RatioTapChanger avec d'autres classes.

Tableau 262 – Extrémités d'association de Wires::RatioTapChanger avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..*	RatioTapChangerTable	0..1	RatioTapChangerTable	Tableau de rapport de prise pour ce changeur de rapport de prise.
0..1	TransformerEnd	1..1	TransformerEnd	Extrémité de transformateur à laquelle appartient ce changeur de rapport de prise.
0..*	TapChangerControl	0..1	TapChangerControl	hérité de: TapChanger
1..1	SvTapStep	0..1	SvTapStep	hérité de: TapChanger
1..1	TapSchedules	0..*	TapSchedule	hérité de: TapChanger
0..*	PSRType	0..1	PSRType	hérité de: PowerSystemResource
0..1	Controls	0..*	Control	hérité de: PowerSystemResource
0..1	Measurements	0..*	Measurement	hérité de: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	hérité de: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	hérité de: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.4.63 RatioTapChangerTable

Décrit une courbe qui représente la façon dont la valeur de tension et l'impédance varient avec l'échelon de prise.

Le Tableau 263 présente tous les attributs de RatioTapChangerTable.

Tableau 263 – Attributs de Wires::RatioTapChangerTable

nom	mult	type	description
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 264 présente toutes les extrémités d'association de RatioTapChangerTable avec d'autres classes.

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Tableau 264 – Extrémités d'association de Wires::RatioTapChangerTable avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..1	RatioTapChanger	0..*	RatioTapChanger	Changeur de rapport de prise de ce tableau de rapport de prise.
1..1	RatioTapChangerTablePoint	1..*	RatioTapChangerTablePoint	Points de ce tableau.
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.4.64 RatioTapChangerTablePoint

Décrit chaque échelon de prise dans la courbe tabulaire de changeur de rapport de prise.

Le Tableau 265 présente tous les attributs de RatioTapChangerTablePoint.

Tableau 265 – Attributs de Wires::RatioTapChangerTablePoint

nom	mult	type	description
b	0..1	PerCent	hérité de: TapChangerTablePoint
g	0..1	PerCent	hérité de: TapChangerTablePoint
r	0..1	PerCent	hérité de: TapChangerTablePoint
ratio	0..1	Float	hérité de: TapChangerTablePoint
step	0..1	Integer	hérité de: TapChangerTablePoint
x	0..1	PerCent	hérité de: TapChangerTablePoint

Le Tableau 266 présente toutes les extrémités d'association de RatioTapChangerTablePoint avec d'autres classes.

Tableau 266 – Extrémités d'association de Wires::RatioTapChangerTablePoint avec d'autres classes

mult à partir de	nom	mult vers	type	description
1..*	RatioTapChangerTable	1..1	RatioTapChangerTable	Tableau de ce point.

6.4.65 ReactiveCapabilityCurve

Courbe enveloppe assignée de puissance réactive en fonction de la puissance active de la machine synchrone, en mode générateur et moteur. Il existe, pour chaque valeur de puissance active, une valeur limite supérieure et inférieure correspondante de la puissance réactive. En règle générale, il y a une courbe distincte pour chaque état du fluide de refroidissement, tel que la pression de l'hydrogène. Les valeurs de l'axe Y1 représentent le minimum de la puissance réactive alors que les valeurs de l'axe Y2 représentent le maximum de la puissance réactive.

Le Tableau 267 présente tous les attributs de ReactiveCapabilityCurve.

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Tableau 267 – Attributs de Wires::ReactiveCapabilityCurve

nom	mult	type	description
coolantTemperature	0..1	Temperature	Température du liquide de refroidissement de la machine (air ambiant ou eau de refroidissement du stator, par exemple).
hydrogenPressure	0..1	Pressure	Pression du liquide de refroidissement hydrogène.
curveStyle	0..1	CurveStyle	hérité de: Curve
xMultiplier	0..1	UnitMultiplier	hérité de: Curve
xUnit	0..1	UnitSymbol	hérité de: Curve
y1Multiplier	0..1	UnitMultiplier	hérité de: Curve
y1Unit	0..1	UnitSymbol	hérité de: Curve
y2Multiplier	0..1	UnitMultiplier	hérité de: Curve
y2Unit	0..1	UnitSymbol	hérité de: Curve
y3Multiplier	0..1	UnitMultiplier	hérité de: Curve
y3Unit	0..1	UnitSymbol	hérité de: Curve
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 268 présente toutes les extrémités d'association de ReactiveCapabilityCurve avec d'autres classes.

Tableau 268 – Extrémités d'association de Wires::ReactiveCapabilityCurve avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..1	EquivalentInjection	0..*	EquivalentInjection	Injection équivalente qui utilise cette courbe de capacité réactive.
0..1	InitiallyUsedBySynchronousMachines	1..*	SynchronousMachine	Machines synchrones utilisant cette courbe comme courbe par défaut.
0..*	SynchronousMachines	1..*	SynchronousMachine	Machines synchrones utilisant cette courbe.
1..1	CurveDatas	0..*	CurveData	hérité de: Curve
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

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6.4.66 Recloser

Interrupteur de défaut monté sur poteau, à relais intégrés de phase et de mise à la terre, transformateur de courant (CT) et commandes supplémentaires.

Le Tableau 269 présente tous les attributs de Recloser.

Tableau 269 – Attributs de Wires::Recloser

nom	mult	type	description
breakingCapacity	0..1	CurrentFlow	hérité de: ProtectedSwitch
normalOpen	0..1	Boolean	hérité de: Switch
ratedCurrent	0..1	CurrentFlow	hérité de: Switch
switchOnCount	0..1	Integer	(déconseillé) hérité de: Switch
switchOnDate	0..1	DateTime	(déconseillé) hérité de: Switch
retained	0..1	Boolean	hérité de: Switch
open	0..1	Boolean	hérité de: Switch
locked	0..1	Boolean	hérité de: Switch
aggregate	0..1	Boolean	hérité de: Equipment
inService	0..1	Boolean	hérité de: Equipment
networkAnalysisEnabled	0..1	Boolean	hérité de: Equipment
normallyInService	0..1	Boolean	hérité de: Equipment
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 270 présente toutes les extrémités d'association de Recloser avec d'autres classes.

Tableau 270 – Extrémités d'association de Wires::Recloser avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..*	OperatedByProtectionEquipment	0..*	ProtectionEquipment	hérité de: ProtectedSwitch
1..1	RecloseSequences	0..*	RecloseSequence	hérité de: ProtectedSwitch
1..1	SwitchPhase	0..*	SwitchPhase	hérité de: Switch
1..1	SwitchSchedules	0..*	SwitchSchedule	hérité de: Switch
0..*	CompositeSwitch	0..1	CompositeSwitch	hérité de: Switch
1..1	SvSwitch	0..*	SvSwitch	hérité de: Switch
0..*	BaseVoltage	0..1	BaseVoltage	hérité de: ConductingEquipment
1..1	SvStatus	0..*	SvStatus	hérité de: ConductingEquipment
0..*	ProtectionEquipments	0..*	ProtectionEquipment	hérité de: ConductingEquipment
1..1	Terminals	0..*	Terminal	hérité de: ConductingEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	hérité de: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	hérité de: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	hérité de: Equipment
0..1	Faults	0..*	Fault	hérité de: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	hérité de: Equipment
0..*	PSRType	0..1	PSRType	hérité de: PowerSystemResource
0..1	Controls	0..*	Control	hérité de: PowerSystemResource
0..1	Measurements	0..*	Measurement	hérité de: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	hérité de: PowerSystemResource

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mult à partir de	nom	mult vers	type	description
0..*	ReportingGroup	0..*	ReportingGroup	hérité de: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.4.67 RegulatingCondEq

Type d'équipement conducteur qui peut réguler une grandeur (c'est-à-dire une tension ou un flux) en un point spécifique du réseau.

Le Tableau 271 présente tous les attributs de RegulatingCondEq.

Tableau 271 – Attributs de Wires::RegulatingCondEq

nom	mult	type	description
controlEnabled	0..1	Boolean	Spécifie le statut de régulation de l'équipement. True, il régule. False, il ne régule pas.
aggregate	0..1	Boolean	hérité de: Equipment
inService	0..1	Boolean	hérité de: Equipment
networkAnalysisEnabled	0..1	Boolean	hérité de: Equipment
normallyInService	0..1	Boolean	hérité de: Equipment
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 272 présente toutes les extrémités d'association de RegulatingCondEq avec d'autres classes.

Tableau 272 – Extrémités d'association de Wires::RegulatingCondEq avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..*	RegulatingControl	0..1	RegulatingControl	Schéma de commande de régulation auquel cet équipement participe.
0..*	BaseVoltage	0..1	BaseVoltage	hérité de: ConductingEquipment
1..1	SvStatus	0..*	SvStatus	hérité de: ConductingEquipment
0..*	ProtectionEquipments	0..*	ProtectionEquipment	hérité de: ConductingEquipment
1..1	Terminals	0..*	Terminal	hérité de: ConductingEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	hérité de: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	hérité de: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	hérité de: Equipment
0..1	Faults	0..*	Fault	hérité de: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	hérité de: Equipment

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mult à partir de	nom	mult vers	type	description
0..*	PSRType	0..1	PSRType	hérité de: PowerSystemResource
0..1	Controls	0..*	Control	hérité de: PowerSystemResource
0..1	Measurements	0..*	Measurement	hérité de: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	hérité de: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	hérité de: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.4.68 RegulatingControl

Spécifie un ensemble d'équipements qui fonctionnent ensemble pour réguler une grandeur de système de puissance telle que la tension ou le flux.

Il est possible de régler la tension du bus à distance en spécifiant la borne commandée située à un emplacement éloigné de l'équipement de commande.

La borne spécifiée doit être associée au nœud de connectivité du point commandé. Le sous-type le plus spécifique de RegulatingControl doit être utilisé lorsque de tels équipements participent à la commande, par exemple TapChangerControl pour les changeurs de prises.

La convention de signe charge est utilisée pour la commande du flux, c'est-à-dire que le signe positif signifie un flux à partir d'un TopologicalNode (bus) vers l'équipement conducteur.

Les attributs minAllowedTargetValue et maxAllowedTargetValue sont exigés dans les cas suivants:

– pour un module de génération de puissance fonctionnant en mode de commande de facteur de puissance pour spécifier les valeurs maximales et minimales du facteur de puissance;

– lorsqu'il est nécessaire de disposer d'une tension cible excentrée pour le régulateur de changeur de prises. Par exemple, compte tenu de la présence de longs câbles reliant les parcs d'éoliennes en pleine mer et de la nécessité de simplifier le montage au niveau de la plate-forme du transformateur en pleine mer, la tension est commandée depuis la terre au point de connexion avec le parc d'éoliennes en pleine mer. Dans la mesure où la tension augmente généralement le long du câble, il en résulte une surtension caractéristique jusqu'à 3 kV à 4 kV par rapport à ce qui se produit dans un poste à terre. De ce fait, en fonctionnement normal, le changeur de prises du poste à terre fonctionne avec un point de consigne cible se situant dans les parties inférieures de la bande morte.

Les attributs minAllowedTargetValue et maxAllowedTargetValue ne sont pas associés à l'attribut targetDeadband et ne sont de ce fait pas traités comme une variante à la targetDeadband. Ils sont nécessaires en raison des limitations qui existent dans le contrôleur du poste local. L'attribut targetDeadband est utilisé pour empêcher que le flux de puissance ne fasse tourner (oscillation) la prise qui doit être utilisée indépendamment des attributs minAllowedTargetValue et maxAllowedTargetValue.

Le Tableau 273 présente tous les attributs de RegulatingControl.

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Tableau 273 – Attributs de Wires::RegulatingControl

nom	mult	type	description
discrete	0..1	Boolean	La régulation est effectuée dans un mode discret. Elle s'applique à l'équipement avec une commande discrète, par exemple changeurs de prises et compensateurs shunt.
enabled	0..1	Boolean	L'indicateur indique si la régulation est activée.
mode	0..1	RegulatingControlModeKind	Mode de commande de régulation actuellement disponible. La présente spécification permet de déterminer le genre de régulation sans la nécessité d'obtenir les unités à partir d'un programme.
monitoredPhase	0..1	PhaseCode	Tension de phase commandant ce régulateur, mesurée à l'emplacement du régulateur.
targetDeadband	0..1	Float	Il s'agit d'une bande morte utilisée avec une commande discrète afin d'éviter une mise à jour excessive des commandes comme les changeurs de prises et les batteries de compensateurs shunt pendant la régulation. Unités pour ceux qui sont appropriés pour ce mode. La valeur de l'attribut doit être positive pour zéro. Si la valeur "false" est attribuée à RegulatingControl.discrete, RegulatingControl.targetDeadband doit être ignorée Noter que, par exemple, si targetValue est 100 kV et que targetDeadband est 2 kV, la plage est comprise entre 99 et 101 kV.
targetValue	0..1	Float	Valeur cible spécifiée pour "case input". Cette valeur peut être utilisée pour la valeur cible sans utilisation de programmes. Cette valeur a les unités appropriées à l'attribut de mode.
targetValueUnitMultiplier	0..1	UnitMultiplier	Spécifier le multiplicateur utilisé pour targetValue.
maxAllowedTargetValue	0..1	Float	Valeur cible maximale admissible (RegulatingControl.targetValue).
minAllowedTargetValue	0..1	Float	Valeur cible minimale admissible (RegulatingControl.targetValue).
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 274 présente toutes les extrémités d'association de RegulatingControl avec d'autres classes.

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Tableau 274 – Extrémités d'association de Wires::RegulatingControl avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..*	Terminal	0..1	Terminal	Borne associée à cette commande de régulation. La borne est associée au lieu d'un nœud, puisque la borne peut être connectée soit à un nœud topologique ou à un nœud de connectivité. Il est parfois utile de modéliser la régulation au niveau d'une borne d'un objet de jeu de barres.
0..1	RegulatingCondEq	0..*	RegulatingCondEq	Équipement qui participe à ce plan de commande de régulation.
1..1	RegulationSchedule	0..*	RegulationSchedule	Programme pour cette commande de régulation.
0..*	PSRType	0..1	PSRType	hérité de: PowerSystemResource
0..1	Controls	0..*	Control	hérité de: PowerSystemResource
0..1	Measurements	0..*	Measurement	hérité de: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	hérité de: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	hérité de: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.4.69 Enumération RegulatingControlModeKind

Genre de modèle de régulation. Par exemple: tension de régulation, puissance réactive, puissance active, etc.

Le Tableau 275 présente tous les libellés de RegulatingControlModeKind.

Tableau 275 – Libellés de Wires::RegulatingControlModeKind

libellé	value	description
voltage		La tension est spécifiée.
activePower		La puissance active est spécifiée.
reactivePower		La puissance réactive est spécifiée.
currentFlow		L'intensité est spécifiée.
admittance		L'admittance est spécifiée.
timeScheduled		La commande s'active/se désactive par heure du jour. Les heures peuvent varier à la fin de semaine ou dans des saisons différentes.
temperature		La commande s'active/se désactive en fonction de la température locale (c'est-à-dire, un thermostat).
powerFactor		Le facteur de puissance est spécifié.

6.4.70 RegulationSchedule

Modèle prédéfini sur une longue durée pour une variable commandée, par exemple la tension du jeu de barres.

Le Tableau 276 présente tous les attributs de RegulationSchedule.

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Tableau 276 – Attributs de Wires::RegulationSchedule

nom	mult	type	description
endTime	0..1	DateTime	hérité de: RegularIntervalSchedule
timeStep	0..1	Seconds	hérité de: RegularIntervalSchedule
startTime	0..1	DateTime	hérité de: BasicIntervalSchedule
value1Multiplier	0..1	UnitMultiplier	hérité de: BasicIntervalSchedule
value1Unit	0..1	UnitSymbol	hérité de: BasicIntervalSchedule
value2Multiplier	0..1	UnitMultiplier	hérité de: BasicIntervalSchedule
value2Unit	0..1	UnitSymbol	hérité de: BasicIntervalSchedule
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 277 présente toutes les extrémités d'association de RegulationSchedule avec d'autres classes.

Tableau 277 – Extrémités d'association de Wires::RegulationSchedule avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..*	RegulatingControl	1..1	RegulatingControl	Commandes de régulation disposant de ce programme.
0..1	VoltageControlZones	0..*	VoltageControlZone	Une VoltageControlZone peut avoir un programme de régulation de tension.
0..*	DayType	0..1	DayType	hérité de: SeasonDayTypeSchedule
0..*	Season	0..1	Season	hérité de: SeasonDayTypeSchedule
1..1	TimePoints	1..*	RegularTimePoint	hérité de: RegularIntervalSchedule
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.4.71 RotatingMachine

Machine tournante qui peut être utilisée comme générateur ou comme moteur.

Le Tableau 278 présente tous les attributs de RotatingMachine.

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Tableau 278 – Attributs de Wires::RotatingMachine

nom	mult	type	description
ratedPowerFactor	0..1	Float	Facteur de puissance (données constructeur). Utilisé principalement pour l'échange de données relatives à un court-circuit, conformément à l'IEC 60909. La valeur de l'attribut ne peut pas être négative.
p	0..1	ActivePower	Injection de puissance active. La convention de signe charge est utilisée, c'est-à-dire que le signe positif signifie un flux à partir d'un nœud. Valeur de départ pour une solution en régime établi.
ratedS	0..1	ApparentPower	Puissance apparente assignée constructeur de la tranche. L'attribut doit avoir une valeur positive.
q	0..1	ReactivePower	Injection de puissance réactive. La convention de signe charge est utilisée, c'est-à-dire que le signe positif signifie un flux à partir d'un nœud. Valeur de départ pour une solution en régime établi.
ratedU	0..1	Voltage	Tension assignée (données constructeur, Ur dans l'IEC 60909-0). Utilisé principalement pour l'échange de données relatives à un court-circuit, conformément à l'IEC 60909. La valeur de l'attribut doit être positive.
controlEnabled	0..1	Boolean	hérité de: RegulatingCondEq
aggregate	0..1	Boolean	hérité de: Equipment
inService	0..1	Boolean	hérité de: Equipment
networkAnalysisEnabled	0..1	Boolean	hérité de: Equipment
normallyInService	0..1	Boolean	hérité de: Equipment
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 279 présente toutes les extrémités d'association de RotatingMachine avec d'autres classes.

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Tableau 279 – Extrémités d'association de Wires::RotatingMachine avec d'autres classes

mult à partir de	nom	mult vers	type	description
1..1	HydroPump	0..1	HydroPump	La machine synchrone entraîne la turbine qui déplace l'eau de bas en haut. Le sens de rotation de la machine pour le pompage peut ou peut ne pas être identique à celui utilisé pour la production.
0..*	GeneratingUnit	0..1	GeneratingUnit	Une machine synchrone peut fonctionner comme générateur et devenir par conséquent un élément de l'unité de production.
0..*	RegulatingControl	0..1	RegulatingControl	hérité de: RegulatingCondEq
0..*	BaseVoltage	0..1	BaseVoltage	hérité de: ConductingEquipment
1..1	SvStatus	0..*	SvStatus	hérité de: ConductingEquipment
0..*	ProtectionEquipments	0..*	ProtectionEquipment	hérité de: ConductingEquipment
1..1	Terminals	0..*	Terminal	hérité de: ConductingEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	hérité de: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	hérité de: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	hérité de: Equipment
0..1	Faults	0..*	Fault	hérité de: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	hérité de: Equipment
0..*	PSRType	0..1	PSRType	hérité de: PowerSystemResource
0..1	Controls	0..*	Control	hérité de: PowerSystemResource
0..1	Measurements	0..*	Measurement	hérité de: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	hérité de: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	hérité de: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.4.72 Sectionaliser

Commutateur automatique capable de se verrouiller en position ouverte pour isoler une section défectueuse. Il peut ou peut ne pas comporter une capacité de coupure de charge. Il a pour rôle premier de fournir un sectionnement de défaut à des emplacements dans lesquels le courant de défaut est soit trop élevé soit trop faible pour coordonner correctement les fusibles.

Le Tableau 280 présente tous les attributs de Sectionaliser.

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Tableau 280 – Attributs de Wires::Sectionaliser

nom	mult	type	description
normalOpen	0..1	Boolean	hérité de: Switch
ratedCurrent	0..1	CurrentFlow	hérité de: Switch
switchOnCount	0..1	Integer	(déconseillé) hérité de: Switch
switchOnDate	0..1	DateTime	(déconseillé) hérité de: Switch
retained	0..1	Boolean	hérité de: Switch
open	0..1	Boolean	hérité de: Switch
locked	0..1	Boolean	hérité de: Switch
aggregate	0..1	Boolean	hérité de: Equipment
inService	0..1	Boolean	hérité de: Equipment
networkAnalysisEnabled	0..1	Boolean	hérité de: Equipment
normallyInService	0..1	Boolean	hérité de: Equipment
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 281 présente toutes les extrémités d'association de Sectionaliser avec d'autres classes.

Tableau 281 – Extrémités d'association de Wires::Sectionaliser avec d'autres classes

mult à partir de	nom	mult vers	type	description
1..1	SwitchPhase	0..*	SwitchPhase	hérité de: Switch
1..1	SwitchSchedules	0..*	SwitchSchedule	hérité de: Switch
0..*	CompositeSwitch	0..1	CompositeSwitch	hérité de: Switch
1..1	SvSwitch	0..*	SvSwitch	hérité de: Switch
0..*	BaseVoltage	0..1	BaseVoltage	hérité de: ConductingEquipment
1..1	SvStatus	0..*	SvStatus	hérité de: ConductingEquipment
0..*	ProtectionEquipments	0..*	ProtectionEquipment	hérité de: ConductingEquipment
1..1	Terminals	0..*	Terminal	hérité de: ConductingEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	hérité de: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	hérité de: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	hérité de: Equipment
0..1	Faults	0..*	Fault	hérité de: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	hérité de: Equipment
0..*	PSRType	0..1	PSRType	hérité de: PowerSystemResource
0..1	Controls	0..*	Control	hérité de: PowerSystemResource
0..1	Measurements	0..*	Measurement	hérité de: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	hérité de: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	hérité de: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

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6.4.73 SeriesCompensator

Un Series Compensator (compensateur série) est un condensateur ou une inductance série ou une ligne de transport en courant alternatif sans susceptance de charge. Il s'agit d'un appareil à deux bornes.

Le Tableau 282 présente tous les attributs de SeriesCompensator.

Tableau 282 – Attributs de Wires::SeriesCompensator

nom	mult	type	description
r	0..1	Resistance	Résistance directe.
r0	0..1	Resistance	Résistance homopolaire.
x	0..1	Reactance	Réactance directe.
x0	0..1	Reactance	Réactance homopolaire.
varistorPresent	0..1	Boolean	Indique si une varistance à oxyde métallique (mov) à des fins de protection contre les surtensions est configurée en parallèle avec le compensateur série. Est utilisé pour les calculs de court-circuit.
varistorRatedCurrent	0..1	CurrentFlow	Le courant maximal de la varistance est conçu pour les manipulations pendant une durée spécifiée. Est utilisé pour les calculs de court-circuit et uniquement échangé si SeriesCompensator.varistorPresent est fixé à true. La valeur de l'attribut doit être positive.
varistorVoltageThreshold	0..1	Voltage	Tension en courant continu à laquelle la varistance devient conductrice. Est utilisée pour les calculs de court-circuit et uniquement échangée si SeriesCompensator.varistorPresent est fixé à true
aggregate	0..1	Boolean	hérité de: Equipment
inService	0..1	Boolean	hérité de: Equipment
networkAnalysisEnabled	0..1	Boolean	hérité de: Equipment
normallyInService	0..1	Boolean	hérité de: Equipment
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 283 présente toutes les extrémités d'association de SeriesCompensator avec d'autres classes.

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Tableau 283 – Extrémités d'association de Wires::SeriesCompensator avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..*	BaseVoltage	0..1	BaseVoltage	hérité de: ConductingEquipment
1..1	SvStatus	0..*	SvStatus	hérité de: ConductingEquipment
0..*	ProtectionEquipments	0..*	ProtectionEquipment	hérité de: ConductingEquipment
1..1	Terminals	0..*	Terminal	hérité de: ConductingEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	hérité de: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	hérité de: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	hérité de: Equipment
0..1	Faults	0..*	Fault	hérité de: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	hérité de: Equipment
0..*	PSRType	0..1	PSRType	hérité de: PowerSystemResource
0..1	Controls	0..*	Control	hérité de: PowerSystemResource
0..1	Measurements	0..*	Measurement	hérité de: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	hérité de: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	hérité de: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.4.74 Enumération ShortCircuitRotorKind

Type de rotor, utilisé par les applications de courts-circuits.

Le Tableau 284 présente tous les libellés de ShortCircuitRotorKind.

Tableau 284 – Libellés de Wires::ShortCircuitRotorKind

libelle	value	description
salientPole1		Pôle saillant 1 de l'IEC 60909.
salientPole2		Pôle saillant 2 de l'IEC 60909.
turboSeries1		Série turbo 1 de l'IEC 60909.
turboSeries2		Série turbo 2 de l'IEC 60909.

6.4.75 ShuntCompensator

Condensateur shunt ou inductance ou batterie commutable de condensateurs-shunts ou d'inductances. Une section d'un compensateur shunt est un condensateur individuel ou une inductance individuelle. Une valeur négative pour ~~reactivePerSection~~ bPerSection indique que le compensateur est une inductance. ShuntCompensator est un appareil à une seule borne. La terre est impliquée.

Le Tableau 285 présente tous les attributs de ShuntCompensator.

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Tableau 285 – Attributs de Wires::ShuntCompensator

nom	mult	type	description
aVRDelay	0..1	Seconds	Temps de régulation automatique de tension (AVRDelay) qui s'écoule entre une variation de tension et le moment auquel le condensateur peut changer d'état. Ceci permet de filtrer les variations temporaires de tension.
grounded	0..1	Boolean	Utilisée pour des connexions Yn et Zn. Vrai si le neutre est solidement mis à la terre.
maximumSections	0..1	Integer	Nombre maximal de sections qui peuvent être mises en service.
nomU	0..1	Voltage	Tension à laquelle peut être calculée la puissance réactive nominale. Il convient qu'elle soit normalement dans les limites de 10 % de la tension à laquelle le condensateur est connecté au réseau.
normalSections	0..1	Integer	Nombre normal de sections mises en service. La valeur doit être comprise entre zéro et ShuntCompensator.maximumSections.
phaseConnection	0..1	PhaseShuntConnectionKind	Type de connexion de phase, par exemple montage en étoile ou en triangle.
switchOnCount	0..1	Integer	(déconseillé) Compteur de mise en route depuis la dernière initialisation ou réinitialisation du compteur de condensateur.
switchOnDate	0..1	DateTime	(déconseillé) Date et heure auxquelles la batterie de condensateurs a été activée pour la dernière fois.
voltageSensitivity	0..1	VoltagePerReactivePower	Sensibilité de tension exigée pour que l'appareil régule la tension du bus, en tension par puissance réactive.
sections	0..1	Float	Sections de compensateurs shunt en cours d'utilisation. Valeur de départ pour une solution en régime établi. La valeur de l'attribut doit être positive ou égale à zéro. Aucune valeur entière n'est autorisée pour prendre en charge des variables continues. La valeur continue sert à appuyer les cas d'études dans lesquels aucun compensateur shunt discret n'a encore été conçu, une solution pour laquelle la bande étroite de tension force les sections à osciller ou à s'ajuster pour obtenir une solution continue comme entrée. Pour LinearShuntConpensator, la valeur doit être comprise entre zéro et ShuntCompensator.maximumSections. A zéro, la valeur de la conductance et admittance de compensateur shunt est égale à zéro. L'interpolation linéaire de la conductance et de l'admittance entre la section d'entier précédente et suivante est appliquée dans le cas de valeurs non entières. Pour NonlinearShuntCompensator-s, la valeur ne doit être fixée qu'à un seul NonlinearShuntCompenstorPoint.sectionNumber. Il n'existe aucune interpolation entre les NonlinearShuntCompenstorPoint-s.
controlEnabled	0..1	Boolean	hérité de: RegulatingCondEq
aggregate	0..1	Boolean	hérité de: Equipment
inService	0..1	Boolean	hérité de: Equipment
networkAnalysisEnabled	0..1	Boolean	hérité de: Equipment
normallyInService	0..1	Boolean	hérité de: Equipment

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nom	mult	type	description
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 286 présente toutes les extrémités d'association de ShuntCompensator avec d'autres classes.

Tableau 286 – Extrémités d'association de Wires::ShuntCompensator avec d'autres classes

mult à partir de	nom	mult vers	type	description
1..1	ShuntCompensatorPhase	0..*	ShuntCompensatorPhase	Modèles de phases individuels pour le compensateur shunt.
1..1	SvShuntCompensatorSections	0..*	SvShuntCompensatorSections	État pour le nombre de sections de compensateur shunt en service.
0..*	RegulatingControl	0..1	RegulatingControl	hérité de: RegulatingCondEq
0..*	BaseVoltage	0..1	BaseVoltage	hérité de: ConductingEquipment
1..1	SvStatus	0..*	SvStatus	hérité de: ConductingEquipment
0..*	ProtectionEquipments	0..*	ProtectionEquipment	hérité de: ConductingEquipment
1..1	Terminals	0..*	Terminal	hérité de: ConductingEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	hérité de: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	hérité de: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	hérité de: Equipment
0..1	Faults	0..*	Fault	hérité de: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	hérité de: Equipment
0..*	PSRType	0..1	PSRType	hérité de: PowerSystemResource
0..1	Controls	0..*	Control	hérité de: PowerSystemResource
0..1	Measurements	0..*	Measurement	hérité de: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	hérité de: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	hérité de: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

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6.4.76 ShuntCompensatorPhase

Phase unique d'un compensateur shunt polyphasé quand ses attributs peuvent être différents pour chaque phase.

Le Tableau 287 présente tous les attributs de ShuntCompensatorPhase.

Tableau 287 – Attributs de Wires::ShuntCompensatorPhase

nom	mult	type	description
maximumSections	0..1	Integer	Nombre maximal de sections qui peuvent être mises en service pour cette phase.
normalSections	0..1	Integer	Pour la phase du condensateur, le nombre normal de sections mises en service. La valeur doit être comprise entre zéro et ShuntCompensatorPhase.maximumSections.
sections	0..1	Float	Sections de compensateurs shunt en cours d'utilisation. La valeur de l'attribut doit être positive ou égale à zéro. Aucune valeur entière n'est autorisée pour prendre en charge des variables continues. La valeur continue sert à appuyer les cas d'études dans lesquels aucun compensateur shunt discret n'a encore été conçu, une solution pour laquelle la bande étroite de tension force les sections à osciller ou à s'ajuster pour obtenir une solution continue comme entrée. Pour LinearShuntConpensator, la valeur doit être comprise entre zéro et ShuntCompensator.maximumSections. A zéro, la valeur de la conductance et admittance de compensateur shunt est égale à zéro. L'interpolation linéaire de la conductance et de l'admittance entre la section d'entier précédente et suivante est appliquée dans le cas de valeurs non entières. Pour NonlinearShuntCompensator-s, la valeur ne doit être fixée qu'à un seul NonlinearShuntCompenstorPhasePoint.sectionNumber. Il n'existe aucune interpolation entre les NonlinearShuntCompenstorPhasePoint-s.
phase	0..1	SinglePhaseKind	Phase de ce composant de compensateur shunt. Si le compensateur shunt est monté en étoile, la connexion est réalisée de la phase indiquée vers la mise centrale à la terre ou le point neutre. Si le compensateur shunt est monté en triangle, la phase indique qu'un compensateur shunt est connecté de la phase indiquée vers la phase non neutre logique qui suit.
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 288 présente toutes les extrémités d'association de ShuntCompensatorPhase avec d'autres classes.

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Tableau 288 – Extrémités d'association de Wires::ShuntCompensatorPhase avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..*	ShuntCompensator	1..1	ShuntCompensator	Compensateur shunt de cette phase de compensateur shunt.
0..*	PSRType	0..1	PSRType	hérité de: PowerSystemResource
0..1	Controls	0..*	Control	hérité de: PowerSystemResource
0..1	Measurements	0..*	Measurement	hérité de: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	hérité de: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	hérité de: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.4.77 Enumération SinglePhaseKind

Enumération des identificateurs de phase particulière. Permet de désigner des phases particulières à la fois pour l'équipement, les circuits et les charges de transport et de distribution.

Le Tableau 289 présente tous les libellés de SinglePhaseKind.

Tableau 289 – Libellés de Wires::SinglePhaseKind

libellé	value	description
A		Phase A.
B		Phase B.
C		Phase C.
N		Neutre.
s1		Phase secondaire 1.
s2		Phase secondaire 2.

6.4.78 StaticVarCompensator

Installation proposant une puissance réactive de shunt variable et modulable. Le SVC consiste généralement en un transformateur abaisseur, un filtre, une inductance commandée par thyristor et des bras de condensateur commutés par thyristor.

Le SVC peut fonctionner dans le mode de sortie MVar fixe ou dans le mode de commande de tension. Dans le mode de commande de tension, la sortie du SVC est proportionnelle à l'écart de tension au niveau du bus commandé par rapport au point de consigne de la tension. La pente caractéristique du SVC définit la proportion. Si la tension au niveau du bus commandé est égale au point de consigne de la tension, la sortie MVar du SVC est nulle.

Le Tableau 290 présente tous les attributs de StaticVarCompensator.

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Tableau 290 – Attributs de Wires::StaticVarCompensator

nom	mult	type	description
capacitiveRating	0..1	Reactance	Réactance capacitive à la puissance réactive capacitive maximale. Doit toujours être positive.
inductiveRating	0..1	Reactance	Réactance inductive à la puissance réactive inductive maximale. Doit toujours être négative.
slope	0..1	VoltagePerReactivePower	La pente de la caractéristique d'un SVC définit comment la sortie de puissance réactive change proportionnellement à la différence entre la tension régulée du bus et le point de consigne de la tension. La valeur de l'attribut doit être positive ou égale à zéro.
q	0..1	ReactivePower	Injection de puissance réactive. La convention de signe charge est utilisée, c'est-à-dire que le signe positif signifie un flux à partir d'un nœud. Valeur de départ pour une solution en régime établi.
sVCControlMode	0..1	SVCControlMode	Mode de commande du SVC.
voltageSetPoint	0..1	Voltage	La sortie de puissance réactive du SVC est proportionnelle à la différence entre la tension régulée du bus et le point de consigne de la tension (voltage set point). Lorsque la tension régulée du bus est égale au point de consigne de la tension, la sortie de puissance réactive est nulle.
controlEnabled	0..1	Boolean	hérité de: RegulatingCondEq
aggregate	0..1	Boolean	hérité de: Equipment
inService	0..1	Boolean	hérité de: Equipment
networkAnalysisEnabled	0..1	Boolean	hérité de: Equipment
normallyInService	0..1	Boolean	hérité de: Equipment
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 291 présente toutes les extrémités d'association de StaticVarCompensator avec d'autres classes.

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Tableau 291 – Extrémités d'association de Wires::StaticVarCompensator avec d'autres classes

mult à partir de	nom	mult vers	type	description
1..1	StaticVarCompensatorDynamics	0..1	StaticVarCompensatorDynamics	Modèle dynamique du compensateur de Var statique utilisé pour décrire le comportement dynamique de ce compensateur de Var statique.
0..*	RegulatingControl	0..1	RegulatingControl	hérité de: RegulatingCondEq
0..*	BaseVoltage	0..1	BaseVoltage	hérité de: ConductingEquipment
1..1	SvStatus	0..*	SvStatus	hérité de: ConductingEquipment
0..*	ProtectionEquipments	0..*	ProtectionEquipment	hérité de: ConductingEquipment
1..1	Terminals	0..*	Terminal	hérité de: ConductingEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	hérité de: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	hérité de: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	hérité de: Equipment
0..1	Faults	0..*	Fault	hérité de: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	hérité de: Equipment
0..*	PSRType	0..1	PSRType	hérité de: PowerSystemResource
0..1	Controls	0..*	Control	hérité de: PowerSystemResource
0..1	Measurements	0..*	Measurement	hérité de: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	hérité de: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	hérité de: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.4.79 Enumération SVCControlMode

Mode de commande du compensateur de VAr statique.

Le Tableau 292 présente tous les libellés de SVCControlMode.

Tableau 292 – Libellés de Wires::SVCControlMode

libellé	value	description
reactivePower		Commande de puissance réactive.
voltage		Commande de tension.

6.4.80 Switch

Appareil générique visant à établir et/ou interrompre le courant dans un ou plusieurs circuits électriques. Tous les commutateurs (Switches) sont des appareils à deux bornes, y compris les commutateurs de mise à la terre. Le ACDCTTerminal.connected des deux côtés du commutateur ne doit pas être utilisé pour évaluer la connectivité du commutateur, c'est-à-dire que seuls Switch.open, .normalOpen et .locked sont appropriés.

Le Tableau 293 présente tous les attributs de Switch.

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Tableau 293 – Attributs de Wires::Switch

nom	mult	type	description
normalOpen	0..1	Boolean	L'attribut est utilisé dans des cas où aucun Measurement (mesure) pour la valeur de statut n'est présent. Si le Switch a un Measurement de statut, alors la valeur Discrete.normalValue est réputée correspondre au Switch.normalOpen.
ratedCurrent	0..1	CurrentFlow	Capacité de transport maximale du courant continu en ampères d'après le matériau et la construction de l'appareil. La valeur de l'attribut doit être positive.
switchOnCount	0..1	Integer	(déconseillé) Compteur de mise en route depuis la dernière initialisation ou réinitialisation du commutateur (Switch).
switchOnDate	0..1	DateTime	(déconseillé) Date et heure de la dernière mise en route du commutateur.
retained	0..1	Boolean	La branche est retenue dans la solution topologique. Le flux qui passe par les commutateurs retenus est normalement calculé en flux de puissance.
open	0..1	Boolean	L'attribut indique si le commutateur est considéré comme ouvert lorsqu'il est utilisé comme entrée de traitement de topologie.
locked	0..1	Boolean	Si la valeur est true, le commutateur est verrouillé. L'état du commutateur qui en résulte est une combinaison des attributs locked et Switch.open comme suit: – locked=true et Switch.open=true. L'état qui en résulte est ouvert et verrouillé; – locked=false et Switch.open=true. L'état qui en résulte est ouvert; – locked=false et Switch.open=false. L'état qui en résulte est fermé.
aggregate	0..1	Boolean	hérité de: Equipment
inService	0..1	Boolean	hérité de: Equipment
networkAnalysisEnabled	0..1	Boolean	hérité de: Equipment
normallyInService	0..1	Boolean	hérité de: Equipment
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 294 présente toutes les extrémités d'association de Switch avec d'autres classes.

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Tableau 294 – Extrémités d'association de Wires::Switch avec d'autres classes

mult à partir de	nom	mult vers	type	description
1..1	SwitchPhase	0..*	SwitchPhase	Phases commutateur individuelles pour le commutateur.
1..1	SwitchSchedules	0..*	SwitchSchedule	Un Switch peut être associé avec SwitchSchedules.
0..*	CompositeSwitch	0..1	CompositeSwitch	Commutateur composite auquel appartient ce Switch.
1..1	SvSwitch	0..*	SvSwitch	État du commutateur associé au commutateur.
0..*	BaseVoltage	0..1	BaseVoltage	hérité de: ConductingEquipment
1..1	SvStatus	0..*	SvStatus	hérité de: ConductingEquipment
0..*	ProtectionEquipments	0..*	ProtectionEquipment	hérité de: ConductingEquipment
1..1	Terminals	0..*	Terminal	hérité de: ConductingEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	hérité de: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	hérité de: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	hérité de: Equipment
0..1	Faults	0..*	Fault	hérité de: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	hérité de: Equipment
0..*	PSRType	0..1	PSRType	hérité de: PowerSystemResource
0..1	Controls	0..*	Control	hérité de: PowerSystemResource
0..1	Measurements	0..*	Measurement	hérité de: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	hérité de: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	hérité de: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.4.81 SwitchPhase

Phase unique d'un commutateur polyphasé quand ses attributs peuvent être différents pour chaque phase.

Le Tableau 295 présente tous les attributs de SwitchPhase.

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Tableau 295 – Attributs de Wires::SwitchPhase

nom	mult	type	description
normalOpen	0..1	Boolean	Utilisé dans des cas où aucun Measurement (mesure) pour la valeur de statut n'est présent. Si la SwitchPhase a un Measurement de statut, alors Discrete.normalValue est réputé correspondre à cette valeur.
phaseSide1	0..1	SinglePhaseKind	Phase de cette SwitchPhase sur le côté dont le numéro d'ordre de borne est égal à 1. Il convient que ce soit une phase contenue dans cet attribut de phase de borne.
phaseSide2	0..1	SinglePhaseKind	Phase de cette SwitchPhase sur le côté dont le numéro d'ordre de borne est égal à 2. Il convient qu'il s'agisse d'une phase contenue dans l'attribut Terminal.phases de cette borne.
closed	0..1	Boolean	L'attribut indique si le commutateur est considéré comme fermé lorsqu'il est utilisé comme entrée de traitement de topologie.
ratedCurrent	0..1	CurrentFlow	Capacité de transport maximale du courant continu en ampères d'après le matériau et la construction de l'appareil. La valeur de l'attribut doit être positive.
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 296 présente toutes les extrémités d'association de SwitchPhase avec d'autres classes.

Tableau 296 – Extrémités d'association de Wires::SwitchPhase avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..*	Switch	1..1	Switch	Commutateur de la phase commutateur.
0..*	PSRType	0..1	PSRType	hérité de: PowerSystemResource
0..1	Controls	0..*	Control	hérité de: PowerSystemResource
0..1	Measurements	0..*	Measurement	hérité de: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	hérité de: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	hérité de: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

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6.4.82 SwitchSchedule

Programme des positions de commutateur. Si RegularTimePoint.value1 est égale à 0, le commutateur est ouvert. Si 1, le commutateur est fermé.

Le Tableau 297 présente tous les attributs de SwitchSchedule.

Tableau 297 – Attributs de Wires::SwitchSchedule

nom	mult	type	description
endTime	0..1	DateTime	hérité de: RegularIntervalSchedule
timeStep	0..1	Seconds	hérité de: RegularIntervalSchedule
startTime	0..1	DateTime	hérité de: BasicIntervalSchedule
value1Multiplier	0..1	UnitMultiplier	hérité de: BasicIntervalSchedule
value1Unit	0..1	UnitSymbol	hérité de: BasicIntervalSchedule
value2Multiplier	0..1	UnitMultiplier	hérité de: BasicIntervalSchedule
value2Unit	0..1	UnitSymbol	hérité de: BasicIntervalSchedule
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 298 présente toutes les extrémités d'association de SwitchSchedule avec d'autres classes.

Tableau 298 – Extrémités d'association de Wires::SwitchSchedule avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..*	Switch	1..1	Switch	Un SwitchSchedule est associé à un Switch.
0..*	DayType	0..1	DayType	hérité de: SeasonDayTypeSchedule
0..*	Season	0..1	Season	hérité de: SeasonDayTypeSchedule
1..1	TimePoints	1..*	RegularTimePoint	hérité de: RegularIntervalSchedule
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.4.83 SynchronousMachine

Appareil électromécanique fonctionnant par rotation synchrone d'un arbre avec le réseau. Il s'agit d'une machine unique opérant comme un générateur, comme un condensateur synchrone ou comme une pompe.

Le Tableau 299 présente tous les attributs de SynchronousMachine.

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Tableau 299 – Attributs de Wires::SynchronousMachine

nom	mult	type	description
aVRToManualLag	0..1	Seconds	Retard exigé pour le passage de la régulation de tension automatique (AVR – Automatic Voltage Regulation) à Manuel pour une infraction MVAr de retard de phase.
aVRToManualLead	0..1	Seconds	Retard exigé pour le passage de la régulation de tension automatique (AVR) à Manuel pour une infraction MVAr d'avance de phase.
baseQ	0..1	ReactivePower	Valeur par défaut de la puissance réactive de base. Cette valeur représente la puissance réactive initiale qui peut être utilisée par toute fonction d'application.
condenserP	0..1	ActivePower	Puissance active consommée lors du fonctionnement en mode condensateur.
coolantCondition	0..1	Float	Température ou pression du milieu du fluide de refroidissement
coolantType	0..1	CoolantType	Méthode de refroidissement de la machine.
earthing	0..1	Boolean	Indique si le générateur est mis à la terre ou non. Utilisé pour l'échange de données relatives à un court-circuit, conformément à l'IEC 60909.
earthingStarPointR	0..1	Resistance	Résistance (Re) de mise à la terre du point neutre du générateur. Utilisé pour l'échange de données relatives à un court-circuit, conformément à l'IEC 60909.
earthingStarPointX	0..1	Reactance	Réactance (Xe) de mise à la terre du point neutre du générateur. Utilisé pour l'échange de données relatives à un court-circuit, conformément à l'IEC 60909.
ikk	0..1	CurrentFlow	Courant de court-circuit en régime établi (en ampères pour le profil) du générateur avec excitation compound pendant un court-circuit triphasé. – Ikk=0: Générateur sans excitation compound. – Ikk<>0: Générateur avec excitation compound. Ikk est utilisé pour calculer le courant de court-circuit minimal en régime établi pour les générateurs avec excitation compound. (4.6.1.2 de l'IEC 60909-0:2001). Utilisé uniquement pour les courts-circuits à alimentation unique d'un générateur. (4.3.4.2 de l'IEC 60909-0:2001).
manualToAVR	0..1	Seconds	Retard exigé pour le passage de Manuel à régulation automatique de tension. Cette valeur est utilisée dans le référentiel électrique d'accélération pour les programmes de calcul de répartition
maxQ	0..1	ReactivePower	Limite maximale de la puissance réactive. Il s'agit de la limite maximale (constructeur) de l'unité.
maxU	0..1	Voltage	Limite de tension maximale de la tranche.
minQ	0..1	ReactivePower	Limite de puissance réactive minimale de la tranche.
minU	0..1	Voltage	Limite de tension minimale de la tranche.
mu	0..1	Float	Facteur servant à calculer le courant coupé (section 4.5.2.1 de l'IEC 60909-0). Utilisé uniquement pour les courts-circuits à alimentation unique d'un générateur (section 4.3.4.2. de l'IEC 60909-0).
operatingMode	0..1	SynchronousMachineOperatingMode	Mode de fonctionnement courant.

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nom	mult	type	description
qPercent	0..1	PerCent	Partie de la commande réactive coordonnée qui provient de cette machine. L'attribut est utilisé comme facteur de participation ne s'élevant pas nécessairement à 100 % pour les appareils qui participent à la commande.
r	0..1	Resistance	Résistance équivalente (RG) du générateur. RG est prise en compte pour le calcul de tous les courants, à l'exception du calcul du courant de crête, ip. Utilisé pour l'échange de données relatives à un court-circuit, conformément à l'IEC 60909.
r0	0..1	Resistance	Résistance homopolaire de la machine synchrone.
r2	0..1	Resistance	Résistance inverse.
referencePriority	0..1	Integer	Priorité de l'unité pour une utilisation comme sélection de bus de référence pour l'angle de phase de la tension du flux de puissance. 0 = don't care (peu importe, valeur par défaut) 1 = plus haute priorité. 2 est moins que 1 et ainsi de suite.
satDirectSubtransX	0..1	PU	Réactance subtransitoire longitudinale saturée, également appelée Xd"sat.
satDirectSyncX	0..1	PU	Réactance longitudinale synchrone saturée (xdsat); réciproque du rapport de court-circuit. Utilisée pour l'échange de données relatives à un court-circuit, uniquement pour les courts-circuits à alimentation unique d'un générateur. (4.3.4.2 de l'IEC 60909-0:2001).
satDirectTransX	0..1	PU	Réactance transitoire longitudinale saturée. L'attribut est principalement utilisé pour calculer les courts-circuits conformément à l'ANSI.
shortCircuitRotorType	0..1	ShortCircuitRotorKind	Type de rotor, utilisé pour les applications de courts-circuits, uniquement pour les courts-circuits à alimentation unique, conformément à l'IEC 60909.
type	0..1	SynchronousMachineKind	Modes dans lesquels cette machine synchrone peut fonctionner.
voltageRegulationRange	0..1	PerCent	Plage de régulation de la tension du générateur (PG dans l'IEC 60909-0) utilisée pour calculer le facteur de correction d'impédance KG défini dans l'IEC 60909-0. Cet attribut est utilisé pour décrire la tension de fonctionnement de l'unité de production.
x0	0..1	Reactance	Réactance homopolaire de la machine synchrone.
x2	0..1	Reactance	Réactance inverse.
ratedPowerFactor	0..1	Float	hérité de: RotatingMachine
p	0..1	ActivePower	hérité de: RotatingMachine
ratedS	0..1	ApparentPower	hérité de: RotatingMachine
q	0..1	ReactivePower	hérité de: RotatingMachine
ratedU	0..1	Voltage	hérité de: RotatingMachine
controlEnabled	0..1	Boolean	hérité de: RegulatingCondEq
aggregate	0..1	Boolean	hérité de: Equipment
inService	0..1	Boolean	hérité de: Equipment
networkAnalysisEnabled	0..1	Boolean	hérité de: Equipment
normallyInService	0..1	Boolean	hérité de: Equipment
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

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Le Tableau 300 présente toutes les extrémités d'association de SynchronousMachine avec d'autres classes.

Tableau 300 – Extrémités d'association de Wires::SynchronousMachine avec d'autres classes

mult à partir de	nom	mult vers	type	description
1..*	InitialReactiveCapabilityCurve	0..1	ReactiveCapabilityCurve	Courbe de capacité réactive par défaut utilisée par une machine synchrone.
1..*	ReactiveCapabilityCurves	0..*	ReactiveCapabilityCurve	Toutes les courbes de capacité réactive disponibles pour cette machine synchrone.
0..*	PrimeMovers	0..*	PrimeMover	Machines motrices qui entraînent cette SynchronousMachine.
1..1	SynchronousMachineDynamics	0..1	SynchronousMachineDynamics	Modèle dynamique de machine synchrone utilisé pour décrire le comportement dynamique de cette machine synchrone.
1..1	HydroPump	0..1	HydroPump	hérité de: RotatingMachine
0..*	GeneratingUnit	0..1	GeneratingUnit	hérité de: RotatingMachine
~~1~~0..*	RegulatingControl	0..1	RegulatingControl	hérité de: RegulatingCondEq
0..*	BaseVoltage	0..1	BaseVoltage	hérité de: ConductingEquipment
1..1	SvStatus	0..*	SvStatus	hérité de: ConductingEquipment
0..*	ProtectionEquipments	0..*	ProtectionEquipment	hérité de: ConductingEquipment
1..1	Terminals	0..*	Terminal	hérité de: ConductingEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	hérité de: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	hérité de: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	hérité de: Equipment
0..1	Faults	0..*	Fault	hérité de: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	hérité de: Equipment
0..*	PSRType	0..1	PSRType	hérité de: PowerSystemResource
0..1	Controls	0..*	Control	hérité de: PowerSystemResource
0..1	Measurements	0..*	Measurement	hérité de: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	hérité de: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	hérité de: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

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6.4.84 Enumération SynchronousMachineOperatingMode

Mode de fonctionnement de la machine synchrone.

Le Tableau 301 présente tous les libellés de SynchronousMachineOperatingMode.

Tableau 301 – Libellés de Wires::SynchronousMachineOperatingMode

libellé	value	description
generator		Fonctionnement comme un générateur.
condenser		Fonctionnement comme un condensateur.
motor		Fonctionnement comme un moteur.

6.4.85 Enumération SynchronousMachineKind

Type de la machine synchrone.

Le Tableau 302 présente tous les libellés de SynchronousMachineKind.

Tableau 302 – Libellés de Wires::SynchronousMachineKind

libellé	value	description
generator		Indique que la machine synchrone peut fonctionner comme un générateur.
condenser		Indique que la machine synchrone peut fonctionner comme un condensateur.
generatorOrCondenser		Indique que la machine synchrone peut fonctionner comme un générateur ou un condensateur.
motor		Indique que la machine synchrone peut fonctionner comme un moteur.
generatorOrMotor		Indique que la machine synchrone peut fonctionner comme un générateur ou un moteur.
motorOrCondenser		Indique que la machine synchrone peut fonctionner comme un moteur ou un condensateur.
generatorOrCondenserOrMotor		Indique que la machine synchrone peut fonctionner comme un générateur, un condensateur ou un moteur.

6.4.86 TapChanger

Mécanisme de modification des positions des prises d'enroulement du transformateur.

Le Tableau 303 présente tous les attributs de TapChanger.

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Tableau 303 – Attributs de Wires::TapChanger

nom	mult	type	description
controlEnabled	0..1	Boolean	Spécifie le statut de régulation de l'équipement. True, il régule. False, il ne régule pas.
highStep	0..1	Integer	Position la plus élevée possible du régleur de prise en partant de neutre L'attribut doit être supérieur à lowStep.
initialDelay	0..1	Seconds	Pour un changeur de prises en charge, retard de fonctionnement initial du régleur (première modification).
lowStep	0..1	Integer	Position la plus basse possible du régleur de prise (retardée à neutre)
ltcFlag	0..1	Boolean	Spécifie si, oui ou non, un TapChanger a des capacités de changeur de prises en charge.
neutralStep	0..1	Integer	Position neutre du régleur de prise pour cet enroulement. L'attribut doit être supérieur ou égal à lowStep et inférieur ou égal à highStep. Il s'agit de la position du régleur à laquelle la tension est neutralU lorsque les autres bornes du transformateur sont à ratedU. En présence d'autres changeurs de prises sur le transformateur, ces prises sont maintenues constantes en position neutralStep.
neutralU	0..1	Voltage	Tension à laquelle l'enroulement fonctionne au réglage de la prise neutre. Il s'agit de la tension au niveau de la borne de la PowerTransformerEnd associée au changeur de prise lorsque tous les changeurs de prise du transformateur sont en position neutralStep. En principe, la neutralU du changeur de prise est identique à la ratedU de la PowerTransformerEnd, mais elle peut être différente dans des cas particuliers, comme lorsque le mécanisme de réglage de prise est séparé de l'enroulement, le plus souvent sur des transformateurs basse tension. Cet attribut n'est pas pertinent pour PhaseTapChangerAsymmetrical, PhaseTapChangerSymmetrical et PhaseTapChangerLinear.
normalStep	0..1	Integer	Position du régleur de prise utilisée en fonctionnement “normal” du réseau pour cet enroulement. Pour un changeur de prise "Fixed" (fixe), indique le réglage de prise physique actuel. L'attribut doit être supérieur ou égal à lowStep et inférieur ou égal à highStep.
subsequentDelay	0..1	Seconds	Pour un changeur de prises en charge, délai de fonctionnement supplémentaire du changeur de prises (deuxième modification et modifications suivantes du régleur)

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nom	mult	type	description
step	0..1	Float	Position du changeur de prises. Échelon de départ pour une solution en régime établi. Aucune valeur entière n'est autorisée pour prendre en charge des variables continues de prise. La valeur continue sert à appuyer les cas d'études dans lesquels aucun changeur de prises discret n'a encore été conçu, une solution pour laquelle la bande étroite de tension force le régleur de prise à osciller ou à s'ajuster pour obtenir une solution continue comme entrée. L'attribut doit être supérieur ou égal à lowStep et inférieur ou égal à highStep.
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 304 présente toutes les extrémités d'association de TapChanger avec d'autres classes.

Tableau 304 – Extrémités d'association de Wires::TapChanger avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..*	TapChangerControl	0..1	TapChangerControl	Schéma de commande de régulation auquel ce changeur de prises.
1..1	SvTapStep	0..1	SvTapStep	État d'échelon de prise associé au changeur de prises.
1..1	TapSchedules	0..*	TapSchedule	Un TapChanger peut avoir des TapSchedules.
0..*	PSRType	0..1	PSRType	hérité de: PowerSystemResource
0..1	Controls	0..*	Control	hérité de: PowerSystemResource
0..1	Measurements	0..*	Measurement	hérité de: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	hérité de: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	hérité de: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.4.87 TapChangerControl

Décrit le comportement spécifique aux changeurs de prises, par exemple la manière dont la tension à l'extrémité d'une ligne varie avec le niveau de charge et la compensation de la chute de tension lors de l'ajustement de la prise.

Le Tableau 305 présente tous les attributs de TapChangerControl.

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Tableau 305 – Attributs de Wires::TapChangerControl

nom	mult	type	description
limitVoltage	0..1	Voltage	Tension régulée maximale autorisée sur le secondaire du PT, quelle que soit la compensation de perte de ligne. Parfois appelée "first-house protection" (protection de premier stade).
lineDropCompensation	0..1	Boolean	Si true (vrai), la compensation de perte de ligne doit être appliquée.
lineDropR	0..1	Resistance	Réglage de la résistance de compensation de perte de ligne pour le flux de puissance normal (direct).
lineDropX	0..1	Reactance	Réglage de la réactance de compensation de perte de ligne pour le flux de puissance normal (direct).
reverseLineDropR	0..1	Resistance	Réglage de la résistance de compensation de perte de ligne pour le flux de puissance inverse.
reverseLineDropX	0..1	Reactance	Réglage de la réactance de compensation de perte de ligne pour le flux de puissance inverse.
discrete	0..1	Boolean	hérité de: RegulatingControl
enabled	0..1	Boolean	hérité de: RegulatingControl
mode	0..1	RegulatingControlModeKind	hérité de: RegulatingControl
monitoredPhase	0..1	PhaseCode	hérité de: RegulatingControl
targetDeadband	0..1	Float	hérité de: RegulatingControl
targetValue	0..1	Float	hérité de: RegulatingControl
targetValueUnitMultiplier	0..1	UnitMultiplier	hérité de: RegulatingControl
maxAllowedTargetValue	0..1	Float	hérité de: RegulatingControl
minAllowedTargetValue	0..1	Float	hérité de: RegulatingControl
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 306 présente toutes les extrémités d'association de TapChangerControl avec d'autres classes.

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Tableau 306 – Extrémités d'association de Wires::TapChangerControl avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..1	TapChanger	0..*	TapChanger	Changeurs de prises qui participent à ce plan de commande de prise de régulation.
0..*	Terminal	0..1	Terminal	hérité de: RegulatingControl
0..1	RegulatingCondEq	0..*	RegulatingCondEq	hérité de: RegulatingControl
1..1	RegulationSchedule	0..*	RegulationSchedule	hérité de: RegulatingControl
0..*	PSRType	0..1	PSRType	hérité de: PowerSystemResource
0..1	Controls	0..*	Control	hérité de: PowerSystemResource
0..1	Measurements	0..*	Measurement	hérité de: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	hérité de: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	hérité de: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.4.88 Classe racine TapChangerTablePoint

Décrit chaque échelon de prise dans la courbe tabulaire.

Le Tableau 307 présente tous les attributs de TapChangerTablePoint.

Tableau 307 – Attributs de Wires::TapChangerTablePoint

nom	mult	type	description
b	0..1	PerCent	Ecart de susceptance de la branche magnétisante, en pourcentage de la valeur nominale. La susceptance réelle est calculée de la manière suivante: susceptance magnétisante calculée = b(nominal) * (1 + b(de cette classe)/100). Le terme b(nominal) est défini comme la susceptance magnétisante statique à l'extrémité ou aux extrémités du transformateur de puissance associé. Ce modèle part de l'hypothèse que l'impédance a une forme en étoile (modèle pi).
g	0..1	PerCent	Ecart de conductance de la branche magnétisante, en pourcentage de la valeur nominale. La conductance réelle est calculée de la manière suivante: conductance magnétisante calculée = g(nominal) * (1 + g(de cette classe)/100). Le terme g(nominal) est défini comme la conductance magnétisante statique à l'extrémité ou aux extrémités du transformateur de puissance associé. Ce modèle part de l'hypothèse que l'impédance a une forme en étoile (modèle pi).

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nom	mult	type	description
r	0..1	PerCent	Ecart de résistance, en pourcentage de la valeur nominale. La réactance réelle est calculée de la manière suivante: résistance calculée = r(nominal) * (1 + r(de cette classe)/100). Le terme r(nominal) est défini comme la résistance statique à l'extrémité ou aux extrémités du transformateur de puissance associé. Ce modèle part de l'hypothèse que l'impédance a une forme en étoile (modèle pi).
ratio	0..1	Float	Tension à l'échelon de prise divisée par la tension assignée de l'extrémité du transformateur ayant le changeur de prises. Cette valeur est donc proche de un. Par exemple, si le rapport à l'échelon 1 est de 1,01 et que la tension assignée de l'extrémité du transformateur est de 110 kV, alors la tension obtenue en réglant le changeur de prises à l'échelon 1 est de 111,1 kV.
step	0..1	Integer	Echelon de prise.
x	0..1	PerCent	Ecart de réactance série, en pourcentage de la valeur nominale. La réactance réelle est calculée de la manière suivante: réactance calculée = x(nominal) * (1 + x(de cette classe)/100). Le terme x(nominal) est défini comme la réactance série statique à l'extrémité ou aux extrémités du transformateur de puissance associé. Ce modèle part de l'hypothèse que l'impédance a une forme en étoile (modèle pi).

6.4.89 TapSchedule

Modèle prédéfini sur une durée pour un échelon de prise.

Le Tableau 308 présente tous les attributs de TapSchedule.

Tableau 308 – Attributs de Wires::TapSchedule

nom	mult	type	description
endTime	0..1	DateTime	hérité de: RegularIntervalSchedule
timeStep	0..1	Seconds	hérité de: RegularIntervalSchedule
startTime	0..1	DateTime	hérité de: BasicIntervalSchedule
value1Multiplier	0..1	UnitMultiplier	hérité de: BasicIntervalSchedule
value1Unit	0..1	UnitSymbol	hérité de: BasicIntervalSchedule
value2Multiplier	0..1	UnitMultiplier	hérité de: BasicIntervalSchedule
value2Unit	0..1	UnitSymbol	hérité de: BasicIntervalSchedule
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 309 présente toutes les extrémités d'association de TapSchedule avec d'autres classes.

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Tableau 309 – Extrémités d'association de Wires::TapSchedule avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..*	TapChanger	1..1	TapChanger	Un TapSchedule est associé à un TapChanger.
0..*	DayType	0..1	DayType	hérité de: SeasonDayTypeSchedule
0..*	Season	0..1	Season	hérité de: SeasonDayTypeSchedule
1..1	TimePoints	1..*	RegularTimePoint	hérité de: RegularIntervalSchedule
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.4.90 Enumération TransformerControlMode

Modes de commande pour un transformateur.

Le Tableau 310 présente tous les libellés de TransformerControlMode.

Tableau 310 – Libellés de Wires::TransformerControlMode

libellé	value	description
volt		Commande de tension.
reactive		Commande de flux de puissance réactive.

6.4.91 TransformerCoreAdmittance

Admittance du noyau du transformateur. Utilisée pour spécifier l'admittance du noyau d'un transformateur de telle manière qu'elle puisse être répartie entre transformateurs de puissance.

Le Tableau 311 présente tous les attributs de TransformerCoreAdmittance.

Tableau 311 – Attributs de Wires::TransformerCoreAdmittance

nom	mult	type	description
b	0..1	Susceptance	Susceptance de branche magnétique (B mag). La valeur peut être positive ou négative.
b0	0..1	Susceptance	Susceptance de branche magnétique homopolaire.
g	0..1	Conductance	Conductance de branche magnétique (G mag).
g0	0..1	Conductance	Conductance de branche magnétique homopolaire.
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 312 présente toutes les extrémités d'association de TransformerCoreAdmittance avec d'autres classes.

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Tableau 312 – Extrémités d'association de Wires::TransformerCoreAdmittance avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..1	TransformerEnd	0..*	TransformerEnd	Toutes les extrémités de transformateur qui ont cette admittance de noyau.
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.4.92 TransformerEnd

Point de connexion conductrice d'un transformateur de puissance. Il correspond à une borne d'enroulement physique du transformateur. Dans les versions antérieures du CIM, la classe TransformerWinding avait un but comparable, mais cette classe est plus souple parce qu'elle s'associe à une borne, mais n'est pas une spécialisation de ConductingEquipment.

Le Tableau 313 présente tous les attributs de TransformerEnd.

Tableau 313 – Attributs de Wires::TransformerEnd

nom	mult	type	description
bmagSat	0..1	PerCent	Susceptance magnétisante du shunt central dans la zone de saturation.
endNumber	0..1	Integer	Numéro pour cette extrémité de transformateur, qui correspond à l'ordre des extrémités dans le groupe vectoriel du transformateur de puissance ou au numéro de position de l'angle de phase. Il convient que l'enroulement de tension maximum soit de 1. Il convient que chaque extrémité dans un transformateur de puissance ait un nombre unique d'extrémités ultérieures. Noter que le numéro d'extrémité du transformateur ne correspond pas nécessairement au numéro d'ordre de la borne.
grounded	0..1	Boolean	(pour les connexions Yn et Zn) True (vrai) si le neutre est mis à la terre solidement.
magBaseU	0..1	Voltage	Tension de référence à laquelle les mesures de saturation magnétisante ont été effectuées.
magSatFlux	0..1	PerCent	Niveau de flux au coude de la courbe de saturation et magnétisante du noyau.
rground	0..1	Resistance	(pour les connexions Yn et Zn) Partie résistive de l'impédance neutre lorsque "grounded" (mis à la terre) est true (vrai).
xground	0..1	Reactance	(pour les connexions Yn et Zn) Partie réactive de l'impédance neutre lorsque "grounded" (mis à la terre) est true (vrai).
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 314 présente toutes les extrémités d'association de TransformerEnd avec d'autres classes.

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Tableau 314 – Extrémités d'association de Wires::TransformerEnd avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..*	BaseVoltage	0..1	BaseVoltage	Tension de base de l'extrémité du transformateur. Elle est primordiale pour calculer le PU.
0..*	Terminal	0..1	Terminal	Borne du transformateur de puissance à laquelle appartient cette extrémité de transformateur.
1..1	PhaseTapChanger	0..1	PhaseTapChanger	Changeur de prises pour phase associé à cette extrémité de transformateur.
1..1	RatioTapChanger	0..1	RatioTapChanger	Changeur de prises pour rapport associé à cette extrémité de transformateur.
0..*	StarImpedance	0..1	TransformerStarImpedance	(précis pour les transformateurs à deux ou trois enroulements seulement) Impédances de modèle Pi de cette extrémité de transformateur. Par convention, il convient que, pour un transformateur à deux enroulements, les valeurs totales du transformateur soient entrées à l'extrémité haute tension (endNumber=1).
0..*	CoreAdmittance	0..1	TransformerCoreAdmittance	Admittance de noyau de cette extrémité de transformateur, représentant le courant magnétisant et les pertes dans le noyau. Il convient de fournir toutes les valeurs du transformateur pour une extrémité de transformateur uniquement.
1..*	ToMeshImpedance	0..*	TransformerMeshImpedance	Toutes les impédances de maille entre cette extrémité de transformateur (de) et les autres extrémités de transformateur (vers).
1..1	FromMeshImpedance	0..*	TransformerMeshImpedance	Toutes les impédances de maille entre cette extrémité de transformateur (vers) et les autres extrémités de transformateur (de).
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.4.93 TransformerMeshImpedance

Impédance en maille du transformateur modèle en triangle (Delta-model) entre les extrémités du transformateur.

En règle générale, cette classe décrit par paires l'impédance entre deux extrémités de transformateur, c'est-à-dire que les cardinalités sont de 1 aux deux associations d'extrémité de transformateur. Cependant, les cardinalités sont supérieures à 1 quand deux extrémités de transformateur ou davantage sont modélisées.

Le Tableau 315 présente tous les attributs de TransformerMeshImpedance.

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Tableau 315 – Attributs de Wires::TransformerMeshImpedance

nom	mult	type	description
r	0..1	Resistance	Résistance entre l'extrémité d'origine (de) et de destination (vers), du point de vue de l'extrémité d'origine (de).
r0	0..1	Resistance	Résistance homopolaire entre l'extrémité d'origine (de) et de destination (vers), du point de vue de l'extrémité d'origine (de).
x	0..1	Reactance	Réactance entre l'extrémité d'origine (de) et de destination (vers), du point de vue de l'extrémité d'origine (de).
x0	0..1	Reactance	Réactance homopolaire entre l'extrémité d'origine (de) et de destination (vers), du point de vue de l'extrémité de l'extrémité d'origine (de).
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 316 présente toutes les extrémités d'association de TransformerMeshImpedance avec d'autres classes.

Tableau 316 – Extrémités d'association de Wires::TransformerMeshImpedance avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..*	ToTransformerEnd	1..*	TransformerEnd	Toutes les extrémités de transformateur auxquelles est connectée cette impédance en maille.
0..*	FromTransformerEnd	1..1	TransformerEnd	Extrémité d'origine à laquelle est connectée cette impédance en maille. Elle détermine la référence de tension.
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.4.94 TransformerStarImpedance

Impédance en étoile du transformateur (modèle Pi) qui reflète précisément l'impédance pour les transformateurs à 2 ou 3 enroulements. Pour les transformateurs à 4 enroulements ou plus, la classe TransformerMeshImpedance doit être utilisée.

Pour des réseaux de transport, utiliser les impédances PowerTransformerEnd (r, r0, x, x0, b, b0, g et g0).

Le Tableau 317 présente tous les attributs de TransformerStarImpedance.

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Tableau 317 – Attributs de Wires::TransformerStarImpedance

nom	mult	type	description
r	0..1	Resistance	Résistance de l'extrémité du transformateur.
r0	0..1	Resistance	Résistance série homopolaire de l'extrémité du transformateur.
x	0..1	Reactance	Réactance série directe de l'extrémité du transformateur.
x0	0..1	Reactance	Réactance série homopolaire de l'extrémité du transformateur.
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 318 présente toutes les extrémités d'association de TransformerStarImpedance avec d'autres classes.

Tableau 318 – Extrémités d'association de Wires::TransformerStarImpedance avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..1	TransformerEnd	0..*	TransformerEnd	Toutes les extrémités de transformateur qui ont cette impédance en étoile.
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.4.95 TransformerTank

Ensemble de deux enroulements couplés ou plus qui transforme la puissance électrique entre des niveaux de tension. Ces enroulements sont liés sur un noyau commun et se trouvent dans la même cuve. La cuve de transformateur peut être utilisée pour modéliser à la fois des transformateurs monophasés et triphasés.

Le Tableau 319 présente tous les attributs de TransformerTank.

Tableau 319 – Attributs de Wires::TransformerTank

nom	mult	type	description
aggregate	0..1	Boolean	hérité de: Equipment
inService	0..1	Boolean	hérité de: Equipment
networkAnalysisEnabled	0..1	Boolean	hérité de: Equipment
normallyInService	0..1	Boolean	hérité de: Equipment
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 320 présente toutes les extrémités d'association de TransformerTank avec d'autres classes.

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Tableau 320 – Extrémités d'association de Wires::TransformerTank avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..*	PowerTransformer	0..1	PowerTransformer	Batterie à laquelle ce transformateur appartient.
0..1	TransformerTankEnds	1..*	TransformerTankEnd	Tous les enroulements de ce transformateur.
0..1	OperationalLimitSet	0..*	OperationalLimitSet	hérité de: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	hérité de: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	hérité de: Equipment
0..1	Faults	0..*	Fault	hérité de: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	hérité de: Equipment
0..*	PSRType	0..1	PSRType	hérité de: PowerSystemResource
0..1	Controls	0..*	Control	hérité de: PowerSystemResource
0..1	Measurements	0..*	Measurement	hérité de: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	hérité de: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	hérité de: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.4.96 TransformerTankEnd

Une extrémité de cuve de transformateur représente un enroulement individuel pour des modèles déséquilibrés ou pour des cuves de transformateur connectées dans une batterie (et une batterie est modélisée avec le PowerTransformer).

Le Tableau 321 présente tous les attributs de TransformerTankEnd.

Tableau 321 – Attributs de Wires::TransformerTankEnd

nom	mult	type	description
phases	0..1	PhaseCode	Décrit les phases transportées par un équipement conducteur.
bmagSat	0..1	PerCent	hérité de: TransformerEnd
endNumber	0..1	Integer	hérité de: TransformerEnd
grounded	0..1	Boolean	hérité de: TransformerEnd
magBaseU	0..1	Voltage	hérité de: TransformerEnd
magSatFlux	0..1	PerCent	hérité de: TransformerEnd
rground	0..1	Resistance	hérité de: TransformerEnd
xground	0..1	Reactance	hérité de: TransformerEnd
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

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Le Tableau 322 présente toutes les extrémités d'association de TransformerTankEnd avec d'autres classes.

Tableau 322 – Extrémités d'association de Wires::TransformerTankEnd avec d'autres classes

mult à partir de	nom	mult vers	type	description
1..*	TransformerTank	0..1	TransformerTank	Transformateur auquel appartient cet enroulement.
0..*	BaseVoltage	0..1	BaseVoltage	hérité de: TransformerEnd
0..*	Terminal	0..1	Terminal	hérité de: TransformerEnd
1..1	PhaseTapChanger	0..1	PhaseTapChanger	hérité de: TransformerEnd
1..1	RatioTapChanger	0..1	RatioTapChanger	hérité de: TransformerEnd
0..*	StarImpedance	0..1	TransformerStarImpedance	hérité de: TransformerEnd
0..*	CoreAdmittance	0..1	TransformerCoreAdmittance	hérité de: TransformerEnd
1..*	ToMeshImpedance	0..*	TransformerMeshImpedance	hérité de: TransformerEnd
1..1	FromMeshImpedance	0..*	TransformerMeshImpedance	hérité de: TransformerEnd
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.4.97 VoltageControlZone

Zone du système de puissance déterminée pour réguler la tension secondaire. Une zone de réglage de la tension consiste en un ensemble de postes avec un segment de jeu de barres déterminé dont la tension est contrôlée.

Le Tableau 323 présente tous les attributs de VoltageControlZone.

Tableau 323 – Attributs de Wires::VoltageControlZone

nom	mult	type	description
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 324 présente toutes les extrémités d'association de VoltageControlZone avec d'autres classes.

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Tableau 324 – Extrémités d'association de Wires::VoltageControlZone avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..1	BusbarSection	1..1	BusbarSection	Une VoltageControlZone (zone de réglage de la tension) est commandée par une BusbarSection (section de jeu de barres) déterminée.
0..*	RegulationSchedule	0..1	RegulationSchedule	Une VoltageControlZone peut avoir un programme de régulation de tension.
0..*	PSRType	0..1	PSRType	hérité de: PowerSystemResource
0..1	Controls	0..*	Control	hérité de: PowerSystemResource
0..1	Measurements	0..*	Measurement	hérité de: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	hérité de: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	hérité de: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.4.98 WireSegment

Appareil conducteur de puissance à deux bornes d'impédance et de longueur négligeables présenté comme un appareil d'impédance nulle qui peut être utilisé pour connecter l'équipement auxiliaire à ses bornes.

Le Tableau 325 présente tous les attributs de WireSegment.

Tableau 325 – Attributs de Wires::WireSegment

nom	mult	type	description
length	0..1	Length	hérité de: Conductor
aggregate	0..1	Boolean	hérité de: Equipment
inService	0..1	Boolean	hérité de: Equipment
networkAnalysisEnabled	0..1	Boolean	hérité de: Equipment
normallyInService	0..1	Boolean	hérité de: Equipment
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 326 présente toutes les extrémités d'association de WireSegment avec d'autres classes.

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Tableau 326 – Extrémités d'association de Wires::WireSegment avec d'autres classes

mult à partir de	nom	mult vers	type	description
1..1	WireSegmentPhases	0..*	WireSegmentPhase	Phases de segment de fil appartenant au segment de fil.
0..*	BaseVoltage	0..1	BaseVoltage	hérité de: ConductingEquipment
1..1	SvStatus	0..*	SvStatus	hérité de: ConductingEquipment
0..*	ProtectionEquipments	0..*	ProtectionEquipment	hérité de: ConductingEquipment
1..1	Terminals	0..*	Terminal	hérité de: ConductingEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	hérité de: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	hérité de: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	hérité de: Equipment
0..1	Faults	0..*	Fault	hérité de: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	hérité de: Equipment
0..*	PSRType	0..1	PSRType	hérité de: PowerSystemResource
0..1	Controls	0..*	Control	hérité de: PowerSystemResource
0..1	Measurements	0..*	Measurement	hérité de: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	hérité de: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	hérité de: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.4.99 WireSegmentPhase

Représente un fil unique sur un segment de fil à courant alternatif.

Le Tableau 327 présente tous les attributs de WireSegmentPhase.

Tableau 327 – Attributs de Wires::WireSegmentPhase

nom	mult	type	description
phase	0..1	SinglePhaseKind	Connection de phase du fil aux deux extrémités.
sequenceNumber	0..1	Integer	Désignation numérique de la phase de ce segment de fil. Il convient que chaque phase de segment de fil d'un segment de fil n'ait qu'un seul numéro d'ordre.
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 328 présente toutes les extrémités d'association de WireSegmentPhase avec d'autres classes.

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Tableau 328 – Extrémités d'association de Wires::WireSegmentPhase avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..*	WireSegment	1..1	WireSegment	Segment de fil auquel la phase appartient
0..*	PSRType	0..1	PSRType	hérité de: PowerSystemResource
0..1	Controls	0..*	Control	hérité de: PowerSystemResource
0..1	Measurements	0..*	Measurement	hérité de: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	hérité de: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	hérité de: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.4.100 Enumération WindingConnection

Type de connexion d'enroulement.

Le Tableau 329 présente tous les libellés de WindingConnection.

Tableau 329 – Libellés de Wires::WindingConnection

libellé	value	description
D		Delta (en triangle).
Y		Wye (en étoile).
Z		ZigZag.
Yn		Wye (c'est-à-dire I grec, montage en étoile), avec neutre sorti pour la mise à la terre.
Zn		ZigZag, avec neutre sorti pour la mise à la terre.
A		Enroulement commun d'autotransformateur.
I		Enroulement indépendant, pour connexions monophasées.

6.5 Paquetage LoadModel

6.5.1 Généralités

Ce paquetage est chargé de la modélisation des consommateurs d'énergie et de la charge du système sous forme de courbes et de données de courbe associées. Des circonstances particulières pouvant affecter la charge, telles que les saisons et les types de jours, sont également incluses ici.

Ces informations sont utilisées par Load Forecasting (prévision de la charge) et Load Management (gestion de la charge).

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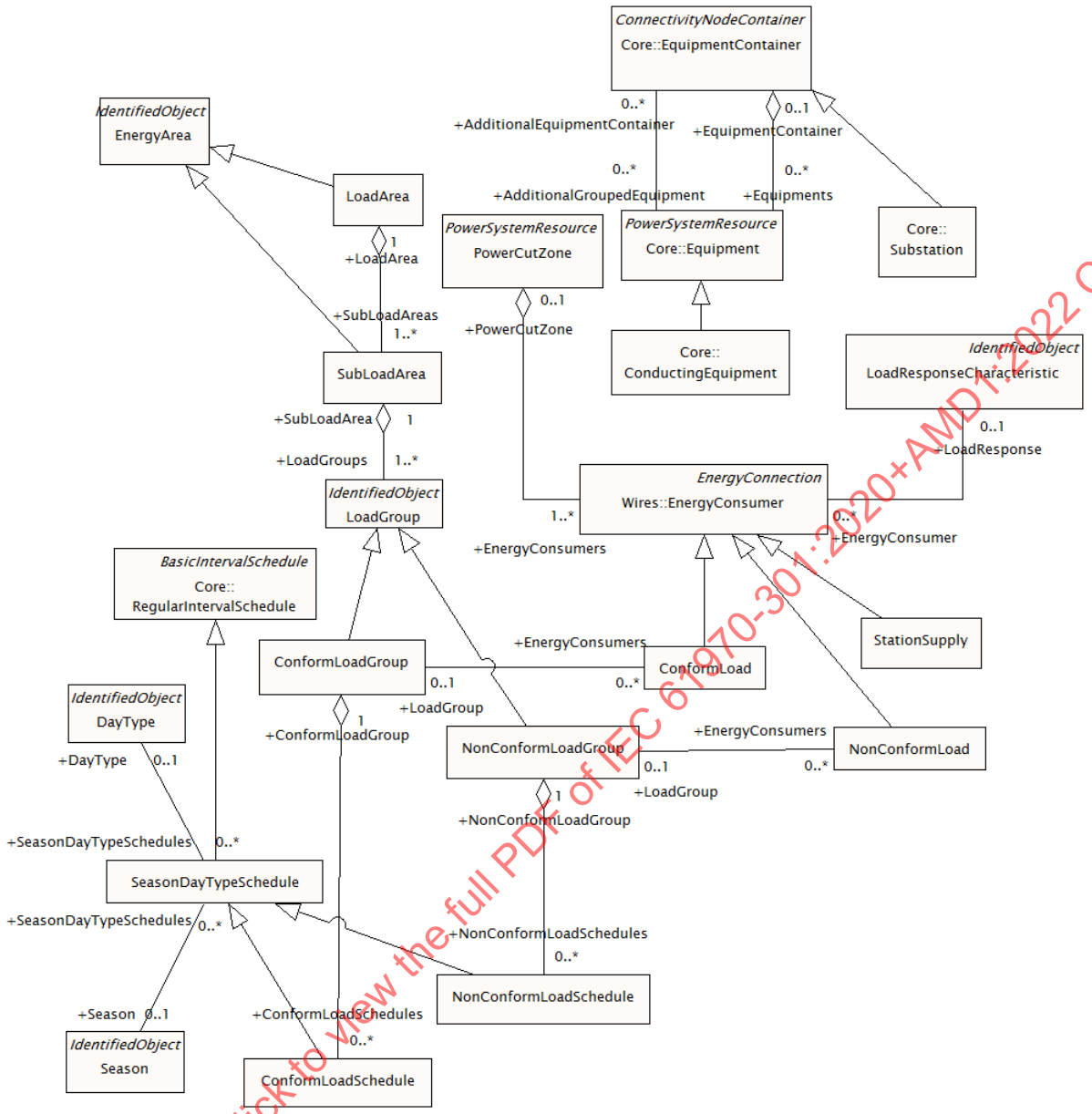


Figure 102 – Diagramme de classe LoadModel::Main

Figure 102: Ce diagramme représente toutes les classes incluses dans le paquetage LoadModel, de même que les classes-clés externes qui ont des associations avec des classes LoadModel.

6.5.2 ConformLoad

Les charges conformes ConformLoad représentent les charges qui suivent un profil de modification de charge quotidienne, ce profil pouvant être utilisé pour mettre à l'échelle la charge avec un système de charge.

Le Tableau 330 présente tous les attributs de ConformLoad.

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Tableau 330 – Attributs de LoadModel::ConformLoad

nom	mult	type	description
customerCount	0..1	Integer	hérité de: EnergyConsumer
grounded	0..1	Boolean	hérité de: EnergyConsumer
pfixed	0..1	ActivePower	hérité de: EnergyConsumer
pfixedPct	0..1	PerCent	hérité de: EnergyConsumer
phaseConnection	0..1	PhaseShuntConnectionKind	hérité de: EnergyConsumer
qfixed	0..1	ReactivePower	hérité de: EnergyConsumer
qfixedPct	0..1	PerCent	hérité de: EnergyConsumer
p	0..1	ActivePower	hérité de: EnergyConsumer
q	0..1	ReactivePower	hérité de: EnergyConsumer
aggregate	0..1	Boolean	hérité de: Equipment
inService	0..1	Boolean	hérité de: Equipment
networkAnalysisEnabled	0..1	Boolean	hérité de: Equipment
normallyInService	0..1	Boolean	hérité de: Equipment
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 331 présente toutes les extrémités d'association de ConformLoad avec d'autres classes.

Tableau 331 – Extrémités d'association de LoadModel::ConformLoad avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..*	LoadGroup	0..1	ConformLoadGroup	Groupe de ce ConformLoad.
0..*	LoadResponse	0..1	LoadResponseCharacteristic	hérité de: EnergyConsumer
1..1	EnergyConsumerPhase	0..*	EnergyConsumerPhase	hérité de: EnergyConsumer
1..*	PowerCutZone	0..1	PowerCutZone	hérité de: EnergyConsumer
0..*	LoadDynamics	0..1	LoadDynamics	hérité de: EnergyConsumer
0..*	BaseVoltage	0..1	BaseVoltage	hérité de: ConductingEquipment
1..1	SvStatus	0..*	SvStatus	hérité de: ConductingEquipment
0..*	ProtectionEquipments	0..*	ProtectionEquipment	hérité de: ConductingEquipment
1..1	Terminals	0..*	Terminal	hérité de: ConductingEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	hérité de: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	hérité de: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	hérité de: Equipment
0..1	Faults	0..*	Fault	hérité de: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	hérité de: Equipment
0..*	PSRType	0..1	PSRType	hérité de: PowerSystemResource

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mult à partir de	nom	mult vers	type	description
0..1	Controls	0..*	Control	hérité de: PowerSystemResource
0..1	Measurements	0..*	Measurement	hérité de: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	hérité de: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	hérité de: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.5.3 ConformLoadGroup

Groupe de charges qui se conforment à un modèle d'attribution.

Le Tableau 332 présente tous les attributs de ConformLoadGroup.

Tableau 332 – Attributs de LoadModel::ConformLoadGroup

nom	mult	type	description
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 333 présente toutes les extrémités d'association de ConformLoadGroup avec d'autres classes.

Tableau 333 – Extrémités d'association de LoadModel::ConformLoadGroup avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..1	EnergyConsumers	0..*	ConformLoad	Charges conformes (ConformLoad) affectées à ce groupe de charges conformes (ConformLoadGroup).
1..1	ConformLoadSchedules	0..*	ConformLoadSchedule	Programmes ConformLoadSchedules dans le groupe ConformLoadGroup.
1..*	SubLoadArea	1..1	SubLoadArea	hérité de: LoadGroup
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.5.4 ConformLoadSchedule

Courbe de la charge en fonction du temps (axe X) indiquant les valeurs de puissance active (axe Y1) et de puissance réactive (axe Y2) de chaque unité de la période couverte. Cette courbe représente un modèle de charge classique pour une période sur un type de jour et une saison donnés.

Le Tableau 334 présente tous les attributs de ConformLoadSchedule.

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Tableau 334 – Attributs de LoadModel::ConformLoadSchedule

nom	mult	type	description
endTime	0..1	DateTime	hérité de: RegularIntervalSchedule
timeStep	0..1	Seconds	hérité de: RegularIntervalSchedule
startTime	0..1	DateTime	hérité de: BasicIntervalSchedule
value1Multiplier	0..1	UnitMultiplier	hérité de: BasicIntervalSchedule
value1Unit	0..1	UnitSymbol	hérité de: BasicIntervalSchedule
value2Multiplier	0..1	UnitMultiplier	hérité de: BasicIntervalSchedule
value2Unit	0..1	UnitSymbol	hérité de: BasicIntervalSchedule
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 335 présente toutes les extrémités d'association de ConformLoadSchedule avec d'autres classes.

Tableau 335 – Extrémités d'association de LoadModel::ConformLoadSchedule avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..*	ConformLoadGroup	1..1	ConformLoadGroup	ConformLoadGroup auquel le ConformLoadSchedule appartient.
0..*	DayType	0..1	DayType	hérité de: SeasonDayTypeSchedule
0..*	Season	0..1	Season	hérité de: SeasonDayTypeSchedule
1..1	TimePoints	1..*	RegularTimePoint	hérité de: RegularIntervalSchedule
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.5.5 DayType

Groupe de jours similaires. Par exemple, il peut être utilisé pour représenter les jours de la semaine, le week-end ou les vacances.

Le Tableau 336 présente tous les attributs de DayType.

Tableau 336 – Attributs de LoadModel::DayType

nom	mult	type	description
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 337 présente toutes les extrémités d'association de DayType avec d'autres classes.

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Tableau 337 – Extrémités d'association de LoadModel::DayType avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..1	SeasonDayTypeSchedules	0..*	SeasonDayTypeSchedule	Programmes utilisant ce DayType.
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.5.6 EnergyArea

Décrit une zone comportant la production ou la consommation d'énergie. Les spécialisations visent à prendre en charge la fonction d'attribution de charge comme cela est généralement exigé dans les systèmes de gestion d'énergie ou les études de planification pour attribuer des niveaux hypothétiques de charge aux points individuels de charge pour l'analyse du flux de charge. La zone d'énergie peut souvent être liée aux niveaux de charge mesurés et prévus.

Le Tableau 338 présente tous les attributs de EnergyArea.

Tableau 338 – Attributs de LoadModel::EnergyArea

nom	mult	type	description
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 339 présente toutes les extrémités d'association de EnergyArea avec d'autres classes.

Tableau 339 – Extrémités d'association de LoadModel::EnergyArea avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..1	ControlArea	0..1	ControlArea	Spécification de zone de commande utilisée pour la prévision de la charge.
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.5.7 LoadArea

La classe est la racine ou le premier niveau dans une structure hiérarchique pour regrouper des charges à des fins de mise à l'échelle des charges du flux de charge.

Le Tableau 340 présente tous les attributs de LoadArea.

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Tableau 340 – Attributs de LoadModel::LoadArea

nom	mult	type	description
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 341 présente toutes les extrémités d'association de LoadArea avec d'autres classes.

Tableau 341 – Extrémités d'association de LoadModel::LoadArea avec d'autres classes

mult à partir de	nom	mult vers	type	description
1..1	SubLoadAreas	1..*	SubLoadArea	SubLoadAreas (sous-zones de charge) de la LoadArea (zone de charge).
0..1	ControlArea	0..1	ControlArea	hérité de: EnergyArea
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.5.8 LoadGroup

La classe est le troisième niveau dans une structure hiérarchique pour regrouper des charges à des fins de mise à l'échelle des charges du flux de charge.

Le Tableau 342 présente tous les attributs de LoadGroup.

Tableau 342 – Attributs de LoadModel::LoadGroup

nom	mult	type	description
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 343 présente toutes les extrémités d'association de LoadGroup avec d'autres classes.

Tableau 343 – Extrémités d'association de LoadModel::LoadGroup avec d'autres classes

mult à partir de	nom	mult vers	type	description
1..*	SubLoadArea	1..1	SubLoadArea	SubLoadArea à laquelle le Loadgroup appartient.
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

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6.5.9 LoadResponseCharacteristic

Modélise la réponse caractéristique de la demande de charge due aux variations des conditions du système telles que la tension et la fréquence. Elle n'est pas liée à la réponse à la demande.

Si LoadResponseCharacteristic.exponentModel est True, les modèles de dépendance exponentielle de tension ou de fréquence sont spécifiés et utilisés pour calculer:

Les composantes de la puissance active et réactive du modèle de charge

Les équations permettant de calculer les composantes de la puissance active et réactive du modèle de charge sont propres au calcul du flux de puissance. Elles appliquent de ce fait des grandeurs différentes en fonction du cas d'utilisation de l'échange de données.

Les équations relatives à la puissance injectée du modèle de charge de dépendance exponentielle de la tension sont:

Pinjection = Pnominal * (Voltage/cim:BaseVoltage.nominalVoltage) ** cim:LoadResponseCharacteristic.pVoltageExponent

qInjection = Qnominal * (Voltage/cim:BaseVoltage.nominalVoltage) ** cim:LoadResponseCharacteristic.qVoltageExponent

où

1) * signifie "multiplier" et ** est "à la puissance".
2) Pnominal et Qnominal représentent la puissance active et la puissance réactive à la tension nominale étant donné que toute charge décrite par le modèle de dépendance exponentielle de la tension doit être prise en compte à la tension nominale. Ceci signifie que EnergyConsumer.p et EnergyConsumer.q sont à la tension nominale.
3) Après résolution du flux de puissance:
   – pInjection et qInjection correspondent à SvPowerflow.p et SvPowerflow.q respectivement;
   – Voltage (tension) correspond à SvVoltage.v au niveau du TopologicalNode où la charge est connectée.

Le Tableau 344 présente tous les attributs de LoadResponseCharacteristic.

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Tableau 344 – Attributs de LoadModel::LoadResponseCharacteristic

nom	mult	type	description
exponentModel	0..1	Boolean	Indique que le modèle de dépendance exponentielle de la tension doit être utilisé. Si false (faux), le modèle de coefficient doit être utilisé. Le modèle de dépendance exponentielle de la tension est constitué des attributs suivants – pVoltageExponent – qVoltageExponent – pFrequencyExponent – qFrequencyExponent. Le modèle de coefficient est constitué des attributs suivants – pConstantImpedance – pConstantCurrent – pConstantPower – qConstantImpedance – qConstantCurrent – qConstantPower. La somme de pConstantImpedance, pConstantCurrent et pConstantPower doit être égale à 1. La somme de qConstantImpedance, qConstantCurrent et qConstantPower doit être égale à 1.
pConstantCurrent	0..1	Float	Partie de la charge de puissance active modélisée comme courant constant.
pConstantImpedance	0..1	Float	Partie de la charge de puissance active modélisée comme impédance constante.
pConstantPower	0..1	Float	Partie de la charge de puissance active modélisée comme puissance constante.
pFrequencyExponent	0..1	Float	Exposant de la fréquence par unité émettant une puissance active.
pVoltageExponent	0..1	Float	Exposant de la tension par unité émettant une puissance réelle.
qConstantCurrent	0..1	Float	Partie de la charge de puissance réactive modélisée comme courant constant.
qConstantImpedance	0..1	Float	Partie de la charge de puissance réactive modélisée comme impédance constante.
qConstantPower	0..1	Float	Partie de la charge de puissance réactive modélisée comme puissance constante.
qFrequencyExponent	0..1	Float	Exposant de la fréquence par unité émettant une puissance réactive.
qVoltageExponent	0..1	Float	Exposant de la tension par unité émettant une puissance réactive.
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 345 présente toutes les extrémités d'association de LoadResponseCharacteristic avec d'autres classes.

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Tableau 345 – Extrémités d'association de LoadModel::LoadResponseCharacteristic avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..1	EnergyConsumer	0..*	EnergyConsumer	Ensemble de charges ayant la caractéristique de réponse.
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.5.10 NonConformLoad

Les charges non conformes NonConformLoad représentent des charges qui ne suivent pas un profil de variation quotidienne de charge et dont les variations ne sont pas corrélées au profil de variation de charge quotidienne.

Le Tableau 346 présente tous les attributs de NonConformLoad.

Tableau 346 – Attributs de LoadModel::NonConformLoad

nom	mult	type	description
customerCount	0..1	Integer	hérité de: EnergyConsumer
grounded	0..1	Boolean	hérité de: EnergyConsumer
pfixed	0..1	ActivePower	hérité de: EnergyConsumer
pfixedPct	0..1	PerCent	hérité de: EnergyConsumer
phaseConnection	0..1	PhaseShuntConnectionKind	hérité de: EnergyConsumer
qfixed	0..1	ReactivePower	hérité de: EnergyConsumer
qfixedPct	0..1	PerCent	hérité de: EnergyConsumer
p	0..1	ActivePower	hérité de: EnergyConsumer
q	0..1	ReactivePower	hérité de: EnergyConsumer
aggregate	0..1	Boolean	hérité de: Equipment
inService	0..1	Boolean	hérité de: Equipment
networkAnalysisEnabled	0..1	Boolean	hérité de: Equipment
normallyInService	0..1	Boolean	hérité de: Equipment
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 347 présente toutes les extrémités d'association de NonConformLoad avec d'autres classes.

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Tableau 347 – Extrémités d'association de LoadModel::NonConformLoad avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..*	LoadGroup	0..1	NonConformLoadGroup	Groupe de ce ConformLoad.
0..*	LoadResponse	0..1	LoadResponseCharacteristic	hérité de: EnergyConsumer
1..1	EnergyConsumerPhase	0..*	EnergyConsumerPhase	hérité de: EnergyConsumer
1..*	PowerCutZone	0..1	PowerCutZone	hérité de: EnergyConsumer
0..*	LoadDynamics	0..1	LoadDynamics	hérité de: EnergyConsumer
0..*	BaseVoltage	0..1	BaseVoltage	hérité de: ConductingEquipment
1..1	SvStatus	0..*	SvStatus	hérité de: ConductingEquipment
0..*	ProtectionEquipments	0..*	ProtectionEquipment	hérité de: ConductingEquipment
1..1	Terminals	0..*	Terminal	hérité de: ConductingEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	hérité de: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	hérité de: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	hérité de: Equipment
0..1	Faults	0..*	Fault	hérité de: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	hérité de: Equipment
0..*	PSRType	0..1	PSRType	hérité de: PowerSystemResource
0..1	Controls	0..*	Control	hérité de: PowerSystemResource
0..1	Measurements	0..*	Measurement	hérité de: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	hérité de: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	hérité de: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.5.11 NonConformLoadGroup

Charges qui ne suivent pas un profil de variation quotidienne et saisonnière de charge.

Le Tableau 348 présente tous les attributs de NonConformLoadGroup.

Tableau 348 – Attributs de LoadModel::NonConformLoadGroup

nom	mult	type	description
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 349 présente toutes les extrémités d'association de NonConformLoadGroup avec d'autres classes.

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Tableau 349 – Extrémités d'association de LoadModel::NonConformLoadGroup avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..1	EnergyConsumers	0..*	NonConformLoad	Charges conformes (ConformLoad) affectées à ce groupe de charges conformes (ConformLoadGroup).
1..1	NonConformLoadSchedules	0..*	NonConformLoadSchedule	Programmes NonConformLoadSchedules dans le groupe NonConformLoadGroup.
1..*	SubLoadArea	1..1	SubLoadArea	hérité de: LoadGroup
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.5.12 NonConformLoadSchedule

Programme (courbes) de puissance active (axe Y1) et de puissance réactive (axe Y2) en fonction du temps (axe X) pour les charges non conformes, par exemple charge industrielle significative ou utilisation de centrale électrique (si modélisée).

Le Tableau 350 présente tous les attributs de NonConformLoadSchedule.

Tableau 350 – Attributs de LoadModel::NonConformLoadSchedule

nom	mult	type	description
endTime	0..1	DateTime	hérité de: RegularIntervalSchedule
timeStep	0..1	Seconds	hérité de: RegularIntervalSchedule
startTime	0..1	DateTime	hérité de: BasicIntervalSchedule
value1Multiplier	0..1	UnitMultiplier	hérité de: BasicIntervalSchedule
value1Unit	0..1	UnitSymbol	hérité de: BasicIntervalSchedule
value2Multiplier	0..1	UnitMultiplier	hérité de: BasicIntervalSchedule
value2Unit	0..1	UnitSymbol	hérité de: BasicIntervalSchedule
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 351 présente toutes les extrémités d'association de NonConformLoadSchedule avec d'autres classes.

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Tableau 351 – Extrémités d'association de LoadModel::NonConformLoadSchedule avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..*	NonConformLoadGroup	1..1	NonConformLoadGroup	NonConformLoadGroup auquel le NonConformLoadSchedule appartient.
0..*	DayType	0..1	DayType	hérité de: SeasonDayTypeSchedule
0..*	Season	0..1	Season	hérité de: SeasonDayTypeSchedule
1..1	TimePoints	1..*	RegularTimePoint	hérité de: RegularIntervalSchedule
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.5.13 PowerCutZone

Section ou zone du système de puissance utilisée pour le délestage.

Le Tableau 352 présente tous les attributs de PowerCutZone.

Tableau 352 – Attributs de LoadModel::PowerCutZone

nom	mult	type	description
cutLevel1	0..1	PerCent	Premier niveau (quantité) de charge à couper en pourcentages de la charge totale de zone.
cutLevel2	0..1	PerCent	Deuxième niveau (quantité) de charge à couper en pourcentages de la charge totale de zone.
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 353 présente toutes les extrémités d'association de PowerCutZone avec d'autres classes.

Tableau 353 – Extrémités d'association de LoadModel::PowerCutZone avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..1	EnergyConsumers	1..*	EnergyConsumer	Le consommateur d'énergie est affecté à une zone de coupure de puissance.
0..*	PSRType	0..1	PSRType	hérité de: PowerSystemResource
0..1	Controls	0..*	Control	hérité de: PowerSystemResource
0..1	Measurements	0..*	Measurement	hérité de: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	hérité de: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	hérité de: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

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6.5.14 Season

Période spécifiée de l'année.

Le Tableau 354 présente tous les attributs de Season.

Tableau 354 – Attributs de LoadModel::Season

nom	mult	type	description
endDate	0..1	MonthDay	Date de fin de la saison.
startDate	0..1	MonthDay	Date de début de la saison.
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 355 présente toutes les extrémités d'association de Season avec d'autres classes.

Tableau 355 – Extrémités d'association de LoadModel::Season avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..1	SeasonDayTypeSchedules	0..*	SeasonDayTypeSchedule	Programmes utilisant cette saison.
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.5.15 SeasonDayTypeSchedule

Programme horaire qui couvre une durée de 24 heures, assortie de données de courbe pour un type spécifique de saison ou de jour.

Le Tableau 356 présente tous les attributs de SeasonDayTypeSchedule.

Tableau 356 – Attributs de LoadModel::SeasonDayTypeSchedule

nom	mult	type	description
endTime	0..1	DateTime	hérité de: RegularIntervalSchedule
timeStep	0..1	Seconds	hérité de: RegularIntervalSchedule
startTime	0..1	DateTime	hérité de: BasicIntervalSchedule
value1Multiplier	0..1	UnitMultiplier	hérité de: BasicIntervalSchedule
value1Unit	0..1	UnitSymbol	hérité de: BasicIntervalSchedule
value2Multiplier	0..1	UnitMultiplier	hérité de: BasicIntervalSchedule
value2Unit	0..1	UnitSymbol	hérité de: BasicIntervalSchedule
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

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Le Tableau 357 présente toutes les extrémités d'association de SeasonDayTypeSchedule avec d'autres classes.

Tableau 357 – Extrémités d'association de LoadModel::SeasonDayTypeSchedule avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..*	DayType	0..1	DayType	DayType (type de jour) pour le programme (Schedule).
0..*	Season	0..1	Season	Season (saison) pour le programme (Schedule).
1..1	TimePoints	1..*	RegularTimePoint	hérité de: RegularIntervalSchedule
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.5.16 StationSupply

Approvisionnement du poste avec une charge dérivée de la sortie de poste.

Le Tableau 358 présente tous les attributs de StationSupply.

Tableau 358 – Attributs de LoadModel::StationSupply

nom	mult	type	description
customerCount	0..1	Integer	hérité de: EnergyConsumer
grounded	0..1	Boolean	hérité de: EnergyConsumer
pfixed	0..1	ActivePower	hérité de: EnergyConsumer
pfixedPct	0..1	PerCent	hérité de: EnergyConsumer
phaseConnection	0..1	PhaseShuntConnectionKind	hérité de: EnergyConsumer
qfixed	0..1	ReactivePower	hérité de: EnergyConsumer
qfixedPct	0..1	PerCent	hérité de: EnergyConsumer
p	0..1	ActivePower	hérité de: EnergyConsumer
q	0..1	ReactivePower	hérité de: EnergyConsumer
aggregate	0..1	Boolean	hérité de: Equipment
inService	0..1	Boolean	hérité de: Equipment
networkAnalysisEnabled	0..1	Boolean	hérité de: Equipment
normallyInService	0..1	Boolean	hérité de: Equipment
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 359 présente toutes les extrémités d'association de StationSupply avec d'autres classes.

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Tableau 359 – Extrémités d'association de LoadModel::StationSupply avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..*	LoadResponse	0..1	LoadResponseCharacteristic	hérité de: EnergyConsumer
1..1	EnergyConsumerPhase	0..*	EnergyConsumerPhase	hérité de: EnergyConsumer
1..*	PowerCutZone	0..1	PowerCutZone	hérité de: EnergyConsumer
0..*	LoadDynamics	0..1	LoadDynamics	hérité de: EnergyConsumer
0..*	BaseVoltage	0..1	BaseVoltage	hérité de: ConductingEquipment
1..1	SvStatus	0..*	SvStatus	hérité de: ConductingEquipment
0..*	ProtectionEquipments	0..*	ProtectionEquipment	hérité de: ConductingEquipment
1..1	Terminals	0..*	Terminal	hérité de: ConductingEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	hérité de: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	hérité de: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	hérité de: Equipment
0..1	Faults	0..*	Fault	hérité de: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	hérité de: Equipment
0..*	PSRType	0..1	PSRType	hérité de: PowerSystemResource
0..1	Controls	0..*	Control	hérité de: PowerSystemResource
0..1	Measurements	0..*	Measurement	hérité de: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	hérité de: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	hérité de: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.5.17 SubLoadArea

La classe est le deuxième niveau dans une structure hiérarchique pour regrouper des charges à des fins de mise à l'échelle des charges du flux de charge.

Le Tableau 360 présente tous les attributs de SubLoadArea.

Tableau 360 – Attributs de LoadModel::SubLoadArea

nom	mult	type	description
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 361 présente toutes les extrémités d'association de SubLoadArea avec d'autres classes.

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Tableau 361 – Extrémités d'association de LoadModel::SubLoadArea avec d'autres classes

mult à partir de	nom	mult vers	type	description
1..1	LoadGroups	1..*	LoadGroup	Loadgroup dans la SubLoadArea.
1..*	LoadArea	1..1	LoadArea	LoadArea à laquelle la SubLoadArea appartient.
0..1	ControlArea	0..1	ControlArea	hérité de: EnergyArea
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.6 Paquetage Generation

6.6.1 Généralités

Ce paquetage contient des paquetages qui portent de l'information pour les applications Planification de l'opération des unités de production ("Unit Commitment"), Dispatching économique des unités de production thermiques et hydrauliques ("Economic Dispatch of Hydro and Thermal Generating Units"), Prévision de la charge ("Load Forecasting"), Contrôle automatique de production ("Automatic Generation Control"), et Modélisation d'unité pour les simulateurs d'entraînement ("Unit Modeling for Training Simulator").

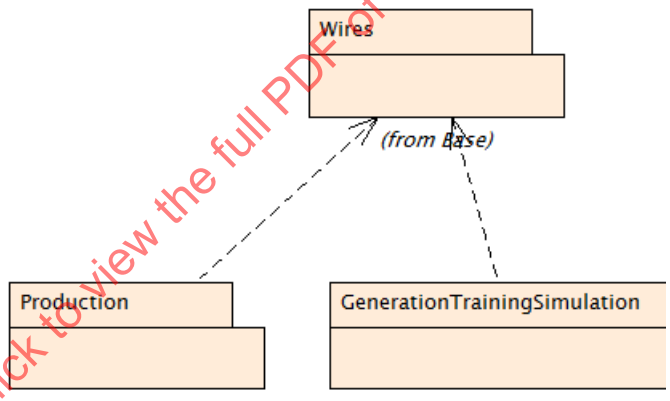


Figure 103 – Diagramme de classe Generation::Main

Figure 103: Ce diagramme représente les paquetages de production principale et leurs relations de dépendance par rapport à d'autres paquetages.

6.6.2 Paquetage GenerationTrainingSimulation

6.6.2.1 Généralités

Le paquetage GenerationTrainingSimululation se compose de machines motrices, comme les turbines ou les chaudières, utiles pour la simulation et à des fins éducatives.

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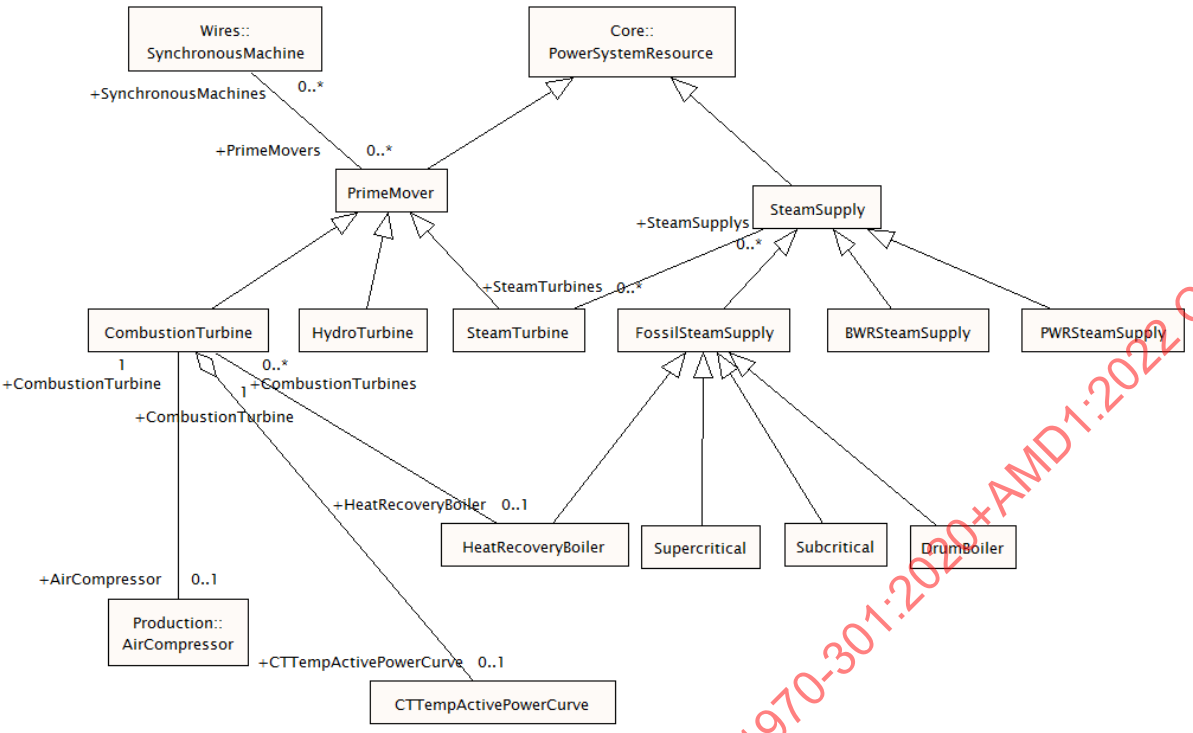


Figure 104 – Diagramme de classe GenerationTrainingSimulation::Main

Figure 104: Ce diagramme représente toutes les classes incluses dans le paquetage GenerationDynamics de même que les classes-clés externes qui ont des associations avec ces classes.

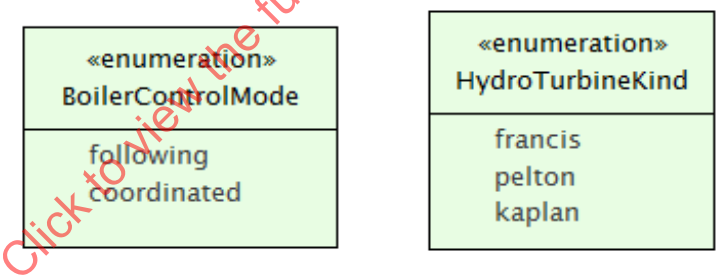


Figure 105 – Diagramme de classe GenerationTrainingSimulation::Datatypes

Figure 105: GenerationTrainingSimulation.

6.6.2.2 BWRSteamSupply

Inductance à eau bouillante alimentant en vapeur une turbine à vapeur.

Le Tableau 362 présente tous les attributs de BWRSteamSupply.

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Tableau 362 – Attributs de GenerationTrainingSimulation::BWRSteamSupply

nom	mult	type	description
highPowerLimit	0..1	PU	Limite de puissance supérieure.
inCoreThermalTC	0..1	Seconds	Constante de temps thermique dans le noyau.
integralGain	0..1	Float	Gain intégral.
lowerLimit	0..1	PU	Limite inférieure initiale.
lowPowerLimit	0..1	PU	Limite de puissance inférieure.
pressureLimit	0..1	PU	Limite de pression.
pressureSetpointGA	0..1	Float	Dispositif d'ajustage de gain du point de consigne de la pression.
pressureSetpointTC1	0..1	Seconds	Constante de temps du point de consigne de la pression.
pressureSetpointTC2	0..1	Seconds	Constante de temps du point de consigne de la pression.
proportionalGain	0..1	Float	Gain proportionnel.
rfAux1	0..1	PU	Coefficient permettant de modéliser l'effet de la fréquence et de la tension hors nominal sur la recirculation et le flux du noyau, et affectant la puissance de sortie BWR.
rfAux2	0..1	PU	Coefficient permettant de modéliser l'effet de la fréquence et de la tension hors nominal sur la recirculation et le flux du noyau, et affectant la puissance de sortie BWR.
rfAux3	0..1	PU	Coefficient permettant de modéliser l'effet de la fréquence et de la tension hors nominal sur la recirculation et le flux du noyau, et affectant la puissance de sortie BWR.
rfAux4	0..1	PU	Coefficient permettant de modéliser l'effet de la fréquence et de la tension hors nominal sur la recirculation et le flux du noyau, et affectant la puissance de sortie BWR.
rfAux5	0..1	PU	Coefficient permettant de modéliser l'effet de la fréquence et de la tension hors nominal sur la recirculation et le flux du noyau, et affectant la puissance de sortie BWR.
rfAux6	0..1	PU	Coefficient permettant de modéliser l'effet de la fréquence et de la tension hors nominal sur la recirculation et le flux du noyau, et affectant la puissance de sortie BWR.
rfAux7	0..1	PU	Coefficient permettant de modéliser l'effet de la fréquence et de la tension hors nominal sur la recirculation et le flux du noyau, et affectant la puissance de sortie BWR.
rfAux8	0..1	PU	Coefficient permettant de modéliser l'effet de la fréquence et de la tension hors nominal sur la recirculation et le flux du noyau, et affectant la puissance de sortie BWR.
rodPattern	0..1	PU	Modèle de barre.
rodPatternConstant	0..1	Float	Constante liée à un modèle de barre.
upperLimit	0..1	PU	Limite supérieure initiale.
steamSupplyRating	0..1	Float	hérité de: SteamSupply
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

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Le Tableau 363 présente toutes les extrémités d'association de BWRSteamSupply avec d'autres classes.

Tableau 363 – Extrémités d'association de GenerationTrainingSimulation::BWRSteamSupply avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..*	SteamTurbines	0..*	SteamTurbine	hérité de: SteamSupply
0..*	PSRType	0..1	PSRType	hérité de: PowerSystemResource
0..1	Controls	0..*	Control	hérité de: PowerSystemResource
0..1	Measurements	0..*	Measurement	hérité de: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	hérité de: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	hérité de: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.6.2.3 Enumération BoilerControlMode

Mode commande de la chaudière.

Le Tableau 364 présente tous les libellés de BoilerControlMode.

Tableau 364 – Libellés de GenerationTrainingSimulation::BoilerControlMode

libellé	value	description
following		Suivant.
coordinated		Coordonné.

6.6.2.4 CTTempActivePowerCurve

Relation entre la puissance de sortie assignée de la turbine à combustion en puissance active brute (axe X) et la température ambiante de l'air (axe Y).

Le Tableau 365 présente tous les attributs de CTTempActivePowerCurve.

Tableau 365 – Attributs de GenerationTrainingSimulation::CTTempActivePowerCurve

nom	mult	type	description
curveStyle	0..1	CurveStyle	hérité de: Curve
xMultiplier	0..1	UnitMultiplier	hérité de: Curve
xUnit	0..1	UnitSymbol	hérité de: Curve
y1Multiplier	0..1	UnitMultiplier	hérité de: Curve
y1Unit	0..1	UnitSymbol	hérité de: Curve
y2Multiplier	0..1	UnitMultiplier	hérité de: Curve
y2Unit	0..1	UnitSymbol	hérité de: Curve
y3Multiplier	0..1	UnitMultiplier	hérité de: Curve
y3Unit	0..1	UnitSymbol	hérité de: Curve
aliasName	0..1	String	hérité de: IdentifiedObject

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nom	mult	type	description
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 366 présente toutes les extrémités d'association de CTTempActivePowerCurve avec d'autres classes.

Tableau 366 – Extrémités d'association de GenerationTrainingSimulation::CTTempActivePowerCurve avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..1	CombustionTurbine	1..1	CombustionTurbine	Une turbine à combustion peut avoir une relation puissance active-température ambiante.
1..1	CurveDatas	0..*	CurveData	hérité de: Curve
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.6.2.5 CombustionTurbine

Machine motrice généralement alimentée en combustible avec du gaz ou du fioul léger.

Le Tableau 367 présente tous les attributs de CombustionTurbine.

Tableau 367 – Attributs de GenerationTrainingSimulation::CombustionTurbine

nom	mult	type	description
ambientTemp	0..1	Temperature	Température ambiante par défaut à utiliser pour les applications de modélisation.
auxPowerVersusFrequency	0..1	PU	Effet de la fréquence hors nominal sur les auxiliaires de turbines. Réduction par unité de la consommation de puissance active des auxiliaires en fonction de la réduction par unité de la fréquence (à partir de la fréquence assignée).
auxPowerVersusVoltage	0..1	PU	Effet de la tension hors nominal sur les auxiliaires de turbines. Réduction par unité de la consommation de puissance active des auxiliaires en fonction de la réduction par unité de la tension des barres de distribution des auxiliaires (à partir d'un niveau spécifié de tension).
capabilityVersusFrequency	0..1	PU	Effet de la fréquence hors nominal sur la capacité de la turbine. Réduction par unité de la capacité de puissance active en fonction de la réduction par unité de la fréquence (à partir de la fréquence assignée).
heatRecoveryFlag	0..1	Boolean	Indicateur défini sur true (vrai) si la turbine à combustion est liée à une chaudière de récupération de la chaleur.
powerVariationByTemp	0..1	PU	Modification par unité de la puissance par (en fonction de) modification par unité de la température ambiante.
referenceTemp	0..1	Temperature	Température de référence à laquelle la puissance de sortie de la turbine a été définie.
timeConstant	0..1	Seconds	Constante de temps de la turbine.
primeMoverRating	0..1	Float	hérité de: PrimeMover

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nom	mult	type	description
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 368 présente toutes les extrémités d'association de CombustionTurbine avec d'autres classes.

Tableau 368 – Extrémités d'association de GenerationTrainingSimulation::CombustionTurbine avec d'autres classes

mult à partir de	nom	mult vers	type	description
1..1	AirCompressor	0..1	AirCompressor	Un compresseur d'air CAES est entraîné par une turbine à combustion.
1..1	CTTempActivePowerCurve	0..1	CTTempActivePowerCurve	Une turbine à combustion peut avoir une relation puissance active-température ambiante.
0..*	HeatRecoveryBoiler	0..1	HeatRecoveryBoiler	Une turbine à combustion peut comporter une chaudière de récupération de la chaleur pour produire de la vapeur.
0..*	SynchronousMachines	0..*	SynchronousMachine	hérité de: PrimeMover
0..*	PSRType	0..1	PSRType	hérité de: PowerSystemResource
0..1	Controls	0..*	Control	hérité de: PowerSystemResource
0..1	Measurements	0..*	Measurement	hérité de: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	hérité de: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	hérité de: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.6.2.6 DrumBoiler

Chaudière à tambour.

Le Tableau 369 présente tous les attributs de DrumBoiler.

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Tableau 369 – Attributs de GenerationTrainingSimulation::DrumBoiler

nom	mult	type	description
drumBoilerRating	0..1	Float	Caractéristiques assignées de la chaudière à tambour dans les unités à vapeur.
auxPowerVersusFrequency	0..1	PU	hérité de: FossilSteamSupply
auxPowerVersusVoltage	0..1	PU	hérité de: FossilSteamSupply
boilerControlMode	0..1	BoilerControlMode	hérité de: FossilSteamSupply
controlErrorBiasP	0..1	Float	hérité de: FossilSteamSupply
controlIC	0..1	Float	hérité de: FossilSteamSupply
controlPC	0..1	Float	hérité de: FossilSteamSupply
controlPEB	0..1	Float	hérité de: FossilSteamSupply
controlPED	0..1	PU	hérité de: FossilSteamSupply
controlTC	0..1	Float	hérité de: FossilSteamSupply
feedWaterIG	0..1	Float	hérité de: FossilSteamSupply
feedWaterPG	0..1	Float	hérité de: FossilSteamSupply
feedWaterTC	0..1	Seconds	hérité de: FossilSteamSupply
fuelDemandLimit	0..1	PU	hérité de: FossilSteamSupply
fuelSupplyDelay	0..1	Seconds	hérité de: FossilSteamSupply
fuelSupplyTC	0..1	Seconds	hérité de: FossilSteamSupply
maxErrorRateP	0..1	Float	hérité de: FossilSteamSupply
mechPowerSensorLag	0..1	Seconds	hérité de: FossilSteamSupply
minErrorRateP	0..1	Float	hérité de: FossilSteamSupply
pressureCtrlDG	0..1	Float	hérité de: FossilSteamSupply
pressureCtrlIG	0..1	Float	hérité de: FossilSteamSupply
pressureCtrlPG	0..1	Float	hérité de: FossilSteamSupply
pressureFeedback	0..1	Integer	hérité de: FossilSteamSupply
superHeater1Capacity	0..1	Float	hérité de: FossilSteamSupply
superHeater2Capacity	0..1	Float	hérité de: FossilSteamSupply
superHeaterPipePD	0..1	Float	hérité de: FossilSteamSupply
throttlePressureSP	0..1	PU	hérité de: FossilSteamSupply
steamSupplyRating	0..1	Float	hérité de: SteamSupply
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 370 présente toutes les extrémités d'association de DrumBoiler avec d'autres classes.

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Tableau 370 – Extrémités d'association de GenerationTrainingSimulation::DrumBoiler avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..*	SteamTurbines	0..*	SteamTurbine	hérité de: SteamSupply
0..*	PSRType	0..1	PSRType	hérité de: PowerSystemResource
0..1	Controls	0..*	Control	hérité de: PowerSystemResource
0..1	Measurements	0..*	Measurement	hérité de: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	hérité de: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	hérité de: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.6.2.7 FossilSteamSupply

Chaudière alimentée en combustible fossile (par exemple: charbon, fioul, gaz).

Le Tableau 371 présente tous les attributs de FossilSteamSupply.

Tableau 371 – Attributs de GenerationTrainingSimulation::FossilSteamSupply

nom	mult	type	description
auxPowerVersusFrequency	0..1	PU	Effet de la fréquence hors nominal sur la puissance auxiliaire réelle. Variation de puissance active par unité en fonction de la variation de fréquence par unité.
auxPowerVersusVoltage	0..1	PU	Effet de la tension hors nominal sur la puissance auxiliaire réelle. Variation de puissance active par unité en fonction de la variation de tension par unité.
boilerControlMode	0..1	BoilerControlMode	Mode de commande de la chaudière.
controlErrorBiasP	0..1	Float	Rapport de biais systématique de la puissance active.
controlIC	0..1	Float	Constante intégrale.
controlPC	0..1	Float	Constante proportionnelle.
controlPEB	0..1	Float	Rapport de biais systématique de la pression.
controlPED	0..1	PU	Bande morte de réglage de la pression.
controlTC	0..1	Float	Constante de temps.
feedWaterIG	0..1	Float	Rapport de gain intégral de l'eau d'alimentation.
feedWaterPG	0..1	Float	Rapport de gain proportionnel de l'eau d'alimentation.
feedWaterTC	0..1	Seconds	Rapport de constante de temps de l'eau d'alimentation.
fuelDemandLimit	0..1	PU	Limite de la demande en combustible.
fuelSupplyDelay	0..1	Seconds	Temps de propagation du combustible.
fuelSupplyTC	0..1	Seconds	Constante de temps de l'alimentation en combustible.
maxErrorRateP	0..1	Float	Limite du taux maximal d'erreur de puissance active.
mechPowerSensorLag	0..1	Seconds	Retard du contrôleur de puissance mécanique.

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nom	mult	type	description
minErrorRateP	0..1	Float	Limite du taux minimal d'erreur de puissance active.
pressureCtrlDG	0..1	Float	Rapport de gain par dérivation du contrôle de la pression.
pressureCtrlIG	0..1	Float	Rapport du gain intégral du contrôle de la pression.
pressureCtrlPG	0..1	Float	Rapport du gain proportionnel du contrôle de la pression.
pressureFeedback	0..1	Integer	Indicateur de rétroaction de la pression.
superHeater1Capacity	0..1	Float	Capacité du surchauffeur tambour/primaire.
superHeater2Capacity	0..1	Float	Capacité du superchauffeur secondaire.
superHeaterPipePD	0..1	Float	Constante de chute de la pression du conduit du superchauffeur.
throttlePressureSP	0..1	PU	Point de consigne du régulateur de pression.
steamSupplyRating	0..1	Float	hérité de: SteamSupply
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 372 présente toutes les extrémités d'association de FossilSteamSupply avec d'autres classes.

Tableau 372 – Extrémités d'association de GenerationTrainingSimulation::FossilSteamSupply avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..*	SteamTurbines	0..*	SteamTurbine	hérité de: SteamSupply
0..*	PSRType	0..1	PSRType	hérité de: PowerSystemResource
0..1	Controls	0..*	Control	hérité de: PowerSystemResource
0..1	Measurements	0..*	Measurement	hérité de: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	hérité de: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	hérité de: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.6.2.8 HeatRecoveryBoiler

Système de récupération de la chaleur associé aux turbines à combustion permettant de produire de la vapeur destinée aux centrales à cycle combiné.

Le Tableau 373 présente tous les attributs de HeatRecoveryBoiler.

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Tableau 373 – Attributs de GenerationTrainingSimulation::HeatRecoveryBoiler

nom	mult	type	description
steamSupplyRating2	0..1	Float	Caractéristique assignée de l'alimentation en vapeur, en kilopounds par heure, pour les chaudières à pression double.
auxPowerVersusFrequency	0..1	PU	hérité de: FossilSteamSupply
auxPowerVersusVoltage	0..1	PU	hérité de: FossilSteamSupply
boilerControlMode	0..1	BoilerControlMode	hérité de: FossilSteamSupply
controlErrorBiasP	0..1	Float	hérité de: FossilSteamSupply
controlIC	0..1	Float	hérité de: FossilSteamSupply
controlPC	0..1	Float	hérité de: FossilSteamSupply
controlPEB	0..1	Float	hérité de: FossilSteamSupply
controlPED	0..1	PU	hérité de: FossilSteamSupply
controlTC	0..1	Float	hérité de: FossilSteamSupply
feedWaterIG	0..1	Float	hérité de: FossilSteamSupply
feedWaterPG	0..1	Float	hérité de: FossilSteamSupply
feedWaterTC	0..1	Seconds	hérité de: FossilSteamSupply
fuelDemandLimit	0..1	PU	hérité de: FossilSteamSupply
fuelSupplyDelay	0..1	Seconds	hérité de: FossilSteamSupply
fuelSupplyTC	0..1	Seconds	hérité de: FossilSteamSupply
maxErrorRateP	0..1	Float	hérité de: FossilSteamSupply
mechPowerSensorLag	0..1	Seconds	hérité de: FossilSteamSupply
minErrorRateP	0..1	Float	hérité de: FossilSteamSupply
pressureCtrlDG	0..1	Float	hérité de: FossilSteamSupply
pressureCtrlIG	0..1	Float	hérité de: FossilSteamSupply
pressureCtrlPG	0..1	Float	hérité de: FossilSteamSupply
pressureFeedback	0..1	Integer	hérité de: FossilSteamSupply
superHeater1Capacity	0..1	Float	hérité de: FossilSteamSupply
superHeater2Capacity	0..1	Float	hérité de: FossilSteamSupply
superHeaterPipePD	0..1	Float	hérité de: FossilSteamSupply
throttlePressureSP	0..1	PU	hérité de: FossilSteamSupply
steamSupplyRating	0..1	Float	hérité de: SteamSupply
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

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Le Tableau 374 présente toutes les extrémités d'association de HeatRecoveryBoiler avec d'autres classes.

Tableau 374 – Extrémités d'association de GenerationTrainingSimulation::HeatRecoveryBoiler avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..1	CombustionTurbines	0..*	CombustionTurbine	Une turbine à combustion peut comporter une chaudière de récupération de la chaleur pour produire de la vapeur.
0..*	SteamTurbines	0..*	SteamTurbine	hérité de: SteamSupply
0..*	PSRType	0..1	PSRType	hérité de: PowerSystemResource
0..1	Controls	0..*	Control	hérité de: PowerSystemResource
0..1	Measurements	0..*	Measurement	hérité de: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	hérité de: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	hérité de: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.6.2.9 HydroTurbine

Machine motrice entraînée par l'eau. Les principaux types de turbines sont les suivants: Francis, Kaplan et Pelton.

Le Tableau 375 présente tous les attributs de HydroTurbine.

Tableau 375 – Attributs de GenerationTrainingSimulation::HydroTurbine

nom	mult	type	description
gateRateLimit	0..1	Float	Limite du débit de la vanne.
gateUpperLimit	0..1	PU	Limite supérieure de la vanne.
maxHeadMaxP	0..1	ActivePower	Puissance active à rendement maximal pour des cas de hauteur de chute maximale.
minHeadMaxP	0..1	ActivePower	Puissance active à rendement maximal pour des cas de hauteur de chute minimale.
speedRating	0..1	RotationSpeed	Vitesse assignée en nombre de tours.
speedRegulation	0..1	PU	Régulation de la vitesse.
transientDroopTime	0..1	Seconds	Constante de temps du statisme transitoire.
transientRegulation	0..1	PU	Régulation transitoire.
turbineRating	0..1	ActivePower	Puissance active assignée de la turbine.
turbineType	0..1	HydroTurbineKind	Type de turbine.
waterStartingTime	0..1	Seconds	Temps au démarrage de l'écoulement de l'eau.
primeMoverRating	0..1	Float	hérité de: PrimeMover
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 376 présente toutes les extrémités d'association de HydroTurbine avec d'autres classes.

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Tableau 376 – Extrémités d'association de GenerationTrainingSimulation::HydroTurbine avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..*	SynchronousMachines	0..*	SynchronousMachine	hérité de: PrimeMover
0..*	PSRType	0..1	PSRType	hérité de: PowerSystemResource
0..1	Controls	0..*	Control	hérité de: PowerSystemResource
0..1	Measurements	0..*	Measurement	hérité de: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	hérité de: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	hérité de: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.6.2.10 PWRSteamSupply

Inductance d'eau sous pression utilisée pour alimenter en vapeur une turbine à vapeur.

Le Tableau 377 présente tous les attributs de PWRSteamSupply.

Tableau 377 – Attributs de GenerationTrainingSimulation::PWRSteamSupply

nom	mult	type	description
coldLegFBLagTC	0..1	PU	Constante de retard de la boucle de rétroaction branche froide.
coldLegFBLeadTC1	0..1	PU	Constante d'avance de la boucle de rétroaction branche froide.
coldLegFBLeadTC2	0..1	PU	Constante d'avance de la boucle de rétroaction branche froide.
coldLegFG1	0..1	PU	Gain 1 de la boucle de rétroaction branche froide.
coldLegFG2	0..1	PU	Gain 2 de la boucle de rétroaction branche froide.
coldLegLagTC	0..1	PU	Constante de retard branche froide.
coreHTLagTC1	0..1	PU	Constante de retard du transfert de chaleur du noyau.
coreHTLagTC2	0..1	PU	Constante de retard du transfert de chaleur du noyau.
coreNeutronicsEffTC	0..1	PU	Constante de temps réelle de la neutronique du noyau.
coreNeutronicsHT	0..1	PU	Neutronique du noyau et transfert de chaleur.
feedbackFactor	0..1	PU	Facteur de rétroaction.
hotLegLagTC	0..1	PU	Constante de retard branche chaude.
hotLegSteamGain	0..1	PU	Gain de vapeur branche chaude.
hotLegToColdLegGain	0..1	PU	Gain entre branche chaude et branche froide.
pressureCG	0..1	PU	Gain de commande de la pression.
steamFlowFG	0..1	PU	Gain de la boucle de rétroaction du flux de vapeur.
steamPressureDropLagTC	0..1	PU	Constante de retard de chute de la pression de vapeur.
steamPressureFG	0..1	PU	Gain de la boucle de rétroaction de la pression de vapeur.
throttlePressureFactor	0..1	PU	Facteur de pression du régulateur.
throttlePressureSP	0..1	PU	Point de consigne du régulateur de pression.
steamSupplyRating	0..1	Float	hérité de: SteamSupply
aliasName	0..1	String	hérité de: IdentifiedObject

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nom	mult	type	description
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 378 présente toutes les extrémités d'association de PWRSteamSupply avec d'autres classes.

Tableau 378 – Extrémités d'association de GenerationTrainingSimulation:: PWRSteamSupply avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..*	SteamTurbines	0..*	SteamTurbine	hérité de: SteamSupply
0..*	PSRType	0..1	PSRType	hérité de: PowerSystemResource
0..1	Controls	0..*	Control	hérité de: PowerSystemResource
0..1	Measurements	0..*	Measurement	hérité de: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	hérité de: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	hérité de: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.6.2.11 PrimeMover

Machine utilisée pour développer l'énergie mécanique utilisée pour entraîner un générateur.

Le Tableau 379 présente tous les attributs de PrimeMover.

Tableau 379 – Attributs de GenerationTrainingSimulation::PrimeMover

nom	mult	type	description
primeMoverRating	0..1	Float	Caractéristique assignée de la machine motrice.
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 380 présente toutes les extrémités d'association de PrimeMover avec d'autres classes.

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Tableau 380 – Extrémités d'association de GenerationTrainingSimulation::PrimeMover avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..*	SynchronousMachines	0..*	SynchronousMachine	Machines synchrones entraînées par cette machine motrice.
0..*	PSRType	0..1	PSRType	hérité de: PowerSystemResource
0..1	Controls	0..*	Control	hérité de: PowerSystemResource
0..1	Measurements	0..*	Measurement	hérité de: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	hérité de: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	hérité de: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.6.2.12 SteamSupply

Alimentation en vapeur pour les turbines à vapeur.

Le Tableau 381 présente tous les attributs de SteamSupply.

Tableau 381 – Attributs de GenerationTrainingSimulation::SteamSupply

nom	mult	type	description
steamSupplyRating	0..1	Float	Caractéristique assignée de l'alimentation en vapeur.
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 382 présente toutes les extrémités d'association de SteamSupply avec d'autres classes.

Tableau 382 – Extrémités d'association de GenerationTrainingSimulation::SteamSupply avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..*	SteamTurbines	0..*	SteamTurbine	Les turbines à vapeur peuvent être alimentées en vapeur par une source d'alimentation en vapeur.
0..*	PSRType	0..1	PSRType	hérité de: PowerSystemResource
0..1	Controls	0..*	Control	hérité de: PowerSystemResource
0..1	Measurements	0..*	Measurement	hérité de: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	hérité de: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	hérité de: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

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6.6.2.13 SteamTurbine

Turbine à vapeur.

Le Tableau 383 présente tous les attributs de SteamTurbine.

Tableau 383 – Attributs de GenerationTrainingSimulation::SteamTurbine

nom	mult	type	description
crossoverTC	0..1	Seconds	Constante de temps du point de convergence.
reheater1TC	0..1	Seconds	Constante de temps du premier resurchauffeur.
reheater2TC	0..1	Seconds	Constante de temps du deuxième resurchauffeur.
shaft1PowerHP	0..1	Float	Fraction d'énergie à partir de la puissance de sortie de la turbine haute pression arbre 1.
shaft1PowerIP	0..1	Float	Fraction d'énergie à partir de la puissance de sortie de la turbine pression intermédiaire arbre 1.
shaft1PowerLP1	0..1	Float	Fraction d'énergie à partir de la puissance de sortie de la première turbine basse pression arbre 1.
shaft1PowerLP2	0..1	Float	Fraction d'énergie à partir de la puissance de sortie de la seconde turbine basse pression arbre 1.
shaft2PowerHP	0..1	Float	Fraction d'énergie à partir de la puissance de sortie de la turbine haute pression arbre 2.
shaft2PowerIP	0..1	Float	Fraction d'énergie à partir de la puissance de sortie de la turbine pression intermédiaire arbre 2.
shaft2PowerLP1	0..1	Float	Fraction d'énergie à partir de la puissance de sortie de la première turbine basse pression arbre 2.
shaft2PowerLP2	0..1	Float	Fraction d'énergie à partir de la puissance de sortie de la seconde turbine basse pression arbre 2.
steamChestTC	0..1	Seconds	Constante de temps du coffre de vapeur.
primeMoverRating	0..1	Float	hérité de: PrimeMover
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 384 présente toutes les extrémités d'association de SteamTurbine avec d'autres classes.

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Tableau 384 – Extrémités d'association de GenerationTrainingSimulation::SteamTurbine avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..*	SteamSupplys	0..*	SteamSupply	Les turbines à vapeur peuvent être alimentées en vapeur par une source d'alimentation en vapeur.
0..*	SynchronousMachines	0..*	SynchronousMachine	hérité de: PrimeMover
0..*	PSRType	0..1	PSRType	hérité de: PowerSystemResource
0..1	Controls	0..*	Control	hérité de: PowerSystemResource
0..1	Measurements	0..*	Measurement	hérité de: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	hérité de: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	hérité de: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.6.2.14 Subcritical

Chaudière sous-critique à circulation forcée.

Le Tableau 385 présente tous les attributs de Subcritical.

Tableau 385 – Attributs de GenerationTrainingSimulation::Subcritical

nom	mult	type	description
auxPowerVersusFrequency	0..1	PU	hérité de: FossilSteamSupply
auxPowerVersusVoltage	0..1	PU	hérité de: FossilSteamSupply
boilerControlMode	0..1	BoilerControlMode	hérité de: FossilSteamSupply
controlErrorBiasP	0..1	Float	hérité de: FossilSteamSupply
controlIC	0..1	Float	hérité de: FossilSteamSupply
controlPC	0..1	Float	hérité de: FossilSteamSupply
controlPEB	0..1	Float	hérité de: FossilSteamSupply
controlPED	0..1	PU	hérité de: FossilSteamSupply
controlTC	0..1	Float	hérité de: FossilSteamSupply
feedWaterIG	0..1	Float	hérité de: FossilSteamSupply
feedWaterPG	0..1	Float	hérité de: FossilSteamSupply
feedWaterTC	0..1	Seconds	hérité de: FossilSteamSupply
fuelDemandLimit	0..1	PU	hérité de: FossilSteamSupply
fuelSupplyDelay	0..1	Seconds	hérité de: FossilSteamSupply
fuelSupplyTC	0..1	Seconds	hérité de: FossilSteamSupply
maxErrorRateP	0..1	Float	hérité de: FossilSteamSupply
mechPowerSensorLag	0..1	Seconds	hérité de: FossilSteamSupply
minErrorRateP	0..1	Float	hérité de: FossilSteamSupply
pressureCtrlDG	0..1	Float	hérité de: FossilSteamSupply
pressureCtrlIG	0..1	Float	hérité de: FossilSteamSupply
pressureCtrlPG	0..1	Float	hérité de: FossilSteamSupply

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nom	mult	type	description
pressureFeedback	0..1	Integer	hérité de: FossilSteamSupply
superHeater1Capacity	0..1	Float	hérité de: FossilSteamSupply
superHeater2Capacity	0..1	Float	hérité de: FossilSteamSupply
superHeaterPipePD	0..1	Float	hérité de: FossilSteamSupply
throttlePressureSP	0..1	PU	hérité de: FossilSteamSupply
steamSupplyRating	0..1	Float	hérité de: SteamSupply
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 386 présente toutes les extrémités d'association de Subcritical avec d'autres classes.

Tableau 386 – Extrémités d'association de GenerationTrainingSimulation::Subcritical avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..*	SteamTurbines	0..*	SteamTurbine	hérité de: SteamSupply
0..*	PSRType	0..1	PSRType	hérité de: PowerSystemResource
0..1	Controls	0..*	Control	hérité de: PowerSystemResource
0..1	Measurements	0..*	Measurement	hérité de: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	hérité de: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	hérité de: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.6.2.15 Supercritical

Chaudière surcritique à circulation forcée.

Le Tableau 387 présente tous les attributs de Supercritical.

Tableau 387 – Attributs de GenerationTrainingSimulation::Supercritical

nom	mult	type	description
auxPowerVersusFrequency	0..1	PU	hérité de: FossilSteamSupply
auxPowerVersusVoltage	0..1	PU	hérité de: FossilSteamSupply
boilerControlMode	0..1	BoilerControlMode	hérité de: FossilSteamSupply
controlErrorBiasP	0..1	Float	hérité de: FossilSteamSupply
controlIC	0..1	Float	hérité de: FossilSteamSupply
controlPC	0..1	Float	hérité de: FossilSteamSupply
controlPEB	0..1	Float	hérité de: FossilSteamSupply
controlPED	0..1	PU	hérité de: FossilSteamSupply

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nom	mult	type	description
controlTC	0..1	Float	hérité de: FossilSteamSupply
feedWaterIG	0..1	Float	hérité de: FossilSteamSupply
feedWaterPG	0..1	Float	hérité de: FossilSteamSupply
feedWaterTC	0..1	Seconds	hérité de: FossilSteamSupply
fuelDemandLimit	0..1	PU	hérité de: FossilSteamSupply
fuelSupplyDelay	0..1	Seconds	hérité de: FossilSteamSupply
fuelSupplyTC	0..1	Seconds	hérité de: FossilSteamSupply
maxErrorRateP	0..1	Float	hérité de: FossilSteamSupply
mechPowerSensorLag	0..1	Seconds	hérité de: FossilSteamSupply
minErrorRateP	0..1	Float	hérité de: FossilSteamSupply
pressureCtrlDG	0..1	Float	hérité de: FossilSteamSupply
pressureCtrlIG	0..1	Float	hérité de: FossilSteamSupply
pressureCtrlPG	0..1	Float	hérité de: FossilSteamSupply
pressureFeedback	0..1	Integer	hérité de: FossilSteamSupply
superHeater1Capacity	0..1	Float	hérité de: FossilSteamSupply
superHeater2Capacity	0..1	Float	hérité de: FossilSteamSupply
superHeaterPipePD	0..1	Float	hérité de: FossilSteamSupply
throttlePressureSP	0..1	PU	hérité de: FossilSteamSupply
steamSupplyRating	0..1	Float	hérité de: SteamSupply
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 388 présente toutes les extrémités d'association de Supercritical avec d'autres classes.

Tableau 388 – Extrémités d'association de GenerationTrainingSimulation:: Supercritical avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..*	SteamTurbines	0..*	SteamTurbine	hérité de: SteamSupply
0..*	PSRType	0..1	PSRType	hérité de: PowerSystemResource
0..1	Controls	0..*	Control	hérité de: PowerSystemResource
0..1	Measurements	0..*	Measurement	hérité de: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	hérité de: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	hérité de: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

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6.6.2.16 Enumération HydroTurbineKind

Type de turbine.

Le Tableau 389 présente tous les libellés de HydroTurbineKind.

Tableau 389 – Libellés de GenerationTrainingSimulation::HydroTurbineKind

libellé	value	description
francis		Francis.
pelton		Pelton.
kaplan		Kaplan.

6.6.3 Paquetage Production

6.6.3.1 Généralités

Le paquetage production se charge des classes décrivant différents types de générateurs. Ces classes fournissent également des informations relatives au coût de production, utilisées pour répartir, selon des critères économiques, la demande entre les unités engagées et pour calculer les quantités de réserve.

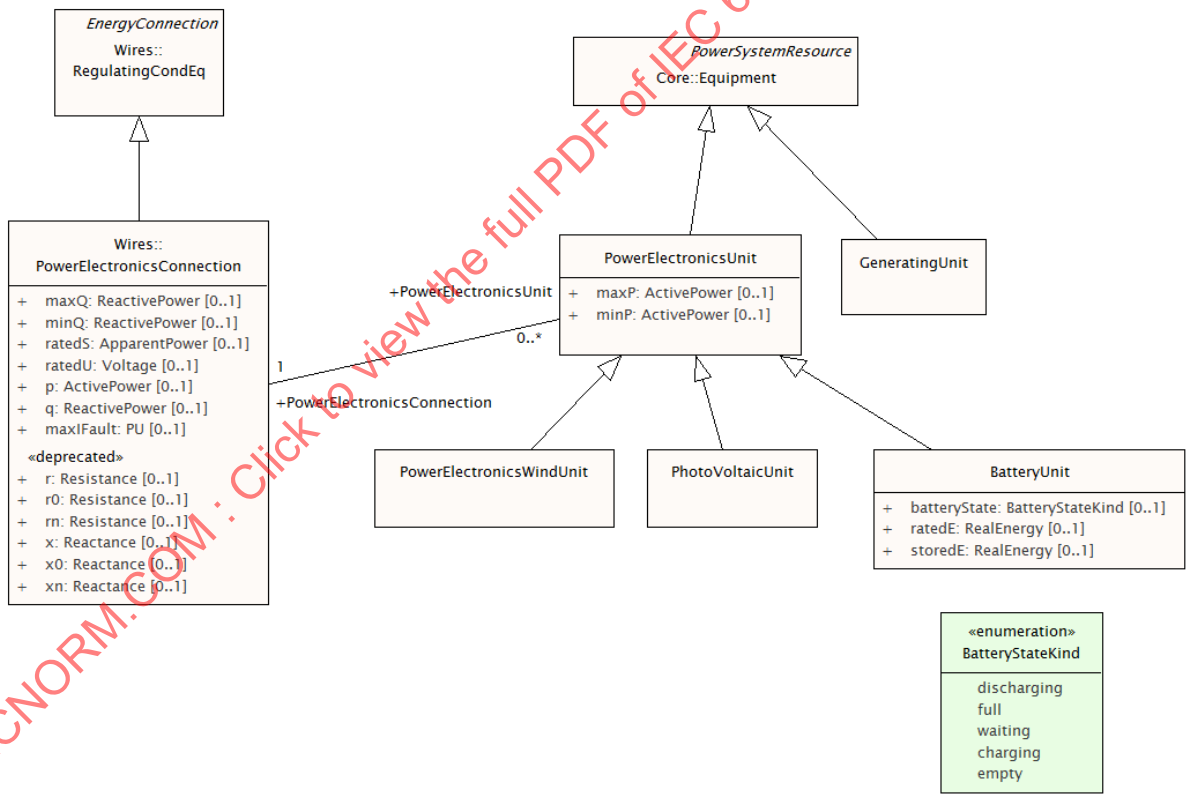


Figure 106 – Diagramme de classe Production::PowerElectronics

Figure 106: Ce diagramme représente les classes et l'héritage de l'électronique de puissance.

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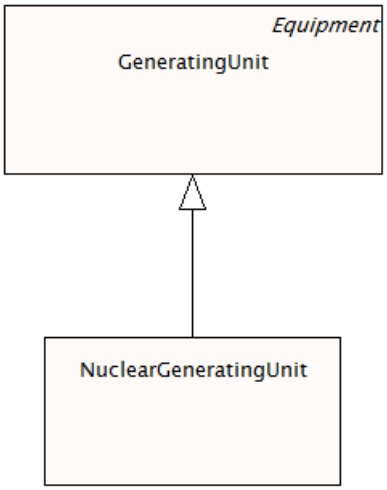


Figure 107 – Diagramme de classe Production::Nuclear

Figure 107: Ce diagramme représente l'héritage de production nucléaire.

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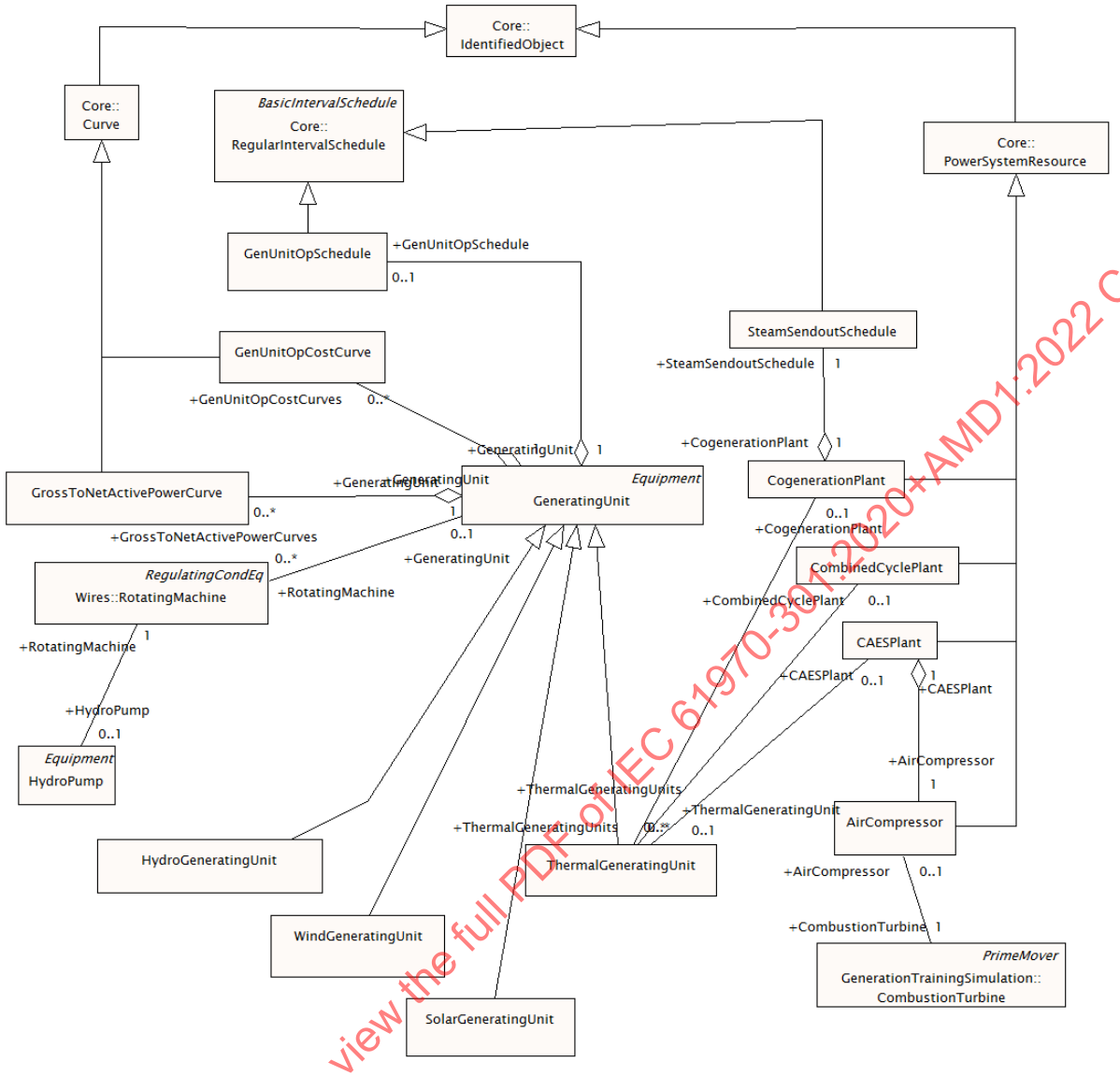


Figure 108 – Diagramme de classe Production::Main

Figure 108: Ce diagramme représente toutes les classes incluses dans le paquetage Production qui sont nécessaires à la production Thermal (thermique) et aussi Hydro (hydraulique). Il représente également les classes-clés externes qui ont des associations avec les classes de Production.

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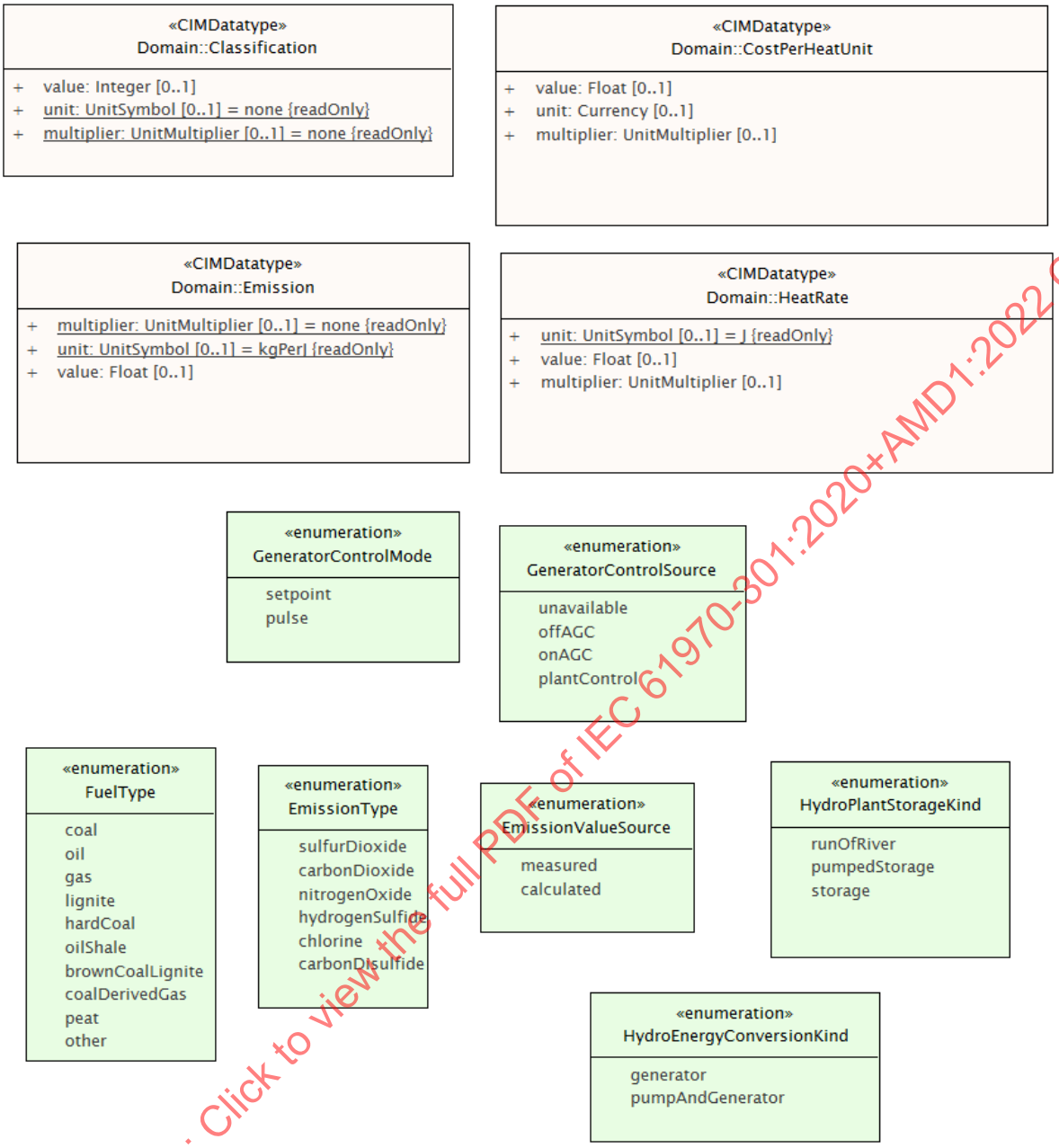


Figure 109 – Diagramme de classe Production::Datatypes

Figure 109: Ce diagramme représente les types de données spécifiques au paquetage Production.

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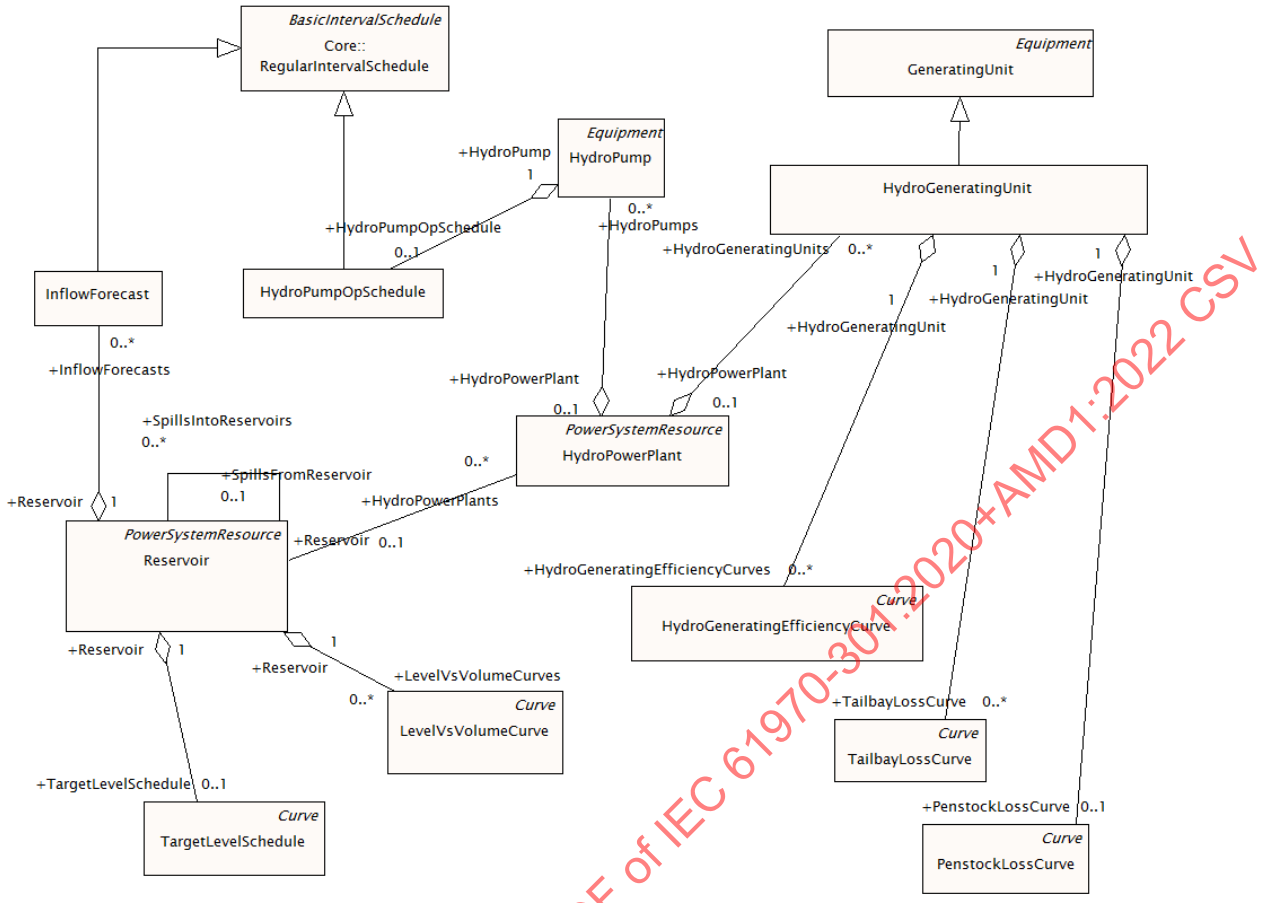


Figure 110 – Diagramme de classe Production::Hydro

Figure 110: Ce diagramme représente toutes les classes incluses dans le paquetage Hydro, de même que les classes-clés externes, qui ont des associations avec des classes Hydro.

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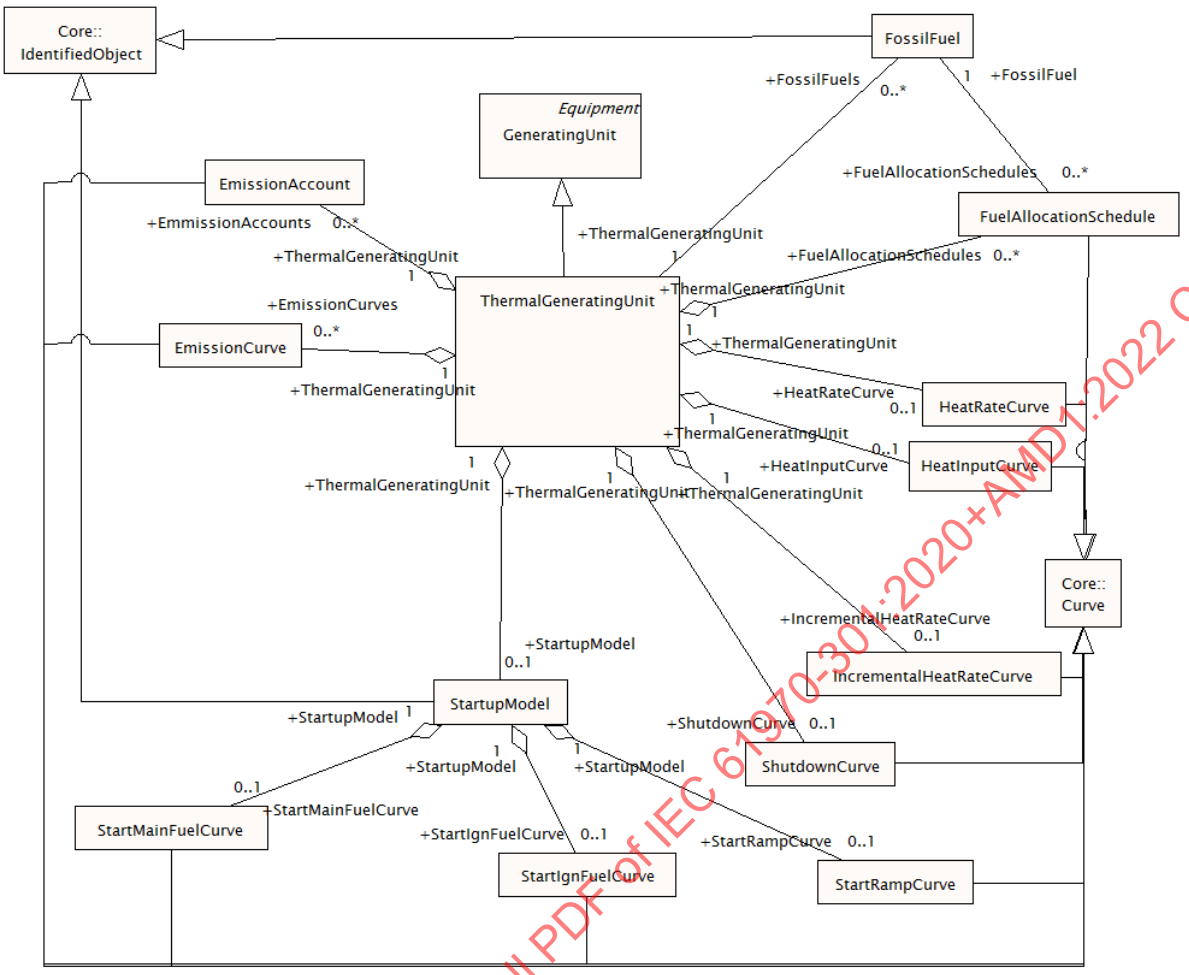


Figure 111 – Diagramme de classe Production::Thermal

Figure 111: Ce diagramme représente toutes les classes incluses dans le paquetage Thermal, de même que les classes-clés externes, qui ont des associations avec des classes Thermal.

6.6.3.2 AirCompressor

Compresseur d'air de la turbine à combustion qui fait partie intégrante d'une centrale CAES (Compressed Air Energy Storage: stockage d'air comprimé).

Le Tableau 390 présente tous les attributs de AirCompressor.

Tableau 390 – Attributs de Production::AirCompressor

nom	mult	type	description
airCompressorRating	0..1	Float	Caractéristique assignée du compresseur d'air CAES.
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 391 présente toutes les extrémités d'association de AirCompressor avec d'autres classes.

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Tableau 391 – Extrémités d'association de Production::AirCompressor avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..1	CombustionTurbine	1..1	CombustionTurbine	Un compresseur d'air CAES est entraîné par une turbine à combustion.
1..1	CAESPlant	1..1	CAESPlant	Un compresseur d'air peut faire partie d'une centrale de stockage d'air comprimé.
0..*	PSRType	0..1	PSRType	hérité de: PowerSystemResource
0..1	Controls	0..*	Control	hérité de: PowerSystemResource
0..1	Measurements	0..*	Measurement	hérité de: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	hérité de: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	hérité de: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.6.3.3 Enumération BatteryStateKind

État de l'unité de batterie.

Le Tableau 392 présente tous les libellés de BatteryStateKind.

Tableau 392 – Libellés de Production::BatteryStateKind

libellé	value	description
discharging		L'énergie emmagasinée diminue.
full		Impossible de charger, et ne décharge pas.
waiting		Pas de chargement ni de déchargement, mais peut le faire.
charging		L'énergie emmagasinée augmente.
empty		Impossible de décharger, et ne charge pas.

6.6.3.4 BatteryUnit

Appareil de stockage de l'énergie électrochimique.

Le Tableau 393 présente tous les attributs de BatteryUnit.

Tableau 393 – Attributs de Production::BatteryUnit

nom	mult	type	description
batteryState	0..1	BatteryStateKind	État en cours de la batterie (en charge, pleine, etc.).
ratedE	0..1	RealEnergy	Capacité de stockage d'énergie totale de la batterie. La valeur de l'attribut doit être positive.
storedE	0..1	RealEnergy	Quantité d'énergie actuellement stockée. La valeur de l'attribut doit être positive ou égale à zéro et inférieure à BatteryUnit.ratedE.
maxP	0..1	ActivePower	hérité de: PowerElectronicsUnit
minP	0..1	ActivePower	hérité de: PowerElectronicsUnit
aggregate	0..1	Boolean	hérité de: Equipment

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nom	mult	type	description
inService	0..1	Boolean	hérité de: Equipment
networkAnalysisEnabled	0..1	Boolean	hérité de: Equipment
normallyInService	0..1	Boolean	hérité de: Equipment
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 394 présente toutes les extrémités d'association de BatteryUnit avec d'autres classes.

Tableau 394 – Extrémités d'association de Production:: BatteryUnit avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..*	PowerElectronicsConnection	1..1	PowerElectronicsConnection	hérité de: PowerElectronicsUnit
0..1	OperationalLimitSet	0..*	OperationalLimitSet	hérité de: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	hérité de: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	hérité de: Equipment
0..1	Faults	0..*	Fault	hérité de: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	hérité de: Equipment
0..*	PSRType	0..1	PSRType	hérité de: PowerSystemResource
0..1	Controls	0..*	Control	hérité de: PowerSystemResource
0..1	Measurements	0..*	Measurement	hérité de: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	hérité de: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	hérité de: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.6.3.5 CAESPlant

Centrale de stockage d'air comprimé.

Le Tableau 395 présente tous les attributs de CAESPlant.

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Tableau 395 – Attributs de Production::CAESPlant

nom	mult	type	description
energyStorageCapacity	0..1	RealEnergy	Capacité assignée de stockage d'énergie. La valeur de l'attribut doit être positive.
ratedCapacityP	0..1	ActivePower	Capacité génératrice assignée brute de la centrale CAES. La valeur de l'attribut doit être positive.
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 396 présente toutes les extrémités d'association de CAESPlant avec d'autres classes.

Tableau 396 – Extrémités d'association de Production::CAESPlant avec d'autres classes

mult à partir de	nom	mult vers	type	description
1..1	AirCompressor	1..1	AirCompressor	Un compresseur d'air peut faire partie d'une centrale de stockage d'air comprimé.
0..1	ThermalGeneratingUnit	0..1	ThermalGeneratingUnit	Une unité de production thermique peut faire partie d'une centrale de stockage d'air comprimé.
0..*	PSRType	0..1	PSRType	hérité de: PowerSystemResource
0..1	Controls	0..*	Control	hérité de: PowerSystemResource
0..1	Measurements	0..*	Measurement	hérité de: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	hérité de: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	hérité de: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.6.3.6 CogenerationPlant

Ensemble d'unités de production thermique pour la production d'énergie électrique et de vapeur à usage industriel (généralement vapeur de sortie des turbines à vapeur). La vapeur évacuée est généralement utilisée à des fins industrielles ou pour le chauffage et la ventilation urbains.

Le Tableau 397 présente tous les attributs de CogenerationPlant.

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Tableau 397 – Attributs de Production::CogenerationPlant

nom	mult	type	description
cogenHPSendoutRating	0..1	Float	Emission de vapeur à haute pression.
cogenHPSteamRating	0..1	Float	Caractéristique assignée de vapeur à haute pression.
cogenLPSendoutRating	0..1	Float	Emission de vapeur à basse pression.
cogenLPSteamRating	0..1	Float	Caractéristique assignée de vapeur à basse pression.
ratedP	0..1	ActivePower	Puissance active de sortie assignée de la centrale de cogénération. La valeur de l'attribut doit être positive.
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 398 présente toutes les extrémités d'association de CogenerationPlant avec d'autres classes.

Tableau 398 – Extrémités d'association de Production::CogenerationPlant avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..1	ThermalGeneratingUnits	0..*	ThermalGeneratingUnit	Une unité de production thermique peut faire partie d'une centrale de cogénération.
1..1	SteamSendoutSchedule	1..1	SteamSendoutSchedule	Une centrale de cogénération comporte un programme d'émission de vapeur.
0..*	PSRType	0..1	PSRType	hérité de: PowerSystemResource
0..1	Controls	0..*	Control	hérité de: PowerSystemResource
0..1	Measurements	0..*	Measurement	hérité de: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	hérité de: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	hérité de: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.6.3.7 CombinedCyclePlant

Ensemble de turbines à combustion et de turbines à vapeur dans lequel la chaleur évacuée des turbines à combustion est récupérée pour générer de la vapeur destinée aux turbines à vapeur, entraînant ainsi un accroissement global du rendement de la centrale.

Le Tableau 399 présente tous les attributs de CombinedCyclePlant.

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Tableau 399 – Attributs de Production::CombinedCyclePlant

nom	mult	type	description
combCyclePlantRating	0..1	ActivePower	Puissance active de sortie assignée de la centrale à cycle combiné.
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 400 présente toutes les extrémités d'association de CombinedCyclePlant avec d'autres classes.

Tableau 400 – Extrémités d'association de Production::CombinedCyclePlant avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..1	ThermalGeneratingUnits	0..*	ThermalGeneratingUnit	Une unité de production thermique peut faire partie d'une centrale à cycle combiné.
0..*	PSRType	0..1	PSRType	hérité de: PowerSystemResource
0..1	Controls	0..*	Control	hérité de: PowerSystemResource
0..1	Measurements	0..*	Measurement	hérité de: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	hérité de: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	hérité de: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.6.3.8 EmissionAccount

Comptes de suivi de l'utilisation et crédits d'émissions alloués aux unités de production thermique. Une unité peut avoir zéro à plusieurs comptes d'émissions et elle peut, généralement, avoir un compte pour le suivi d'utilisation et un autre pour le suivi des crédits.

Le Tableau 401 présente tous les attributs de EmissionAccount.

Tableau 401 – Attributs de Production::EmissionAccount

nom	mult	type	description
emissionType	0..1	EmissionType	Type d'émission, par exemple, dioxyde de soufre (SO2). Les y1AxisUnits de la courbe contiennent les unités de mesure (par exemple, kg) tandis que emissionType est le type d'émission (par exemple, dioxyde de soufre).
emissionValueSource	0..1	EmissionValueSource	Source de la valeur d'émission.
curveStyle	0..1	CurveStyle	hérité de: Curve
xMultiplier	0..1	UnitMultiplier	hérité de: Curve
xUnit	0..1	UnitSymbol	hérité de: Curve
y1Multiplier	0..1	UnitMultiplier	hérité de: Curve
y1Unit	0..1	UnitSymbol	hérité de: Curve

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nom	mult	type	description
y2Multiplier	0..1	UnitMultiplier	hérité de: Curve
y2Unit	0..1	UnitSymbol	hérité de: Curve
y3Multiplier	0..1	UnitMultiplier	hérité de: Curve
y3Unit	0..1	UnitSymbol	hérité de: Curve
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 402 présente toutes les extrémités d'association de EmissionAccount avec d'autres classes.

Tableau 402 – Extrémités d'association de Production::EmissionAccount avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..*	ThermalGeneratingUnit	1..1	ThermalGeneratingUnit	Une unité de production thermique peut comporter un ou plusieurs rapports d'autorisation d'émission.
1..1	CurveDatas	0..*	CurveData	hérité de: Curve
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.6.3.9 EmissionCurve

Relation entre le taux d'émission de l'unité exprimé en unités de masse par heure (axe Y) et la puissance active de sortie (axe X) pour un type d'émission donné. Cette courbe ne s'applique que lorsqu'un seul type de combustible est brûlé.

Le Tableau 403 présente tous les attributs de EmissionCurve.

Tableau 403 – Attributs de Production::EmissionCurve

nom	mult	type	description
emissionContent	0..1	Emission	Quantité d'émission par quantité de combustible brûlé.
emissionType	0..1	EmissionType	Type d'émission qui fournit également l'unité de mesure du taux de production. Les y1AxisUnits de la courbe contiennent les unités de mesure (par exemple, kg) tandis que emissionType est le type d'émission (par exemple, dioxyde de soufre).
isNetGrossP	0..1	Boolean	L'indicateur est défini sur true (vrai) lorsque la sortie est exprimée en puissance active nette.
curveStyle	0..1	CurveStyle	hérité de: Curve
xMultiplier	0..1	UnitMultiplier	hérité de: Curve
xUnit	0..1	UnitSymbol	hérité de: Curve
y1Multiplier	0..1	UnitMultiplier	hérité de: Curve
y1Unit	0..1	UnitSymbol	hérité de: Curve
y2Multiplier	0..1	UnitMultiplier	hérité de: Curve

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nom	mult	type	description
y2Unit	0..1	UnitSymbol	hérité de: Curve
y3Multiplier	0..1	UnitMultiplier	hérité de: Curve
y3Unit	0..1	UnitSymbol	hérité de: Curve
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 404 présente toutes les extrémités d'association de EmissionCurve avec d'autres classes.

Tableau 404 – Extrémités d'association de Production::EmissionCurve avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..*	ThermalGeneratingUnit	1..1	ThermalGeneratingUnit	Une unité de production thermique peut comporter une ou plusieurs courbes d'émission.
1..1	CurveDatas	0..*	CurveData	hérité de: Curve
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.6.3.10 Enumération EmissionType

Type d'émission.

Le Tableau 405 présente tous les libellés de EmissionType.

Tableau 405 – Libellés de Production::EmissionType

libellé	value	description
sulfurDioxide		Dioxyde de soufre.
carbonDioxide		Dioxyde de carbone.
nitrogenOxide		Oxyde d'azote.
hydrogenSulfide		Sulfure d'hydrogène.
chlorine		Chlore.
carbonDisulfide		Sulfure de carbone.

6.6.3.11 Enumération WindGenUnitKind

Genre de générateur éolien.

Le Tableau 406 présente tous les libellés de WindGenUnitKind.

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Tableau 406 – Libellés de Production::WindGenUnitKind

libellé	value	description
offshore		Le générateur éolien est situé en pleine mer.
onshore		Le générateur éolien est situé à terre.

6.6.3.12 Enumération EmissionValueSource

Source de la valeur d'émission.

Le Tableau 407 présente tous les libellés de EmissionValueSource.

Tableau 407 – Libellés de Production::EmissionValueSource

libellé	value	description
measured		Mesuré.
calculated		Calculé.

6.6.3.13 FossilFuel

Combustible fossile consommé par l'unité de production thermique non nucléaire. Par exemple, charbon, pétrole, gaz, etc. Ce sont les combustibles spécifiés que peut consommer l'unité de production.

Le Tableau 408 présente tous les attributs de FossilFuel.

Tableau 408 – Attributs de Production::FossilFuel

nom	mult	type	description
fossilFuelType	0..1	FuelType	Type de combustible fossile tel que le charbon, le pétrole ou le gaz.
fuelCost	0..1	CostPerHeatUnit	Coût en termes de pouvoir calorifique pour le type de combustible donné.
fuelDispatchCost	0..1	CostPerHeatUnit	Coût du combustible utilisé pour le dispatching économique comprenant les éléments suivants: coût du combustible, coût du transport et coût de la maintenance supplémentaire.
fuelEffFactor	0..1	PU	Facteur d'efficacité du combustible (par unité) en termes d'énergie réelle absorbée.
fuelHandlingCost	0..1	CostPerHeatUnit	Coût de manipulation et de traitement associé à ce combustible.
fuelHeatContent	0..1	Float	Quantité de chaleur par poids (ou par volume) du type de combustible donné.
fuelMixture	0..1	PerCent	Quantité relative du type de combustible donné lorsque plusieurs combustibles sont consommés.
fuelSulfur	0..1	PU	Partie du combustible des crédits de pollution par unité de capacité calorifique.
highBreakpointP	0..1	ActivePower	Niveau de sortie en puissance active de l'unité auquel le type de combustible donné est démarré. Ce combustible (pétrole, par exemple) est parfois utilisé pour remplacer le combustible de base (charbon, par exemple) à des niveaux élevés de sortie de puissance active.

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nom	mult	type	description
lowBreakpointP	0..1	ActivePower	Niveau de sortie en puissance active de l'unité auquel le type de combustible donné est arrêté. Ce combustible (pétrole, par exemple) est parfois utilisé pour stabiliser le combustible de base (charbon, par exemple) à de faibles niveaux de sortie de puissance active.
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 409 présente toutes les extrémités d'association de FossilFuel avec d'autres classes.

Tableau 409 – Extrémités d'association de Production::FossilFuel avec d'autres classes

mult à partir de	nom	mult vers	type	description
1..1	FuelAllocationSchedules	0..*	FuelAllocationSchedule	Un programme d'attribution du combustible doit comporter un combustible fossile.
0..*	ThermalGeneratingUnit	1..1	ThermalGeneratingUnit	Une unité de production thermique peut comporter un ou plusieurs combustibles fossiles.
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.6.3.14 FuelAllocationSchedule

Quantité de combustible d'un type donné attribué à la consommation sur une période déterminée.

Le Tableau 410 présente tous les attributs de FuelAllocationSchedule.

Tableau 410 – Attributs de Production::FuelAllocationSchedule

nom	mult	type	description
fuelAllocationEndDate	0..1	DateTime	Heure et date de fin du programme d'attribution du combustible.
fuelAllocationStartDate	0..1	DateTime	Heure et date de début du programme d'attribution du combustible.
fuelType	0..1	FuelType	Type de combustible, indique également l'unité de mesure correspondante.
maxFuelAllocation	0..1	Float	Quantité maximale de combustible attribuée à la consommation pour la période programmée.
minFuelAllocation	0..1	Float	Quantité minimale de combustible attribuée à la consommation pour la période programmée, sur la base, par exemple, d'un contrat "à prendre tel quel ou à payer".
curveStyle	0..1	CurveStyle	hérité de: Curve
xMultiplier	0..1	UnitMultiplier	hérité de: Curve
xUnit	0..1	UnitSymbol	hérité de: Curve
y1Multiplier	0..1	UnitMultiplier	hérité de: Curve

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nom	mult	type	description
y1Unit	0..1	UnitSymbol	hérité de: Curve
y2Multiplier	0..1	UnitMultiplier	hérité de: Curve
y2Unit	0..1	UnitSymbol	hérité de: Curve
y3Multiplier	0..1	UnitMultiplier	hérité de: Curve
y3Unit	0..1	UnitSymbol	hérité de: Curve
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 411 présente toutes les extrémités d'association de FuelAllocationSchedule avec d'autres classes.

Tableau 411 – Extrémités d'association de Production::FuelAllocationSchedule avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..*	ThermalGeneratingUnit	1..1	ThermalGeneratingUnit	Une unité de production thermique peut comporter un ou plusieurs programmes d'attribution de combustibles.
0..*	FossilFuel	1..1	FossilFuel	Un programme d'attribution du combustible doit comporter un combustible fossile.
1..1	CurveDatas	0..*	CurveData	hérité de: Curve
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.6.3.15 Enumération FuelType

Type de combustible.

Le Tableau 412 présente tous les libellés de FuelType.

Tableau 412 – Libellés de Production::FuelType

libellé	value	description
coal		Charbon générique, ne comprend pas le type lignite.
oil		Pétrole.
gas		Gaz naturel.
lignite		Le combustible est le charbon de lignite. Noter qu'il s'agit d'un type spécial de charbon et, donc, l'autre énumération de charbon est réservée aux types de charbon dur ou si le type exact du charbon n'est pas connu.
hardCoal		Charbon dur.
oilShale		Schiste bitumineux.
brownCoalLignite		Lignite.
coalDerivedGas		Gaz dérivé du charbon.

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libellé	value	description
peat		Tourbe.
other		Tout type de combustible absent de la valeur énumérée.

6.6.3.16 GenUnitOpCostCurve

Relation entre le coût de fonctionnement de l'unité (axe Y) et la puissance active de sortie de l'unité (axe X). La courbe de coût de fonctionnement des unités thermiques est dérivée des apports de chaleur et des coûts de combustible. La courbe de coût de fonctionnement des unités hydrauliques est dérivée des taux de débit d'eau et des coûts d'eau équivalents.

Le Tableau 413 présente tous les attributs de GenUnitOpCostCurve.

Tableau 413 – Attributs de Production::GenUnitOpCostCurve

nom	mult	type	description
isNetGrossP	0..1	Boolean	L'indicateur est défini sur true (vrai) lorsque la sortie est exprimée en puissance active nette.
curveStyle	0..1	CurveStyle	hérité de: Curve
xMultiplier	0..1	UnitMultiplier	hérité de: Curve
xUnit	0..1	UnitSymbol	hérité de: Curve
y1Multiplier	0..1	UnitMultiplier	hérité de: Curve
y1Unit	0..1	UnitSymbol	hérité de: Curve
y2Multiplier	0..1	UnitMultiplier	hérité de: Curve
y2Unit	0..1	UnitSymbol	hérité de: Curve
y3Multiplier	0..1	UnitMultiplier	hérité de: Curve
y3Unit	0..1	UnitSymbol	hérité de: Curve
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 414 présente toutes les extrémités d'association de GenUnitOpCostCurve avec d'autres classes.

Tableau 414 – Extrémités d'association de Production::GenUnitOpCostCurve avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..*	GeneratingUnit	1..1	GeneratingUnit	Une unité de production peut avoir une ou plusieurs courbes de coûts, en fonction du mélange combustible et du prix du combustible.
1..1	CurveDatas	0..*	CurveData	hérité de: Curve
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

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6.6.3.17 GenUnitOpSchedule

Programme (ou plan) de fonctionnement actuel approuvé par l'opérateur de l'unité de production, généralement produit à l'aide des analyses du type Planification de l'opération des unités de production. L'axe X représente le temps absolu. L'axe Y1 représente le statut (0 = hors ligne et indisponible: 1 = non disponible: 2 = marche imposée: 3 = (marche imposée à une valeur de puissance fixe: etc.). L'axe Y2 représente la valeur de puissance imposée fixe le cas échéant.

Le Tableau 415 présente tous les attributs de GenUnitOpSchedule.

Tableau 415 – Attributs de Production::GenUnitOpSchedule

nom	mult	type	description
endTime	0..1	DateTime	hérité de: RegularIntervalSchedule
timeStep	0..1	Seconds	hérité de: RegularIntervalSchedule
startTime	0..1	DateTime	hérité de: BasicIntervalSchedule
value1Multiplier	0..1	UnitMultiplier	hérité de: BasicIntervalSchedule
value1Unit	0..1	UnitSymbol	hérité de: BasicIntervalSchedule
value2Multiplier	0..1	UnitMultiplier	hérité de: BasicIntervalSchedule
value2Unit	0..1	UnitSymbol	hérité de: BasicIntervalSchedule
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 416 présente toutes les extrémités d'association de GenUnitOpSchedule avec d'autres classes.

Tableau 416 – Extrémités d'association de Production::GenUnitOpSchedule avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..1	GeneratingUnit	1..1	GeneratingUnit	Une unité de production peut comprendre un programme de fonctionnement, indiquant un fonctionnement planifié de l'unité.
1..1	TimePoints	1..*	RegularTimePoint	hérité de: RegularIntervalSchedule
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

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6.6.3.18 GeneratingUnit

Une seule machine synchrone ou un ensemble de machines synchrones pour la conversion de la puissance mécanique en puissance à courant alternatif. Des machines individuelles dans un ensemble peuvent être, par exemple, définies dans un but de programmation alors qu'un seul signal de contrôle est dérivé pour l'ensemble. Dans ce cas, une GeneratingUnit (unité de production) pour chaque membre de l'ensemble et une GeneratingUnit supplémentaire correspondant à l'ensemble sont définies.

Le Tableau 417 présente tous les attributs de GeneratingUnit.

Tableau 417 – Attributs de Production::GeneratingUnit

nom	mult	type	description
allocSpinResP	0..1	ActivePower	Capacité planifiée non utilisée (réserve tournante) qui peut être utilisée pour absorber une charge d'urgence.
autoCntrlMarginP	0..1	ActivePower	Capacité planifiée non utilisée qui peut être utilisée pour absorber les à-coups de la régulation automatique.
baseP	0..1	ActivePower	Pour les unités commandables, cette valeur représente le point de fonctionnement économique de base en puissance active alors que pour les unités non commandables, cette valeur correspond à la valeur fixe de production. La valeur doit être comprise entre les points haut et bas des limites de fonctionnement.
controlDeadband	0..1	ActivePower	Bande morte de réglage. Lorsqu'une modification en puissance active souhaitée pour l'unité est inférieure à cette bande morte, aucune impulsion de commande n'est transmise à l'unité.
controlPulseHigh	0..1	Seconds	Limite supérieure de l'impulsion correspondant à l'impulsion de commande la plus élevée à laquelle l'unité peut répondre.
controlPulseLow	0..1	Seconds	Limite inférieure de l'impulsion correspondant à l'impulsion de commande la plus basse à laquelle l'unité peut répondre.
controlResponseRate	0..1	ActivePowerChangeRate	Taux de réponse de l'unité spécifiant la modification de puissance active pour une impulsion de commande d'une seconde dans le niveau de charge le plus réactif de l'unité.
efficiency	0..1	PerCent	Efficacité de l'unité à convertir l'énergie mécanique, depuis la machine motrice, en énergie électrique.
genControlMode	0..1	GeneratorControlMode	Le mode de commande de l'unité.
genControlSource	0..1	GeneratorControlSource	Source de commandes pour une unité de production. Définit le statut de commande de l'unité de production.
governorMPL	0..1	PU	Limite de position du moteur du régulateur.
governorSCD	0..1	PerCent	Statisme du changeur de vitesse du régulateur. Il s'agit de la variation de puissance de sortie du générateur divisée par la variation de fréquence normalisée par la puissance nominale du générateur et la fréquence nominale et exprimée en pourcentage et changée de signe. Une valeur positive du statisme de changement de vitesse fournit une sortie additive du générateur à la suite d'une chute de fréquence.
highControlLimit	0..1	ActivePower	Limite supérieure du réglage secondaire (AGC, automatic generation control).

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nom	mult	type	description
initialP	0..1	ActivePower	Valeur initiale par défaut de la puissance active, permettant d'enregistrer un résultat de flux de puissance pour la valeur initiale de puissance active de cette unité, pour cette configuration réseau.
longPF	0..1	Float	Facteur de participation économique à long terme de l'unité de production.
lowControlLimit	0..1	ActivePower	Limite inférieure du réglage secondaire (AGC).
lowerRampRate	0..1	ActivePowerChangeRate	Le taux maximal normal auquel la puissance active de sortie de l'unité de production peut être abaissée par des actions de commande.
maxEconomicP	0..1	ActivePower	Limite économique supérieure maximale de puissance active; il convient qu'elle ne dépasse pas la limite de puissance active maximale de fonctionnement.
maximumAllowableSpinningReserve	0..1	ActivePower	Réserve tournante maximale autorisée. La réserve tournante n'est jamais supérieure à cette valeur sans tenir compte du point de fonctionnement en cours.
maxOperatingP	0..1	ActivePower	Limite maximale de puissance active de fonctionnement pouvant être entrée dans l'unité par le répartiteur.
minEconomicP	0..1	ActivePower	Limite économique inférieure de puissance active devant être supérieure ou égale à la limite minimale de puissance active de fonctionnement.
minimumOffTime	0..1	Seconds	Intervalle de temps minimal entre l'arrêt et le démarrage de l'unité.
minOperatingP	0..1	ActivePower	Limite minimale de puissance active de fonctionnement pouvant être entrée dans l'unité par le répartiteur.
modelDetail	0..1	Classification	Détails des données de modèle du générateur.
nominalP	0..1	ActivePower	Puissance nominale de l'unité de production. Utilisée pour donner une signification précise à des attributs fondés sur le pourcentage tels que le statisme de changement de vitesse du régulateur (attribut govenorSCD). L'attribut doit être une valeur positive inférieure ou égale à RotatingMachine.ratedS.
normalPF	0..1	Float	Facteur de participation économique de l'unité de production. La somme des facteurs de participation des unités de production ne doit pas être égale à un. Il est utilisé pour représenter le facteur de participation de la marge répartie. La valeur de l'attribut doit être positive ou égale à zéro.
penaltyFactor	0..1	Float	Défini de la manière suivante: 1 / (1 − perte de transport différentielle); la perte de transport différentielle est exprimée en valeur plus/moins. Les facteurs de retenue (penalty factors) types sont compris entre 0,9 et 1,1.
raiseRampRate	0..1	ActivePowerChangeRate	Le taux maximal normal auquel la puissance active de sortie de l'unité de production peut être augmentée par des actions de commande.
ratedGrossMaxP	0..1	ActivePower	Capacité maximale brute assignée de l'unité (valeur comptable). La valeur de l'attribut doit être positive.

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nom	mult	type	description
ratedGrossMinP	0..1	ActivePower	Niveau de production minimal brut assigné avec lequel l'unité peut fonctionner sans risques en fournissant de l'énergie à la grille de transport. La valeur de l'attribut doit être positive.
ratedNetMaxP	0..1	ActivePower	Capacité maximale nette assignée obtenue en soustrayant la puissance auxiliaire utilisée pour faire fonctionner les machines internes de la centrale de la capacité maximale brute assignée. La valeur de l'attribut doit être positive.
shortPF	0..1	Float	Facteur de participation économique à court terme de l'unité de production.
startupCost	0..1	Money	Coût de démarrage initial encouru pour chaque démarrage de l'unité de production GeneratingUnit.
startupTime	0..1	Seconds	Temps requis pour connecter l'unité, à partir du moment où la puissance mécanique des machines motrices est appliquée.
tieLinePF	0..1	Float	Facteur de participation économique de l'unité de production.
totalEfficiency	0..1	PerCent	Efficacité de l'unité à convertir le combustible en énergie électrique.
variableCost	0..1	Money	Composante coût variable de production par unité de puissance active (ActivePower).
aggregate	0..1	Boolean	hérité de: Equipment
inService	0..1	Boolean	hérité de: Equipment
networkAnalysisEnabled	0..1	Boolean	hérité de: Equipment
normallyInService	0..1	Boolean	hérité de: Equipment
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 418 présente toutes les extrémités d'association de GeneratingUnit avec d'autres classes.

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Tableau 418 – Extrémités d'association de Production::GeneratingUnit avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..1	RotatingMachine	0..*	RotatingMachine	Une machine synchrone peut fonctionner comme générateur et devenir par conséquent un élément de l'unité de production.
1..1	GenUnitOpCostCurves	0..*	GenUnitOpCostCurve	Une unité de production peut avoir une ou plusieurs courbes de coûts, en fonction du mélange combustible et du prix du combustible.
1..1	GenUnitOpSchedule	0..1	GenUnitOpSchedule	Une unité de production peut comprendre un programme de fonctionnement, indiquant un fonctionnement planifié de l'unité.
1..1	ControlAreaGeneratingUnit	0..*	ControlAreaGeneratingUnit	Spécifications relatives à la zone de commande ControlArea pour cette unité de production.
1..1	GrossToNetActivePowerCurves	0..*	GrossToNetActivePowerCurve	Une unité de production peut comprendre une courbe de la puissance active brute en fonction de la puissance active nette, décrivant les pertes et les exigences de puissance auxiliaire de l'unité.
0..1	OperationalLimitSet	0..*	OperationalLimitSet	hérité de: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	hérité de: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	hérité de: Equipment
0..1	Faults	0..*	Fault	hérité de: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	hérité de: Equipment
0..*	PSRType	0..1	PSRType	hérité de: PowerSystemResource
0..1	Controls	0..*	Control	hérité de: PowerSystemResource
0..1	Measurements	0..*	Measurement	hérité de: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	hérité de: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	hérité de: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.6.3.19 Enumération GeneratorControlMode

Modes de commande pour l'unité.

Le Tableau 419 présente tous les libellés de GeneratorControlMode.

Tableau 419 – Libellés de Production::GeneratorControlMode

libellé	value	description
setpoint		Mode de commande du point de consigne.
pulse		Mode de commande de l'impulsion.

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6.6.3.20 Enumération GeneratorControlSource

Source de commandes pour une unité de production.

Le Tableau 420 présente tous les libellés de GeneratorControlSource.

Tableau 420 – Libellés de Production::GeneratorControlSource

libellé	value	description
unavailable		Non disponible.
offAGC		Désactivation du contrôle automatique de production (AGC).
onAGC		Activation du contrôle automatique de production (AGC).
plantControl		La centrale a les commandes.

6.6.3.21 GrossToNetActivePowerCurve

Relation entre la sortie de puissance active brute de l'unité de production sur l'axe X (mesurée sur les bornes de la (des) machine(s)) et la sortie de puissance active nette de l'unité de production sur l'axe Y (fondée sur les mesures définies par l'entreprise de service public d'électricité à la centrale électrique). Il convient que les charges de service de poste, si elles sont modélisées, soient considérées comme des charges de jeu de barres non conformes. Il peut exister plus d'une courbe, en fonction de l'équipement auxiliaire en service.

Le Tableau 421 présente tous les attributs de GrossToNetActivePowerCurve.

Tableau 421 – Attributs de Production::GrossToNetActivePowerCurve

nom	mult	type	description
curveStyle	0..1	CurveStyle	hérité de: Curve
xMultiplier	0..1	UnitMultiplier	hérité de: Curve
xUnit	0..1	UnitSymbol	hérité de: Curve
y1Multiplier	0..1	UnitMultiplier	hérité de: Curve
y1Unit	0..1	UnitSymbol	hérité de: Curve
y2Multiplier	0..1	UnitMultiplier	hérité de: Curve
y2Unit	0..1	UnitSymbol	hérité de: Curve
y3Multiplier	0..1	UnitMultiplier	hérité de: Curve
y3Unit	0..1	UnitSymbol	hérité de: Curve
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 422 présente toutes les extrémités d'association de GrossToNetActivePowerCurve avec d'autres classes.

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Tableau 422 – Extrémités d'association de Production::GrossToNetActivePowerCurve avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..*	GeneratingUnit	1..1	GeneratingUnit	Une unité de production peut comprendre une courbe de la puissance active brute en fonction de la puissance active nette, décrivant les pertes et les exigences de puissance auxiliaire de l'unité.
1..1	CurveDatas	0..*	CurveData	hérité de: Curve
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.6.3.22 HeatInputCurve

Relation entre l'apport de chaleur de l'unité en énergie par durée pour le combustible principal (axe Y1) et le combustible complémentaire (axe Y2) en fonction de la sortie de l'unité en puissance active (axe X). La quantité de combustible principal utilisé pour soutenir la production à ce niveau de sortie est distribuée au prorata pour un réglage entre les points de définition. La quantité de combustible additionnel utilisé à ce niveau de sortie est fixée et n'est pas distribuée au prorata.

Le Tableau 423 présente tous les attributs de HeatInputCurve.

Tableau 423 – Attributs de Production::HeatInputCurve

nom	mult	type	description
auxPowerMult	0..1	PU	Sortie de puissance – facteur d'ajustement de multiplication puissance auxiliaire.
auxPowerOffset	0..1	ActivePower	Sortie de puissance – facteur d'ajustement de compensation puissance auxiliaire.
heatInputEff	0..1	PU	Apport de chaleur – facteur d'ajustement de multiplication efficacité.
heatInputOffset	0..1	HeatRate	Apport de chaleur – facteur d'ajustement de compensation.
isNetGrossP	0..1	Boolean	L'indicateur est défini sur true (vrai) lorsque la sortie est exprimée en puissance active nette.
curveStyle	0..1	CurveStyle	hérité de: Curve
xMultiplier	0..1	UnitMultiplier	hérité de: Curve
xUnit	0..1	UnitSymbol	hérité de: Curve
y1Multiplier	0..1	UnitMultiplier	hérité de: Curve
y1Unit	0..1	UnitSymbol	hérité de: Curve
y2Multiplier	0..1	UnitMultiplier	hérité de: Curve
y2Unit	0..1	UnitSymbol	hérité de: Curve
y3Multiplier	0..1	UnitMultiplier	hérité de: Curve
y3Unit	0..1	UnitSymbol	hérité de: Curve
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

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Le Tableau 424 présente toutes les extrémités d'association de HeatInputCurve avec d'autres classes.

Tableau 424 – Extrémités d'association de Production::HeatInputCurve avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..1	ThermalGeneratingUnit	1..1	ThermalGeneratingUnit	Une unité de production thermique peut comporter une courbe d'apport de chaleur.
1..1	CurveDatas	0..*	CurveData	hérité de: Curve
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.6.3.23 HeatRateCurve

Relation entre consommation calorifique de l'unité par puissance active (axe Y) et la sortie de l'unité (axe X). L'apport de chaleur provient de tous les combustibles.

Le Tableau 425 présente tous les attributs de HeatRateCurve.

Tableau 425 – Attributs de Production::HeatRateCurve

nom	mult	type	description
isNetGrossP	0..1	Boolean	L'indicateur est défini sur true (vrai) lorsque la sortie est exprimée en puissance active nette.
curveStyle	0..1	CurveStyle	hérité de: Curve
xMultiplier	0..1	UnitMultiplier	hérité de: Curve
xUnit	0..1	UnitSymbol	hérité de: Curve
y1Multiplier	0..1	UnitMultiplier	hérité de: Curve
y1Unit	0..1	UnitSymbol	hérité de: Curve
y2Multiplier	0..1	UnitMultiplier	hérité de: Curve
y2Unit	0..1	UnitSymbol	hérité de: Curve
y3Multiplier	0..1	UnitMultiplier	hérité de: Curve
y3Unit	0..1	UnitSymbol	hérité de: Curve
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 426 présente toutes les extrémités d'association de HeatRateCurve avec d'autres classes.

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Tableau 426 – Extrémités d'association de Production::HeatRateCurve avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..1	ThermalGeneratingUnit	1..1	ThermalGeneratingUnit	Une unité de production thermique peut comporter une courbe de consommation calorifique.
1..1	CurveDatas	0..*	CurveData	hérité de: Curve
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.6.3.24 Enumération HydroEnergyConversionKind

Spécifie la capacité de l'unité de production hydraulique à convertir l'énergie comme un générateur ou une pompe.

Le Tableau 427 présente tous les libellés de HydroEnergyConversionKind.

Tableau 427 – Libellés de Production::HydroEnergyConversionKind

libellé	value	description
generator		Capable de générer de la puissance, mais incapable de pomper l'eau pour stockage d'énergie.
pumpAndGenerator		Capable à la fois de générer de la puissance et de pomper de l'eau pour le stockage d'énergie.

6.6.3.25 HydroGeneratingEfficiencyCurve

Relation entre rendement de l'unité en pourcentage et la puissance active de sortie de l'unité pour une hauteur de chute nette en mètres. La relation entre rendement, décharge, hauteur de chute et puissance de sortie est exprimée comme suit:

$$E = KP/HQ$$

où: E est le rendement, en pourcentage; P est la puissance active; H est la hauteur; Q est la décharge, unité volume/temps; K est une constante.

Par exemple, une courbe pour une hauteur de chute nette donnée peut présenter le rendement (axe Y) en fonction de la puissance de sortie active (axe X) ou en fonction de la décharge sur l'axe X.

Le Tableau 428 présente tous les attributs de HydroGeneratingEfficiencyCurve.

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Tableau 428 – Attributs de Production::HydroGeneratingEfficiencyCurve

nom	mult	type	description
curveStyle	0..1	CurveStyle	hérité de: Curve
xMultiplier	0..1	UnitMultiplier	hérité de: Curve
xUnit	0..1	UnitSymbol	hérité de: Curve
y1Multiplier	0..1	UnitMultiplier	hérité de: Curve
y1Unit	0..1	UnitSymbol	hérité de: Curve
y2Multiplier	0..1	UnitMultiplier	hérité de: Curve
y2Unit	0..1	UnitSymbol	hérité de: Curve
y3Multiplier	0..1	UnitMultiplier	hérité de: Curve
y3Unit	0..1	UnitSymbol	hérité de: Curve
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 429 présente toutes les extrémités d'association de HydroGeneratingEfficiencyCurve avec d'autres classes.

Tableau 429 – Extrémités d'association de Production::HydroGeneratingEfficiencyCurve avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..*	HydroGeneratingUnit	1..1	HydroGeneratingUnit	Une unité hydrogénératrice a une courbe de rendement.
1..1	CurveDatas	0..*	CurveData	hérité de: Curve
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.6.3.26 HydroGeneratingUnit

Unité de production dont la machine motrice est une turbine hydraulique (par exemple, Francis, Pelton, Kaplan).

Le Tableau 430 présente tous les attributs de HydroGeneratingUnit.

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Tableau 430 – Attributs de Production::HydroGeneratingUnit

nom	mult	type	description
energyConversionCapability	0..1	HydroEnergyConversionKind	Capacité de conversion en énergie pour la production.
hydroUnitWaterCost	0..1	CostPerVolume	Coût équivalent de l'eau qui entraîne la turbine hydraulique.
dropHeight	0..1	Length	Hauteur de chute de l'eau entre le milieu du réservoir et la turbine.
turbineType	0..1	HydroTurbineKind	Type de turbine.
allocSpinResP	0..1	ActivePower	hérité de: GeneratingUnit
autoCntrlMarginP	0..1	ActivePower	hérité de: GeneratingUnit
baseP	0..1	ActivePower	hérité de: GeneratingUnit
controlDeadband	0..1	ActivePower	hérité de: GeneratingUnit
controlPulseHigh	0..1	Seconds	hérité de: GeneratingUnit
controlPulseLow	0..1	Seconds	hérité de: GeneratingUnit
controlResponseRate	0..1	ActivePowerChangeRate	hérité de: GeneratingUnit
efficiency	0..1	PerCent	hérité de: GeneratingUnit
genControlMode	0..1	GeneratorControlMode	hérité de: GeneratingUnit
genControlSource	0..1	GeneratorControlSource	hérité de: GeneratingUnit
governorMPL	0..1	PU	hérité de: GeneratingUnit
governorSCD	0..1	PerCent	hérité de: GeneratingUnit
highControlLimit	0..1	ActivePower	hérité de: GeneratingUnit
initialP	0..1	ActivePower	hérité de: GeneratingUnit
longPF	0..1	Float	hérité de: GeneratingUnit
lowControlLimit	0..1	ActivePower	hérité de: GeneratingUnit
lowerRampRate	0..1	ActivePowerChangeRate	hérité de: GeneratingUnit
maxEconomicP	0..1	ActivePower	hérité de: GeneratingUnit
maximumAllowableSpinningReserve	0..1	ActivePower	hérité de: GeneratingUnit
maxOperatingP	0..1	ActivePower	hérité de: GeneratingUnit
minEconomicP	0..1	ActivePower	hérité de: GeneratingUnit
minimumOffTime	0..1	Seconds	hérité de: GeneratingUnit
minOperatingP	0..1	ActivePower	hérité de: GeneratingUnit
modelDetail	0..1	Classification	hérité de: GeneratingUnit
nominalP	0..1	ActivePower	hérité de: GeneratingUnit
normalPF	0..1	Float	hérité de: GeneratingUnit
penaltyFactor	0..1	Float	hérité de: GeneratingUnit
raiseRampRate	0..1	ActivePowerChangeRate	hérité de: GeneratingUnit
ratedGrossMaxP	0..1	ActivePower	hérité de: GeneratingUnit
ratedGrossMinP	0..1	ActivePower	hérité de: GeneratingUnit
ratedNetMaxP	0..1	ActivePower	hérité de: GeneratingUnit
shortPF	0..1	Float	hérité de: GeneratingUnit
startupCost	0..1	Money	hérité de: GeneratingUnit
startupTime	0..1	Seconds	hérité de: GeneratingUnit
tieLinePF	0..1	Float	hérité de: GeneratingUnit
totalEfficiency	0..1	PerCent	hérité de: GeneratingUnit

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nom	mult	type	description
variableCost	0..1	Money	hérité de: GeneratingUnit
aggregate	0..1	Boolean	hérité de: Equipment
inService	0..1	Boolean	hérité de: Equipment
networkAnalysisEnabled	0..1	Boolean	hérité de: Equipment
normallyInService	0..1	Boolean	hérité de: Equipment
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 431 présente toutes les extrémités d'association de HydroGeneratingUnit avec d'autres classes.

Tableau 431 – Extrémités d'association de Production::HydroGeneratingUnit avec d'autres classes

mult à partir de	nom	mult vers	type	description
1..1	HydroGeneratingEfficiencyCurves	0..*	HydroGeneratingEfficiencyCurve	Une unité hydrogénératrice a une courbe de rendement.
1..1	TailbayLossCurve	0..*	TailbayLossCurve	Une unité hydrogénératrice a une courbe de perte de sortie d'écluse.
0..*	HydroPowerPlant	0..1	HydroPowerPlant	L'unité de production hydraulique appartient à une centrale hydro-électrique.
1..1	PenstockLossCurve	0..1	PenstockLossCurve	Une unité hydrogénératrice a une courbe de perte de conduite forcée.
0..1	RotatingMachine	0..*	RotatingMachine	hérité de: GeneratingUnit
1..1	GenUnitOpCostCurves	0..*	GenUnitOpCostCurve	hérité de: GeneratingUnit
1..1	GenUnitOpSchedule	0..1	GenUnitOpSchedule	hérité de: GeneratingUnit
1..1	ControlAreaGeneratingUnit	0..*	ControlAreaGeneratingUnit	hérité de: GeneratingUnit
1..1	GrossToNetActivePowerCurves	0..*	GrossToNetActivePowerCurve	hérité de: GeneratingUnit
0..1	OperationalLimitSet	0..*	OperationalLimitSet	hérité de: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	hérité de: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	hérité de: Equipment
0..1	Faults	0..*	Fault	hérité de: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	hérité de: Equipment
0..*	PSRType	0..1	PSRType	hérité de: PowerSystemResource
0..1	Controls	0..*	Control	hérité de: PowerSystemResource
0..1	Measurements	0..*	Measurement	hérité de: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	hérité de: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	hérité de: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

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6.6.3.27 Enumération HydroPlantStorageKind

Type de centrale hydroélectrique.

Le Tableau 432 présente tous les libellés de HydroPlantStorageKind.

Tableau 432 – Libellés de Production::HydroPlantStorageKind

libellé	value	description
runOfRiver		Fil de l'eau.
pumpedStorage		Stockage pompé.
storage		Stockage.

6.6.3.28 HydroPowerPlant

Centrale hydroélectrique qui peut produire ou pomper. Pour la production, les turbines génératrices reçoivent l'eau d'un réservoir supérieur. Pour le pompage, les pompes reçoivent l'eau d'un réservoir inférieur.

Le Tableau 433 présente tous les attributs de HydroPowerPlant.

Tableau 433 – Attributs de Production::HydroPowerPlant

nom	mult	type	description
dischargeTravelDelay	0..1	Seconds	Course de l'eau depuis la sortie d'écluse jusqu'à la prochaine centrale hydroélectrique en aval.
genRatedP	0..1	ActivePower	Régime assigné de production de la centrale hydroélectrique en puissance active, dans des conditions de hauteur de chute assignée. La valeur de l'attribut doit être positive.
hydroPlantStorageType	0..1	HydroPlantStorageKind	Type de stockage d'eau dans une centrale hydroélectrique.
penstockType	0..1	String	Type et configuration de la (des) conduite(s) forcée(s) de la centrale hydroélectrique.
plantDischargeCapacity	0..1	VolumeFlowRate	Capacité de décharge totale de la centrale.
plantRatedHead	0..1	Length	Hauteur de chute brute assignée de la centrale. La valeur de l'attribut doit être positive.
pumpRatedP	0..1	ActivePower	Régime assigné de pompage de la centrale hydroélectrique en puissance active, dans des conditions de hauteur de chute assignée. La valeur de l'attribut doit être positive.
surgeTankCode	0..1	String	Code décrivant le type (ou l'absence) de cheminée d'équilibre liée à la centrale hydroélectrique.
surgeTankCrestLevel	0..1	WaterLevel	Niveau à partir duquel la cheminée d'équilibre déborde.
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

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Le Tableau 434 présente toutes les extrémités d'association de HydroPowerPlant avec d'autres classes.

Tableau 434 – Extrémités d'association de Production::HydroPowerPlant avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..1	HydroGeneratingUnits	0..*	HydroGeneratingUnit	L'unité de production hydraulique appartient à une centrale hydro-électrique.
0..1	HydroPumps	0..*	HydroPump	La pompe hydraulique peut être un membre de la centrale d'accumulation par pompage ou une pompe de distribution d'eau.
0..*	Reservoir	0..1	Reservoir	Un réservoir en aval reçoit l'eau évacuée par des générateurs ou alimente des pompes en eau.
0..*	GenSourcePumpDischargeReservoir	1..1	Reservoir	Un réservoir en amont alimente des générateurs en eau ou reçoit l'eau évacuée par des pompes.
0..*	PSRType	0..1	PSRType	hérité de: PowerSystemResource
0..1	Controls	0..*	Control	hérité de: PowerSystemResource
0..1	Measurements	0..*	Measurement	hérité de: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	hérité de: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	hérité de: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.6.3.29 HydroPump

Pompe synchrone entraînée par moteur, généralement associée à une centrale de pompage.

Le Tableau 435 présente tous les attributs de HydroPump.

Tableau 435 – Attributs de Production::HydroPump

nom	mult	type	description
pumpDischAtMaxHead	0..1	VolumeFlowRate	Décharge du pompage en cas de hauteur de chute maximale, habituellement avec vannes au maximum.
pumpDischAtMinHead	0..1	VolumeFlowRate	Décharge du pompage en cas de hauteur de chute minimale, habituellement avec vannes au maximum.
pumpPowerAtMaxHead	0..1	ActivePower	Puissance du pompage en cas de hauteur de chute maximale, habituellement avec vannes au maximum.
pumpPowerAtMinHead	0..1	ActivePower	Puissance du pompage en cas de hauteur de chute minimale, habituellement avec vannes au maximum.
aggregate	0..1	Boolean	hérité de: Equipment
inService	0..1	Boolean	hérité de: Equipment

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nom	mult	type	description
networkAnalysisEnabled	0..1	Boolean	hérité de: Equipment
normallyInService	0..1	Boolean	hérité de: Equipment
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 436 présente toutes les extrémités d'association de HydroPump avec d'autres classes.

Tableau 436 – Extrémités d'association de Production::HydroPump avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..1	RotatingMachine	1..1	RotatingMachine	La machine synchrone entraîne la turbine qui déplace l'eau de bas en haut. Le sens de rotation de la machine pour le pompage peut ou peut ne pas être identique à celui utilisé pour la production.
0..*	HydroPowerPlant	0..1	HydroPowerPlant	La pompe hydraulique peut être un membre de la centrale d'accumulation par pompage ou une pompe de distribution d'eau.
1..1	HydroPumpOpSchedule	0..1	HydroPumpOpSchedule	La pompe hydraulique possède un programme de pompage sur la durée, précisant le moment auquel le pompage doit avoir lieu.
0..1	OperationalLimitSet	0..*	OperationalLimitSet	hérité de: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	hérité de: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	hérité de: Equipment
0..1	Faults	0..*	Fault	hérité de: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	hérité de: Equipment
0..*	PSRType	0..1	PSRType	hérité de: PowerSystemResource
0..1	Controls	0..*	Control	hérité de: PowerSystemResource
0..1	Measurements	0..*	Measurement	hérité de: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	hérité de: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	hérité de: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

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6.6.3.30 HydroPumpOpSchedule

Programme (ou plan) de fonctionnement actuel approuvé par l'opérateur de la pompe hydraulique, généralement produit à l'aide des analyses du type Planification de l'opération des unités de production. Le statut du plan de fonctionnement de l'unité est en général donné sous la forme: (0 = unavailable – non disponible) (1 = available to startup or shutdown – disponible pour démarrage ou arrêt) (2 = must pump – pompage imposé).

Le Tableau 437 présente tous les attributs de HydroPumpOpSchedule.

Tableau 437 – Attributs de Production::HydroPumpOpSchedule

nom	mult	type	description
endTime	0..1	DateTime	hérité de: RegularIntervalSchedule
timeStep	0..1	Seconds	hérité de: RegularIntervalSchedule
startTime	0..1	DateTime	hérité de: BasicIntervalSchedule
value1Multiplier	0..1	UnitMultiplier	hérité de: BasicIntervalSchedule
value1Unit	0..1	UnitSymbol	hérité de: BasicIntervalSchedule
value2Multiplier	0..1	UnitMultiplier	hérité de: BasicIntervalSchedule
value2Unit	0..1	UnitSymbol	hérité de: BasicIntervalSchedule
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 438 présente toutes les extrémités d'association de HydroPumpOpSchedule avec d'autres classes.

Tableau 438 – Extrémités d'association de Production::HydroPumpOpSchedule avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..1	HydroPump	1..1	HydroPump	La pompe hydraulique possède un programme de pompage sur la durée, précisant le moment auquel le pompage doit avoir lieu.
1..1	TimePoints	1..*	RegularTimePoint	hérité de: RegularIntervalSchedule
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.6.3.31 IncrementalHeatRateCurve

Relation entre la consommation incrémentale de chaleur (IHR, incremental heat rate) de l'unité en (delta énergie/temps) par (delta puissance active) et la sortie de l'unité en puissance active. La courbe IHR représente la pente de la HeatInputCurve. Noter que la consommation incrémentale de chaleur (incremental heat rate) et la consommation de chaleur (heat rate) sont exprimées dans les mêmes unités techniques.

Le Tableau 439 présente tous les attributs de IncrementalHeatRateCurve.

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Tableau 439 – Attributs de Production::IncrementalHeatRateCurve

nom	mult	type	description
isNetGrossP	0..1	Boolean	L'indicateur est défini sur true (vrai) lorsque la sortie est exprimée en puissance active nette.
curveStyle	0..1	CurveStyle	hérité de: Curve
xMultiplier	0..1	UnitMultiplier	hérité de: Curve
xUnit	0..1	UnitSymbol	hérité de: Curve
y1Multiplier	0..1	UnitMultiplier	hérité de: Curve
y1Unit	0..1	UnitSymbol	hérité de: Curve
y2Multiplier	0..1	UnitMultiplier	hérité de: Curve
y2Unit	0..1	UnitSymbol	hérité de: Curve
y3Multiplier	0..1	UnitMultiplier	hérité de: Curve
y3Unit	0..1	UnitSymbol	hérité de: Curve
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 440 présente toutes les extrémités d'association de IncrementalHeatRateCurve avec d'autres classes.

Tableau 440 – Extrémités d'association de Production::IncrementalHeatRateCurve avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..1	ThermalGeneratingUnit	1..1	ThermalGeneratingUnit	Une unité de production thermique peut comporter une courbe de consommation incrémentale de chaleur.
1..1	CurveDatas	0..*	CurveData	hérité de: Curve
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.6.3.32 InflowForecast

Arrivée naturelle d'eau dans un réservoir, normalement calculable d'après la quantité d'eau de pluie et de neige fondue prévue. Généralement en incréments d'une heure pendant une période pouvant aller jusqu'à 10 jours. La prévision est estimée en mètres cubes par seconde (en moyenne) sur la durée de l'augmentation.

Le Tableau 441 présente tous les attributs de InflowForecast.

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Tableau 441 – Attributs de Production::InflowForecast

nom	mult	type	description
endTime	0..1	DateTime	hérité de: RegularIntervalSchedule
timeStep	0..1	Seconds	hérité de: RegularIntervalSchedule
startTime	0..1	DateTime	hérité de: BasicIntervalSchedule
value1Multiplier	0..1	UnitMultiplier	hérité de: BasicIntervalSchedule
value1Unit	0..1	UnitSymbol	hérité de: BasicIntervalSchedule
value2Multiplier	0..1	UnitMultiplier	hérité de: BasicIntervalSchedule
value2Unit	0..1	UnitSymbol	hérité de: BasicIntervalSchedule
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 442 présente toutes les extrémités d'association de InflowForecast avec d'autres classes.

Tableau 442 – Extrémités d'association de Production::InflowForecast avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..*	Reservoir	1..1	Reservoir	Un réservoir peut avoir une prévision de flux d'entrée "naturelle".
1..1	TimePoints	1..*	RegularTimePoint	hérité de: RegularIntervalSchedule
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.6.3.33 LevelVsVolumeCurve

Relation entre le volume d'un réservoir et le niveau du réservoir. Le volume est en ordonnée (sur l'axe Y) et le niveau du réservoir en abscisse (sur l'axe X).

Le Tableau 443 présente tous les attributs de LevelVsVolumeCurve.

Tableau 443 – Attributs de Production::LevelVsVolumeCurve

nom	mult	type	description
curveStyle	0..1	CurveStyle	hérité de: Curve
xMultiplier	0..1	UnitMultiplier	hérité de: Curve
xUnit	0..1	UnitSymbol	hérité de: Curve
y1Multiplier	0..1	UnitMultiplier	hérité de: Curve
y1Unit	0..1	UnitSymbol	hérité de: Curve
y2Multiplier	0..1	UnitMultiplier	hérité de: Curve
y2Unit	0..1	UnitSymbol	hérité de: Curve
y3Multiplier	0..1	UnitMultiplier	hérité de: Curve
y3Unit	0..1	UnitSymbol	hérité de: Curve

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nom	mult	type	description
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 444 présente toutes les extrémités d'association de LevelVsVolumeCurve avec d'autres classes.

Tableau 444 – Extrémités d'association de Production::LevelVsVolumeCurve avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..*	Reservoir	1..1	Reservoir	Un réservoir peut avoir une relation niveau en fonction du volume.
1..1	CurveDatas	0..*	CurveData	hérité de: Curve
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.6.3.34 NuclearGeneratingUnit

Unité de production nucléaire.

Le Tableau 445 présente tous les attributs de NuclearGeneratingUnit.

Tableau 445 – Attributs de Production::NuclearGeneratingUnit

nom	mult	type	description
allocSpinResP	0..1	ActivePower	hérité de: GeneratingUnit
autoCntrlMarginP	0..1	ActivePower	hérité de: GeneratingUnit
baseP	0..1	ActivePower	hérité de: GeneratingUnit
controlDeadband	0..1	ActivePower	hérité de: GeneratingUnit
controlPulseHigh	0..1	Seconds	hérité de: GeneratingUnit
controlPulseLow	0..1	Seconds	hérité de: GeneratingUnit
controlResponseRate	0..1	ActivePowerChangeRate	hérité de: GeneratingUnit
efficiency	0..1	PerCent	hérité de: GeneratingUnit
genControlMode	0..1	GeneratorControlMode	hérité de: GeneratingUnit
genControlSource	0..1	GeneratorControlSource	hérité de: GeneratingUnit
governorMPL	0..1	PU	hérité de: GeneratingUnit
governorSCD	0..1	PerCent	hérité de: GeneratingUnit
highControlLimit	0..1	ActivePower	hérité de: GeneratingUnit
initialP	0..1	ActivePower	hérité de: GeneratingUnit
longPF	0..1	Float	hérité de: GeneratingUnit
lowControlLimit	0..1	ActivePower	hérité de: GeneratingUnit
lowerRampRate	0..1	ActivePowerChangeRate	hérité de: GeneratingUnit
maxEconomicP	0..1	ActivePower	hérité de: GeneratingUnit

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nom	mult	type	description
maximumAllowableSpinningReserve	0..1	ActivePower	hérité de: GeneratingUnit
maxOperatingP	0..1	ActivePower	hérité de: GeneratingUnit
minEconomicP	0..1	ActivePower	hérité de: GeneratingUnit
minimumOffTime	0..1	Seconds	hérité de: GeneratingUnit
minOperatingP	0..1	ActivePower	hérité de: GeneratingUnit
modelDetail	0..1	Classification	hérité de: GeneratingUnit
nominalP	0..1	ActivePower	hérité de: GeneratingUnit
normalPF	0..1	Float	hérité de: GeneratingUnit
penaltyFactor	0..1	Float	hérité de: GeneratingUnit
raiseRampRate	0..1	ActivePowerChangeRate	hérité de: GeneratingUnit
ratedGrossMaxP	0..1	ActivePower	hérité de: GeneratingUnit
ratedGrossMinP	0..1	ActivePower	hérité de: GeneratingUnit
ratedNetMaxP	0..1	ActivePower	hérité de: GeneratingUnit
shortPF	0..1	Float	hérité de: GeneratingUnit
startupCost	0..1	Money	hérité de: GeneratingUnit
startupTime	0..1	Seconds	hérité de: GeneratingUnit
tieLinePF	0..1	Float	hérité de: GeneratingUnit
totalEfficiency	0..1	PerCent	hérité de: GeneratingUnit
variableCost	0..1	Money	hérité de: GeneratingUnit
aggregate	0..1	Boolean	hérité de: Equipment
inService	0..1	Boolean	hérité de: Equipment
networkAnalysisEnabled	0..1	Boolean	hérité de: Equipment
normallyInService	0..1	Boolean	hérité de: Equipment
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 446 présente toutes les extrémités d'association de NuclearGeneratingUnit avec d'autres classes.

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Tableau 446 – Extrémités d'association de Production::NuclearGeneratingUnit avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..1	RotatingMachine	0..*	RotatingMachine	hérité de: GeneratingUnit
1..1	GenUnitOpCostCurves	0..*	GenUnitOpCostCurve	hérité de: GeneratingUnit
1..1	GenUnitOpSchedule	0..1	GenUnitOpSchedule	hérité de: GeneratingUnit
1..1	ControlAreaGeneratingUnit	0..*	ControlAreaGeneratingUnit	hérité de: GeneratingUnit
1..1	GrossToNetActivePowerCurves	0..*	GrossToNetActivePowerCurve	hérité de: GeneratingUnit
0..1	OperationalLimitSet	0..*	OperationalLimitSet	hérité de: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	hérité de: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	hérité de: Equipment
0..1	Faults	0..*	Fault	hérité de: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	hérité de: Equipment
0..*	PSRType	0..1	PSRType	hérité de: PowerSystemResource
0..1	Controls	0..*	Control	hérité de: PowerSystemResource
0..1	Measurements	0..*	Measurement	hérité de: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	hérité de: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	hérité de: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.6.3.35 PenstockLossCurve

Relation entre la perte de la hauteur de chute de la conduite forcée (en mètres) et l'évacuation totale à travers la conduite forcée (en mètres cubes par seconde). Une ou plusieurs turbines peuvent être connectées à la même conduite forcée.

Le Tableau 447 présente tous les attributs de PenstockLossCurve.

Tableau 447 – Attributs de Production::PenstockLossCurve

nom	mult	type	description
curveStyle	0..1	CurveStyle	hérité de: Curve
xMultiplier	0..1	UnitMultiplier	hérité de: Curve
xUnit	0..1	UnitSymbol	hérité de: Curve
y1Multiplier	0..1	UnitMultiplier	hérité de: Curve
y1Unit	0..1	UnitSymbol	hérité de: Curve
y2Multiplier	0..1	UnitMultiplier	hérité de: Curve
y2Unit	0..1	UnitSymbol	hérité de: Curve
y3Multiplier	0..1	UnitMultiplier	hérité de: Curve
y3Unit	0..1	UnitSymbol	hérité de: Curve
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject

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nom	mult	type	description
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 448 présente toutes les extrémités d'association de PenstockLossCurve avec d'autres classes.

Tableau 448 – Extrémités d'association de Production::PenstockLossCurve avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..1	HydroGeneratingUnit	1..1	HydroGeneratingUnit	Une unité hydrogénératrice a une courbe de perte de conduite forcée.
1..1	CurveDatas	0..*	CurveData	hérité de: Curve
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.6.3.36 PhotoVoltaicUnit

Un appareil photovoltaïque ou un ensemble de ces appareils.

Le Tableau 449 présente tous les attributs de PhotoVoltaicUnit.

Tableau 449 – Attributs de Production::PhotoVoltaicUnit

nom	mult	type	description
maxP	0..1	ActivePower	hérité de: PowerElectronicsUnit
minP	0..1	ActivePower	hérité de: PowerElectronicsUnit
aggregate	0..1	Boolean	hérité de: Equipment
inService	0..1	Boolean	hérité de: Equipment
networkAnalysisEnabled	0..1	Boolean	hérité de: Equipment
normallyInService	0..1	Boolean	hérité de: Equipment
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 450 présente toutes les extrémités d'association de PhotoVoltaicUnit avec d'autres classes.

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Tableau 450 – Extrémités d'association de Production::PhotoVoltaicUnit avec d'autres noms

mult à partir de	nom	mult vers	type	description
0..*	PowerElectronicsConnection	1..1	PowerElectronicsConnection	hérité de: PowerElectronicsUnit
0..1	OperationalLimitSet	0..*	OperationalLimitSet	hérité de: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	hérité de: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	hérité de: Equipment
0..1	Faults	0..*	Fault	hérité de: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	hérité de: Equipment
0..*	PSRType	0..1	PSRType	hérité de: PowerSystemResource
0..1	Controls	0..*	Control	hérité de: PowerSystemResource
0..1	Measurements	0..*	Measurement	hérité de: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	hérité de: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	hérité de: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.6.3.37 PowerElectronicsUnit

Unité de production, batterie ou agrégation qui se connecte au réseau à courant alternatif à l'aide de l'électronique de puissance plutôt que de machines tournantes.

Le Tableau 451 présente tous les attributs de PowerElectronicsUnit.

Tableau 451 – Attributs de Production::PowerElectronicsUnit

nom	mult	type	description
maxP	0..1	ActivePower	Limite maximale de la puissance active. Il s'agit de la limite maximale (constructeur) de l'unité.
minP	0..1	ActivePower	Limite minimale de la puissance active. Il s'agit de la limite minimale (constructeur) de l'unité.
aggregate	0..1	Boolean	hérité de: Equipment
inService	0..1	Boolean	hérité de: Equipment
networkAnalysisEnabled	0..1	Boolean	hérité de: Equipment
normallyInService	0..1	Boolean	hérité de: Equipment
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 452 présente toutes les extrémités d'association de PowerElectronicsUnit avec d'autres classes.

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Tableau 452 – Extrémités d'association de Production::PowerElectronicsUnit avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..*	PowerElectronicsConnection	1..1	PowerElectronicsConnection	Une unité d'électronique de puissance a une connexion avec le réseau à courant alternatif.
0..1	OperationalLimitSet	0..*	OperationalLimitSet	hérité de: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	hérité de: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	hérité de: Equipment
0..1	Faults	0..*	Fault	hérité de: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	hérité de: Equipment
0..*	PSRType	0..1	PSRType	hérité de: PowerSystemResource
0..1	Controls	0..*	Control	hérité de: PowerSystemResource
0..1	Measurements	0..*	Measurement	hérité de: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	hérité de: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	hérité de: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.6.3.38 PowerElectronicsWindUnit

Générateur éolien ou agrégation de générateurs éoliens qui connectent le réseau à courant alternatif à des électroniques de puissance plutôt qu'à des machines tournantes.

Le Tableau 453 présente tous les attributs de PowerElectronicsWindUnit.

Tableau 453 – Attributs de Production::PowerElectronicsWindUnit

nom	mult	type	description
maxP	0..1	ActivePower	hérité de: PowerElectronicsUnit
minP	0..1	ActivePower	hérité de: PowerElectronicsUnit
aggregate	0..1	Boolean	hérité de: Equipment
inService	0..1	Boolean	hérité de: Equipment
networkAnalysisEnabled	0..1	Boolean	hérité de: Equipment
normallyInService	0..1	Boolean	hérité de: Equipment
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 454 présente toutes les extrémités d'association de PowerElectronicsWindUnit avec d'autres classes.

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Tableau 454 – Extrémités d'association de Production::PowerElectronicsWindUnit avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..*	PowerElectronicsConnection	1..1	PowerElectronicsConnection	hérité de: PowerElectronicsUnit
0..1	OperationalLimitSet	0..*	OperationalLimitSet	hérité de: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	hérité de: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	hérité de: Equipment
0..1	Faults	0..*	Fault	hérité de: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	hérité de: Equipment
0..*	PSRType	0..1	PSRType	hérité de: PowerSystemResource
0..1	Controls	0..*	Control	hérité de: PowerSystemResource
0..1	Measurements	0..*	Measurement	hérité de: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	hérité de: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	hérité de: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.6.3.39 Reservoir

Installation de stockage d'eau dans un système hydraulique, comprenant: étangs, lacs, lagunes et rivières. Le stockage se fait généralement après un barrage.

Le Tableau 455 présente tous les attributs de Reservoir.

Tableau 455 – Attributs de Production::Reservoir

nom	mult	type	description
activeStorageCapacity	0..1	Volume	Volume de stockage entre le niveau d'alimentation plein et le niveau de fonctionnement normal minimum.
energyStorageRating	0..1	Float	Régime nominal de stockage de l'énergie du réservoir, en énergie, pour des cas de hauteur de chute donnés.
fullSupplyLevel	0..1	WaterLevel	Niveau d'alimentation plein, au-dessus duquel l'eau déborde. Il peut correspondre au niveau de crête du canal de trop-plein ou au niveau atteint au sommet des vannes fermées.
grossCapacity	0..1	Volume	Capacité totale du réservoir.
normalMinOperateLevel	0..1	WaterLevel	Niveau de fonctionnement normal minimum en dessous duquel les conduites forcées drainent de l'air.
riverOutletWorks	0..1	String	Ouvrages fluviaux pour lâchage d'eau lié aux droits de riveraineté ou pour d'autres raisons.
spillTravelDelay	0..1	Seconds	Temps additionnel de course de l'eau du canal de trop-plein jusqu'au prochain réservoir en aval.
spillwayCapacity	0..1	Float	Capacité d'écoulement du canal de trop-plein, en mètres cubes par seconde.
spillwayCrestLength	0..1	Length	Longueur de la crête de trop-plein.
spillwayCrestLevel	0..1	WaterLevel	Niveau de crête du niveau de trop-plein au-dessus duquel l'eau déborde.

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nom	mult	type	description
spillWayGateType	0..1	String	Type de vanne de canal de trop-plein, comprenant des paramètres.
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 456 présente toutes les extrémités d'association de Reservoir avec d'autres classes.

Tableau 456 – Extrémités d'association de Production::Reservoir avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..1	SpillsIntoReservoirs	0..*	Reservoir	Un réservoir peut s'écouler dans un réservoir situé en aval.
0..1	HydroPowerPlants	0..*	HydroPowerPlant	Un réservoir en aval reçoit l'eau évacuée par des générateurs ou alimente des pompes en eau.
1..1	UpstreamFromHydroPowerPlants	0..*	HydroPowerPlant	Un réservoir en amont alimente des générateurs en eau ou reçoit l'eau évacuée par des pompes.
1..1	InflowForecasts	0..*	InflowForecast	Un réservoir peut avoir une prévision de flux d'entrée "naturelle".
1..1	LevelVsVolumeCurves	0..*	LevelVsVolumeCurve	Un réservoir peut avoir une relation niveau en fonction du volume.
1..1	TargetLevelSchedule	0..1	TargetLevelSchedule	Un réservoir peut comprendre un programme d'objectif à atteindre en niveau d'eau.
0..*	SpillsFromReservoir	0..1	Reservoir	Un réservoir peut s'écouler dans un réservoir situé en aval.
0..*	PSRType	0..1	PSRType	hérité de: PowerSystemResource
0..1	Controls	0..*	Control	hérité de: PowerSystemResource
0..1	Measurements	0..*	Measurement	hérité de: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	hérité de: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	hérité de: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

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6.6.3.40 ShutdownCurve

Relation entre le taux exprimé en puissance active brute/minute (axe Y) auquel il convient qu'une unité s'arrête et la sortie brute actuelle en MW (axe X) de l'unité.

Le Tableau 457 présente tous les attributs de ShutdownCurve.

Tableau 457 – Attributs de Production::ShutdownCurve

nom	mult	type	description
shutdownCost	0..1	Money	Coût fixe de l'arrêt.
shutdownDate	0..1	DateTime	Date et heure du dernier arrêt de l'unité de production.
curveStyle	0..1	CurveStyle	hérité de: Curve
xMultiplier	0..1	UnitMultiplier	hérité de: Curve
xUnit	0..1	UnitSymbol	hérité de: Curve
y1Multiplier	0..1	UnitMultiplier	hérité de: Curve
y1Unit	0..1	UnitSymbol	hérité de: Curve
y2Multiplier	0..1	UnitMultiplier	hérité de: Curve
y2Unit	0..1	UnitSymbol	hérité de: Curve
y3Multiplier	0..1	UnitMultiplier	hérité de: Curve
y3Unit	0..1	UnitSymbol	hérité de: Curve
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 458 présente toutes les extrémités d'association de ShutdownCurve avec d'autres classes.

Tableau 458 – Extrémités d'association de Production::ShutdownCurve avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..1	ThermalGeneratingUnit	1..1	ThermalGeneratingUnit	Une unité de production thermique peut comporter une courbe d'arrêt.
1..1	CurveDatas	0..*	CurveData	hérité de: Curve
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.6.3.41 SolarGeneratingUnit

Centrale solaire, connectée au réseau au moyen d'une machine tournante. Cette classe ne représente pas la production photovoltaïque (PV).

Le Tableau 459 présente tous les attributs de SolarGeneratingUnit.

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Tableau 459 – Attributs de Production::SolarGeneratingUnit

nom	mult	type	description
allocSpinResP	0..1	ActivePower	hérité de: GeneratingUnit
autoCntrlMarginP	0..1	ActivePower	hérité de: GeneratingUnit
baseP	0..1	ActivePower	hérité de: GeneratingUnit
controlDeadband	0..1	ActivePower	hérité de: GeneratingUnit
controlPulseHigh	0..1	Seconds	hérité de: GeneratingUnit
controlPulseLow	0..1	Seconds	hérité de: GeneratingUnit
controlResponseRate	0..1	ActivePowerChangeRate	hérité de: GeneratingUnit
efficiency	0..1	PerCent	hérité de: GeneratingUnit
genControlMode	0..1	GeneratorControlMode	hérité de: GeneratingUnit
genControlSource	0..1	GeneratorControlSource	hérité de: GeneratingUnit
governorMPL	0..1	PU	hérité de: GeneratingUnit
governorSCD	0..1	PerCent	hérité de: GeneratingUnit
highControlLimit	0..1	ActivePower	hérité de: GeneratingUnit
initialP	0..1	ActivePower	hérité de: GeneratingUnit
longPF	0..1	Float	hérité de: GeneratingUnit
lowControlLimit	0..1	ActivePower	hérité de: GeneratingUnit
lowerRampRate	0..1	ActivePowerChangeRate	hérité de: GeneratingUnit
maxEconomicP	0..1	ActivePower	hérité de: GeneratingUnit
maximumAllowableSpinningReserve	0..1	ActivePower	hérité de: GeneratingUnit
maxOperatingP	0..1	ActivePower	hérité de: GeneratingUnit
minEconomicP	0..1	ActivePower	hérité de: GeneratingUnit
minimumOffTime	0..1	Seconds	hérité de: GeneratingUnit
minOperatingP	0..1	ActivePower	hérité de: GeneratingUnit
modelDetail	0..1	Classification	hérité de: GeneratingUnit
nominalP	0..1	ActivePower	hérité de: GeneratingUnit
normalPF	0..1	Float	hérité de: GeneratingUnit
penaltyFactor	0..1	Float	hérité de: GeneratingUnit
raiseRampRate	0..1	ActivePowerChangeRate	hérité de: GeneratingUnit
ratedGrossMaxP	0..1	ActivePower	hérité de: GeneratingUnit
ratedGrossMinP	0..1	ActivePower	hérité de: GeneratingUnit
ratedNetMaxP	0..1	ActivePower	hérité de: GeneratingUnit
shortPF	0..1	Float	hérité de: GeneratingUnit
startupCost	0..1	Money	hérité de: GeneratingUnit
startupTime	0..1	Seconds	hérité de: GeneratingUnit
tieLinePF	0..1	Float	hérité de: GeneratingUnit
totalEfficiency	0..1	PerCent	hérité de: GeneratingUnit
variableCost	0..1	Money	hérité de: GeneratingUnit
aggregate	0..1	Boolean	hérité de: Equipment
inService	0..1	Boolean	hérité de: Equipment
networkAnalysisEnabled	0..1	Boolean	hérité de: Equipment

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nom	mult	type	description
normallyInService	0..1	Boolean	hérité de: Equipment
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 460 présente toutes les extrémités d'association de SolarGeneratingUnit avec d'autres classes.

Tableau 460 – Extrémités d'association de Production::SolarGeneratingUnit avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..1	RotatingMachine	0..*	RotatingMachine	hérité de: GeneratingUnit
1..1	GenUnitOpCostCurves	0..*	GenUnitOpCostCurve	hérité de: GeneratingUnit
1..1	GenUnitOpSchedule	0..1	GenUnitOpSchedule	hérité de: GeneratingUnit
1..1	ControlAreaGeneratingUnit	0..*	ControlAreaGeneratingUnit	hérité de: GeneratingUnit
1..1	GrossToNetActivePowerCurves	0..*	GrossToNetActivePowerCurve	hérité de: GeneratingUnit
0..1	OperationalLimitSet	0..*	OperationalLimitSet	hérité de: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	hérité de: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	hérité de: Equipment
0..1	Faults	0..*	Fault	hérité de: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	hérité de: Equipment
0..*	PSRType	0..1	PSRType	hérité de: PowerSystemResource
0..1	Controls	0..*	Control	hérité de: PowerSystemResource
0..1	Measurements	0..*	Measurement	hérité de: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	hérité de: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	hérité de: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.6.3.42 StartIgnFuelCurve

Quantité de combustible d'allumage (axe Y) utilisée pour redémarrer et compenser la puissance auxiliaire consommée en fonction du nombre d'heures (axe X) pendant lesquelles l'unité était hors service.

Le Tableau 461 présente tous les attributs de StartIgnFuelCurve.

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Tableau 461 – Attributs de Production::StartIgnFuelCurve

nom	mult	type	description
ignitionFuelType	0..1	FuelType	Type de combustible d'allumage.
curveStyle	0..1	CurveStyle	hérité de: Curve
xMultiplier	0..1	UnitMultiplier	hérité de: Curve
xUnit	0..1	UnitSymbol	hérité de: Curve
y1Multiplier	0..1	UnitMultiplier	hérité de: Curve
y1Unit	0..1	UnitSymbol	hérité de: Curve
y2Multiplier	0..1	UnitMultiplier	hérité de: Curve
y2Unit	0..1	UnitSymbol	hérité de: Curve
y3Multiplier	0..1	UnitMultiplier	hérité de: Curve
y3Unit	0..1	UnitSymbol	hérité de: Curve
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 462 présente toutes les extrémités d'association de StartIgnFuelCurve avec d'autres classes.

Tableau 462 – Extrémités d'association de Production::StartIgnFuelCurve avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..1	StartupModel	1..1	StartupModel	Le modèle de démarrage de l'unité peut comporter une courbe de combustible d'allumage de démarrage.
1..1	CurveDatas	0..*	CurveData	hérité de: Curve
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.6.3.43 StartMainFuelCurve

Quantité de combustible principal (axe Y) utilisée pour redémarrer et compenser l'énergie auxiliaire consommée en fonction du nombre d'heures (axe X) pendant lesquelles l'unité était hors service.

Le Tableau 463 présente tous les attributs de StartMainFuelCurve.

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Tableau 463 – Attributs de Production::StartMainFuelCurve

nom	mult	type	description
mainFuelType	0..1	FuelType	Type de combustible principal.
curveStyle	0..1	CurveStyle	hérité de: Curve
xMultiplier	0..1	UnitMultiplier	hérité de: Curve
xUnit	0..1	UnitSymbol	hérité de: Curve
y1Multiplier	0..1	UnitMultiplier	hérité de: Curve
y1Unit	0..1	UnitSymbol	hérité de: Curve
y2Multiplier	0..1	UnitMultiplier	hérité de: Curve
y2Unit	0..1	UnitSymbol	hérité de: Curve
y3Multiplier	0..1	UnitMultiplier	hérité de: Curve
y3Unit	0..1	UnitSymbol	hérité de: Curve
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 464 présente toutes les extrémités d'association de StartMainFuelCurve avec d'autres classes.

Tableau 464 – Extrémités d'association de Production::StartMainFuelCurve avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..1	StartupModel	1..1	StartupModel	Le modèle de démarrage de l'unité peut comporter une courbe de combustible principal de démarrage.
1..1	CurveDatas	0..*	CurveData	hérité de: Curve
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.6.3.44 StartRampCurve

Taux exprimé en puissance active brute par minute (axe Y) auquel une unité peut être chargée en fonction du nombre d'heures (axe X) pendant lesquelles l'unité était hors service.

Le Tableau 465 présente tous les attributs de StartRampCurve.

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Tableau 465 – Attributs de Production::StartRampCurve

nom	mult	type	description
hotStandbyRamp	0..1	ActivePowerChangeRate	Taux de démarrage de la rampe en brut pour une unité en attente à chaud.
curveStyle	0..1	CurveStyle	hérité de: Curve
xMultiplier	0..1	UnitMultiplier	hérité de: Curve
xUnit	0..1	UnitSymbol	hérité de: Curve
y1Multiplier	0..1	UnitMultiplier	hérité de: Curve
y1Unit	0..1	UnitSymbol	hérité de: Curve
y2Multiplier	0..1	UnitMultiplier	hérité de: Curve
y2Unit	0..1	UnitSymbol	hérité de: Curve
y3Multiplier	0..1	UnitMultiplier	hérité de: Curve
y3Unit	0..1	UnitSymbol	hérité de: Curve
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 466 présente toutes les extrémités d'association de StartRampCurve avec d'autres classes.

Tableau 466 – Extrémités d'association de Production::StartRampCurve avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..1	StartupModel	1..1	StartupModel	Le modèle de démarrage de l'unité peut comporter une courbe de rampe de démarrage.
1..1	CurveDatas	0..*	CurveData	hérité de: Curve
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.6.3.45 StartupModel

Caractéristiques de démarrage de l'unité qui sont fonction de la durée pendant laquelle l'unité a été hors service.

Le Tableau 467 présente tous les attributs de StartupModel.

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Tableau 467 – Attributs de Production::StartupModel

nom	mult	type	description
fixedMaintCost	0..1	CostRate	Coût fixe de la maintenance.
hotStandbyHeat	0..1	HeatRate	Quantité d'apport de chaleur exigée par unité de temps pour un fonctionnement en attente à chaud.
incrementalMaintCost	0..1	CostPerEnergyUnit	Coût marginal de maintenance.
minimumDownTime	0..1	Hours	Nombre minimal d'heures pendant lesquelles l'unité doit être arrêtée avant de redémarrer.
minimumRunTime	0..1	Hours	Nombre minimal d'heures pendant lesquelles l'unité doit fonctionner avant de pouvoir être arrêtée.
riskFactorCost	0..1	Money	Coût d'opportunité lié aux rentrées en unités monétaires. Ce coût représente la "part" de dépréciation de l'unité et de risque qu'un incident susceptible d'endommager l'unité se produise, due au redémarrage.
startupCost	0..1	Money	Coûts totaux divers de démarrage.
startupDate	0..1	DateTime	Date et heure du dernier démarrage de l'unité de production.
startupPriority	0..1	Integer	Priorité de démarrage à l'intérieur de la zone de commande dans laquelle des nombres plus petits correspondent à des priorités plus hautes. Plusieurs unités de production d'une zone peuvent se voir attribuer la même priorité.
stbyAuxP	0..1	ActivePower	Consommation de puissance active auxiliaire de l'unité de production permettant de rester en mode "standby" (veille).
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 468 présente toutes les extrémités d'association de StartupModel avec d'autres classes.

Tableau 468 – Extrémités d'association de Production::StartupModel avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..1	ThermalGeneratingUnit	1..1	ThermalGeneratingUnit	Une unité de production thermique peut comporter un modèle de démarrage.
1..1	StartIgnFuelCurve	0..1	StartIgnFuelCurve	Le modèle de démarrage de l'unité peut comporter une courbe de combustible d'allumage de démarrage.
1..1	StartMainFuelCurve	0..1	StartMainFuelCurve	Le modèle de démarrage de l'unité peut comporter une courbe de combustible principal de démarrage.
1..1	StartRampCurve	0..1	StartRampCurve	Le modèle de démarrage de l'unité peut comporter une courbe de rampe de démarrage.
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

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6.6.3.46 SteamSendoutSchedule

Programme d'émission de vapeur de la centrale de cogénération en volume par unité de temps.

Le Tableau 469 présente tous les attributs de SteamSendoutSchedule.

Tableau 469 – Attributs de Production::SteamSendoutSchedule

nom	mult	type	description
endTime	0..1	DateTime	hérité de: RegularIntervalSchedule
timeStep	0..1	Seconds	hérité de: RegularIntervalSchedule
startTime	0..1	DateTime	hérité de: BasicIntervalSchedule
value1Multiplier	0..1	UnitMultiplier	hérité de: BasicIntervalSchedule
value1Unit	0..1	UnitSymbol	hérité de: BasicIntervalSchedule
value2Multiplier	0..1	UnitMultiplier	hérité de: BasicIntervalSchedule
value2Unit	0..1	UnitSymbol	hérité de: BasicIntervalSchedule
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 470 présente toutes les extrémités d'association de SteamSendoutSchedule avec d'autres classes.

Tableau 470 – Extrémités d'association de Production::SteamSendoutSchedule avec d'autres classes

mult à partir de	nom	mult vers	type	description
1..1	CogenerationPlant	1..1	CogenerationPlant	Une centrale de cogénération comporte un programme d'émission de vapeur.
1..1	TimePoints	1..*	RegularTimePoint	hérité de: RegularIntervalSchedule
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.6.3.47 TailbayLossCurve

Relation entre la perte de hauteur de chute de sortie d'écluse, en hauteur (axe Y), et l'évacuation totale dans la sortie d'écluse de la centrale électrique, en volume par unité de temps (axe X). Plusieurs courbes peuvent être obtenues, selon le niveau du réservoir de la sortie d'écluse ou le niveau de la rivière.

Le Tableau 471 présente tous les attributs de TailbayLossCurve.

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Tableau 471 – Attributs de Production::TailbayLossCurve

nom	mult	type	description
curveStyle	0..1	CurveStyle	hérité de: Curve
xMultiplier	0..1	UnitMultiplier	hérité de: Curve
xUnit	0..1	UnitSymbol	hérité de: Curve
y1Multiplier	0..1	UnitMultiplier	hérité de: Curve
y1Unit	0..1	UnitSymbol	hérité de: Curve
y2Multiplier	0..1	UnitMultiplier	hérité de: Curve
y2Unit	0..1	UnitSymbol	hérité de: Curve
y3Multiplier	0..1	UnitMultiplier	hérité de: Curve
y3Unit	0..1	UnitSymbol	hérité de: Curve
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 472 présente toutes les extrémités d'association de TailbayLossCurve avec d'autres classes.

Tableau 472 – Extrémités d'association de Production::TailbayLossCurve avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..*	HydroGeneratingUnit	1..1	HydroGeneratingUnit	Une unité hydrogénératrice a une courbe de perte de sortie d'écluse.
1..1	CurveDatas	0..*	CurveData	hérité de: Curve
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.6.3.48 TargetLevelSchedule

Objectifs de niveau d'eau dans le réservoir établis d'après des études avancées ou des "courbes d'exploitation optimum". Généralement en incréments d'une heure pendant une période pouvant aller jusqu'à 10 jours.

Le Tableau 473 présente tous les attributs de TargetLevelSchedule.

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Tableau 473 – Attributs de Production::TargetLevelSchedule

nom	mult	type	description
highLevelLimit	0..1	WaterLevel	Limite supérieure du niveau à atteindre, au-dessus de laquelle le réservoir ne peut pas fonctionner normalement.
lowLevelLimit	0..1	WaterLevel	Limite inférieure du niveau à atteindre, en dessous de laquelle le réservoir ne peut pas fonctionner normalement.
curveStyle	0..1	CurveStyle	hérité de: Curve
xMultiplier	0..1	UnitMultiplier	hérité de: Curve
xUnit	0..1	UnitSymbol	hérité de: Curve
y1Multiplier	0..1	UnitMultiplier	hérité de: Curve
y1Unit	0..1	UnitSymbol	hérité de: Curve
y2Multiplier	0..1	UnitMultiplier	hérité de: Curve
y2Unit	0..1	UnitSymbol	hérité de: Curve
y3Multiplier	0..1	UnitMultiplier	hérité de: Curve
y3Unit	0..1	UnitSymbol	hérité de: Curve
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 474 présente toutes les extrémités d'association de TargetLevelSchedule avec d'autres classes.

Tableau 474 – Extrémités d'association de Production::TargetLevelSchedule avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..1	Reservoir	1..1	Reservoir	Un réservoir peut comprendre un programme d'objectif à atteindre en niveau d'eau.
1..1	CurveDatas	0..*	CurveData	hérité de: Curve
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.6.3.49 ThermalGeneratingUnit

Unité de production dont la pour machine motrice peut être, par exemple, une turbine à vapeur, une turbine à combustion ou un moteur diesel.

Le Tableau 475 présente tous les attributs de ThermalGeneratingUnit.

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Tableau 475 – Attributs de Production::ThermalGeneratingUnit

nom	mult	type	description
oMCost	0..1	CostPerHeatUnit	Coût de fonctionnement et de maintenant de l'unité thermique.
allocSpinResP	0..1	ActivePower	hérité de: GeneratingUnit
autoCntrlMarginP	0..1	ActivePower	hérité de: GeneratingUnit
baseP	0..1	ActivePower	hérité de: GeneratingUnit
controlDeadband	0..1	ActivePower	hérité de: GeneratingUnit
controlPulseHigh	0..1	Seconds	hérité de: GeneratingUnit
controlPulseLow	0..1	Seconds	hérité de: GeneratingUnit
controlResponseRate	0..1	ActivePowerChangeRate	hérité de: GeneratingUnit
efficiency	0..1	PerCent	hérité de: GeneratingUnit
genControlMode	0..1	GeneratorControlMode	hérité de: GeneratingUnit
genControlSource	0..1	GeneratorControlSource	hérité de: GeneratingUnit
governorMPL	0..1	PU	hérité de: GeneratingUnit
governorSCD	0..1	PerCent	hérité de: GeneratingUnit
highControlLimit	0..1	ActivePower	hérité de: GeneratingUnit
initialP	0..1	ActivePower	hérité de: GeneratingUnit
longPF	0..1	Float	hérité de: GeneratingUnit
lowControlLimit	0..1	ActivePower	hérité de: GeneratingUnit
lowerRampRate	0..1	ActivePowerChangeRate	hérité de: GeneratingUnit
maxEconomicP	0..1	ActivePower	hérité de: GeneratingUnit
maximumAllowableSpinningReserve	0..1	ActivePower	hérité de: GeneratingUnit
maxOperatingP	0..1	ActivePower	hérité de: GeneratingUnit
minEconomicP	0..1	ActivePower	hérité de: GeneratingUnit
minimumOffTime	0..1	Seconds	hérité de: GeneratingUnit
minOperatingP	0..1	ActivePower	hérité de: GeneratingUnit
modelDetail	0..1	Classification	hérité de: GeneratingUnit
nominalP	0..1	ActivePower	hérité de: GeneratingUnit
normalPF	0..1	Float	hérité de: GeneratingUnit
penaltyFactor	0..1	Float	hérité de: GeneratingUnit
raiseRampRate	0..1	ActivePowerChangeRate	hérité de: GeneratingUnit
ratedGrossMaxP	0..1	ActivePower	hérité de: GeneratingUnit
ratedGrossMinP	0..1	ActivePower	hérité de: GeneratingUnit
ratedNetMaxP	0..1	ActivePower	hérité de: GeneratingUnit
shortPF	0..1	Float	hérité de: GeneratingUnit
startupCost	0..1	Money	hérité de: GeneratingUnit
startupTime	0..1	Seconds	hérité de: GeneratingUnit
tieLinePF	0..1	Float	hérité de: GeneratingUnit
totalEfficiency	0..1	PerCent	hérité de: GeneratingUnit
variableCost	0..1	Money	hérité de: GeneratingUnit
aggregate	0..1	Boolean	hérité de: Equipment
inService	0..1	Boolean	hérité de: Equipment
networkAnalysisEnabled	0..1	Boolean	hérité de: Equipment

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nom	mult	type	description
normallyInService	0..1	Boolean	hérité de: Equipment
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 476 présente toutes les extrémités d'association de ThermalGeneratingUnit avec d'autres classes.

Tableau 476 – Extrémités d'association de Production::ThermalGeneratingUnit avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..1	CAESPlant	0..1	CAESPlant	Une unité de production thermique peut faire partie d'une centrale de stockage d'air comprimé.
0..*	CogenerationPlant	0..1	CogenerationPlant	Une unité de production thermique peut faire partie d'une centrale de cogénération.
0..*	CombinedCyclePlant	0..1	CombinedCyclePlant	Une unité de production thermique peut faire partie d'une centrale à cycle combiné.
1..1	EmmissionAccounts	0..*	EmissionAccount	Une unité de production thermique peut comporter un ou plusieurs rapports d'autorisation d'émission.
1..1	EmissionCurves	0..*	EmissionCurve	Une unité de production thermique peut comporter une ou plusieurs courbes d'émission.
1..1	FossilFuels	0..*	FossilFuel	Une unité de production thermique peut comporter un ou plusieurs combustibles fossiles.
1..1	FuelAllocationSchedules	0..*	FuelAllocationSchedule	Une unité de production thermique peut comporter un ou plusieurs programmes d'attribution de combustibles.
1..1	HeatInputCurve	0..1	HeatInputCurve	Une unité de production thermique peut comporter une courbe d'apport de chaleur.
1..1	HeatRateCurve	0..1	HeatRateCurve	Une unité de production thermique peut comporter une courbe de consommation calorifique.
1..1	IncrementalHeatRateCurve	0..1	IncrementalHeatRateCurve	Une unité de production thermique peut comporter une courbe de consommation incrémentale de chaleur.
1..1	ShutdownCurve	0..1	ShutdownCurve	Une unité de production thermique peut comporter une courbe d'arrêt.
1..1	StartupModel	0..1	StartupModel	Une unité de production thermique peut comporter un modèle de démarrage.
0..1	RotatingMachine	0..*	RotatingMachine	hérité de: GeneratingUnit
1..1	GenUnitOpCostCurves	0..*	GenUnitOpCostCurve	hérité de: GeneratingUnit
1..1	GenUnitOpSchedule	0..1	GenUnitOpSchedule	hérité de: GeneratingUnit
1..1	ControlAreaGeneratingUnit	0..*	ControlAreaGeneratingUnit	hérité de: GeneratingUnit

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mult à partir de	nom	mult vers	type	description
1..1	GrossToNetActivePowerCurves	0..*	GrossToNetActivePowerCurve	hérité de: GeneratingUnit
0..1	OperationalLimitSet	0..*	OperationalLimitSet	hérité de: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	hérité de: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	hérité de: Equipment
0..1	Faults	0..*	Fault	hérité de: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	hérité de: Equipment
0..*	PSRType	0..1	PSRType	hérité de: PowerSystemResource
0..1	Controls	0..*	Control	hérité de: PowerSystemResource
0..1	Measurements	0..*	Measurement	hérité de: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	hérité de: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	hérité de: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.6.3.50 WindGeneratingUnit

Bloc générateur éolien, connecté au réseau au moyen d'une machine tournante. Peut être utilisé pour représenter une turbine simple ou une agrégation.

Le Tableau 477 présente tous les attributs de WindGeneratingUnit.

Tableau 477 – Attributs de Production::WindGeneratingUnit

nom	mult	type	description
windGenUnitType	0..1	WindGenUnitKind	Genre de générateur éolien.
allocSpinResP	0..1	ActivePower	hérité de: GeneratingUnit
autoCntrlMarginP	0..1	ActivePower	hérité de: GeneratingUnit
baseP	0..1	ActivePower	hérité de: GeneratingUnit
controlDeadband	0..1	ActivePower	hérité de: GeneratingUnit
controlPulseHigh	0..1	Seconds	hérité de: GeneratingUnit
controlPulseLow	0..1	Seconds	hérité de: GeneratingUnit
controlResponseRate	0..1	ActivePowerChangeRate	hérité de: GeneratingUnit
efficiency	0..1	PerCent	hérité de: GeneratingUnit
genControlMode	0..1	GeneratorControlMode	hérité de: GeneratingUnit
genControlSource	0..1	GeneratorControlSource	hérité de: GeneratingUnit
governorMPL	0..1	PU	hérité de: GeneratingUnit
governorSCD	0..1	PerCent	hérité de: GeneratingUnit
highControlLimit	0..1	ActivePower	hérité de: GeneratingUnit
initialP	0..1	ActivePower	hérité de: GeneratingUnit
longPF	0..1	Float	hérité de: GeneratingUnit
lowControlLimit	0..1	ActivePower	hérité de: GeneratingUnit

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nom	mult	type	description
lowerRampRate	0..1	ActivePowerChangeRate	hérité de: GeneratingUnit
maxEconomicP	0..1	ActivePower	hérité de: GeneratingUnit
maximumAllowableSpinningReserve	0..1	ActivePower	hérité de: GeneratingUnit
maxOperatingP	0..1	ActivePower	hérité de: GeneratingUnit
minEconomicP	0..1	ActivePower	hérité de: GeneratingUnit
minimumOffTime	0..1	Seconds	hérité de: GeneratingUnit
minOperatingP	0..1	ActivePower	hérité de: GeneratingUnit
modelDetail	0..1	Classification	hérité de: GeneratingUnit
nominalP	0..1	ActivePower	hérité de: GeneratingUnit
normalPF	0..1	Float	hérité de: GeneratingUnit
penaltyFactor	0..1	Float	hérité de: GeneratingUnit
raiseRampRate	0..1	ActivePowerChangeRate	hérité de: GeneratingUnit
ratedGrossMaxP	0..1	ActivePower	hérité de: GeneratingUnit
ratedGrossMinP	0..1	ActivePower	hérité de: GeneratingUnit
ratedNetMaxP	0..1	ActivePower	hérité de: GeneratingUnit
shortPF	0..1	Float	hérité de: GeneratingUnit
startupCost	0..1	Money	hérité de: GeneratingUnit
startupTime	0..1	Seconds	hérité de: GeneratingUnit
tieLinePF	0..1	Float	hérité de: GeneratingUnit
totalEfficiency	0..1	PerCent	hérité de: GeneratingUnit
variableCost	0..1	Money	hérité de: GeneratingUnit
aggregate	0..1	Boolean	hérité de: Equipment
inService	0..1	Boolean	hérité de: Equipment
networkAnalysisEnabled	0..1	Boolean	hérité de: Equipment
normallyInService	0..1	Boolean	hérité de: Equipment
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 478 présente toutes les extrémités d'association de WindGeneratingUnit avec d'autres classes.

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Tableau 478 – Extrémités d'association de Production::WindGeneratingUnit avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..1	RotatingMachine	0..*	RotatingMachine	hérité de: GeneratingUnit
1..1	GenUnitOpCostCurves	0..*	GenUnitOpCostCurve	hérité de: GeneratingUnit
1..1	GenUnitOpSchedule	0..1	GenUnitOpSchedule	hérité de: GeneratingUnit
1..1	ControlAreaGeneratingUnit	0..*	ControlAreaGeneratingUnit	hérité de: GeneratingUnit
1..1	GrossToNetActivePowerCurves	0..*	GrossToNetActivePowerCurve	hérité de: GeneratingUnit
0..1	OperationalLimitSet	0..*	OperationalLimitSet	hérité de: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	hérité de: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	hérité de: Equipment
0..1	Faults	0..*	Fault	hérité de: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	hérité de: Equipment
0..*	PSRType	0..1	PSRType	hérité de: PowerSystemResource
0..1	Controls	0..*	Control	hérité de: PowerSystemResource
0..1	Measurements	0..*	Measurement	hérité de: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	hérité de: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	hérité de: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.7 Paquetage DC

6.7.1 Généralités

Ce paquetage contient un modèle d'équipements à courant continu et de commandes.

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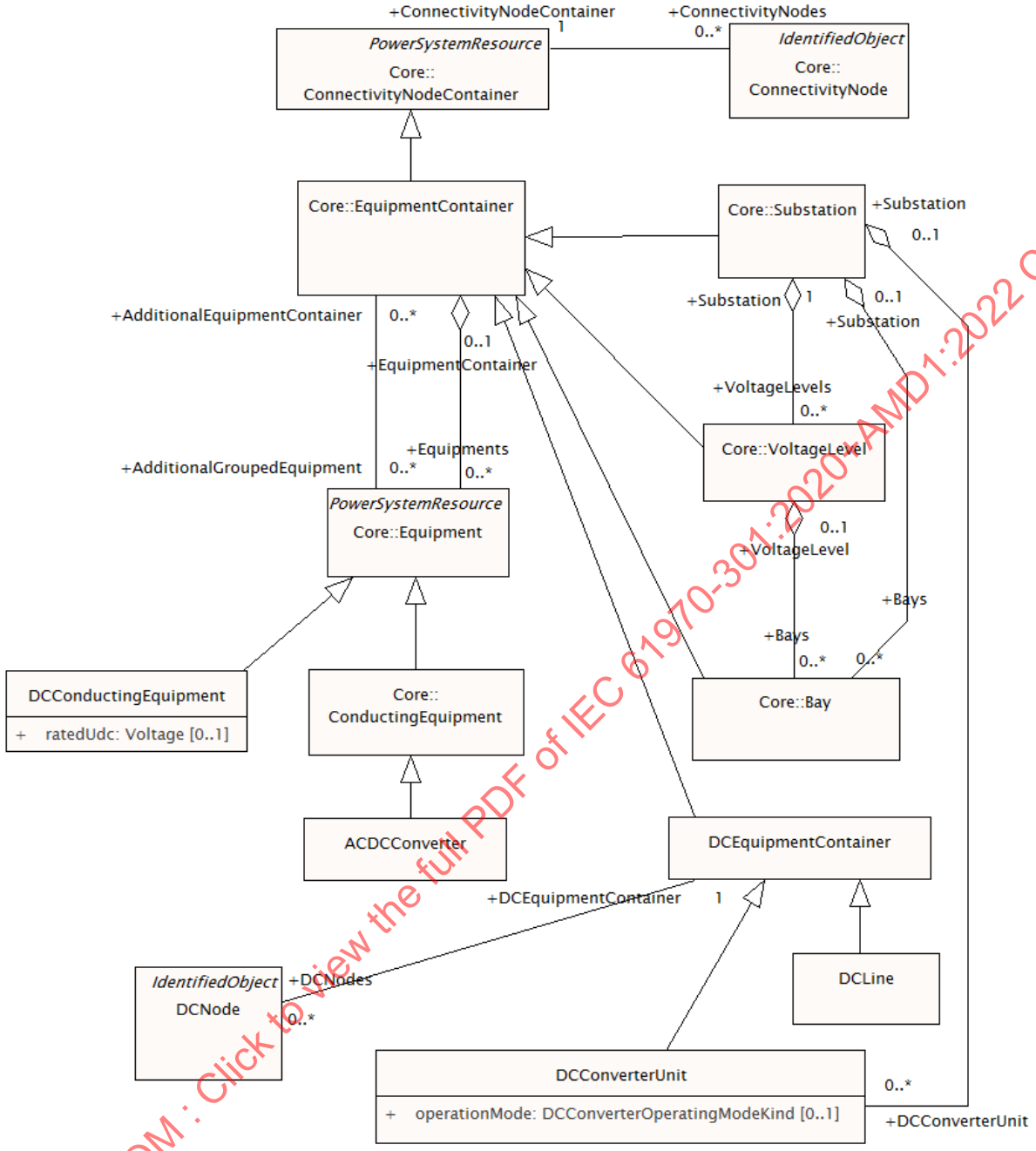


Figure 112 – Diagramme de classe DC::DCContainment

Figure 112: Le diagramme représente le modèle d'emboîtement en courant continu.

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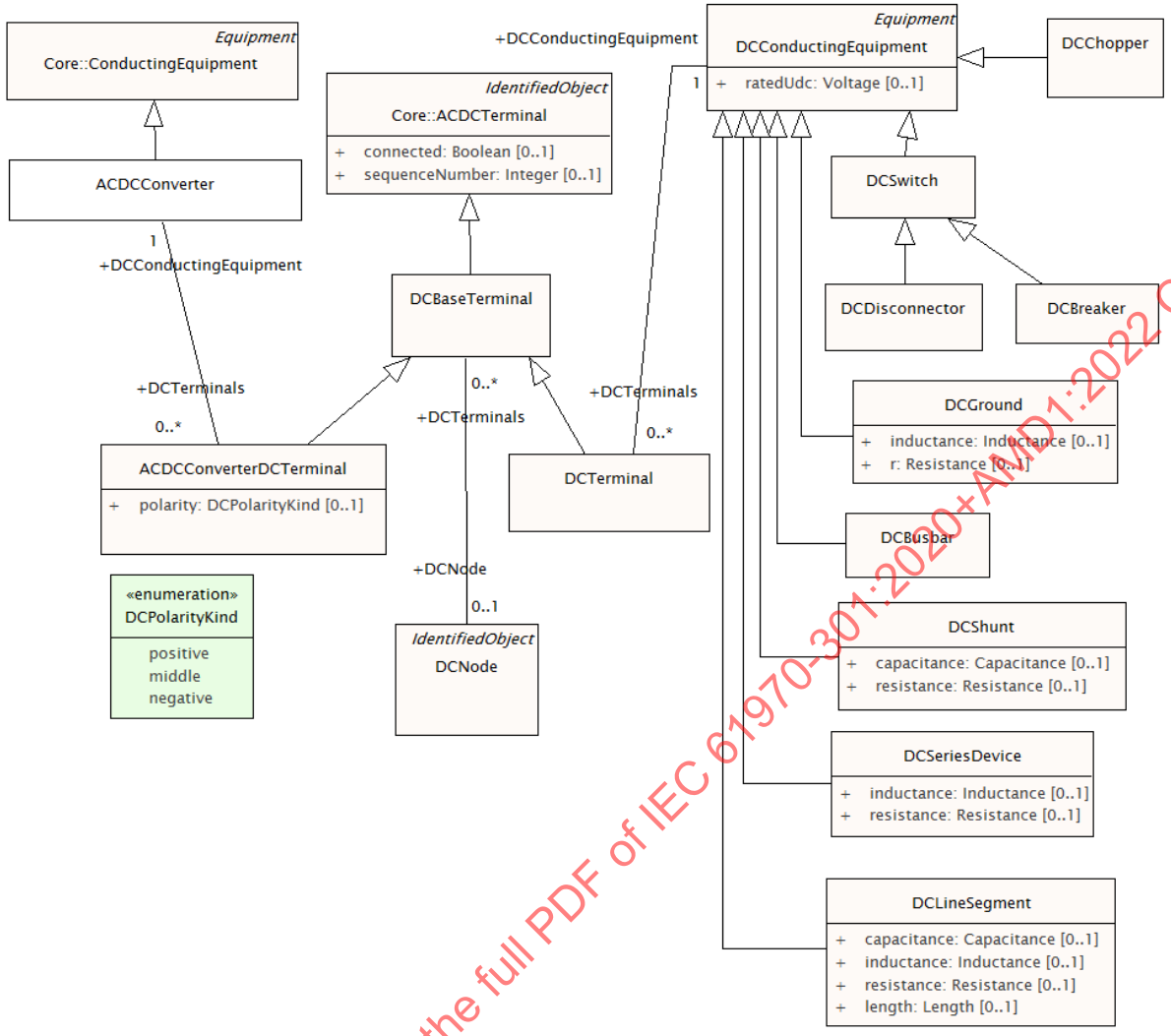


Figure 113 – Diagramme de classe DC::DCEquipment

Figure 113: Le diagramme représente le modèle d'équipement en courant continu.

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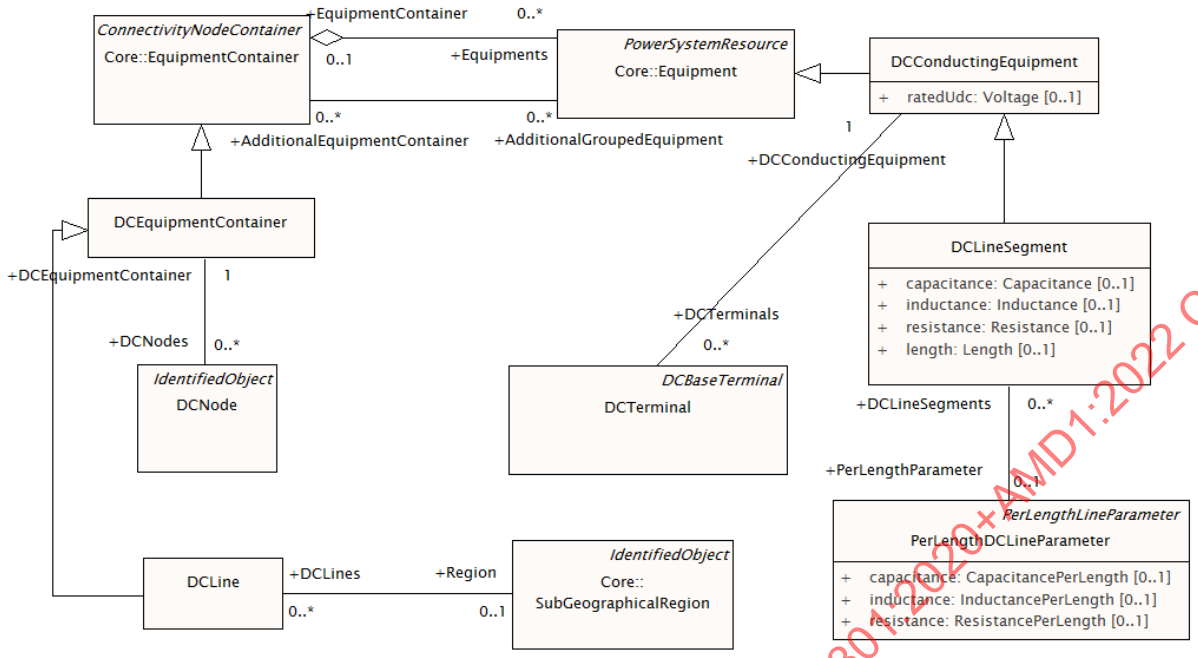
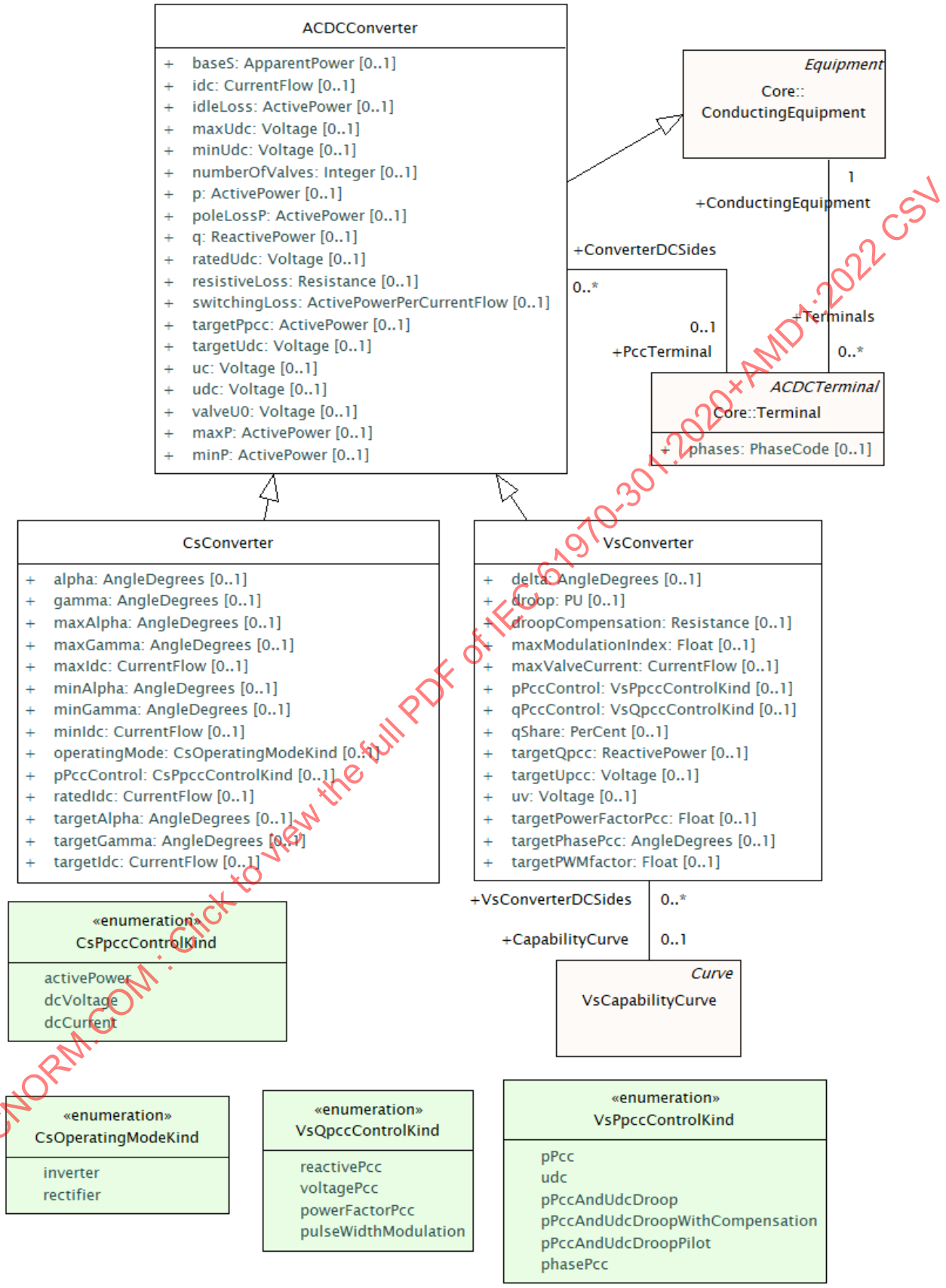


Figure 114 – Diagramme de classe DC::DCLineModel

Figure 114: Le diagramme représente le modèle de ligne en courant continu.

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Figure 115 – Diagramme de classe DC::ACDCConverter

Figure 115: Ce diagramme représente les classes utilisées pour modéliser des convertisseurs à courant continu.

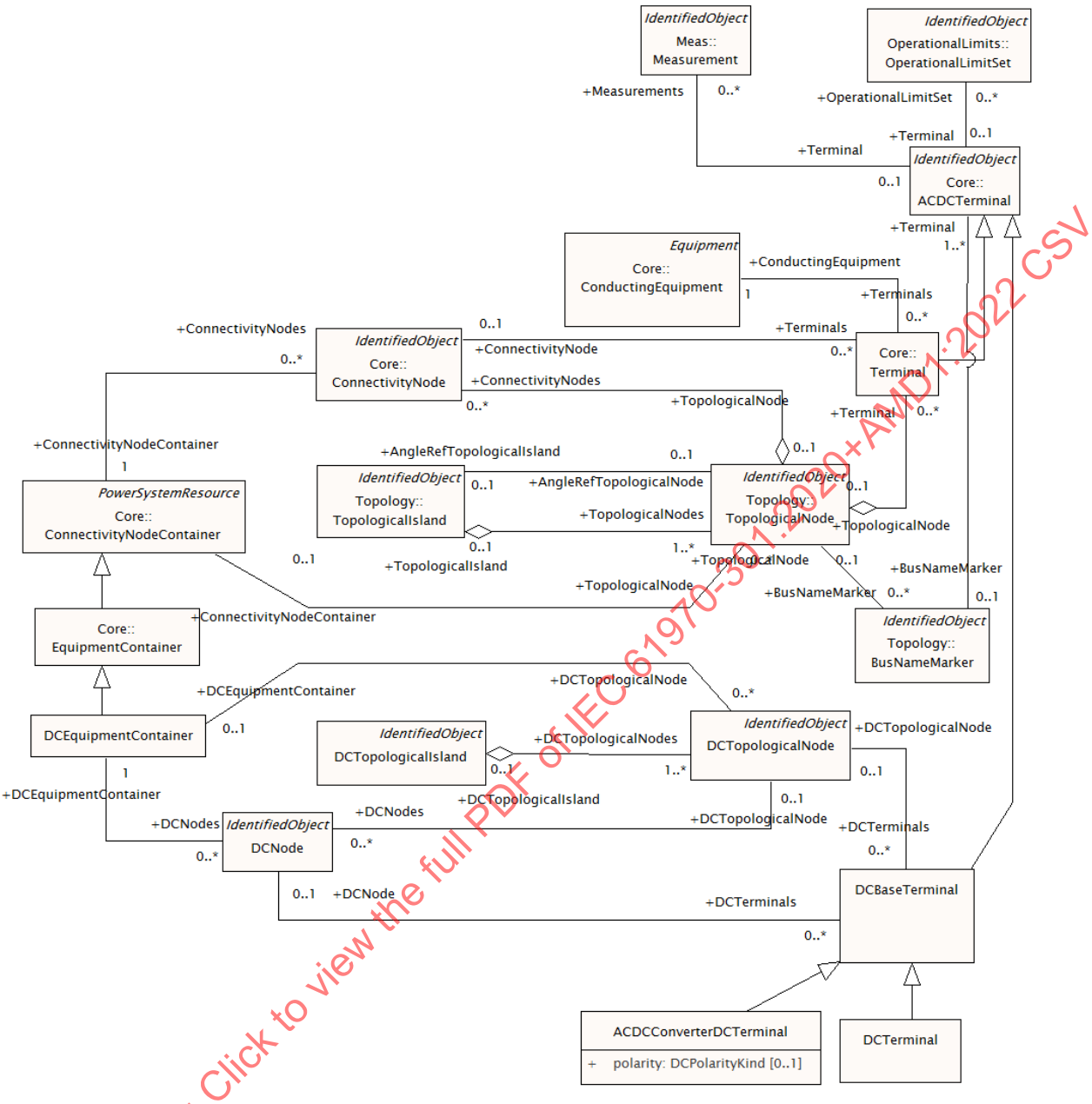


Figure 116 – Diagramme de classe DC::ACDCConnectivityModel

Figure 116: Ce diagramme représente la connectivité et le modèle topologique pour les réseaux à courant alternatif et à courant continu.

6.7.2 ACDCConverter

Unité comportant des valves pour trois phases, associées à un équipement de commande, des appareils essentiels de protection et de commutation, des condensateurs de stockage en courant continu, des composants réactifs et des auxiliaires, le cas échéant, utilisés pour la conversion.

Le Tableau 479 présente tous les attributs de ACDCConverter.

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Tableau 479 – Attributs de DC::ACDCConverter

nom	mult	type	description
baseS	0..1	ApparentPower	Puissance de base apparente du pôle de convertisseur. La valeur de l'attribut doit être positive.
idc	0..1	CurrentFlow	Courant continu du convertisseur, également appelé Id. Variable d'état constant, résultat du flux de puissance.
idleLoss	0..1	ActivePower	Perte de puissance active dans le pôle sans transfert de puissance. Données de configuration du convertisseur utilisées dans le flux de puissance. La valeur de l'attribut doit être positive.
maxUdc	0..1	Voltage	Tension maximale du côté courant continu à laquelle il convient que le convertisseur fonctionne. Données de configuration du convertisseur utilisées dans le flux de puissance. La valeur de l'attribut doit être positive.
minUdc	0..1	Voltage	Tension minimale du côté courant continu à laquelle il convient que le convertisseur fonctionne. Données de configuration du convertisseur utilisées dans le flux de puissance. La valeur de l'attribut doit être positive.
numberOfValves	0..1	Integer	Nombre de valves dans le convertisseur. Utilisé dans les calculs de pertes.
p	0..1	ActivePower	Puissance active au point de couplage commun. La convention de signe charge est utilisée, c'est-à-dire que le signe positif signifie un flux à partir d'un nœud. Valeur de départ pour une solution en régime établi pour les cas dans lesquels un modèle simplifié de flux de puissance est utilisé.
poleLossP	0..1	ActivePower	Perte de puissance active au niveau du pôle de courant continu. = idleLoss + switchingLoss*|Idc| + resitiveLoss*Idc^2 Pour un fonctionnement sans perte, Pdc=Pac Pour un fonctionnement du redresseur avec des pertes, Pdc=Pac-lossP Pour un fonctionnement de l'onduleur avec des pertes, Pdc=Pac+lossP Variable d'état du convertisseur utilisée dans le flux de puissance. La valeur de l'attribut doit être positive.
q	0..1	ReactivePower	Puissance réactive au point de couplage commun. La convention de signe charge est utilisée, c'est-à-dire que le signe positif signifie un flux à partir d'un nœud. Valeur de départ pour une solution en régime établi pour les cas dans lesquels un modèle simplifié de flux de puissance est utilisé.
ratedUdc	0..1	Voltage	Tension continue assignée du convertisseur, également appelée UdN. La valeur de l'attribut doit être positive. Données de configuration du convertisseur utilisées dans le flux de puissance. Par exemple, une liaison CCHT bipolaire d'une valeur de 200 kV présente une différence de 400 kV entre les lignes à courant continu.
resistiveLoss	0..1	Resistance	Données de configuration du convertisseur utilisées dans le flux de puissance. Se référer à poleLossP. La valeur de l'attribut doit être positive.

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nom	mult	type	description
switchingLoss	0..1	ActivePowerPerCurrentFlow	Pertes de commutations relatives à la puissance de base apparente 'baseS'. Se référer à poleLossP. La valeur de l'attribut doit être positive.
targetPpcc	0..1	ActivePower	Cible de l'injection de puissance réelle dans le réseau à courant alternatif, au niveau du point de couplage commun. La convention de signe charge est utilisée, c'est-à-dire que le signe positif signifie un flux à partir d'un nœud.
targetUdc	0..1	Voltage	Valeur cible de la tension continue. La valeur de l'attribut doit être positive.
uc	0..1	Voltage	Tension entre phases du convertisseur, du côté courant alternatif de la valve. Variable d'état constant, résultat du flux de puissance. La valeur de l'attribut doit être positive.
udc	0..1	Voltage	Tension du convertisseur du côté courant continu, également appelée Ud. Variable d'état constant, résultat du flux de puissance. La valeur de l'attribut doit être positive.
valveU0	0..1	Voltage	Tension seuil de la valve, également appelée Uvalve. Chute de tension directe lorsque la valve est conductrice. Utilisée dans les calculs de pertes, c'est-à-dire que switchLoss dépend de numberOfValves * valveU0.
maxP	0..1	ActivePower	Limite de puissance active maximale. La valeur est écrasée par les valeurs de VsCapabilityCurve, si elle existe.
minP	0..1	ActivePower	Limite de puissance active minimale. La valeur est écrasée par les valeurs de VsCapabilityCurve, si elle existe.
aggregate	0..1	Boolean	hérité de: Equipment
inService	0..1	Boolean	hérité de: Equipment
networkAnalysisEnabled	0..1	Boolean	hérité de: Equipment
normallyInService	0..1	Boolean	hérité de: Equipment
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 480 présente toutes les extrémités d'association de ACDCConverter avec d'autres classes.

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Tableau 480 – Extrémités d'association de DC::ACDCConverter avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..*	PccTerminal	0..1	Terminal	Borne du point de couplage commun pour le côté courant continu de ce convertisseur. Il s'agit généralement de la borne du transformateur de puissance (ou du commutateur) le plus proche du réseau à courant alternatif.
1..1	DCTerminals	0..*	ACDCConverterDCTerminal	Un convertisseur de courant continu a des bornes de convertisseur à courant continu. Un convertisseur a deux bornes de convertisseur à courant continu.
0..*	BaseVoltage	0..1	BaseVoltage	hérité de: ConductingEquipment
1..1	SvStatus	0..*	SvStatus	hérité de: ConductingEquipment
0..*	ProtectionEquipments	0..*	ProtectionEquipment	hérité de: ConductingEquipment
1..1	Terminals	0..*	Terminal	hérité de: ConductingEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	hérité de: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	hérité de: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	hérité de: Equipment
0..1	Faults	0..*	Fault	hérité de: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	hérité de: Equipment
0..*	PSRType	0..1	PSRType	hérité de: PowerSystemResource
0..1	Controls	0..*	Control	hérité de: PowerSystemResource
0..1	Measurements	0..*	Measurement	hérité de: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	hérité de: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	hérité de: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.7.3 ACDCConverterDCTerminal

Point de connexion électrique à courant continu au convertisseur de courant alternatif/courant continu. Le convertisseur de courant alternatif/courant continu est également électriquement connecté au côté courant alternatif. La connexion de courant alternatif est héritée de l'équipement conducteur à courant alternatif de la même manière que tout autre équipement à courant alternatif. La borne de courant continu du convertisseur de courant alternatif/courant continu est séparée de la borne générique de courant continu afin de limiter la connexion du convertisseur de courant alternatif/courant continu avec le côté courant alternatif, et de telle sorte qu'aucun autre équipement conducteur à courant continu ne puisse être connecté au côté courant alternatif.

Le Tableau 481 présente tous les attributs de ACDCConverterDCTerminal.

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Tableau 481 – Attributs de DC::ACDCConverterDCTerminal

nom	mult	type	description
polarity	0..1	DCPolarityKind	Représente la condition de polarité normale du réseau. En fonction de la configuration du convertisseur, la valeur doit être réglée comme suit: – Pour un monopole à deux bornes du convertisseur, utiliser DCPolarityKind “positif” et “négatif”. – Pour un monopole bipole ou symétrique à trois bornes de convertisseur, utiliser DCPolarityKind “positif”, “médian” et “négatif”.
connected	0..1	Boolean	hérité de: ACDCTerminal
sequenceNumber	0..1	Integer	hérité de: ACDCTerminal
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 482 présente toutes les extrémités d'association de ACDCConverterDCTerminal avec d'autres classes.

Tableau 482 – Extrémités d'association de DC::ACDCConverterDCTerminal avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..*	DCConductingEquipment	1..1	ACDCConverter	Borne de convertisseur de courant continu qui appartient à un convertisseur de courant continu.
0..*	DCTopologicalNode	0..1	DCTopologicalNode	hérité de: DCBaseTerminal
0..*	DCNode	0..1	DCNode	hérité de: DCBaseTerminal
1..*	BusNameMarker	0..1	BusNameMarker	hérité de: ACDCTerminal
0..1	OperationalLimitSet	0..*	OperationalLimitSet	hérité de: ACDCTerminal
0..1	Measurements	0..*	Measurement	hérité de: ACDCTerminal
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

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6.7.4 CsConverter

Côté courant continu du convertisseur de source de courant (CSC).

L'angle d'amorçage commande la tension en courant continu au niveau du convertisseur, à la fois pour le redresseur et l'onduleur. La différence entre les tensions en courant continu du redresseur et de l'onduleur détermine le courant continu. L'angle d'extinction est utilisé pour limiter la tension en courant continu au niveau de l'onduleur, si cela s'avère nécessaire. Il n'est pas utilisé dans la commande de puissance active. L'angle d'amorçage, la position de la prise de transformateur et le nombre de filtres connectés constituent les principaux moyens permettant de commander une ligne de source de courant continu. Des commandes de niveau supérieur sont établies sur le dessus, par exemple tension en courant continu, courant continu et puissance active. S'agissant de régime établi, il suffit de spécifier le transfert de puissance active souhaité (ACDCConverter.targetPpcc) et permettre ainsi aux fonctions de commande de régler de manière conforme la tension en courant continu, le courant continu, l'angle d'amorçage, la position de la prise de transformateur et le nombre de filtres connectés. Par conséquent, les attributs targetAlpha et targetGamma ne sont pas applicables dans ce cas.

La puissance réactive consommée par le convertisseur dépend de l'angle d'amorçage, de la position de la prise de transformateur et du nombre de filtres connectés, ce qui peut être approché avec la moitié de la puissance active. Les pertes dépendent de la tension en courant continu et du courant continu.

Les attributs minAlpha et maxAlpha définissent la plage des angles d'amorçage pour le fonctionnement du redresseur entre lesquels ne se produit aucune action discrète du changeur de prises. La plage est généralement comprise entre 10 degrés et 18 degrés.

Les attributs minGamma et maxGamma définissent la plage des angles d'extinction pour le fonctionnement de l'onduleur entre lesquels ne se produit aucune action discrète du changeur de prises. La plage est généralement comprise entre 17 degrés et 20 degrés.

Le Tableau 483 présente tous les attributs de CsConverter.

Tableau 483 – Attributs de DC::CsConverter

nom	mult	type	description
alpha	0..1	AngleDegrees	Angle d'amorçage qui détermine la tension en courant continu au niveau de la borne du convertisseur en courant continu. Valeur type comprise entre 10 degrés et 18 degrés pour un redresseur. Variable d'état constant du convertisseur, résultat du flux de puissance. La valeur de l'attribut doit être positive.
gamma	0..1	AngleDegrees	Angle d'extinction. Utilisé pour limiter la tension en courant continu au niveau de l'onduleur, si cela s'avère nécessaire. Valeur type comprise entre 17 degrés et 20 degrés. Variable d'état du convertisseur, résultat du flux de puissance. La valeur de l'attribut doit être positive.
maxAlpha	0..1	AngleDegrees	Angle maximal d'amorçage. Données de configuration du convertisseur utilisées dans le flux de puissance. La valeur de l'attribut doit être positive.
maxGamma	0..1	AngleDegrees	Angle maximal d'extinction. Données de configuration du convertisseur utilisées dans le flux de puissance. La valeur de l'attribut doit être positive.
maxIdc	0..1	CurrentFlow	Courant continu (Id) maximal du côté courant continu auquel il convient que le convertisseur fonctionne. Données de configuration du convertisseur utilisées dans le flux de puissance. La valeur de l'attribut doit être positive.

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nom	mult	type	description
minAlpha	0..1	AngleDegrees	Angle minimal d'amorçage. Données de configuration du convertisseur utilisées dans le flux de puissance. La valeur de l'attribut doit être positive.
minGamma	0..1	AngleDegrees	Angle minimal d'extinction. Données de configuration du convertisseur utilisées dans le flux de puissance. La valeur de l'attribut doit être positive.
minIdc	0..1	CurrentFlow	Courant continu (Id) minimal du côté courant continu auquel il convient que le convertisseur fonctionne. Données de configuration du convertisseur utilisées dans le flux de puissance. La valeur de l'attribut doit être positive.
operatingMode	0..1	CsOperatingModeKind	Indique si le pôle de courant continu fonctionne comme onduleur ou comme redresseur. Variable de commande du convertisseur utilisée dans le flux de puissance.
pPccControl	0..1	CsPpccControlKind	Genre de commande de puissance active.
ratedIdc	0..1	CurrentFlow	Courant continu assigné du convertisseur, également appelé IdN. La valeur de l'attribut doit être positive. Données de configuration du convertisseur utilisées dans le flux de puissance.
targetAlpha	0..1	AngleDegrees	Angle cible d'amorçage. Variable de commande du convertisseur utilisée dans le flux de puissance. Ne s'applique que pour le redresseur si la commande de changeur de prises continue est utilisée. Les valeurs admises sont comprises dans la plage de minAlpha<=targetAlpha<=maxAlpha. La valeur de l'attribut doit être positive.
targetGamma	0..1	AngleDegrees	Angle cible d'extinction. Variable de commande du convertisseur utilisée dans le flux de puissance. Ne s'applique que pour l'onduleur si la commande de changeur de prises continue est utilisée. Les valeurs admises sont comprises dans la plage de minGamma<=targetGamma<=maxGamma. La valeur de l'attribut doit être positive.
targetIdc	0..1	CurrentFlow	Valeur cible du courant continu. Variable de commande du convertisseur utilisée dans le flux de puissance. La valeur de l'attribut doit être positive.
baseS	0..1	ApparentPower	hérité de: ACDCConverter
idc	0..1	CurrentFlow	hérité de: ACDCConverter
idleLoss	0..1	ActivePower	hérité de: ACDCConverter
maxUdc	0..1	Voltage	hérité de: ACDCConverter
minUdc	0..1	Voltage	hérité de: ACDCConverter
numberOfValves	0..1	Integer	hérité de: ACDCConverter
p	0..1	ActivePower	hérité de: ACDCConverter
poleLossP	0..1	ActivePower	hérité de: ACDCConverter
q	0..1	ReactivePower	hérité de: ACDCConverter
ratedUdc	0..1	Voltage	hérité de: ACDCConverter
resistiveLoss	0..1	Resistance	hérité de: ACDCConverter
switchingLoss	0..1	ActivePowerPerCurrentFlow	hérité de: ACDCConverter
targetPpcc	0..1	ActivePower	hérité de: ACDCConverter
targetUdc	0..1	Voltage	hérité de: ACDCConverter
uc	0..1	Voltage	hérité de: ACDCConverter
udc	0..1	Voltage	hérité de: ACDCConverter
valveU0	0..1	Voltage	hérité de: ACDCConverter

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nom	mult	type	description
maxP	0..1	ActivePower	hérité de: ACDCConverter
minP	0..1	ActivePower	hérité de: ACDCConverter
aggregate	0..1	Boolean	hérité de: Equipment
inService	0..1	Boolean	hérité de: Equipment
networkAnalysisEnabled	0..1	Boolean	hérité de: Equipment
normallyInService	0..1	Boolean	hérité de: Equipment
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 484 présente toutes les extrémités d'association de CsConverter avec d'autres classes.

Tableau 484 – Extrémités d'association de DC::CsConverter avec d'autres classes

mult à partir de	nom	mult vers	type	description
1..1	CSCDynamics	0..1	CSCDynamics	Modèle dynamique du convertisseur de source de courant utilisé pour décrire le comportement dynamique de ce convertisseur.
0..*	PccTerminal	0..1	Terminal	hérité de: ACDCConverter
1..1	DCTerminals	0..*	ACDCConverterDCTerminal	hérité de: ACDCConverter
0..*	BaseVoltage	0..1	BaseVoltage	hérité de: ConductingEquipment
1..1	SvStatus	0..*	SvStatus	hérité de: ConductingEquipment
0..*	ProtectionEquipments	0..*	ProtectionEquipment	hérité de: ConductingEquipment
1..1	Terminals	0..*	Terminal	hérité de: ConductingEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	hérité de: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	hérité de: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	hérité de: Equipment
0..1	Faults	0..*	Fault	hérité de: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	hérité de: Equipment
0..*	PSRType	0..1	PSRType	hérité de: PowerSystemResource
0..1	Controls	0..*	Control	hérité de: PowerSystemResource
0..1	Measurements	0..*	Measurement	hérité de: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	hérité de: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	hérité de: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

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6.7.5 DCTopologicalNode

Bus à courant continu.

Le Tableau 485 présente tous les attributs de DCTopologicalNode.

Tableau 485 – Attributs de DC::DCTopologicalNode

nom	mult	type	description
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 486 présente toutes les extrémités d'association de DCTopologicalNode avec d'autres classes.

Tableau 486 – Extrémités d'association de DC::DCTopologicalNode avec d'autres classes

mult à partir de	nom	mult vers	type	description
1..*	DCTopologicalIsland	0..1	DCTopologicalIsland	Un TopologicalNode (nœud topologique) à courant continu appartient à un TopologicalIsland (îlot topologique) à courant continu.
0..1	DCTerminals	0..*	DCBaseTerminal	Voir l'extrémité d'association TopologicalNode.Terminal.
0..1	DCNodes	0..*	DCNode	Les nœuds de connectivité à courant continu se sont combinés les uns aux autres pour former ce nœud topologique à courant continu. Peut dépendre de l'état courant des commutateurs dans le réseau.
0..*	DCEquipmentContainer	0..1	DCEquipmentContainer	Conteneur de nœuds de connectivité auquel le nœud topologique appartient.
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.7.6 Enumération CsOperatingModeKind

Mode de fonctionnement pour les lignes CCHT fonctionnant comme convertisseur de source de courant.

Le Tableau 487 présente tous les libellés de CsOperatingModeKind.

Tableau 487 – Libellés de DC::CsOperatingModeKind

libellé	value	description
inverter		Fonctionne comme onduleur qui représente l'extrémité de réception de la puissance.
rectifier		Fonctionne comme redresseur qui représente l'extrémité de transmission de la puissance.

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6.7.7 Enumération CsPpccControlKind

Modes de commande de puissance active pour les lignes CCHT fonctionnant comme convertisseur de source de courant.

Le Tableau 488 présente tous les libellés de CsPpccControlKind.

Tableau 488 – Libellés de DC::CsPpccControlKind

libellé	value	description
activePower		Commande de puissance active côté courant alternatif au point de couplage commun. La cible est fournie par ACDCConverter.targetPpcc.
dcVoltage		Commande de tension en courant continu avec la valeur cible fournie par ACDCConverter.targetUdc.
dcCurrent		Commande de courant continu avec la valeur cible fournie par CsConverter.targetIdc.

6.7.8 DCBaseTerminal

Point de connexion électrique à une partie d'un équipement conducteur à courant continu. Les bornes à courant continu sont connectées au niveau d'un nœud physique à courant continu qui peut avoir plusieurs bornes de courant continu qui lui sont raccordées. Un nœud à courant continu est similaire à un nœud de connectivité à courant alternatif. Le modèle exige que les connexions de courant continu soient distinctes des connexions de courant alternatif.

Le Tableau 489 présente tous les attributs de DCBaseTerminal.

Tableau 489 – Attributs de DC::DCBaseTerminal

nom	mult	type	description
connected	0..1	Boolean	hérité de: ACDCTerminal
sequenceNumber	0..1	Integer	hérité de: ACDCTerminal
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 490 présente toutes les extrémités d'association de DCBaseTerminal avec d'autres classes.

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Tableau 490 – Extrémités d'association de DC::DCBaseTerminal avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..*	DCTopologicalNode	0..1	DCTopologicalNode	Voir l'extrémité d'association Terminal.TopologicalNode.
0..*	DCNode	0..1	DCNode	Nœud de connectivité de courant continu auquel cette borne de courant continu de base est connectée à impédance nulle.
1..*	BusNameMarker	0..1	BusNameMarker	hérité de: ACDCTerminal
0..1	OperationalLimitSet	0..*	OperationalLimitSet	hérité de: ACDCTerminal
0..1	Measurements	0..*	Measurement	hérité de: ACDCTerminal
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.7.9 DCBreaker

Disjoncteur situé dans le système de courant continu.

Le Tableau 491 présente tous les attributs de DCBreaker.

Tableau 491 – Attributs de DC::DCBreaker

nom	mult	type	description
ratedUdc	0..1	Voltage	hérité de: DCConductingEquipment
aggregate	0..1	Boolean	hérité de: Equipment
inService	0..1	Boolean	hérité de: Equipment
networkAnalysisEnabled	0..1	Boolean	hérité de: Equipment
normallyInService	0..1	Boolean	hérité de: Equipment
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 492 présente toutes les extrémités d'association de DCBreaker avec d'autres classes.

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Tableau 492 – Extrémités d'association de DC::DCBreaker avec d'autres classes

mult à partir de	nom	mult vers	type	description
1..1	DCTerminals	0..*	DCTerminal	hérité de: DCConductingEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	hérité de: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	hérité de: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	hérité de: Equipment
0..1	Faults	0..*	Fault	hérité de: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	hérité de: Equipment
0..*	PSRType	0..1	PSRType	hérité de: PowerSystemResource
0..1	Controls	0..*	Control	hérité de: PowerSystemResource
0..1	Measurements	0..*	Measurement	hérité de: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	hérité de: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	hérité de: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.7.10 DCBusbar

Jeu de barres situé dans un système de courant continu.

Le Tableau 493 présente tous les attributs de DCBusbar.

Tableau 493 – Attributs de DC::DCBusbar

nom	mult	type	description
ratedUdc	0..1	Voltage	hérité de: DCConductingEquipment
aggregate	0..1	Boolean	hérité de: Equipment
inService	0..1	Boolean	hérité de: Equipment
networkAnalysisEnabled	0..1	Boolean	hérité de: Equipment
normallyInService	0..1	Boolean	hérité de: Equipment
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 494 présente toutes les extrémités d'association de DCBusbar avec d'autres classes.

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Tableau 494 – Extrémités d'association de DC::DCBusbar avec d'autres classes

mult à partir de	nom	mult vers	type	description
1..1	DCTerminals	0..*	DCTerminal	hérité de: DCConductingEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	hérité de: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	hérité de: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	hérité de: Equipment
0..1	Faults	0..*	Fault	hérité de: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	hérité de: Equipment
0..*	PSRType	0..1	PSRType	hérité de: PowerSystemResource
0..1	Controls	0..*	Control	hérité de: PowerSystemResource
0..1	Measurements	0..*	Measurement	hérité de: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	hérité de: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	hérité de: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.7.11 DCChopper

Équipement à faible résistance utilisé dans le circuit interne à courant continu pour équilibrer les tensions. Il a généralement des bornes positives et négatives de pôles et une terre.

Le Tableau 495 présente tous les attributs de DCChopper.

Tableau 495 – Attributs de DC::DCChopper

nom	mult	type	description
ratedUdc	0..1	Voltage	hérité de: DCConductingEquipment
aggregate	0..1	Boolean	hérité de: Equipment
inService	0..1	Boolean	hérité de: Equipment
networkAnalysisEnabled	0..1	Boolean	hérité de: Equipment
normallyInService	0..1	Boolean	hérité de: Equipment
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 496 présente toutes les extrémités d'association de DCChopper avec d'autres classes.

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Tableau 496 – Extrémités d'association de DC::DCChopper avec d'autres classes

mult à partir de	nom	mult vers	type	description
1..1	DCTerminals	0..*	DCTerminal	hérité de: DCConductingEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	hérité de: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	hérité de: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	hérité de: Equipment
0..1	Faults	0..*	Fault	hérité de: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	hérité de: Equipment
0..*	PSRType	0..1	PSRType	hérité de: PowerSystemResource
0..1	Controls	0..*	Control	hérité de: PowerSystemResource
0..1	Measurements	0..*	Measurement	hérité de: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	hérité de: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	hérité de: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.7.12 DCConductingEquipment

Parties du système de puissance à courant continu conçues pour transporter du courant ou connectées par des bornes à courant continu de façon à assurer la conduction.

Le Tableau 497 présente tous les attributs de DCConductingEquipment.

Tableau 497 – Attributs de DC::DCConductingEquipment

nom	mult	type	description
ratedUdc	0..1	Voltage	Tension assignée de l'appareil à courant continu. La valeur de l'attribut doit être positive. Données de configuration du convertisseur utilisées dans le flux de puissance.
aggregate	0..1	Boolean	hérité de: Equipment
inService	0..1	Boolean	hérité de: Equipment
networkAnalysisEnabled	0..1	Boolean	hérité de: Equipment
normallyInService	0..1	Boolean	hérité de: Equipment
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 498 présente toutes les extrémités d'association de DCConductingEquipment avec d'autres classes.

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Tableau 498 – Extrémités d'association de DC::DCConductingEquipment avec d'autres classes

mult à partir de	nom	mult vers	type	description
1..1	DCTerminals	0..*	DCTerminal	Équipement conducteur à courant continu ayant deux bornes à courant continu.
0..1	OperationalLimitSet	0..*	OperationalLimitSet	hérité de: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	hérité de: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	hérité de: Equipment
0..1	Faults	0..*	Fault	hérité de: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	hérité de: Equipment
0..*	PSRType	0..1	PSRType	hérité de: PowerSystemResource
0..1	Controls	0..*	Control	hérité de: PowerSystemResource
0..1	Measurements	0..*	Measurement	hérité de: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	hérité de: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	hérité de: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.7.13 Enumération DCConverterOperatingModeKind

Mode de fonctionnement d'un bipôle CCHT.

Le Tableau 499 présente tous les libellés de DCConverterOperatingModeKind.

Tableau 499 – Libellés de DC::DCConverterOperatingModeKind

libellé	value	description
bipolar		Fonctionnement bipolaire.
monopolarMetallicReturn		Fonctionnement monopolaire avec retour métallique.
monopolarGroundReturn		Fonctionnement monopolaire avec retour par la terre.

6.7.14 DCConverterUnit

Ensemble opérationnel indivisible comprenant tous les équipements entre le point de couplage commun côté courant alternatif et le point de couplage commun côté courant continu, essentiellement un ou plusieurs convertisseurs, avec un ou plusieurs transformateurs de convertisseur, l'équipement de commande du convertisseur, les dispositifs essentiels de protection et de commutation et les équipements auxiliaires, s'ils existent, pour la conversion.

Le Tableau 500 présente tous les attributs de DCConverterUnit.

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Tableau 500 – Attributs de DC::DCConverterUnit

nom	mult	type	description
operationMode	0..1	DCConverterOperating ModeKind	Mode de fonctionnement d'un bipôle CCHT (bipolaire, retour métallique monopolaire, etc).
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 501 présente toutes les extrémités d'association de DCConverterUnit avec d'autres classes.

Tableau 501 – Extrémités d'association de DC::DCConverterUnit avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..*	Substation	0..1	Substation	Poste dans lequel se trouve l'unité de convertisseur de courant continu.
0..1	DCTopologicalNode	0..*	DCTopologicalNode	hérité de: DCEquipmentContainer
1..1	DCNodes	0..*	DCNode	hérité de: DCEquipmentContainer
0..1	Equipments	0..*	Equipment	hérité de: EquipmentContainer
0..*	AdditionalGroupedEquipment	0..*	Equipment	hérité de: EquipmentContainer
1..1	ConnectivityNodes	0..*	ConnectivityNode	hérité de: ConnectivityNodeContainer
0..1	TopologicalNode	0..*	TopologicalNode	hérité de: ConnectivityNodeContainer
0..*	PSRType	0..1	PSRType	hérité de: PowerSystemResource
0..1	Controls	0..*	Control	hérité de: PowerSystemResource
0..1	Measurements	0..*	Measurement	hérité de: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	hérité de: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	hérité de: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.7.15 DCDisconnector

Sectionneur situé dans un système de courant continu.

Le Tableau 502 présente tous les attributs de DCDisconnector.

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Tableau 502 – Attributs de DC::DCDisconnector

nom	mult	type	description
ratedUdc	0..1	Voltage	hérité de: DCConductingEquipment
aggregate	0..1	Boolean	hérité de: Equipment
inService	0..1	Boolean	hérité de: Equipment
networkAnalysisEnabled	0..1	Boolean	hérité de: Equipment
normallyInService	0..1	Boolean	hérité de: Equipment
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 503 présente toutes les extrémités d'association de DCDisconnector avec d'autres classes.

Tableau 503 – Extrémités d'association de DC::DCDisconnector avec d'autres classes

mult à partir de	nom	mult vers	type	description
1..1	DCTerminals	0..*	DCTerminal	hérité de: DCConductingEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	hérité de: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	hérité de: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	hérité de: Equipment
0..1	Faults	0..*	Fault	hérité de: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	hérité de: Equipment
0..*	PSRType	0..1	PSRType	hérité de: PowerSystemResource
0..1	Controls	0..*	Control	hérité de: PowerSystemResource
0..1	Measurements	0..*	Measurement	hérité de: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	hérité de: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	hérité de: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.7.16 DCEquipmentContainer

Choix de modélisation pour proposer une classe racine qui regroupe des équipements de courant continu et de courant alternatif. Cette classe diffère de EquipmentContainer en courant alternatif dans la mesure où elle peut également comprendre les DCNodes. Par conséquent, elle peut contenir des équipements en courant alternatif et en courant continu.

Le Tableau 504 présente tous les attributs de DCEquipmentContainer.

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Tableau 504 – Attributs de DC::DCEquipmentContainer

nom	mult	type	description
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 505 présente toutes les extrémités d'association de DCEquipmentContainer avec d'autres classes.

Tableau 505 – Extrémités d'association de DC::DCEquipmentContainer avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..1	DCTopologicalNode	0..*	DCTopologicalNode	Nœuds topologiques qui appartiennent à ce conteneur de nœuds de connectivité.
1..1	DCNodes	0..*	DCNode	Nœuds de courant continu contenus dans ce conteneur d'équipements en courant continu.
0..1	Equipments	0..*	Equipment	hérité de: EquipmentContainer
0..*	AdditionalGroupedEquipment	0..*	Equipment	hérité de: EquipmentContainer
1..1	ConnectivityNodes	0..*	ConnectivityNode	hérité de: ConnectivityNodeContainer
0..1	TopologicalNode	0..*	TopologicalNode	hérité de: ConnectivityNodeContainer
0..*	PSRType	0..1	PSRType	hérité de: PowerSystemResource
0..1	Controls	0..*	Control	hérité de: PowerSystemResource
0..1	Measurements	0..*	Measurement	hérité de: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	hérité de: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	hérité de: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.7.17 DCGround

Terre située dans un système de courant continu.

Le Tableau 506 présente tous les attributs de DCGround.

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Tableau 506 – Attributs de DC::DCGround

nom	mult	type	description
inductance	0..1	Inductance	Inductance à la terre.
r	0..1	Resistance	Résistance à la terre.
ratedUdc	0..1	Voltage	hérité de: DCConductingEquipment
aggregate	0..1	Boolean	hérité de: Equipment
inService	0..1	Boolean	hérité de: Equipment
networkAnalysisEnabled	0..1	Boolean	hérité de: Equipment
normallyInService	0..1	Boolean	hérité de: Equipment
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 507 présente toutes les extrémités d'association de DCGround avec d'autres classes.

Tableau 507 – Extrémités d'association de DC::DCGround avec d'autres classes

mult à partir de	nom	mult vers	type	description
1..1	DCTerminals	0..*	DCTerminal	hérité de: DCConductingEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	hérité de: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	hérité de: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	hérité de: Equipment
0..1	Faults	0..*	Fault	hérité de: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	hérité de: Equipment
0..*	PSRType	0..1	PSRType	hérité de: PowerSystemResource
0..1	Controls	0..*	Control	hérité de: PowerSystemResource
0..1	Measurements	0..*	Measurement	hérité de: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	hérité de: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	hérité de: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

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6.7.18 DCLine

Lignes aériennes et/ou câbles connectant deux postes CCHT ou plus.

Le Tableau 508 présente tous les attributs de DCLine.

Tableau 508 – Attributs de DC::DCLine

nom	mult	type	description
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 509 présente toutes les extrémités d'association de DCLine avec d'autres classes.

Tableau 509 – Extrémités d'association de DC::DCLine avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..*	Region	0..1	SubGeographicalRegion	SubGeographicalRegion dans laquelle se trouve cette ligne de courant continu.
0..1	DCTopologicalNode	0..*	DCTopologicalNode	hérité de: DCEquipmentContainer
1..1	DCNodes	0..*	DCNode	hérité de: DCEquipmentContainer
0..1	Equipments	0..*	Equipment	hérité de: EquipmentContainer
0..*	AdditionalGroupedEquipment	0..*	Equipment	hérité de: EquipmentContainer
1..1	ConnectivityNodes	0..*	ConnectivityNode	hérité de: ConnectivityNodeContainer
0..1	TopologicalNode	0..*	TopologicalNode	hérité de: ConnectivityNodeContainer
0..*	PSRType	0..1	PSRType	hérité de: PowerSystemResource
0..1	Controls	0..*	Control	hérité de: PowerSystemResource
0..1	Measurements	0..*	Measurement	hérité de: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	hérité de: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	hérité de: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.7.19 DCLineSegment

Fil ou combinaison de fils non isolés les uns des autres, ayant des caractéristiques électriques cohérentes, utilisés pour transporter du courant continu entre des points dans la région de courant continu du système de puissance.

Le Tableau 510 présente tous les attributs de DCLineSegment.

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Tableau 510 – Attributs de DC::DCLineSegment

nom	mult	type	description
capacitance	0..1	Capacitance	Capacité du segment de ligne à courant continu. Importante uniquement pour les câbles.
inductance	0..1	Inductance	Inductance du segment de ligne à courant continu. Négligeable en comparaison avec le DCSeriesDevice utilisé à des fins de lissage.
resistance	0..1	Resistance	Résistance du segment de ligne à courant continu.
length	0..1	Length	Longueur du segment pour calculer les capacités d'une section de ligne.
ratedUdc	0..1	Voltage	hérité de: DCConductingEquipment
aggregate	0..1	Boolean	hérité de: Equipment
inService	0..1	Boolean	hérité de: Equipment
networkAnalysisEnabled	0..1	Boolean	hérité de: Equipment
normallyInService	0..1	Boolean	hérité de: Equipment
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 511 présente toutes les extrémités d'association de DCLineSegment avec d'autres classes.

Tableau 511 – Extrémités d'association de DC::DCLineSegment avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..*	PerLengthParameter	0..1	PerLengthDCLineParameter	Ensemble de paramètres pour ce segment de ligne, par unité de longueur.
1..1	DCTerminals	0..*	DCTerminal	hérité de: DCConductingEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	hérité de: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	hérité de: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	hérité de: Equipment
0..1	Faults	0..*	Fault	hérité de: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	hérité de: Equipment
0..*	PSRType	0..1	PSRType	hérité de: PowerSystemResource
0..1	Controls	0..*	Control	hérité de: PowerSystemResource
0..1	Measurements	0..*	Measurement	hérité de: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	hérité de: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	hérité de: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

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6.7.20 DCNode

Nœuds à courant continu dans lesquels les bornes d'un équipement conducteur à courant continu sont connectées ensemble avec une impédance nulle.

Le Tableau 512 présente tous les attributs de DCNode.

Tableau 512 – Attributs de DC::DCNode

nom	mult	type	description
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 513 présente toutes les extrémités d'association de DCNode avec d'autres classes.

Tableau 513 – Extrémités d'association de DC::DCNode avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..*	DCTopologicalNode	0..1	DCTopologicalNode	Nœud topologique à courant continu auquel est affecté ce nœud de connectivité à courant continu. Peut dépendre de l'état courant des commutateurs dans le réseau.
0..1	DCTerminals	0..*	DCBaseTerminal	Bornes à courant continu de base interconnectées à impédance nulle à ce nœud de connectivité à courant continu.
0..*	DCEquipmentContainer	1..1	DCEquipmentContainer	Conteneur à courant continu pour les nœuds à courant continu.
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.7.21 Enumération DCPolarityKind

Polarité des circuits à courant continu.

Le Tableau 514 présente tous les libellés de DCPolarityKind.

Tableau 514 – Libellés de DC::DCPolarityKind

libellé	value	description
positive		Pôle positif. La borne du convertisseur est destinée à fonctionner à une tension positive par rapport à la borne médiane ou négative.
middle		Pôle intermédiaire. La borne du convertisseur représente le point médian dans une configuration de monopole bipolaire ou symétrique. Le point médian peut être mis à la terre et/ou avec un retour métallique.
negative		Pôle négatif. La borne du convertisseur est destinée à fonctionner à une tension négative par rapport à la borne médiane ou positive.

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6.7.22 DCSeriesDevice

Appareil série se trouvant dans le système de courant continu. Il s'agit généralement d'une inductance utilisée à des fins de filtrage ou de lissage. Nécessaire à l'étude des transitoires et des courts-circuits.

Le Tableau 515 présente tous les attributs de DCSeriesDevice.

Tableau 515 – Attributs de DC::DCSeriesDevice

nom	mult	type	description
inductance	0..1	Inductance	Inductance de l'appareil.
resistance	0..1	Resistance	Résistance de l'appareil à courant continu.
ratedUdc	0..1	Voltage	hérité de: DCConductingEquipment
aggregate	0..1	Boolean	hérité de: Equipment
inService	0..1	Boolean	hérité de: Equipment
networkAnalysisEnabled	0..1	Boolean	hérité de: Equipment
normallyInService	0..1	Boolean	hérité de: Equipment
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 516 présente toutes les extrémités d'association de DCSeriesDevice avec d'autres classes.

Tableau 516 – Extrémités d'association de DC::DCSeriesDevice avec d'autres classes

mult à partir de	nom	mult vers	type	description
1..1	DCTerminals	0..*	DCTerminal	hérité de: DCConductingEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	hérité de: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	hérité de: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	hérité de: Equipment
0..1	Faults	0..*	Fault	hérité de: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	hérité de: Equipment
0..*	PSRType	0..1	PSRType	hérité de: PowerSystemResource
0..1	Controls	0..*	Control	hérité de: PowerSystemResource
0..1	Measurements	0..*	Measurement	hérité de: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	hérité de: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	hérité de: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

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6.7.23 DCShunt

Appareil shunt se trouvant dans le système de courant continu, généralement utilisé à des fins de filtrage. Nécessaire à l'étude des transitoires et des courts-circuits.

Le Tableau 517 présente tous les attributs de DCShunt.

Tableau 517 – Attributs de DC::DCShunt

nom	mult	type	description
capacitance	0..1	Capacitance	Capacité du shunt à courant continu.
resistance	0..1	Resistance	Résistance de l'appareil à courant continu.
ratedUdc	0..1	Voltage	hérité de: DCConductingEquipment
aggregate	0..1	Boolean	hérité de: Equipment
inService	0..1	Boolean	hérité de: Equipment
networkAnalysisEnabled	0..1	Boolean	hérité de: Equipment
normallyInService	0..1	Boolean	hérité de: Equipment
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 518 présente toutes les extrémités d'association de DCShunt avec d'autres classes.

Tableau 518 – Extrémités d'association de DC::DCShunt avec d'autres classes

mult à partir de	nom	mult vers	type	description
1..1	DCTerminals	0..*	DCTerminal	hérité de: DCConductingEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	hérité de: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	hérité de: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	hérité de: Equipment
0..1	Faults	0..*	Fault	hérité de: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	hérité de: Equipment
0..*	PSRType	0..1	PSRType	hérité de: PowerSystemResource
0..1	Controls	0..*	Control	hérité de: PowerSystemResource
0..1	Measurements	0..*	Measurement	hérité de: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	hérité de: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	hérité de: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.7.24 DCSwitch

Commutateur situé dans le système à courant continu.

Le Tableau 519 présente tous les attributs de DCSwitch.

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Tableau 519 – Attributs de DC::DCSwitch

nom	mult	type	description
ratedUdc	0..1	Voltage	hérité de: DCConductingEquipment
aggregate	0..1	Boolean	hérité de: Equipment
inService	0..1	Boolean	hérité de: Equipment
networkAnalysisEnabled	0..1	Boolean	hérité de: Equipment
normallyInService	0..1	Boolean	hérité de: Equipment
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 520 présente toutes les extrémités d'association de DCSwitch avec d'autres classes.

Tableau 520 – Extrémités d'association de DC::DCSwitch avec d'autres classes

mult à partir de	nom	mult vers	type	description
1..1	DCTerminals	0..*	DCTerminal	hérité de: DCConductingEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	hérité de: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	hérité de: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	hérité de: Equipment
0..1	Faults	0..*	Fault	hérité de: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	hérité de: Equipment
0..*	PSRType	0..1	PSRType	hérité de: PowerSystemResource
0..1	Controls	0..*	Control	hérité de: PowerSystemResource
0..1	Measurements	0..*	Measurement	hérité de: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	hérité de: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	hérité de: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.7.25 DCTerminal

Point de connexion électrique à l'équipement conducteur générique à courant continu.

Le Tableau 521 présente tous les attributs de DCTerminal.

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Tableau 521 – Attributs de DC::DCTerminal

nom	mult	type	description
connected	0..1	Boolean	hérité de: ACDCTerminal
sequenceNumber	0..1	Integer	hérité de: ACDCTerminal
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 522 présente toutes les extrémités d'association de DCTerminal avec d'autres classes.

Tableau 522 – Extrémités d'association de DC::DCTerminal avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..*	DCConductingEquipment	1..1	DCConductingEquipment	Borne à courant continu appartenant à un équipement conducteur à courant continu.
0..*	DCTopologicalNode	0..1	DCTopologicalNode	hérité de: DCBaseTerminal
0..*	DCNode	0..1	DCNode	hérité de: DCBaseTerminal
1..*	BusNameMarker	0..1	BusNameMarker	hérité de: ACDCTerminal
0..1	OperationalLimitSet	0..*	OperationalLimitSet	hérité de: ACDCTerminal
0..1	Measurements	0..*	Measurement	hérité de: ACDCTerminal
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.7.26 DCTopologicalIsland

Sous-ensemble du réseau électriquement connecté. Les îlots topologiques à courant continu peuvent changer lorsque l'état courant du réseau change, par exemple

– la déconnexion de commutateurs ou de disjoncteurs modifie l'état dans un SCADA/EMS,
– il y a création manuelle, modification ou suppression de nœuds topologiques dans un outil de planification.

Seuls les TopologicalNode-s sous tension doivent faire partie de l'îlot topologique.

Le Tableau 523 présente tous les attributs de DCTopologicalIsland.

Tableau 523 – Attributs de DC::DCTopologicalIsland

nom	mult	type	description
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

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Le Tableau 524 présente toutes les extrémités d'association de DCTopologicalIsland avec d'autres classes.

Tableau 524 – Extrémités d'association de DC::DCTopologicalIsland avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..1	DCTopologicalNodes	1..*	DCTopologicalNode	Nœuds topologiques à courant continu dans un îlot topologique à courant continu.
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.7.27 PerLengthDCLineParameter

Type commun pour des catalogues électriques par unité de longueur qui décrit les paramètres de ligne à courant continu.

Le Tableau 525 présente tous les attributs de PerLengthDCLineParameter.

Tableau 525 – Attributs de DC::PerLengthDCLineParameter

nom	mult	type	description
capacitance	0..1	CapacitancePerLength	Capacité du segment de la ligne à courant continu, par unité de longueur; importante pour les câbles uniquement.
inductance	0..1	InductancePerLength	Inductance du segment de la ligne à courant continu, par unité de longueur.
resistance	0..1	ResistancePerLength	Résistance du segment de ligne à courant continu, par unité de longueur.
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 526 présente toutes les extrémités d'association de PerLengthDCLineParameter avec d'autres classes.

Tableau 526 – Extrémités d'association de DC::PerLengthDCLineParameter avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..1	DCLineSegments	0..*	DCLineSegment	Tous les segments de ligne décrits par cet ensemble de paramètres "par unité de longueur".
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

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6.7.28 VsCapabilityCurve

Courbe de capacité P-Q pour un convertisseur de source de tension, avec P sur l'axe X et Qmin et Qmax sur les axes Y1 et Y2.

Le Tableau 527 présente tous les attributs de VsCapabilityCurve.

Tableau 527 – Attributs de DC::VsCapabilityCurve

nom	mult	type	description
curveStyle	0..1	CurveStyle	hérité de: Curve
xMultiplier	0..1	UnitMultiplier	hérité de: Curve
xUnit	0..1	UnitSymbol	hérité de: Curve
y1Multiplier	0..1	UnitMultiplier	hérité de: Curve
y1Unit	0..1	UnitSymbol	hérité de: Curve
y2Multiplier	0..1	UnitMultiplier	hérité de: Curve
y2Unit	0..1	UnitSymbol	hérité de: Curve
y3Multiplier	0..1	UnitMultiplier	hérité de: Curve
y3Unit	0..1	UnitSymbol	hérité de: Curve
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 528 présente toutes les extrémités d'association de VsCapabilityCurve avec d'autres classes.

Tableau 528 – Extrémités d'association de DC::VsCapabilityCurve avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..1	VsConverterDCSides	0..*	VsConverter	Tous les convertisseurs avec cette courbe de capacité.
1..1	CurveDatas	0..*	CurveData	hérité de: Curve
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.7.29 VsConverter

Côté courant continu du convertisseur de source de tension (VSC).

Le Tableau 529 présente tous les attributs de VsConverter.

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Tableau 529 – Attributs de DC::VsConverter

nom	mult	type	description
delta	0..1	AngleDegrees	Angle entre VsConverter et ACDCConverter.uc. Variable d'état du convertisseur utilisée dans le flux de puissance. La valeur de l'attribut doit être positive.
droop	0..1	PU	Constante de statisme. La valeur de pu est obtenue par D [kV/MW] x Sb / Ubdc. La valeur de l'attribut doit être positive.
droopCompensation	0..1	Resistance	Constante de compensation. Utilisée pour compenser les chutes de tension lors du réglage de la tension au niveau d'un bus distant. La valeur de l'attribut doit être positive.
maxModulationIndex	0..1	Float	Quotient maximal entre la tension alternative (Uc) du convertisseur et sa tension continue (Ud). Facteur généralement inférieur à 1. Données de configuration du convertisseur de source de courant (VSC) utilisées dans le flux de puissance.
maxValveCurrent	0..1	CurrentFlow	Courant maximal circulant dans une valve. Données de configuration du convertisseur.
pPccControl	0..1	VsPpccControlKind	Type de commande de puissance réelle et/ou de tension continue.
qPccControl	0..1	VsQpccControlKind	Genre de commande de puissance réactive.
qShare	0..1	PerCent	Facteur de répartition de la puissance réactive entre les convertisseurs parallèles par le biais de la commande Uac. La valeur de l'attribut doit être positive.
targetQpcc	0..1	ReactivePower	Cible de l'injection de puissance réactive dans le réseau à courant alternatif, au niveau du point de couplage commun. La convention de signe charge est utilisée, c'est-à-dire que le signe positif signifie un flux à partir d'un nœud.
targetUpcc	0..1	Voltage	Cible de tension dans le réseau à courant alternatif, au niveau du point de couplage commun. La valeur de l'attribut doit être positive.
uv	0..1	Voltage	Tension entre phases côté valve du transformateur du convertisseur. Variable d'état du convertisseur, résultat du flux de puissance. La valeur de l'attribut doit être positive.
baseS	0..1	ApparentPower	hérité de: ACDCConverter
targetPowerFactorPcc	0..1	Float	Cible du facteur de puissance du côté courant alternatif, au point de couplage commun. La valeur de l'attribut doit être positive.
targetPhasePcc	0..1	AngleDegrees	Cible de la phase du côté courant alternatif, au point de couplage commun. La valeur de l'attribut doit être positive.
targetPWMfactorhasePcc	0..1	Float	Ampleur du facteur de modulation d'impulsion. La valeur de l'attribut doit être positive.
idc	0..1	CurrentFlow	hérité de: ACDCConverter
idleLoss	0..1	ActivePower	hérité de: ACDCConverter
maxUdc	0..1	Voltage	hérité de: ACDCConverter
minUdc	0..1	Voltage	hérité de: ACDCConverter
numberOfValves	0..1	Integer	hérité de: ACDCConverter
p	0..1	ActivePower	hérité de: ACDCConverter
poleLossP	0..1	ActivePower	hérité de: ACDCConverter
q	0..1	ReactivePower	hérité de: ACDCConverter
ratedUdc	0..1	Voltage	hérité de: ACDCConverter

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nom	mult	type	description
resistiveLoss	0..1	Resistance	hérité de: ACDCConverter
switchingLoss	0..1	ActivePowerPerCurrentFlow	hérité de: ACDCConverter
targetPpcc	0..1	ActivePower	hérité de: ACDCConverter
targetUdc	0..1	Voltage	hérité de: ACDCConverter
uc	0..1	Voltage	hérité de: ACDCConverter
udc	0..1	Voltage	hérité de: ACDCConverter
valveU0	0..1	Voltage	hérité de: ACDCConverter
maxP	0..1	ActivePower	hérité de: ACDCConverter
minP	0..1	ActivePower	hérité de: ACDCConverter
aggregate	0..1	Boolean	hérité de: Equipment
inService	0..1	Boolean	hérité de: Equipment
networkAnalysisEnabled	0..1	Boolean	hérité de: Equipment
normallyInService	0..1	Boolean	hérité de: Equipment
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 530 présente toutes les extrémités d'association de VsConverter avec d'autres classes.

Tableau 530 – Extrémités d'association de DC::VsConverter avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..*	CapabilityCurve	0..1	VsCapabilityCurve	Courbe de capacité de ce convertisseur.
1..1	VSCDynamics	0..1	VSCDynamics	Modèle dynamique du convertisseur de source de tension utilisé pour décrire le comportement dynamique de ce convertisseur.
0..*	PccTerminal	0..1	Terminal	hérité de: ACDCConverter
1..1	DCTerminals	0..*	ACDCConverterDCTerminal	hérité de: ACDCConverter
0..*	BaseVoltage	0..1	BaseVoltage	hérité de: ConductingEquipment
1..1	SvStatus	0..*	SvStatus	hérité de: ConductingEquipment
0..*	ProtectionEquipments	0..*	ProtectionEquipment	hérité de: ConductingEquipment
1..1	Terminals	0..*	Terminal	hérité de: ConductingEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	hérité de: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	hérité de: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	hérité de: Equipment
0..1	Faults	0..*	Fault	hérité de: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	hérité de: Equipment
0..*	PSRType	0..1	PSRType	hérité de: PowerSystemResource
0..1	Controls	0..*	Control	hérité de: PowerSystemResource

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mult à partir de	nom	mult vers	type	description
0..1	Measurements	0..*	Measurement	hérité de: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	hérité de: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	hérité de: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.7.30 Enumération VsPpccControlKind

Types applicables à la commande de puissance réelle et/ou à la tension en courant continu par convertisseur de source de tension.

Le Tableau 531 présente tous les libellés de VsPpccControlKind.

Tableau 531 – Libellés de DC::VsPpccControlKind

libellé	value	description
pPcc		Puissance réelle au niveau du point de couplage commun. La valeur cible est fournie par ACDCConverter.targetPpcc.
udc		Tension en courant continu avec la valeur cible fournie par ACDCConverter.targetUcc
pPccAndUdcDroop		Puissance active au point de couplage commun et la tension en courant continu locale, avec statisme. Les valeurs cibles sont fournies par ACDCConverter.targetPpcc, ACDCConverter.targetUdc et VsConverter.droop.
pPccAndUdcDroopWithCompensation		Puissance active au point de couplage commun et la tension en courant continu compensée, avec statisme. Le facteur de compensation est la résistance, comme approximation de la tension en courant continu d'un nœud (réel ou virtuel) commun du réseau à courant continu. Les valeurs cibles sont fournies par ACDCConverter.targetPpcc, ACDCConverter.targetUdc, VsConverter.droop et VsConverter.droopCompensation.
pPccAndUdcDroopPilot		Puissance active au point de couplage commun et la tension en courant continu pilote, avec statisme. Le mode est utilisé pour les systèmes à courant continu de tension élevée à plusieurs bornes (MTDC) dont les multiples postes CCHT sont connectés aux lignes de transmission CCHT. La tension pilote est ensuite utilisée pour coordonner la commande de tension en courant continu dans les postes CCHT. Les cibles sont fournies par ACDCConverter.targetPpcc, ACDCConverter.targetUdc et VsConverter.droop.
pHasePcc		Phase au point de couplage commun. La cible est fournie par VsConverter.targetPhasePcc.

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6.7.31 Enumération VsQpccControlKind

Genre de commande de puissance réactive au point de couplage commun d'un convertisseur de source de tension.

Le Tableau 532 présente tous les libellés de VsQpccControlKind.

Tableau 532 – Libellés de DC::VsQpccControlKind

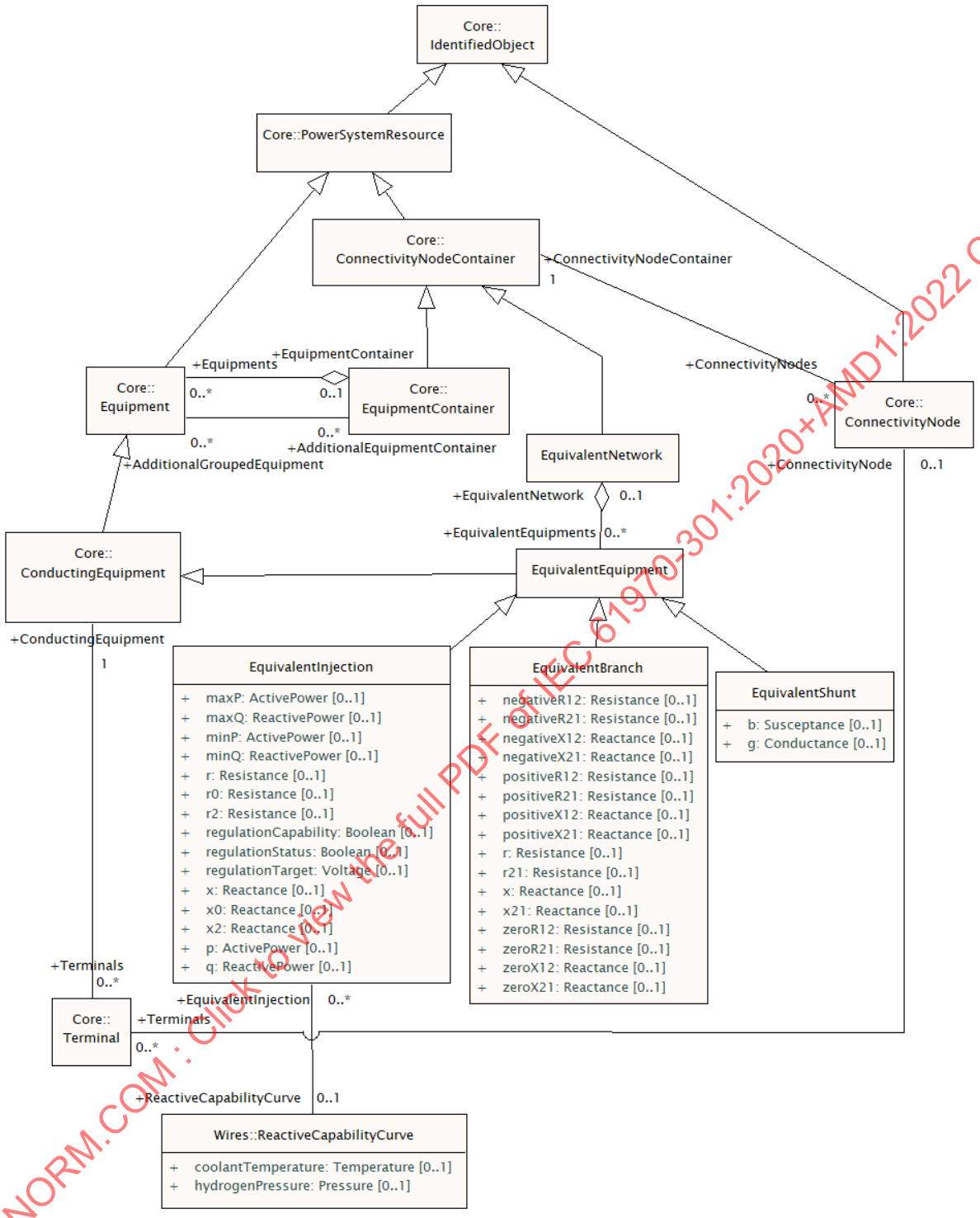
libellé	value	description
reactivePcc		Commande de puissance réactive au point de couplage commun. La cible est fournie par VsConverter.targetQpcc
voltagePcc		Commande de tension au point de couplage commun. La cible est fournie par VsConverter.targetUpcc
powerFactorPcc		Commande de facteur de puissance au point de couplage commun. La cible est fournie par VsConverter.targetPowerFactorPcc
pulseWidthModulation		Pas de commande explicite. Le facteur de modulation d'impulsion est directement établi en amplitude (VsConverter.targetPWMfactor) et en phase (VsConverter.targetPhasePcc)

6.8 Paquetage Equivalents

6.8.1 Généralités

Le paquetage Equivalents modélise les réseaux équivalents.

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Figure 117 – Diagramme de classe Equivalents::Main

Figure 117: Représente le modèle pour des réseaux équivalents.

6.8.2 EquivalentBranch

La classe représente les branches équivalentes. Lorsqu'un déphasage de transformateur est modélisé et que EquivalentBranch s'étend sur les mêmes nœuds, les grandeurs d'impédance pour EquivalentBranch doivent prendre en considération la nécessité du déphasage.

Le Tableau 533 présente tous les attributs de EquivalentBranch.

Tableau 533 – Attributs de Equivalents::EquivalentBranch

nom	mult	type	description
negativeR12	0..1	Resistance	Résistance série inverse du numéro d'ordre de borne 1 au numéro d'ordre de borne 2. Utilisé pour l'échange de données relatives à un court-circuit, conformément à l'IEC 60909. EquivalentBranch est le résultat d'une réduction du réseau préalable à l'échange de données.
negativeR21	0..1	Resistance	Résistance série inverse du numéro d'ordre de borne 2 au numéro d'ordre de borne 1. Utilisé pour l'échange de données relatives à un court-circuit, conformément à l'IEC 60909. EquivalentBranch est le résultat d'une réduction du réseau préalable à l'échange de données.
negativeX12	0..1	Reactance	Réactance série inverse du numéro d'ordre de borne 1 au numéro d'ordre de borne 2. Utilisé pour l'échange de données relatives à un court-circuit, conformément à l'IEC 60909. Utilisation: EquivalentBranch est le résultat d'une réduction du réseau préalable à l'échange de données.
negativeX21	0..1	Reactance	Réactance série inverse du numéro d'ordre de borne 2 au numéro d'ordre de borne 1. Utilisé pour l'échange de données relatives à un court-circuit, conformément à l'IEC 60909. Utilisation: EquivalentBranch est le résultat d'une réduction du réseau préalable à l'échange de données.
positiveR12	0..1	Resistance	Résistance série directe du numéro d'ordre de borne 1 au numéro d'ordre de borne 2. Utilisé pour l'échange de données relatives à un court-circuit, conformément à l'IEC 60909. EquivalentBranch est le résultat d'une réduction du réseau préalable à l'échange de données.
positiveR21	0..1	Resistance	Résistance série directe du numéro d'ordre de borne 2 au numéro d'ordre de borne 1. Utilisé pour l'échange de données relatives à un court-circuit, conformément à l'IEC 60909. EquivalentBranch est le résultat d'une réduction du réseau préalable à l'échange de données.
positiveX12	0..1	Reactance	Réactance série directe du numéro d'ordre de borne 1 au numéro d'ordre de borne 2. Utilisé pour l'échange de données relatives à un court-circuit, conformément à l'IEC 60909. Utilisation: EquivalentBranch est le résultat d'une réduction du réseau préalable à l'échange de données.
positiveX21	0..1	Reactance	Réactance série directe du numéro d'ordre de borne 2 au numéro d'ordre de borne 1. Utilisé pour l'échange de données relatives à un court-circuit, conformément à l'IEC 60909. Utilisation: EquivalentBranch est le résultat d'une réduction du réseau préalable à l'échange de données.
r	0..1	Resistance	Résistance série directe de la branche réduite.

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nom	mult	type	description
r21	0..1	Resistance	Réactance du numéro d'ordre de borne 2 au numéro d'ordre de borne 1. Utilisée pour le flux de puissance en régime établi. L'attribut est facultatif et représente un réseau déséquilibré tel qu'un déphaseur hors nominal. Si seul EquivalentBranch.r est donné, alors EquivalentBranch.r21 est par hypothèse égal à EquivalentBranch.r. Règle d'utilisation: EquivalentBranch est le résultat d'une réduction du réseau préalable à l'échange de données.
x	0..1	Reactance	Réactance série directe de la branche réduite.
x21	0..1	Reactance	Réactance du numéro d'ordre de borne 2 au numéro d'ordre de borne 1. Utilisée pour le flux de puissance en régime établi. L'attribut est facultatif et représente un réseau déséquilibré tel qu'un déphaseur hors nominal. Si seul EquivalentBranch.x est donné, alors EquivalentBranch.x21 est par hypothèse égal à EquivalentBranch.x. Règle d'utilisation: EquivalentBranch est le résultat d'une réduction du réseau préalable à l'échange de données.
zeroR12	0..1	Resistance	Résistance série homopolaire du numéro d'ordre de borne 1 au numéro d'ordre de borne 2. Utilisé pour l'échange de données relatives à un court-circuit, conformément à l'IEC 60909. EquivalentBranch est le résultat d'une réduction du réseau préalable à l'échange de données.
zeroR21	0..1	Resistance	Résistance série homopolaire du numéro d'ordre de borne 2 au numéro d'ordre de borne 1. Utilisé pour l'échange de données relatives à un court-circuit, conformément à l'IEC 60909. Utilisation: EquivalentBranch est le résultat d'une réduction du réseau préalable à l'échange de données.
zeroX12	0..1	Reactance	Réactance série homopolaire du numéro d'ordre de borne 1 au numéro d'ordre de borne 2. Utilisé pour l'échange de données relatives à un court-circuit, conformément à l'IEC 60909. Utilisation: EquivalentBranch est le résultat d'une réduction du réseau préalable à l'échange de données.
zeroX21	0..1	Reactance	Réactance série homopolaire du numéro d'ordre de borne 2 au numéro d'ordre de borne 1. Utilisé pour l'échange de données relatives à un court-circuit, conformément à l'IEC 60909. Utilisation: EquivalentBranch est le résultat d'une réduction du réseau préalable à l'échange de données.
aggregate	0..1	Boolean	hérité de: Equipment
inService	0..1	Boolean	hérité de: Equipment
networkAnalysisEnabled	0..1	Boolean	hérité de: Equipment
normallyInService	0..1	Boolean	hérité de: Equipment
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 534 présente toutes les extrémités d'association de EquivalentBranch avec d'autres classes.

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Tableau 534 – Extrémités d'association de Equivalents::EquivalentBranch avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..*	EquivalentNetwork	0..1	EquivalentNetwork	hérité de: EquivalentEquipment
0..*	BaseVoltage	0..1	BaseVoltage	hérité de: ConductingEquipment
1..1	SvStatus	0..*	SvStatus	hérité de: ConductingEquipment
0..*	ProtectionEquipments	0..*	ProtectionEquipment	hérité de: ConductingEquipment
1..1	Terminals	0..*	Terminal	hérité de: ConductingEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	hérité de: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	hérité de: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	hérité de: Equipment
0..1	Faults	0..*	Fault	hérité de: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	hérité de: Equipment
0..*	PSRType	0..1	PSRType	hérité de: PowerSystemResource
0..1	Controls	0..*	Control	hérité de: PowerSystemResource
0..1	Measurements	0..*	Measurement	hérité de: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	hérité de: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	hérité de: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.8.3 EquivalentEquipment

La classe représente les objets équivalents qui sont le résultat d'une réduction de réseau. La classe est la base pour les objets équivalents de types différents.

Le Tableau 535 présente tous les attributs de EquivalentEquipment.

Tableau 535 – Attributs de Equivalents::EquivalentEquipment

nom	mult	type	description
aggregate	0..1	Boolean	hérité de: Equipment
inService	0..1	Boolean	hérité de: Equipment
networkAnalysisEnabled	0..1	Boolean	hérité de: Equipment
normallyInService	0..1	Boolean	hérité de: Equipment
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 536 présente toutes les extrémités d'association de EquivalentEquipment avec d'autres classes.

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Tableau 536 – Extrémités d'association de Equivalents::EquivalentEquipment avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..*	EquivalentNetwork	0..1	EquivalentNetwork	Équivalent auquel le modèle réduit appartient.
0..*	BaseVoltage	0..1	BaseVoltage	hérité de: ConductingEquipment
1..1	SvStatus	0..*	SvStatus	hérité de: ConductingEquipment
0..*	ProtectionEquipments	0..*	ProtectionEquipment	hérité de: ConductingEquipment
1..1	Terminals	0..*	Terminal	hérité de: ConductingEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	hérité de: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	hérité de: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	hérité de: Equipment
0..1	Faults	0..*	Fault	hérité de: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	hérité de: Equipment
0..*	PSRType	0..1	PSRType	hérité de: PowerSystemResource
0..1	Controls	0..*	Control	hérité de: PowerSystemResource
0..1	Measurements	0..*	Measurement	hérité de: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	hérité de: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	hérité de: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.8.4 EquivalentInjection

Cette classe représente des injections équivalentes (production ou charge). La régulation de tension est autorisée seulement au point de connexion.

Le Tableau 537 présente tous les attributs de EquivalentInjection.

Tableau 537 – Attributs de Equivalents::EquivalentInjection

nom	mult	type	description
maxP	0..1	ActivePower	Puissance active maximale de l'injection.
maxQ	0..1	ReactivePower	Puissance réactive maximale de l'injection. Utilisé pour la modélisation d'alimentation pour l'échange de flux de charge. Pas utilisé pour la modélisation de courts-circuits. Si maxQ et minQ ne sont pas utilisés, ReactiveCapabilityCurve peut être utilisée.
minP	0..1	ActivePower	Puissance active minimale de l'injection.
minQ	0..1	ReactivePower	Puissance réactive minimale de l'injection. Utilisé pour la modélisation d'alimentation pour l'échange de flux de charge. Pas utilisé pour la modélisation de courts-circuits. Si maxQ et minQ ne sont pas utilisés, ReactiveCapabilityCurve peut être utilisée.
r	0..1	Resistance	Résistance directe. Utilisée pour représenter Extended-Ward(IEC 60909). Utilisation: Extended-Ward est le résultat d'une réduction du réseau préalable à l'échange de données.

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nom	mult	type	description
r0	0..1	Resistance	Résistance homopolaire. Utilisée pour représenter Extended-Ward(IEC 60909). Utilisation: Extended-Ward est le résultat d'une réduction du réseau préalable à l'échange de données.
r2	0..1	Resistance	Résistance inverse. Utilisée pour représenter Extended-Ward(IEC 60909). Utilisation: Extended-Ward est le résultat d'une réduction du réseau préalable à l'échange de données.
regulationCapability	0..1	Boolean	Spécifie si, oui ou non, l'EquivalentInjection a la capacité de réguler la tension locale. Si la valeur est true (vrai), EquivalentInjection peut réguler. Si la valeur est false (faux), EquivalentInjection ne peut pas réguler. ReactiveCapabilityCurve ne peut être associé qu'à EquivalentInjection si l'indicateur est true.
regulationStatus	0..1	Boolean	Spécifie le statut de régulation de l'EquivalentInjection. True, il régule. False, il ne régule pas.
regulationTarget	0..1	Voltage	Tension cible pour la régulation de tension. La valeur de l'attribut doit être positive.
x	0..1	Reactance	Réactance directe. Utilisée pour représenter Extended-Ward(IEC 60909). Utilisation: Extended-Ward est le résultat d'une réduction du réseau préalable à l'échange de données.
x0	0..1	Reactance	Réactance homopolaire. Utilisée pour représenter Extended-Ward(IEC 60909). Utilisation: Extended-Ward est le résultat d'une réduction du réseau préalable à l'échange de données.
x2	0..1	Reactance	Réactance inverse. Utilisée pour représenter Extended-Ward(IEC 60909). Utilisation: Extended-Ward est le résultat d'une réduction du réseau préalable à l'échange de données.
p	0..1	ActivePower	Injection équivalente de puissance active. La convention de signe charge est utilisée, c'est-à-dire que le signe positif signifie un flux à partir d'un nœud. Valeur de départ pour des solutions en régime établi.
q	0..1	ReactivePower	Injection équivalente de puissance réactive. La convention de signe charge est utilisée, c'est-à-dire que le signe positif signifie un flux à partir d'un nœud. Valeur de départ pour des solutions en régime établi.
aggregate	0..1	Boolean	hérité de: Equipment
inService	0..1	Boolean	hérité de: Equipment
networkAnalysisEnabled	0..1	Boolean	hérité de: Equipment
normallyInService	0..1	Boolean	hérité de: Equipment
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

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Le Tableau 538 présente toutes les extrémités d'association de EquivalentInjection avec d'autres classes.

Tableau 538 – Extrémités d'association de Equivalents::EquivalentInjection avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..*	ReactiveCapabilityCurve	0..1	ReactiveCapabilityCurve	Courbe de capacité réactive utilisée par cette injection équivalente.
0..*	EquivalentNetwork	0..1	EquivalentNetwork	hérité de: EquivalentEquipment
0..*	BaseVoltage	0..1	BaseVoltage	hérité de: ConductingEquipment
1..1	SvStatus	0..*	SvStatus	hérité de: ConductingEquipment
0..*	ProtectionEquipments	0..*	ProtectionEquipment	hérité de: ConductingEquipment
1..1	Terminals	0..*	Terminal	hérité de: ConductingEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	hérité de: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	hérité de: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	hérité de: Equipment
0..1	Faults	0..*	Fault	hérité de: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	hérité de: Equipment
0..*	PSRType	0..1	PSRType	hérité de: PowerSystemResource
0..1	Controls	0..*	Control	hérité de: PowerSystemResource
0..1	Measurements	0..*	Measurement	hérité de: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	hérité de: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	hérité de: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.8.5 EquivalentNetwork

Classe regroupant des équivalents électriques, y compris des nœuds internes, d'un réseau qui a été réduit. Les ConnectivityNode contenus dans l'équivalent sont réputés refléter les nœuds internes de l'équivalent. Les nœuds de connectivité aux limites lorsque l'équivalent se connecte à l'extérieur de lui-même ne sont PAS contenus dans l'équivalent.

Le Tableau 539 présente tous les attributs de EquivalentNetwork.

Tableau 539 – Attributs de Equivalents::EquivalentNetwork

nom	mult	type	description
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 540 présente toutes les extrémités d'association de EquivalentNetwork avec d'autres classes.

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Tableau 540 – Extrémités d'association de Equivalents::EquivalentNetwork avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..1	EquivalentEquipments	0..*	EquivalentEquipment	Équivalents réduits associés.
1..1	ConnectivityNodes	0..*	ConnectivityNode	hérité de: ConnectivityNodeContainer
0..1	TopologicalNode	0..*	TopologicalNode	hérité de: ConnectivityNodeContainer
0..*	PSRType	0..1	PSRType	hérité de: PowerSystemResource
0..1	Controls	0..*	Control	hérité de: PowerSystemResource
0..1	Measurements	0..*	Measurement	hérité de: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	hérité de: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	hérité de: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.8.6 EquivalentShunt

La classe représente les shunts équivalents.

Le Tableau 541 présente tous les attributs de EquivalentShunt.

Tableau 541 – Attributs de Equivalents::EquivalentShunt

nom	mult	type	description
b	0..1	Susceptance	Susceptance shunt directe.
g	0..1	Conductance	Conductance shunt directe.
aggregate	0..1	Boolean	hérité de: Equipment
inService	0..1	Boolean	hérité de: Equipment
networkAnalysisEnabled	0..1	Boolean	hérité de: Equipment
normallyInService	0..1	Boolean	hérité de: Equipment
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 542 présente toutes les extrémités d'association de EquivalentShunt avec d'autres classes.

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Tableau 542 – Extrémités d'association de Equivalents::EquivalentShunt avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..*	EquivalentNetwork	0..1	EquivalentNetwork	hérité de: EquivalentEquipment
0..*	BaseVoltage	0..1	BaseVoltage	hérité de: ConductingEquipment
1..1	SvStatus	0..*	SvStatus	hérité de: ConductingEquipment
0..*	ProtectionEquipments	0..*	ProtectionEquipment	hérité de: ConductingEquipment
1..1	Terminals	0..*	Terminal	hérité de: ConductingEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	hérité de: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	hérité de: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	hérité de: Equipment
0..1	Faults	0..*	Fault	hérité de: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	hérité de: Equipment
0..*	PSRType	0..1	PSRType	hérité de: PowerSystemResource
0..1	Controls	0..*	Control	hérité de: PowerSystemResource
0..1	Measurements	0..*	Measurement	hérité de: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	hérité de: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	hérité de: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.9 Paquetage AuxiliaryEquipment

6.9.1 Généralités

Contient de l'équipement qui n'est pas de l'équipement conducteur normal, comme des capteurs, des localisateurs de défaut et des parafoudres. Ces appareils ne définissent pas de connexions topologiques conductrices de courant comme de l'équipement conducteur, mais ils sont associés aux bornes d'un autre équipement conducteur.

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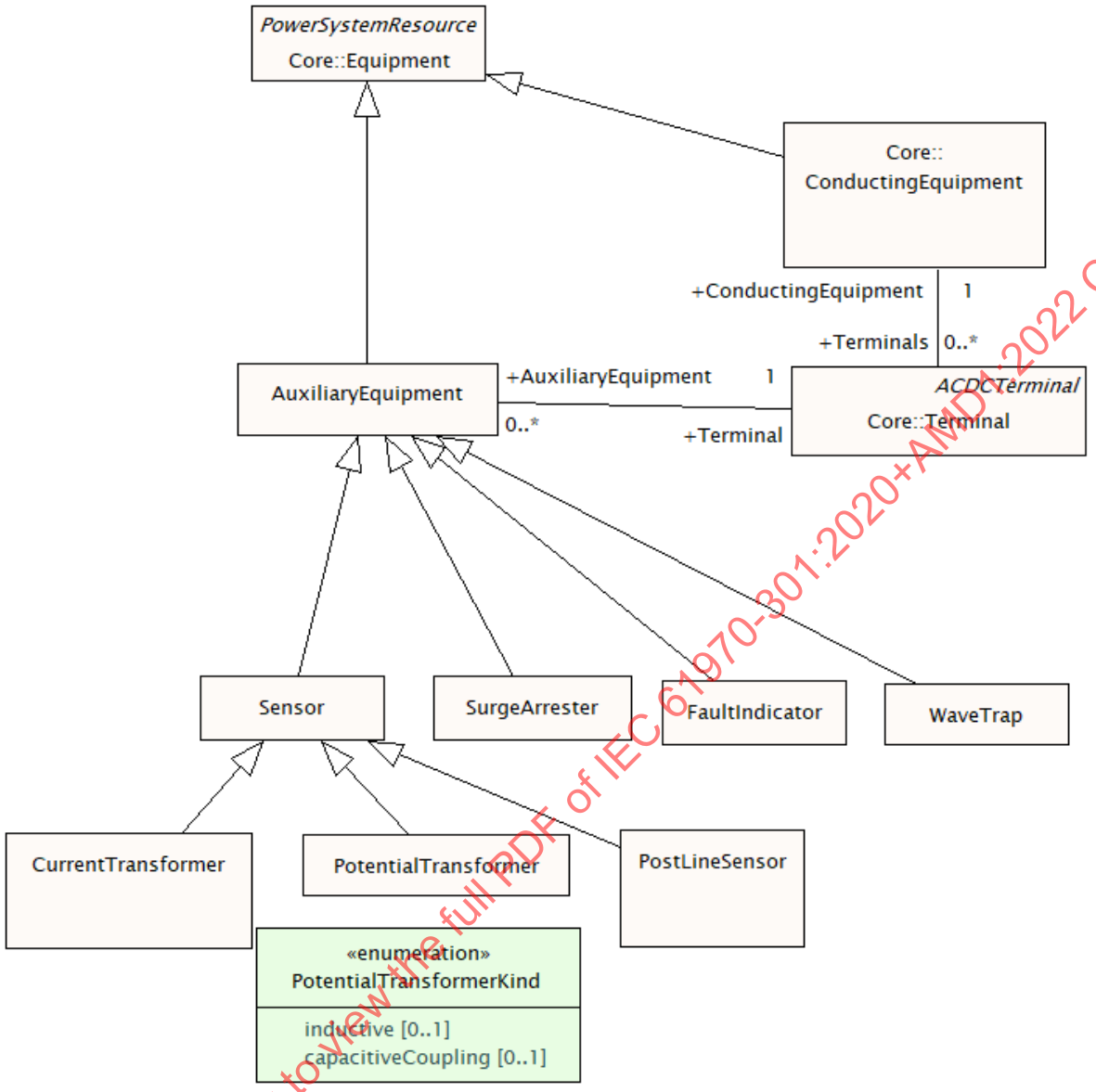


Figure 118 – Diagramme de classe AuxiliaryEquipment::AuxiliaryEquipment

Figure 118: Héritage et associations pour équipement auxiliaire.

6.9.2 AuxiliaryEquipment

AuxiliaryEquipment décrit un équipement qui ne remplit aucune fonction primaire, mais contribue à ce que l'équipement remplisse la fonction primaire.

AuxiliaryEquipment est lié à l'équipement primaire par une association à Terminal.

Le Tableau 543 présente tous les attributs de AuxiliaryEquipment.

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Tableau 543 – Attributs de AuxiliaryEquipment::AuxiliaryEquipment

nom	mult	type	description
aggregate	0..1	Boolean	hérité de: Equipment
inService	0..1	Boolean	hérité de: Equipment
networkAnalysisEnabled	0..1	Boolean	hérité de: Equipment
normallyInService	0..1	Boolean	hérité de: Equipment
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 544 présente toutes les extrémités d'association de AuxiliaryEquipment avec d'autres classes.

Tableau 544 – Extrémités d'association de AuxiliaryEquipment::AuxiliaryEquipment avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..*	Terminal	1..1	Terminal	Borne de l'équipement auquel l'AuxiliaryEquipment est joint.
0..1	OperationalLimitSet	0..*	OperationalLimitSet	hérité de: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	hérité de: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	hérité de: Equipment
0..1	Faults	0..*	Fault	hérité de: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	hérité de: Equipment
0..*	PSRType	0..1	PSRType	hérité de: PowerSystemResource
0..1	Controls	0..*	Control	hérité de: PowerSystemResource
0..1	Measurements	0..*	Measurement	hérité de: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	hérité de: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	hérité de: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.9.3 CurrentTransformer

Transformateur de mesure utilisé pour mesurer des qualités électriques du circuit qui est protégé et/ou surveillé. Généralement utilisé comme transducteur de courant à des fins de comptage ou de protection. Une valeur assignée type du courant secondaire est de 5 A.

Le Tableau 545 présente tous les attributs de CurrentTransformer.

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Tableau 545 – Attributs de AuxiliaryEquipment::CurrentTransformer

nom	mult	type	description
accuracyClass	0..1	String	Classe d'exactitude du transformateur de courant (CT).
accuracyLimit	0..1	PerCent	Pourcentage de courant assigné pour lequel le transformateur de courant reste exact dans les limites spécifiées.
ctClass	0..1	String	Classification du transformateur de courant, c'est-à-dire classe 10P.
usage	0..1	String	Utilisation prévue du transformateur de courant, c'est-à-dire comptage, protection.
coreBurden	0..1	ActivePower	Charge de puissance du noyau du transformateur de courant.
aggregate	0..1	Boolean	hérité de: Equipment
inService	0..1	Boolean	hérité de: Equipment
networkAnalysisEnabled	0..1	Boolean	hérité de: Equipment
normallyInService	0..1	Boolean	hérité de: Equipment
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 546 présente toutes les extrémités d'association de CurrentTransformer avec d'autres classes.

Tableau 546 – Extrémités d'association de AuxiliaryEquipment::CurrentTransformer avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..*	Terminal	1..1	Terminal	hérité de: AuxiliaryEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	hérité de: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	hérité de: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	hérité de: Equipment
0..1	Faults	0..*	Fault	hérité de: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	hérité de: Equipment
0..*	PSRType	0..1	PSRType	hérité de: PowerSystemResource
0..1	Controls	0..*	Control	hérité de: PowerSystemResource
0..1	Measurements	0..*	Measurement	hérité de: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	hérité de: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	hérité de: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

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6.9.4 FaultIndicator

En règle générale, un FaultIndicator est uniquement un indicateur (qui peut ou peut ne pas être surveillé à distance) et non un équipement qui déclenche effectivement un événement de protection. Il est utilisé à des fins de FLISR (Fault Location, Isolation and Supply Restoration – localisation, isolation de pannes et rétablissement de l'alimentation), en portant assistance avec le détachement d'équipes à la partie "la plus vraisemblable" du réseau (c'est-à-dire qu'il aide à déterminer la section de circuit dans laquelle la panne s'est le plus vraisemblablement produite).

Le Tableau 547 présente tous les attributs de FaultIndicator.

Tableau 547 – Attributs de AuxiliaryEquipment::FaultIndicator

nom	mult	type	description
aggregate	0..1	Boolean	hérité de: Equipment
inService	0..1	Boolean	hérité de: Equipment
networkAnalysisEnabled	0..1	Boolean	hérité de: Equipment
normallyInService	0..1	Boolean	hérité de: Equipment
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 548 présente toutes les extrémités d'association de FaultIndicator avec d'autres classes.

Tableau 548 – Extrémités d'association de AuxiliaryEquipment::FaultIndicator avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..*	Terminal	1..1	Terminal	hérité de: AuxiliaryEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	hérité de: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	hérité de: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	hérité de: Equipment
0..1	Faults	0..*	Fault	hérité de: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	hérité de: Equipment
0..*	PSRType	0..1	PSRType	hérité de: PowerSystemResource
0..1	Controls	0..*	Control	hérité de: PowerSystemResource
0..1	Measurements	0..*	Measurement	hérité de: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	hérité de: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	hérité de: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

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6.9.5 PostLineSensor

Capteur principalement utilisé dans les réseaux de distribution aériens pour mesurer à la fois le courant et la tension.

Le Tableau 549 présente tous les attributs de PostLineSensor.

Tableau 549 – Attributs de AuxiliaryEquipment::PostLineSensor

nom	mult	type	description
aggregate	0..1	Boolean	hérité de: Equipment
inService	0..1	Boolean	hérité de: Equipment
networkAnalysisEnabled	0..1	Boolean	hérité de: Equipment
normallyInService	0..1	Boolean	hérité de: Equipment
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 550 présente toutes les extrémités d'association de PostLineSensor avec d'autres classes.

Tableau 550 – Extrémités d'association de AuxiliaryEquipment::PostLineSensor avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..*	Terminal	1..1	Terminal	hérité de: AuxiliaryEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	hérité de: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	hérité de: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	hérité de: Equipment
0..1	Faults	0..*	Fault	hérité de: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	hérité de: Equipment
0..*	PSRType	0..1	PSRType	hérité de: PowerSystemResource
0..1	Controls	0..*	Control	hérité de: PowerSystemResource
0..1	Measurements	0..*	Measurement	hérité de: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	hérité de: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	hérité de: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

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6.9.6 PotentialTransformer

Transformateur de mesure (également appelé "Transformateur de tension") utilisé pour mesurer des qualités électriques du circuit qui est protégé et/ou surveillé. Généralement utilisé comme transducteur de tension à des fins de comptage ou de protection, ou parfois comme alimentation de poste auxiliaire. Une valeur assignée type de la tension secondaire est de 120 V.

Le Tableau 551 présente tous les attributs de PotentialTransformer.

Tableau 551 – Attributs de AuxiliaryEquipment::PotentialTransformer

nom	mult	type	description
accuracyClass	0..1	String	Classe d'exactitude du transformateur de potentiel.
nominalRatio	0..1	Float	Rapport nominal entre la tension primaire et la tension secondaire.
ptClass	0..1	String	Classification du transformateur de potentiel (PT) couvrant la charge.
type	0..1	PotentialTransformerKind	Type de construction du transformateur de potentiel.
aggregate	0..1	Boolean	hérité de: Equipment
inService	0..1	Boolean	hérité de: Equipment
networkAnalysisEnabled	0..1	Boolean	hérité de: Equipment
normallyInService	0..1	Boolean	hérité de: Equipment
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 552 présente toutes les extrémités d'association de PotentialTransformer avec d'autres classes.

Tableau 552 – Extrémités d'association de AuxiliaryEquipment::PotentialTransformer avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..*	Terminal	1..1	Terminal	hérité de: AuxiliaryEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	hérité de: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	hérité de: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	hérité de: Equipment
0..1	Faults	0..*	Fault	hérité de: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	hérité de: Equipment
0..*	PSRType	0..1	PSRType	hérité de: PowerSystemResource
0..1	Controls	0..*	Control	hérité de: PowerSystemResource
0..1	Measurements	0..*	Measurement	hérité de: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	hérité de: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	hérité de: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.9.7 Enumération PotentialTransformerKind

Genre de construction du transformateur de potentiel.

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Le Tableau 553 présente tous les libellés de PotentialTransformerKind.

Tableau 553 – Libellés de AuxiliaryEquipment::PotentialTransformerKind

libellé	value	description
inductive		Le transformateur de potentiel utilise des bobines d'induction pour créer de la tension secondaire.
capacitiveCoupling		Le transformateur de potentiel utilise un couplage capacitif pour créer de la tension secondaire.

6.9.8 Sensor

Cette classe décrit des appareils qui transforment une grandeur mesurée en signaux qui peuvent s'afficher sur un écran, être utilisés pour la commande ou être enregistrés.

Le Tableau 554 présente tous les attributs de Sensor.

Tableau 554 – Attributs de AuxiliaryEquipment::Sensor

nom	mult	type	description
aggregate	0..1	Boolean	hérité de: Equipment
inService	0..1	Boolean	hérité de: Equipment
networkAnalysisEnabled	0..1	Boolean	hérité de: Equipment
normallyInService	0..1	Boolean	hérité de: Equipment
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 555 présente toutes les extrémités d'association de Sensor avec d'autres classes.

Tableau 555 – Extrémités d'association de AuxiliaryEquipment::Sensor avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..*	Terminal	1..1	Terminal	hérité de: AuxiliaryEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	hérité de: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	hérité de: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	hérité de: Equipment
0..1	Faults	0..*	Fault	hérité de: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	hérité de: Equipment
0..*	PSRType	0..1	PSRType	hérité de: PowerSystemResource
0..1	Controls	0..*	Control	hérité de: PowerSystemResource
0..1	Measurements	0..*	Measurement	hérité de: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	hérité de: PowerSystemResource

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mult à partir de	nom	mult vers	type	description
0..*	ReportingGroup	0..*	ReportingGroup	hérité de: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.9.9 SurgeArrester

Appareil shunt, installé sur le réseau, habituellement à proximité de l'équipement électrique, afin de protéger ledit équipement contre les tensions transitoires dues à la foudre ou aux manœuvres.

Le Tableau 556 présente tous les attributs de SurgeArrester.

Tableau 556 – Attributs de AuxiliaryEquipment::SurgeArrester

nom	mult	type	description
aggregate	0..1	Boolean	hérité de: Equipment
inService	0..1	Boolean	hérité de: Equipment
networkAnalysisEnabled	0..1	Boolean	hérité de: Equipment
normallyInService	0..1	Boolean	hérité de: Equipment
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 557 présente toutes les extrémités d'association de SurgeArrester avec d'autres classes.

Tableau 557 – Extrémités d'association de AuxiliaryEquipment::SurgeArrester avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..*	Terminal	1..1	Terminal	hérité de: AuxiliaryEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	hérité de: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	hérité de: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	hérité de: Equipment
0..1	Faults	0..*	Fault	hérité de: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	hérité de: Equipment
0..*	PSRType	0..1	PSRType	hérité de: PowerSystemResource
0..1	Controls	0..*	Control	hérité de: PowerSystemResource
0..1	Measurements	0..*	Measurement	hérité de: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	hérité de: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	hérité de: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject

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mult à partir de	nom	mult vers	type	description
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.9.10 WaveTrap

Les circuits-bouchons sont des appareils qui entravent les signaux porteurs de la ligne électrique haute fréquence tout en présentant une impédance négligeable à la fréquence industrielle principale.

Le Tableau 558 présente tous les attributs de WaveTrap.

Tableau 558 – Attributs de AuxiliaryEquipment::WaveTrap

nom	mult	type	description
aggregate	0..1	Boolean	hérité de: Equipment
inService	0..1	Boolean	hérité de: Equipment
networkAnalysisEnabled	0..1	Boolean	hérité de: Equipment
normallyInService	0..1	Boolean	hérité de: Equipment
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 559 présente toutes les extrémités d'association de WaveTrap avec d'autres classes.

Tableau 559 – Extrémités d'association de AuxiliaryEquipment::WaveTrap avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..*	Terminal	1..1	Terminal	hérité de: AuxiliaryEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	hérité de: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	hérité de: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	hérité de: Equipment
0..1	Faults	0..*	Fault	hérité de: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	hérité de: Equipment
0..*	PSRType	0..1	PSRType	hérité de: PowerSystemResource
0..1	Controls	0..*	Control	hérité de: PowerSystemResource
0..1	Measurements	0..*	Measurement	hérité de: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	hérité de: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	hérité de: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

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6.10 Paquetage Meas

6.10.1 Généralités

Comprend des entités décrivant des données de mesure dynamiques partagées par les applications.

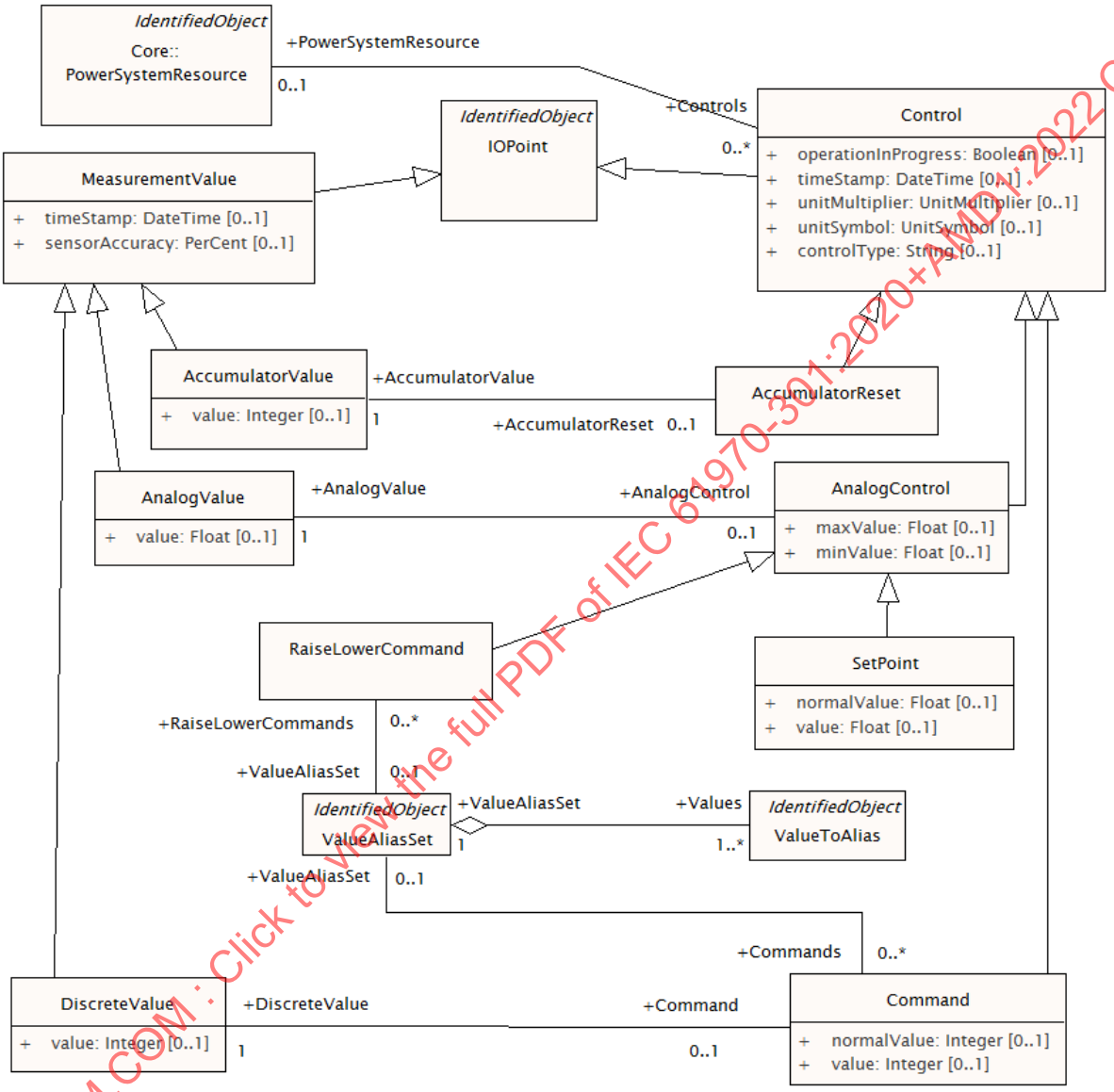


Figure 119 – Diagramme de classe Meas::Control

Figure 119: Ce diagramme représente toutes les classes incluses dans le paquetage Meas.

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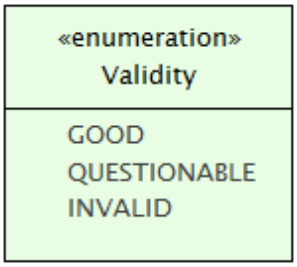
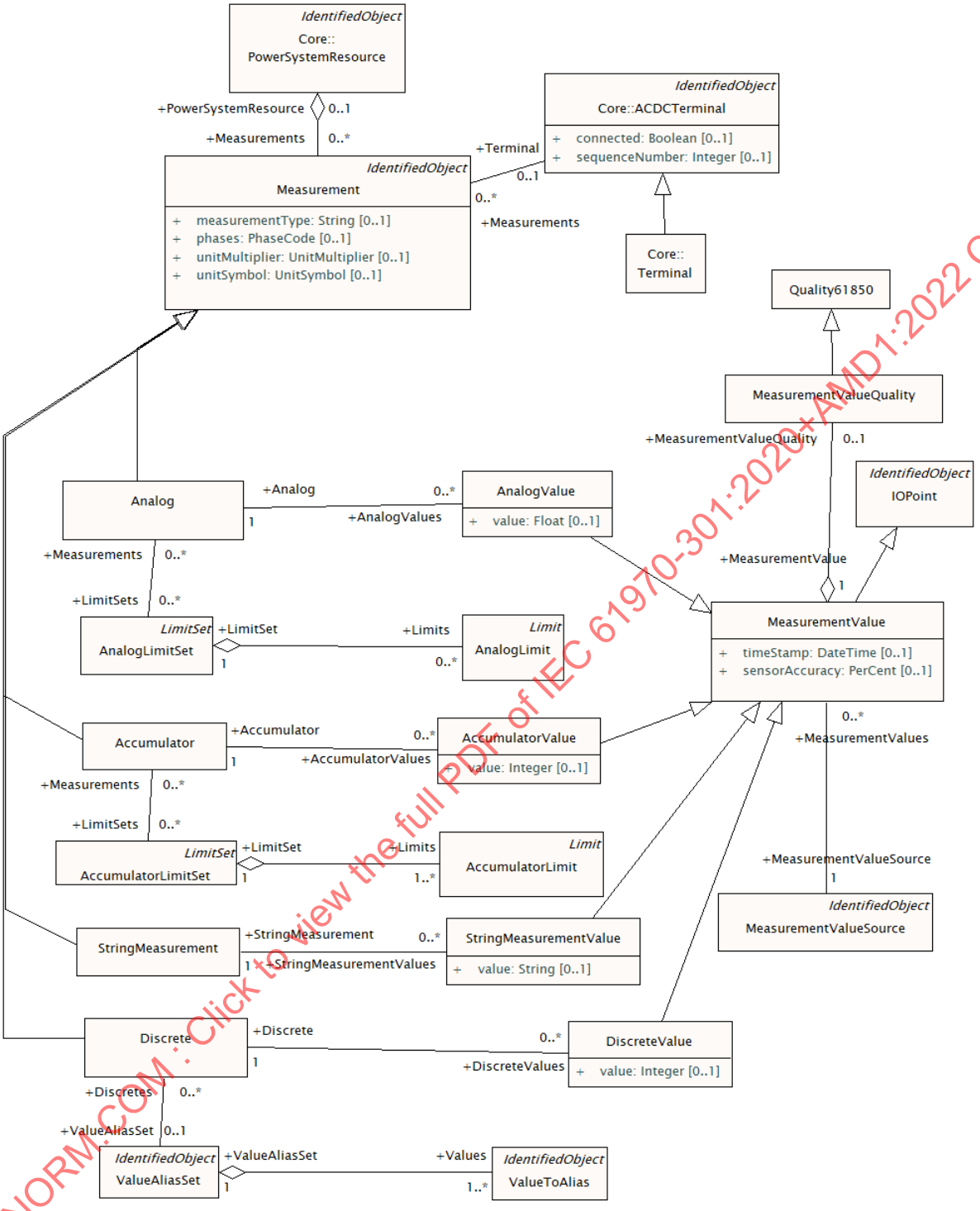


Figure 120 – Diagramme de classe Meas::Datatypes

Figure 120: Représente les types de données pour les Measurements.

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Figure 121 – Diagramme de classe Meas::Measurement

Figure 121: Ce diagramme représente les classes centrales au paquetage Measurement et les connexions à un certain nombre de classes externes.

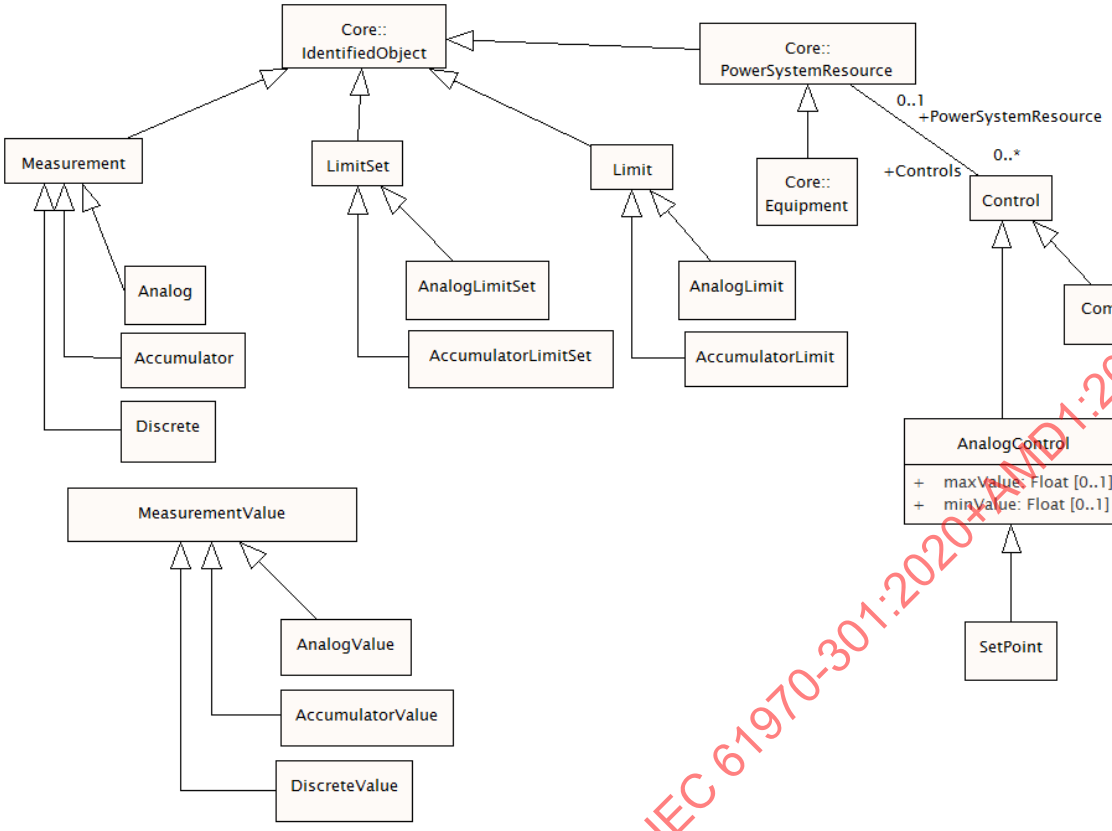


Figure 122 – Diagramme de classe Meas::MeasurementInheritance

Figure 122: Ce diagramme représente l'héritage des classes de mesure.

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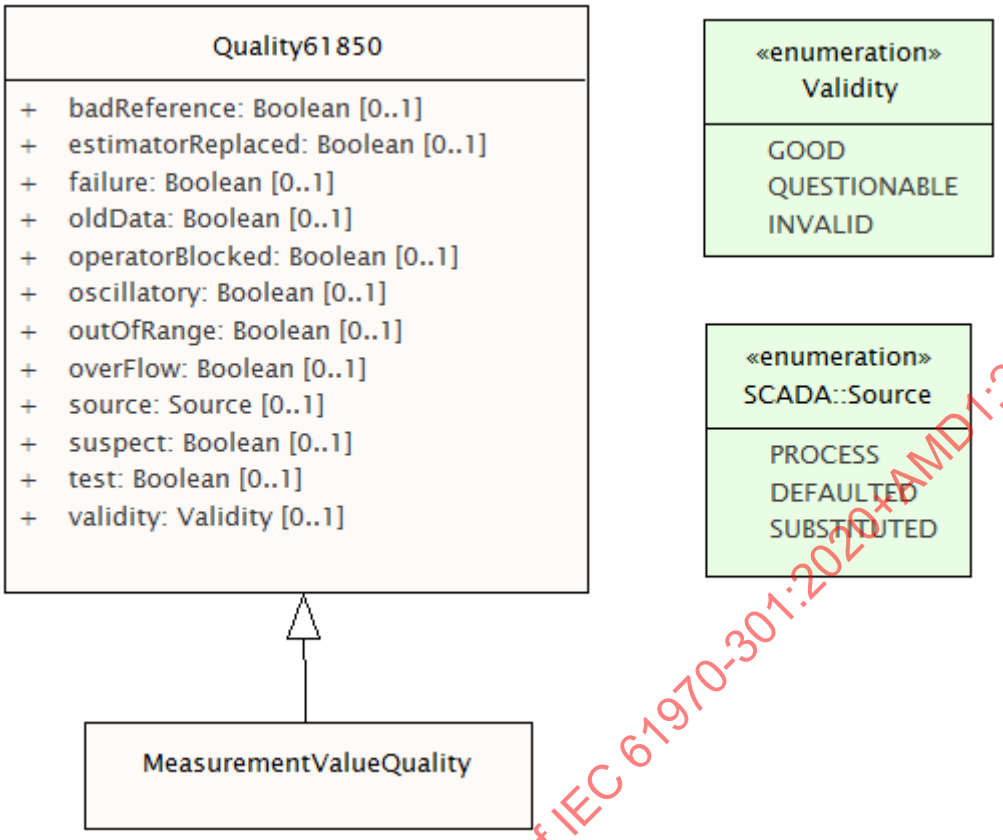


Figure 123 – Diagramme de classe Meas::Quality

Figure 123: Ce diagramme représente le détail des codes de qualité. Les indicateurs de qualité peuvent aussi être utilisés dans d'autres paquetages qui ne sont pas strictement spécifiques à des MeasurementValues. Une classe générique Quality est ajoutée et héritée dans MeasurementValueQuality.

6.10.2 Accumulator

Accumulator (accumulateur) représente un Measurement cumulé (compté), par exemple une valeur d'énergie.

Le Tableau 560 présente tous les attributs de Accumulator.

Tableau 560 – Attributs de Meas::Accumulator

nom	mult	type	description
maxValue	0..1	Integer	Maximum de plage de la valeur normale pour les MeasurementValue.values. Utilisé pour la mise à l'échelle, par exemple dans des graphiques à barres ou pour des valeurs brutes obtenues par télémesure.
measurementType	0..1	String	hérité de: Measurement
phases	0..1	PhaseCode	hérité de: Measurement
unitMultiplier	0..1	UnitMultiplier	hérité de: Measurement
unitSymbol	0..1	UnitSymbol	hérité de: Measurement
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject

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nom	mult	type	description
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 561 présente toutes les extrémités d'association de Accumulator avec d'autres classes.

Tableau 561 – Extrémités d'association de Meas::Accumulator avec d'autres classes

mult à partir de	nom	mult vers	type	description
1..1	AccumulatorValues	0..*	AccumulatorValue	Valeurs connectées à cette mesure.
0..*	LimitSets	0..*	AccumulatorLimitSet	Un Measurement peut avoir zéro ou plusieurs plages de limites qui lui sont propres.
0..*	Terminal	0..1	ACDCTerminal	hérité de: Measurement
0..*	PowerSystemResource	0..1	PowerSystemResource	hérité de: Measurement
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.10.3 AccumulatorLimit

Valeurs limites pour les mesures de l'Accumulator.

Le Tableau 562 présente tous les attributs de AccumulatorLimit.

Tableau 562 – Attributs de Meas::AccumulatorLimit

nom	mult	type	description
value	0..1	Integer	Valeur à ne pas dépasser. La valeur est positive.
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 563 présente toutes les extrémités d'association de AccumulatorLimit avec d'autres classes.

Tableau 563 – Extrémités d'association de Meas::AccumulatorLimit avec d'autres classes

mult à partir de	nom	mult vers	type	description
1..*	LimitSet	1..1	AccumulatorLimitSet	Ensemble de limites.
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

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6.10.4 AccumulatorLimitSet

Un AccumulatorLimitSet spécifie un ensemble de Limits (limites) qui sont associées à une mesure de l'Accumulator.

Le Tableau 564 présente tous les attributs de AccumulatorLimitSet.

Tableau 564 – Attributs de Meas::AccumulatorLimitSet

nom	mult	type	description
isPercentageLimits	0..1	Boolean	hérité de: LimitSet
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 565 présente toutes les extrémités d'association de AccumulatorLimitSet avec d'autres classes.

Tableau 565 – Extrémités d'association de Meas::AccumulatorLimitSet avec d'autres classes

mult à partir de	nom	mult vers	type	description
1..1	Limits	1..*	AccumulatorLimit	Valeurs limites utilisées pour la surveillance des Measurements.
0..*	Measurements	0..*	Accumulator	Measurements utilisant le LimitSet.
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.10.5 AccumulatorReset

Cette commande redéfinit la valeur du compteur sur zéro.

Le Tableau 566 présente tous les attributs de AccumulatorReset.

Tableau 566 – Attributs de Meas::AccumulatorReset

nom	mult	type	description
operationInProgress	0..1	Boolean	hérité de: Control
timeStamp	0..1	DateTime	hérité de: Control
unitMultiplier	0..1	UnitMultiplier	hérité de: Control
unitSymbol	0..1	UnitSymbol	hérité de: Control
controlType	0..1	String	hérité de: Control
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

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Le Tableau 567 présente toutes les extrémités d'association de AccumulatorReset avec d'autres classes.

Tableau 567 – Extrémités d'association de Meas::AccumulatorReset avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..1	AccumulatorValue	1..1	AccumulatorValue	Valeur de l'accumulateur redéfinie par la commande.
0..*	PowerSystemResource	0..1	PowerSystemResource	hérité de: Control
1..1	RemoteControl	0..1	RemoteControl	hérité de: Control
0..1	BilateralToIOPoint	0..*	ProvidedBilateralPoint	hérité de: IOPoint
0..*	IOPointSource	0..1	IOPointSource	hérité de: IOPoint
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.10.6 AccumulatorValue

AccumulatorValue représente une MeasurementValue accumulée (comptée).

Le Tableau 568 présente tous les attributs de AccumulatorValue.

Tableau 568 – Attributs de Meas::AccumulatorValue

nom	mult	type	description
value	0..1	Integer	Valeur à surveiller. La valeur est positive.
timeStamp	0..1	DateTime	hérité de: MeasurementValue
sensorAccuracy	0..1	PerCent	hérité de: MeasurementValue
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 569 présente toutes les extrémités d'association de AccumulatorValue avec d'autres classes.

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Tableau 569 – Extrémités d'association de Meas::AccumulatorValue avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..*	Accumulator	1..1	Accumulator	Measurement auquel cette valeur est connectée.
1..1	AccumulatorReset	0..1	AccumulatorReset	Commande qui redéfinit la valeur de l'accumulateur.
1..1	RemoteSource	0..1	RemoteSource	hérité de: MeasurementValue
1..1	MeasurementValueQuality	0..1	MeasurementValueQuality	hérité de: MeasurementValue
0..*	MeasurementValueSource	1..1	MeasurementValueSource	hérité de: MeasurementValue
0..1	BilateralToIOPoint	0..*	ProvidedBilateralPoint	hérité de: IOPoint
0..*	IOPointSource	0..1	IOPointSource	hérité de: IOPoint
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.10.7 Analog

Analog (analogique) représente un Measurement analogique.

Le Tableau 570 présente tous les attributs de Analog.

Tableau 570 – Attributs de Meas::Analog

nom	mult	type	description
maxValue	0..1	Float	Maximum de plage de la valeur normale pour les MeasurementValue.values. Utilisé pour la mise à l'échelle, par exemple dans des graphiques à barres ou pour des valeurs brutes obtenues par télémesure.
minValue	0..1	Float	Minimum de plage de la valeur normale pour les MeasurementValue.values. Utilisé pour la mise à l'échelle, par exemple dans des graphiques à barres ou pour des valeurs brutes obtenues par télémesure.
normalValue	0..1	Float	Valeur de mesure normale, par exemple utilisée pour des calculs de pourcentages.
positiveFlowIn	0..1	Boolean	Si true (vrai), ce Measurement est une puissance active, une puissance réactive ou un courant selon le principe qu'une valeur positive mesurée sur la Terminal indique que le courant pénètre dans le PowerSystemResource (ressource de système de puissance) correspondant.
measurementType	0..1	String	hérité de: Measurement
phases	0..1	PhaseCode	hérité de: Measurement
unitMultiplier	0..1	UnitMultiplier	hérité de: Measurement
unitSymbol	0..1	UnitSymbol	hérité de: Measurement
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

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Le Tableau 571 présente toutes les extrémités d'association de Analog avec d'autres classes.

Tableau 571 – Extrémités d'association de Meas::Analog avec d'autres classes

mult à partir de	nom	mult vers	type	description
1..1	AnalogValues	0..*	AnalogValue	Valeurs connectées à cette mesure.
0..*	LimitSets	0..*	AnalogLimitSet	Un Measurement peut avoir zéro ou plusieurs plages de limites qui lui sont propres.
0..*	Terminal	0..1	ACDCTerminal	hérité de: Measurement
0..*	PowerSystemResource	0..1	PowerSystemResource	hérité de: Measurement
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.10.8 AnalogControl

Commande analogique utilisée pour la commande de surveillance.

Le Tableau 572 présente tous les attributs de AnalogControl.

Tableau 572 – Attributs de Meas::AnalogControl

nom	mult	type	description
maxValue	0..1	Float	Maximum de plage de la valeur normale pour les Control.values. Utilisé pour la mise à l'échelle, par exemple dans des graphiques à barres.
minValue	0..1	Float	Minimum de plage de la valeur normale pour les Control.values. Utilisé pour la mise à l'échelle, par exemple dans des graphiques à barres.
operationInProgress	0..1	Boolean	hérité de: Control
timeStamp	0..1	DateTime	hérité de: Control
unitMultiplier	0..1	UnitMultiplier	hérité de: Control
unitSymbol	0..1	UnitSymbol	hérité de: Control
controlType	0..1	String	hérité de: Control
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 573 présente toutes les extrémités d'association de AnalogControl avec d'autres classes.

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Tableau 573 – Extrémités d'association de Meas::AnalogControl avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..1	AnalogValue	1..1	AnalogValue	MeasurementValue qui est commandée.
0..*	PowerSystemResource	0..1	PowerSystemResource	hérité de: Control
1..1	RemoteControl	0..1	RemoteControl	hérité de: Control
0..1	BilateralToIOPoint	0..*	ProvidedBilateralPoint	hérité de: IOPoint
0..*	IOPointSource	0..1	IOPointSource	hérité de: IOPoint
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.10.9 AnalogLimit

Valeurs limites pour les mesures Analog (analogiques).

Le Tableau 574 présente tous les attributs de AnalogLimit.

Tableau 574 – Attributs de Meas::AnalogLimit

nom	mult	type	description
value	0..1	Float	Valeur à ne pas dépasser.
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 575 présente toutes les extrémités d'association de AnalogLimit avec d'autres classes.

Tableau 575 – Extrémités d'association de Meas::AnalogLimit avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..*	LimitSet	1..1	AnalogLimitSet	Ensemble de limites.
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.10.10 AnalogLimitSet

Un AnalogLimitSet spécifie un ensemble de Limits (limites) qui sont associées à un Measurement Analog (analogique).

Le Tableau 576 présente tous les attributs de AnalogLimitSet.

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Tableau 576 – Attributs de Meas::AnalogLimitSet

nom	mult	type	description
isPercentageLimits	0..1	Boolean	hérité de: LimitSet
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 577 présente toutes les extrémités d'association de AnalogLimitSet avec d'autres classes.

Tableau 577 – Extrémités d'association de Meas::AnalogLimitSet avec d'autres classes

mult à partir de	nom	mult vers	type	description
1..1	Limits	0..*	AnalogLimit	Valeurs limites utilisées pour la surveillance des Measurements.
0..*	Measurements	0..*	Analog	Measurements utilisant le LimitSet.
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.10.11 AnalogValue

AnalogValue représente une MeasurementValue analogique.

Le Tableau 578 présente tous les attributs de AnalogValue.

Tableau 578 – Attributs de Meas::AnalogValue

nom	mult	type	description
value	0..1	Float	Valeur à surveiller.
timeStamp	0..1	DateTime	hérité de: MeasurementValue
sensorAccuracy	0..1	PerCent	hérité de: MeasurementValue
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 579 présente toutes les extrémités d'association de AnalogValue avec d'autres classes.

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Tableau 579 – Extrémités d'association de Meas::AnalogValue avec d'autres classes

mult à partir de	nom	mult vers	type	description
1..1	AnalogControl	0..1	AnalogControl	Variable de commande associée à la MeasurementValue.
0..*	Analog	1..1	Analog	Measurement auquel cette valeur est connectée.
1..1	AltTieMeas	0..*	AltTieMeas	Utilisation de la mesure dans la spécification de zone de commande.
1..1	AltGeneratingUnit	0..*	AltGeneratingUnitMeas	Unité de production alternative pour laquelle cette valeur de mesure s'applique.
1..1	RemoteSource	0..1	RemoteSource	hérité de: MeasurementValue
1..1	MeasurementValueQuality	0..1	MeasurementValueQuality	hérité de: MeasurementValue
0..*	MeasurementValueSource	1..1	MeasurementValueSource	hérité de: MeasurementValue
0..1	BilateralToIOPoint	0..*	ProvidedBilateralPoint	hérité de: IOPoint
0..*	IOPointSource	0..1	IOPointSource	hérité de: IOPoint
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.10.12 Command

Une Command est une commande discrète utilisée pour la commande de surveillance.

Le Tableau 580 présente tous les attributs de Command.

Tableau 580 – Attributs de Meas::Command

nom	mult	type	description
normalValue	0..1	Integer	Valeur normale de Control.value, utilisée par exemple pour la mise à l'échelle en pourcentage.
value	0..1	Integer	Valeur qui représente la sortie de l'actionneur.
operationInProgress	0..1	Boolean	hérité de: Control
timeStamp	0..1	DateTime	hérité de: Control
unitMultiplier	0..1	UnitMultiplier	hérité de: Control
unitSymbol	0..1	UnitSymbol	hérité de: Control
controlType	0..1	String	hérité de: Control
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 581 présente toutes les extrémités d'association de Command avec d'autres classes.

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Tableau 581 – Extrémités d'association de Meas::Command avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..*	ValueAliasSet	0..1	ValueAliasSet	ValueAliasSet utilisé pour traduire une valeur de Control en un nom.
0..1	DiscreteValue	1..1	DiscreteValue	MeasurementValue qui est commandée.
0..*	PowerSystemResource	0..1	PowerSystemResource	hérité de: Control
1..1	RemoteControl	0..1	RemoteControl	hérité de: Control
0..1	BilateralToIOPoint	0..*	ProvidedBilateralPoint	hérité de: IOPoint
0..*	IOPointSource	0..1	IOPointSource	hérité de: IOPoint
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.10.13 Control

Control est utilisée pour assurer la commande des appareils de surveillance. Elle représente les sorties de commande qui sont utilisées pour changer l'état d'un processus, par exemple ouvrir ou fermer un disjoncteur, une valeur de point de consigne ou une commande augmente/diminue ("raise/lower command").

Le Tableau 582 présente tous les attributs de Control.

Tableau 582 – Attributs de Meas::Control

nom	mult	type	description
operationInProgress	0..1	Boolean	Indique que le client est en train d'émettre des commandes de contrôle et que cette action n'est pas terminée.
timeStamp	0..1	DateTime	Date et heure de la dernière sortie de commande émise.
unitMultiplier	0..1	UnitMultiplier	Multiplicateur d'unité de la grandeur commandée.
unitSymbol	0..1	UnitSymbol	Unité de mesure de la grandeur commandée.
controlType	0..1	String	~~Spécifie le type de Control, par exemple BreakerOn/Off (disjoncteur en service/hors service), GeneratorVoltageSetPoint (point de consigne de tension du générateur), TieLineFlow (flux de ligne d'interconnexion), etc. Le ControlType.name décrit le type et doit être unique parmi tous les types spécifiés.~~ Spécifie le type de Control. Par exemple, ceci spécifie si le Control représente BreakerOpen, BreakerClose, GeneratorVoltageSetPoint, GeneratorRaise, GeneratorLower, etc.
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 583 présente toutes les extrémités d'association de Control avec d'autres classes.

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Tableau 583 – Extrémités d'association de Meas::Control avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..*	PowerSystemResource	0..1	PowerSystemResource	Appareil de régulation régi par cette sortie de commande.
1..1	RemoteControl	0..1	RemoteControl	Point distant commandant l'actionneur physique.
0..1	BilateralToIOPoint	0..*	ProvidedBilateralPoint	hérité de: IOPoint
0..*	IOPointSource	0..1	IOPointSource	hérité de: IOPoint
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.10.14 Discrete

Discrete représente un Measurement discret, c'est-à-dire un Measurement représentant des valeurs discrètes, par exemple une position de Breaker (disjoncteur).

Le Tableau 584 présente tous les attributs de Discrete.

Tableau 584 – Attributs de Meas::Discrete

nom	mult	type	description
maxValue	0..1	Integer	Maximum de plage de la valeur normale pour les MeasurementValue.values. Utilisé pour la mise à l'échelle, par exemple dans des graphiques à barres ou pour des valeurs brutes obtenues par télémesure.
minValue	0..1	Integer	Minimum de plage de la valeur normale pour les MeasurementValue.values. Utilisé pour la mise à l'échelle, par exemple dans des graphiques à barres ou pour des valeurs brutes obtenues par télémesure.
normalValue	0..1	Integer	Valeur de mesure normale, par exemple utilisée pour des calculs de pourcentages.
measurementType	0..1	String	hérité de: Measurement
phases	0..1	PhaseCode	hérité de: Measurement
unitMultiplier	0..1	UnitMultiplier	hérité de: Measurement
unitSymbol	0..1	UnitSymbol	hérité de: Measurement
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 585 présente toutes les extrémités d'association de Discrete avec d'autres classes.

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Tableau 585 – Extrémités d'association de Meas::Discrete avec d'autres classes

mult à partir de	nom	mult vers	type	description
1..1	DiscreteValues	0..*	DiscreteValue	Valeurs connectées à cette mesure.
0..*	ValueAliasSet	0..1	ValueAliasSet	ValueAliasSet utilisé pour traduire une MeasurementValue.value en un nom.
0..*	Terminal	0..1	ACDCTerminal	hérité de: Measurement
0..*	PowerSystemResource	0..1	PowerSystemResource	hérité de: Measurement
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.10.15 DiscreteValue

DiscreteValue représente une MeasurementValue discrète.

Le Tableau 586 présente tous les attributs de DiscreteValue.

Tableau 586 – Attributs de Meas::DiscreteValue

nom	mult	type	description
value	0..1	Integer	Valeur à surveiller.
timeStamp	0..1	DateTime	hérité de: MeasurementValue
sensorAccuracy	0..1	PerCent	hérité de: MeasurementValue
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 587 présente toutes les extrémités d'association de DiscreteValue avec d'autres classes.

Tableau 587 – Extrémités d'association de Meas::DiscreteValue avec d'autres classes

mult à partir de	nom	mult vers	type	description
1..1	Command	0..1	Command	Variable de commande associée à la MeasurementValue.
0..*	Discrete	1..1	Discrete	Measurement auquel cette valeur est connectée.
1..1	RemoteSource	0..1	RemoteSource	hérité de: MeasurementValue
1..1	MeasurementValueQuality	0..1	MeasurementValueQuality	hérité de: MeasurementValue
0..*	MeasurementValueSource	1..1	MeasurementValueSource	hérité de: MeasurementValue
0..1	BilateralToIOPoint	0..*	ProvidedBilateralPoint	hérité de: IOPoint
0..*	IOPointSource	0..1	IOPointSource	hérité de: IOPoint
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject

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mult à partir de	nom	mult vers	type	description
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.10.16 IOPoint

La classe décrit une valeur de mesure ou de commande. Il s'agit de disposer d'attributs et d'associations commun(e)s pour la mesure et la commande.

Le Tableau 588 présente tous les attributs de IOPoint.

Tableau 588 – Attributs de Meas::IOPoint

nom	mult	type	description
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 589 présente toutes les extrémités d'association de IOPoint avec d'autres classes.

Tableau 589 – Extrémités d'association de Meas::IOPoint avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..1	BilateralToIOPoint	0..*	ProvidedBilateralPoint	Point ICCP bilatéral pour la mesure ou la commande.
0..*	IOPointSource	0..1	IOPointSource	Source de valeur de mesure locale pour un point ICCP.
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.10.17 Limit

Spécifie une valeur limite pour un Measurement (mesure). Un Measurement a généralement plusieurs limites qui sont regroupées dans la classe LimitSet. La signification précise et l'usage de l'instance d'un objet Limit ne sont pas donnés par la classe Limit (c'est-à-dire, s'il s'agit d'une alarme, d'un avertissement ou bien d'une limite haute ou basse). Cependant, le nom donné à une instance de Limit peut indiquer à la fois ce qu'elle signifie et son usage.

Le Tableau 590 présente tous les attributs de Limit.

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Tableau 590 – Attributs de Meas::Limit

nom	mult	type	description
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 591 présente toutes les extrémités d'association de Limit avec d'autres classes.

Tableau 591 – Extrémités d'association de Meas::Limit avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.10.18 LimitSet

Spécifie un ensemble de Limits qui sont associées à un Measurement. Un Measurement peut avoir plusieurs LimitSets correspondant à des conditions de changement liées aux saisons ou autres. La condition est traduite dans les attributs name et description. Le même LimitSet peut être partagé entre plusieurs Measurements. En particulier, les limites en pourcentage sont utilisées de cette manière.

Le Tableau 592 présente tous les attributs de LimitSet.

Tableau 592 – Attributs de Meas::LimitSet

nom	mult	type	description
isPercentageLimits	0..1	Boolean	Indique si les valeurs limites sont données en pourcentage de normalValue (valeur normale) ou en Unit (unité) spécifiée pour Measurements et Controls.
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 593 présente toutes les extrémités d'association de LimitSet avec d'autres classes.

Tableau 593 – Extrémités d'association de Meas::LimitSet avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

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6.10.19 Measurement

Un Measurement représente n'importe quelle grandeur mesurée, calculée ou non mesurée non calculée. N'importe quel équipement peut contenir des Measurements, par exemple: un poste peut avoir des mesures de température et des indicateurs d'ouverture de porte, un transformateur peut avoir une mesure de la température d'huile et de la pression de la cuve, une cellule peut contenir un certain nombre de mesures de flux de puissance et un Breaker (disjoncteur) peut contenir une mesure de la position du commutateur.

L'association PSR (Power System Resource – ressource de système de puissance)/Measurement est destinée à traduire cet usage de Measurement et est incluse dans la hiérarchie de dénomination fondée sur EquipmentContainer. La hiérarchie de dénomination a généralement des Measurements comme sous-classes, par exemple: Substation-VoltageLevel-Bay-Switch-Measurement.

Certains Measurements représentent des grandeurs relatives à l'emplacement particulier d'un capteur dans le réseau, par exemple un transformateur de tension (VT) ou de potentiel (PT) sur un jeu de barres ou un transformateur de courant (CT) sur une barre entre un disjoncteur et un isolateur. La position du capteur n'est pas traduite par l'association PSR/Measurement. A l'inverse, elle est traduite dans l'association Measurement/Terminal, qui est utilisée pour définir l'emplacement du capteur dans la topologie du réseau. L'emplacement est défini par le point de connexion entre la Terminal (borne) et le ConductingEquipment (équipement conducteur).

Si une Terminal et un PSR sont tous les deux associés et que le PSR est de type ConductingEquipment, il convient que la Terminal associée appartienne à cette instance ConductingEquipment.

Lorsque l'emplacement du capteur est nécessaire, les associations Measurement/PSR et Measurement/Terminal sont utilisées toutes les deux. L'association Measurement/Terminal n'est jamais utilisée seule.

Le Tableau 594 présente tous les attributs de Measurement.

Tableau 594 – Attributs de Meas::Measurement

nom	mult	type	description
measurementType	0..1	String	Spécifie le type de Measurement. Il spécifie par exemple si le Measurement représente une température intérieure, une température extérieure, la tension de barre, le flux de la ligne, etc. Si le measurementType est défini sur "Specialization", le type de Measurement est défini plus en détail par la classe spécialisée qui hérite de Measurement.
phases	0..1	PhaseCode	Indique à quelles phases s'applique le Measurement et évite la nécessité d'utiliser 'measurementType' pour coder aussi les informations de phase (ce qui multiplierait les types). Les informations de phase dans Measurement, conjointement avec 'measurementType' et 'phases', définissent de façon unique un Measurement pour un appareil, à partir de la phase normale du réseau. Leur signification ne change pas quand le phasage d'excitation calculé est modifié à cause de cavaliers ou pour d'autres raisons. Si l'attribut est manquant, trois phases (ABC) doivent être prises pour hypothèse.
unitMultiplier	0..1	UnitMultiplier	Multiplicateur d'unité de la grandeur mesurée.

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nom	mult	type	description
unitSymbol	0..1	UnitSymbol	Unité de mesure de la grandeur mesurée.
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 595 présente toutes les extrémités d'association de Measurement avec d'autres classes.

Tableau 595 – Extrémités d'association de Meas::Measurement avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..*	Terminal	0..1	ACDCTerminal	Un ou plusieurs Measurements peuvent être associés à une borne du réseau.
0..*	PowerSystemResource	0..1	PowerSystemResource	Ressource du système de puissance qui contient le Measurement.
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.10.20 MeasurementValue

État courant d'un Measurement. La valeur de l'état est une instance d'un Measurement provenant d'une source spécifique. Les Measurements peuvent être associées à différentes valeurs d'état, chacune représentant une source différente pour le Measurement.

Le Tableau 596 présente tous les attributs de MeasurementValue.

Tableau 596 – Attributs de Meas::MeasurementValue

nom	mult	type	description
timeStamp	0..1	DateTime	Date et heure de la dernière mise à jour de la valeur
sensorAccuracy	0..1	PerCent	Limite, exprimée en pourcentage du maximum du capteur, que les erreurs n'excèdent pas lorsque le capteur est utilisé dans les conditions de référence.
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 597 présente toutes les extrémités d'association de MeasurementValue avec d'autres classes.

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Tableau 597 – Extrémités d'association de Meas::MeasurementValue avec d'autres classes

mult à partir de	nom	mult vers	type	description
1..1	RemoteSource	0..1	RemoteSource	Lien avec le point physique de télémesure associé à ce Measurement.
1..1	MeasurementValueQuality	0..1	MeasurementValueQuality	Une MeasurementValue a une MeasurementValueQuality associée.
0..*	MeasurementValueSource	1..1	MeasurementValueSource	Référence au type de source qui met à jour la MeasurementValue, par exemple SCADA, CCLink, manuelle, etc. Les conventions d'utilisateur pour les names des sources sont contenues dans l'introduction à l'IEC 61970-301.
0..1	BilateralToIOPoint	0..*	ProvidedBilateralPoint	hérité de: IOPoint
0..*	IOPointSource	0..1	IOPointSource	hérité de: IOPoint
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.10.21 MeasurementValueQuality

Indicateurs de qualité d'un Measurement. Les bits 0 à 10 sont définis pour l'automatisation de poste dans l'IEC 61850-7-3. Les bits 11 à 15 sont réservés aux compléments futurs d'après ledit document. Les bits 16 à 31 sont réservés aux applications de l'EMS.

Le Tableau 598 présente tous les attributs de MeasurementValueQuality.

Tableau 598 – Attributs de Meas::MeasurementValueQuality

nom	mult	type	description
badReference	0..1	Boolean	hérité de: Quality61850
estimatorReplaced	0..1	Boolean	hérité de: Quality61850
failure	0..1	Boolean	hérité de: Quality61850
oldData	0..1	Boolean	hérité de: Quality61850
operatorBlocked	0..1	Boolean	hérité de: Quality61850
oscillatory	0..1	Boolean	hérité de: Quality61850
outOfRange	0..1	Boolean	hérité de: Quality61850
overFlow	0..1	Boolean	hérité de: Quality61850
source	0..1	Source	hérité de: Quality61850
suspect	0..1	Boolean	hérité de: Quality61850
test	0..1	Boolean	hérité de: Quality61850
validity	0..1	Validity	hérité de: Quality61850

Le Tableau 599 présente toutes les extrémités d'association de MeasurementValueQuality avec d'autres classes.

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Tableau 599 – Extrémités d'association de Meas::MeasurementValueQuality avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..1	MeasurementValue	1..1	MeasurementValue	Une MeasurementValue a une MeasurementValueQuality associée.

6.10.22 MeasurementValueSource

MeasurementValueSource décrit les sources alternatives pour mettre à jour une MeasurementValue. Les conventions d'utilisateur sur la manière d'utiliser les attributs de MeasurementValueSource sont définies dans l'IEC 61970-301.

Le Tableau 600 présente tous les attributs de MeasurementValueSource.

Tableau 600 – Attributs de Meas::MeasurementValueSource

nom	mult	type	description
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 601 présente toutes les extrémités d'association de MeasurementValueSource avec d'autres classes.

Tableau 601 – Extrémités d'association de Meas::MeasurementValueSource avec d'autres classes

mult à partir de	nom	mult vers	type	description
1..1	MeasurementValues	0..*	MeasurementValue	MeasurementValues mises à jour par la source.
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.10.23 Classe racine Quality61850

Les indicateurs de qualité de cette classe sont définis dans l'IEC 61850, à l'exception de estimatorReplaced, qui a été inclus dans cette classe par commodité.

Le Tableau 602 présente tous les attributs de Quality61850.

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Tableau 602 – Attributs de Meas::Quality61850

nom	mult	type	description
badReference	0..1	Boolean	La valeur de Measurement peut être incorrecte à cause d'une référence hors calibre.
estimatorReplaced	0..1	Boolean	La valeur a été remplacée par l'Estimateur d'État (State Estimator). estimatorReplaced n'est pas un bit qualité IEC 61850, mais a été placé dans cette classe par commodité.
failure	0..1	Boolean	Cet identifiant indique qu'une fonction de surveillance a détecté une défaillance interne ou externe, comme une défaillance de communication.
oldData	0..1	Boolean	La valeur de Measurement est ancienne et n'est peut-être pas valide; en effet, elle n'a pas été mise à jour dans un intervalle spécifique.
operatorBlocked	0..1	Boolean	La valeur de Measurement est bloquée et n'est donc pas disponible pour transmission.
oscillatory	0..1	Boolean	Pour prévenir une surcharge des communications, il est raisonnable de détecter et de supprimer les entrées binaires battantes (qui changent très vite). Si un signal change dans un intervalle de temps défini deux fois dans le même sens (de 0 à 1 ou de 1 à 0), alors son caractère battant est détecté et l'indicateur de détail de la qualité "oscillatory" est défini. Si ce cas est détecté, des nombres configurés de changements transitoires ne peuvent pas être pris en compte. Pendant cette période, l'état "questionable" (douteux) de "validity" est défini. Si, après ce nombre défini de changements d'états, le signal est toujours battant, la valeur doit être mise soit dans l'état opposé à la dernière valeur stable, soit à une valeur par défaut prédéfinie. Dans ce cas, l'état "questionable" de "validity" est remplacé par "invalid" aussi longtemps que le signal reste battant. Si, du fait de la configuration, il convient de n'ignorer aucun changement transitoire, "validity" est immédiatement défini sur "invalid" en plus de l'indicateur de qualité de détail "oscillatory" (applicable à l'information de statut uniquement).
outOfRange	0..1	Boolean	La valeur Measurement est au-delà d'une plage de valeurs prédéfinie.
overFlow	0..1	Boolean	La valeur Measurement est au-delà des valeurs susceptibles d'être représentées correctement. Par exemple, une valeur de compteur déborde de la valeur maximale jusqu'à revenir à une valeur nulle.
source	0..1	Source	Source donne des informations relatives à l'origine de la valeur. La valeur peut être acquise du processus, donnée par défaut ou substituée.
suspect	0..1	Boolean	Une fonction de corrélation a détecté que la valeur n'est pas cohérente avec d'autres valeurs. Généralement positionnée par un estimateur d'état (State Estimator) de réseau.
test	0..1	Boolean	La valeur Measurement est transmise à des fins d'essai.
validity	0..1	Validity	Validité de la valeur de Measurement.

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6.10.24 RaiseLowerCommand

Commande analogique qui augmente ou diminue une valeur de point de consigne avec des impulsions. Sauf spécification contraire, une impulsion déplace le point de consigne de un (1).

Le Tableau 603 présente tous les attributs de RaiseLowerCommand.

Tableau 603 – Attributs de Meas::RaiseLowerCommand

nom	mult	type	description
maxValue	0..1	Float	hérité de: AnalogControl
minValue	0..1	Float	hérité de: AnalogControl
operationInProgress	0..1	Boolean	hérité de: Control
timeStamp	0..1	DateTime	hérité de: Control
unitMultiplier	0..1	UnitMultiplier	hérité de: Control
unitSymbol	0..1	UnitSymbol	hérité de: Control
controlType	0..1	String	hérité de: Control
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 604 présente toutes les extrémités d'association de RaiseLowerCommand avec d'autres classes.

Tableau 604 – Extrémités d'association de Meas::RaiseLowerCommand avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..*	ValueAliasSet	0..1	ValueAliasSet	ValueAliasSet utilisé pour traduire une valeur de Control en un nom.
0..1	AnalogValue	1..1	AnalogValue	hérité de: AnalogControl
0..*	PowerSystemResource	0..1	PowerSystemResource	hérité de: Control
1..1	RemoteControl	0..1	RemoteControl	hérité de: Control
0..1	BilateralToIOPoint	0..*	ProvidedBilateralPoint	hérité de: IOPoint
0..*	IOPointSource	0..1	IOPointSource	hérité de: IOPoint
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.10.25 SetPoint

Commande analogique qui émet une valeur de point de consigne.

Le Tableau 605 présente tous les attributs de SetPoint.

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Tableau 605 – Attributs de Meas::SetPoint

nom	mult	type	description
normalValue	0..1	Float	Valeur normale de Control.value, utilisée par exemple pour la mise à l'échelle en pourcentage.
value	0..1	Float	Valeur qui représente la sortie de l'actionneur.
maxValue	0..1	Float	hérité de: AnalogControl
minValue	0..1	Float	hérité de: AnalogControl
operationInProgress	0..1	Boolean	hérité de: Control
timeStamp	0..1	DateTime	hérité de: Control
unitMultiplier	0..1	UnitMultiplier	hérité de: Control
unitSymbol	0..1	UnitSymbol	hérité de: Control
controlType	0..1	String	hérité de: Control
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 606 présente toutes les extrémités d'association de SetPoint avec d'autres classes.

Tableau 606 – Extrémités d'association de Meas::SetPoint avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..1	AnalogValue	1..1	AnalogValue	hérité de: AnalogControl
0..*	PowerSystemResource	0..1	PowerSystemResource	hérité de: Control
1..1	RemoteControl	0..1	RemoteControl	hérité de: Control
0..1	BilateralToIOPoint	0..*	ProvidedBilateralPoint	hérité de: IOPoint
0..*	IOPointSource	0..1	IOPointSource	hérité de: IOPoint
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.10.26 StringMeasurement

StringMeasurement représente un Measurement avec des valeurs de type String (chaîne de caractères).

Le Tableau 607 présente tous les attributs de StringMeasurement.

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Tableau 607 – Attributs de Meas::StringMeasurement

nom	mult	type	description
measurementType	0..1	String	hérité de: Measurement
phases	0..1	PhaseCode	hérité de: Measurement
unitMultiplier	0..1	UnitMultiplier	hérité de: Measurement
unitSymbol	0..1	UnitSymbol	hérité de: Measurement
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 608 présente toutes les extrémités d'association de StringMeasurement avec d'autres classes.

Tableau 608 – Extrémités d'association de Meas::StringMeasurement avec d'autres classes

mult à partir de	nom	mult vers	type	description
1..1	StringMeasurementValues	0..*	StringMeasurementValue	Valeurs connectées à cette mesure.
0..*	Terminal	0..1	ACDCTerminal	hérité de: Measurement
0..*	PowerSystemResource	0..1	PowerSystemResource	hérité de: Measurement
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.10.27 StringMeasurementValue

StringMeasurementValue représente une valeur de mesure de type String (chaîne de caractères).

Le Tableau 609 présente tous les attributs de StringMeasurementValue.

Tableau 609 – Attributs de Meas::StringMeasurementValue

nom	mult	type	description
value	0..1	String	Valeur à surveiller.
timeStamp	0..1	DateTime	hérité de: MeasurementValue
sensorAccuracy	0..1	PerCent	hérité de: MeasurementValue
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 610 présente toutes les extrémités d'association de StringMeasurementValue avec d'autres classes.

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Tableau 610 – Extrémités d'association de Meas::StringMeasurementValue avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..*	StringMeasurement	1..1	StringMeasurement	Measurement auquel cette valeur est connectée.
1..1	RemoteSource	0..1	RemoteSource	hérité de: MeasurementValue
1..1	MeasurementValueQuality	0..1	MeasurementValueQuality	hérité de: MeasurementValue
0..*	MeasurementValueSource	1..1	MeasurementValueSource	hérité de: MeasurementValue
0..1	BilateralToIOPoint	0..*	ProvidedBilateralPoint	hérité de: IOPoint
0..*	IOPointSource	0..1	IOPointSource	hérité de: IOPoint
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.10.28 Enumération Validity

Validité de MeasurementValue.

Le Tableau 611 présente tous les libellés de Validity.

Tableau 611 – Libellés de Meas::Validity

libellé	value	description
GOOD		La valeur est marquée GOOD si aucune condition anormale de la fonction d'acquisition ou de la source d'informations n'est détectée.
QUESTIONABLE		La valeur est marquée QUESTIONABLE si une fonction de surveillance détecte un comportement anormal; cependant, la valeur peut être néanmoins valide. Il est du ressort du client de déterminer s'il convient d'utiliser les valeurs QUESTIONABLE.
INVALID		La valeur est marquée comme INVALID lorsqu'une fonction de surveillance reconnaît des conditions anormales affectant la fonction d'acquisition ou la source d'informations (appareils de mise à jour absents ou non opérationnels). La valeur n'est pas définie dans ces conditions. La marque INVALID permet d'indiquer au client que la valeur peut être incorrecte et qu'elle ne doit pas être utilisée.

6.10.29 ValueAliasSet

Décrit la traduction d'un ensemble de valeurs en un nom et est réputé faciliter les traductions personnalisées. Chaque ValueAliasSet a un nom, une description, etc. Un Measurement spécifique peut représenter un état discret comme Open, Closed, Intermediate, etc. Cela exige une traduction de la valeur numérique MeasurementValue.value en chaîne de caractères, par exemple 0->"Invalid", 1->"Open", 2->"Closed", 3->"Intermediate". Chaque membre ValueToAlias de ValueAliasSet.Value décrit une mise en correspondance entre une valeur particulière et un nom.

Le Tableau 612 présente tous les attributs de ValueAliasSet.

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Tableau 612 – Attributs de Meas::ValueAliasSet

nom	mult	type	description
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 613 présente toutes les extrémités d'association de ValueAliasSet avec d'autres classes.

Tableau 613 – Extrémités d'association de Meas::ValueAliasSet avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..1	Discretes	0..*	Discrete	Measurements utilisant l'ensemble pour la traduction.
1..1	Values	1..*	ValueToAlias	Mises en correspondance de ValueToAlias inclus dans l'ensemble.
0..1	Commands	0..*	Command	Commands utilisant l'ensemble pour la traduction.
0..1	RaiseLowerCommands	0..*	RaiseLowerCommand	Commands utilisant l'ensemble pour la traduction.
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.10.30 ValueToAlias

Décrit la traduction d'une valeur particulière en un nom, par exemple 1 pour "Open".

Le Tableau 614 présente tous les attributs de ValueToAlias.

Tableau 614 – Attributs de Meas::ValueToAlias

nom	mult	type	description
value	0..1	Integer	Valeur mise en correspondance.
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 615 présente toutes les extrémités d'association de ValueToAlias avec d'autres classes.

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Tableau 615 – Extrémités d'association de Meas::ValueToAlias avec d'autres classes

mult à partir de	nom	mult vers	type	description
1..*	ValueAliasSet	1..1	ValueAliasSet	ValueAliasSet ayant les mises en correspondance ValueToAlias.
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.11 Paquetage Topology

6.11.1 Généralités

Extension du paquetage Core qui, associé à la classe Terminal (borne), modélise la Connectivity (connectivité), à savoir la définition physique de la façon dont les équipements sont connectés ensemble. De plus, il modélise la Topology, à savoir la définition logique de la façon dont un équipement est connecté via des commutateurs fermés. La définition de Topology est indépendante des autres caractéristiques électriques.

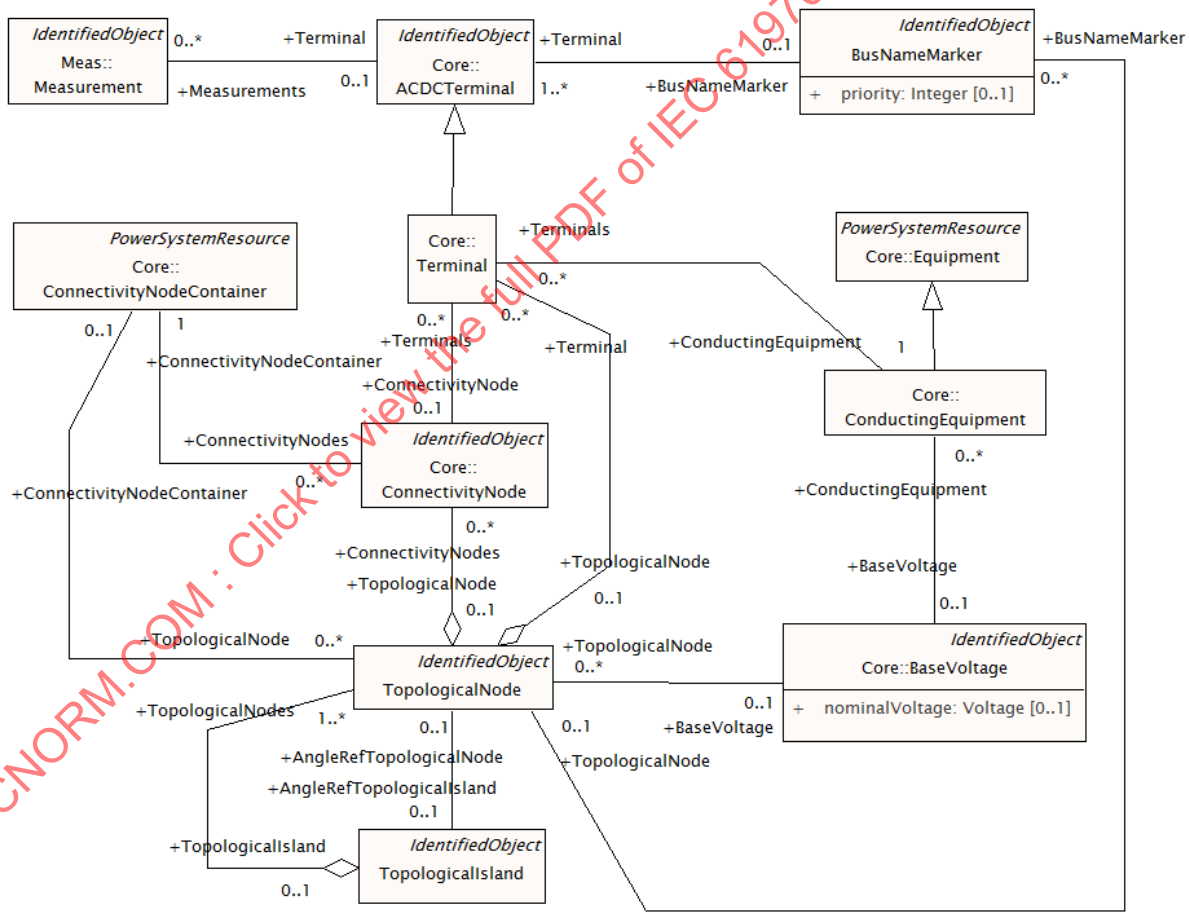


Figure 124 – Diagramme de classe Topology::Main

Figure 124: Ce diagramme représente toutes les classes incluses dans le paquetage Topology, de même que les classes-clés externes, qui ont des associations avec des classes Topology.

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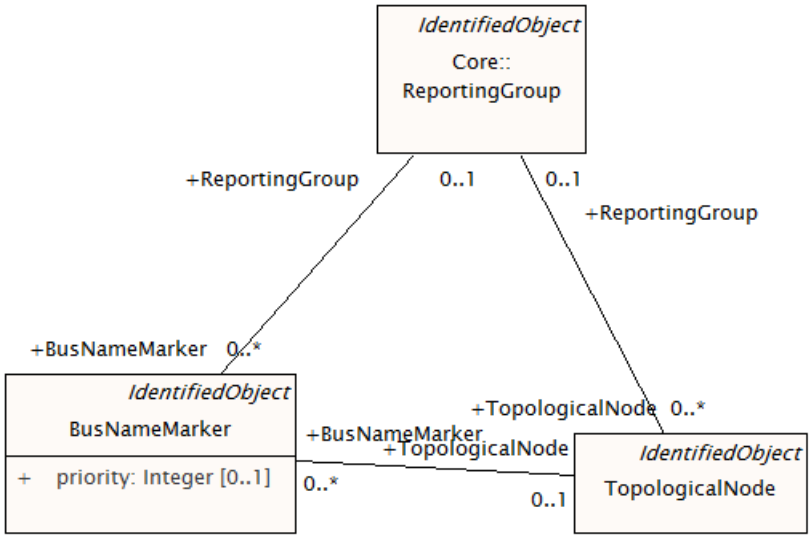


Figure 125 – Diagramme de classe Topology::TopologyReporting

Figure 125: Représente les relations de reporting de topologie.

6.11.2 BusNameMarker

Utilisé pour appliquer les noms normalisés d'utilisateur à des TopologicalNodes. Associé à une ou plusieurs bornes qui sont normalement connectées au nom du bus. Les bornes associées sont normalement reliées par des commutateurs sans retenue. Pour une configuration de poste à barre de transfert en anneau, toutes les bornes BusbarSection dans l'anneau sont généralement associées. Pour un disjoncteur et un demi-schéma, les deux BusbarSections sont normalement associés. Pour une barre de transfert en anneau, tous les BusbarSections sont normalement associés. Pour une configuration "rectiligne" de jeux de barres, seule la borne principale au niveau du BusbarSection est normalement associée.

Le Tableau 616 présente tous les attributs de BusNameMarker.

Tableau 616 – Attributs de Topology::BusNameMarker

nom	mult	type	description
priority	0..1	Integer	Priorité du marqueur de nom de bus pour une utilisation comme nom de bus de topologie. Utiliser 0 pour "don't care" (peu importe). Utiliser 1 pour la plus haute priorité. Utiliser 2 pour une priorité inférieure à 1 et ainsi de suite.
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 617 présente toutes les extrémités d'association de BusNameMarker avec d'autres classes.

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Tableau 617 – Extrémités d'association de Topology::BusNameMarker avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..1	Terminal	1..*	ACDCTerminal	Bornes associées à ce marqueur de nom de bus.
0..*	ReportingGroup	0..1	ReportingGroup	Groupe de reporting auquel appartient ce marqueur de nom de bus.
0..*	TopologicalNode	0..1	TopologicalNode	Nœud topologique défini par l'utilisateur, qui était à l'origine défini dans un modèle de planification ne comportant encore aucune topologie décrite par ConnectivityNodes. Dès la création des ConnectivityNodes, ils peuvent être liés à des ToplogicalNodes définis par l'utilisateur à l'aide de BusNameMarkers.
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.11.3 TopologicalIsland

Sous-ensemble du réseau électriquement connecté. Les îlots topologiques peuvent changer lorsque l'état courant du réseau change, par exemple

– la déconnexion de commutateurs ou de disjoncteurs modifie l'état dans un SCADA/EMS,
– il y a création manuelle, modification ou suppression de nœuds topologiques dans un outil de planification.

Seuls les TopologicalNode-s sous tension doivent faire partie de l'îlot topologique.

Le Tableau 618 présente tous les attributs de TopologicalIsland.

Tableau 618 – Attributs de Topology::TopologicalIsland

nom	mult	type	description
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 619 présente toutes les extrémités d'association de TopologicalIsland avec d'autres classes.

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Tableau 619 – Extrémités d'association de Topology::TopologicalIsland avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..1	AngleRefTopologicalNode	0..1	TopologicalNode	Référence angulaire de l'îlot. Normalement, il y a un TopologicalNode qui est sélectionné comme référence angulaire pour chaque îlot. D'autres schémas de référence existent et, donc, l'association est généralement facultative.
0..1	TopologicalNodes	1..*	TopologicalNode	Un nœud topologique appartient à un îlot topologique.
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.11.4 TopologicalNode

Pour un modèle de poste détaillé, un nœud topologique est un ensemble de nœuds de connectivité qui, dans l'état courant du réseau, sont reliés ensemble par une sorte de commutateurs fermés, y compris des cavaliers. Les nœuds topologiques changent en même temps que l'état courant du réseau change (c'est-à-dire que des commutateurs, des disjoncteurs, etc., modifient l'état).

Pour un modèle de planification, les états des commutateurs ne sont pas utilisés pour former des nœuds topologiques. Au contraire, ils sont créés ou supprimés manuellement dans un outil constructeur de modèle. Les nœuds topologiques conservés de cette manière sont également appelés "bus".

Le Tableau 620 présente tous les attributs de TopologicalNode.

Tableau 620 – Attributs de Topology::TopologicalNode

nom	mult	type	description
pInjection	0..1	ActivePower	Puissance active injectée dans le bus à cet emplacement en plus des injections provenant d'équipements. Un signe positif signifie une injection vers le TopologicalNode (bus). Valeur de départ pour une solution en régime établi.
qInjection	0..1	ReactivePower	Puissance réactive injectée dans le bus à cet emplacement en plus des injections provenant d'équipements. Un signe positif signifie une injection vers le TopologicalNode (bus). Valeur de départ pour une solution en régime établi.
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 621 présente toutes les extrémités d'association de TopologicalNode avec d'autres classes.

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Tableau 621 – Extrémités d'association de Topology::TopologicalNode avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..*	BaseVoltage	0..1	BaseVoltage	Tension de base du nœud topologique.
0..*	ConnectivityNodeContainer	0..1	ConnectivityNodeContainer	Conteneur de nœuds de connectivité auquel le nœud topologique appartient.
0..*	ReportingGroup	0..1	ReportingGroup	Groupe de reporting auquel le nœud topologique appartient.
1..*	TopologicalIsland	0..1	TopologicalIsland	Un nœud topologique appartient à un îlot topologique.
0..1	ConnectivityNodes	0..*	ConnectivityNode	Les nœuds de connectivité se combinent les uns aux autres pour former ce nœud topologique. Peut dépendre de l'état courant des commutateurs dans le réseau.
0..1	Terminal	0..*	Terminal	Les bornes associées au nœud topologique. Ceci peut être utilisé à la place d'un chemin de nœuds de connectivité allant jusqu'à la borne, éliminant donc la nécessité de modéliser les nœuds de connectivité dans certains cas. Noter que si les nœuds de connectivité sont présents dans le modèle, cette association ne serait probablement pas utilisée en tant que spécification d'entrée.
0..1	BusNameMarker	0..*	BusNameMarker	BusnameMarkers qui peut faire référence à un TopologicalNode prédéfini.
0..1	AngleRefTopologicalIsland	0..1	TopologicalIsland	Îlot pour lequel le nœud est une référence angulaire. Normalement, il y a un nœud référence angulaire pour chaque îlot.
1..1	SvInjection	0..*	SvInjection	Variables d'état du flux d'injection associées au nœud topologique.
1..1	SvVoltage	0..*	SvVoltage	État de tension associé au nœud topologique.
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.12 Package DiagramLayout

6.12.1 Généralités

Ce paquetage décrit la présentation du diagramme. Il décrit la manière dont les objets sont disposés dans un système de coordonnées plutôt que la manière dont ils sont rendus.

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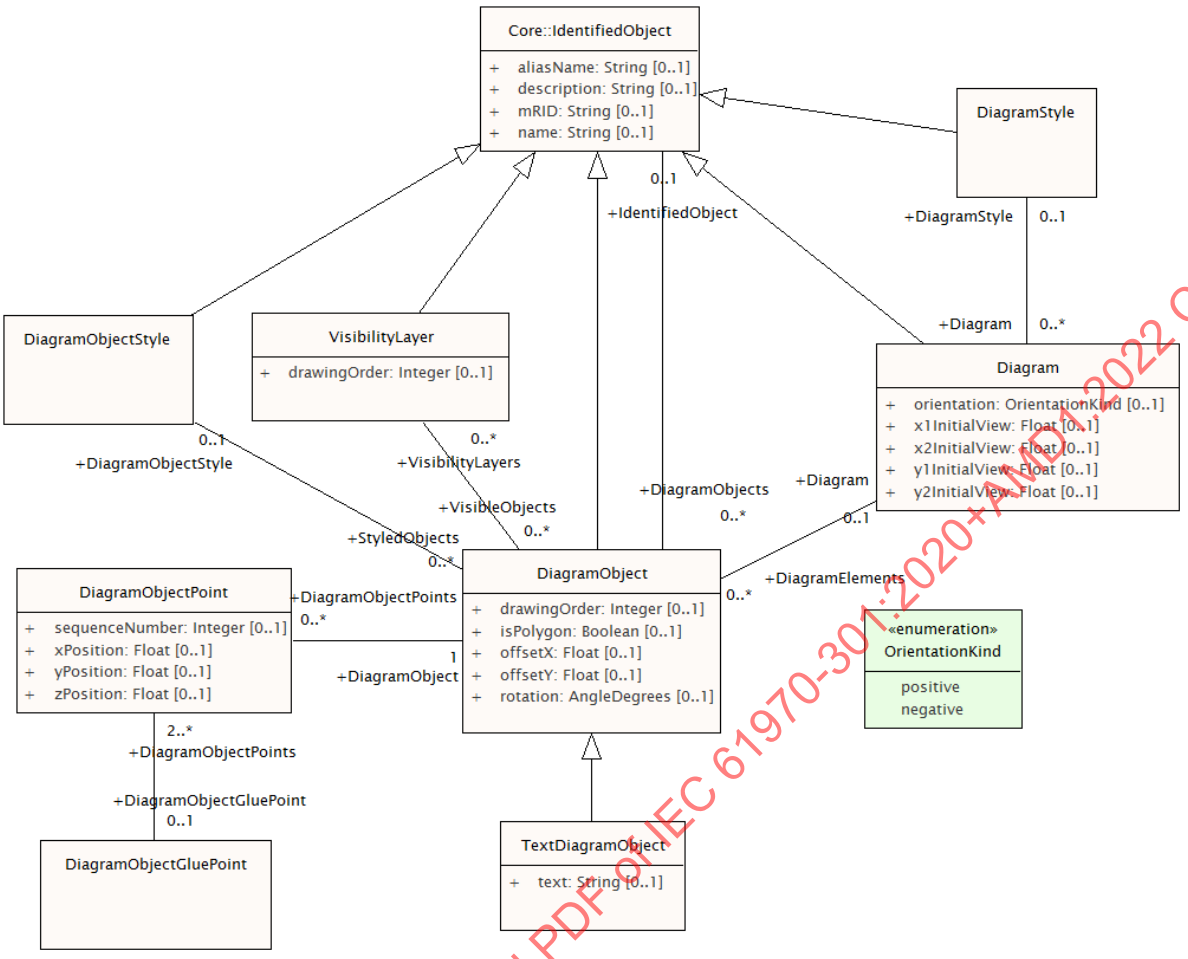


Figure 126 – Diagramme de classe DiagramLayout::DiagramLayout

Figure 126: Présente le modèle de présentation de diagramme.

6.12.2 Diagram

Diagramme échangé. Le système de coordonnées est un système standard de coordonnées cartésiennes et l'attribut Orientation définit l'orientation. Les attributs liés à la vue initiale peuvent être utilisés pour spécifier une vue initiale avec les coordonnées x,y des points sur la diagonale.

Le Tableau 622 présente tous les attributs de Diagram.

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Tableau 622 – Attributs de DiagramLayout::Diagram

nom	mult	type	description
orientation	0..1	OrientationKind	Orientation du système de coordonnées pour le diagramme. Une orientation positive indique l'orientation standard " à droite ", l'orientation négative indiquant une orientation " à gauche ". Pour les diagrammes en 2D, une orientation positive donne lieu à des valeurs X augmentant de la gauche vers la droite et des valeurs Y augmentant du bas vers le haut. Une orientation négative indique l'orientation " à gauche " (privilégiée par les affichages infographiques) avec des valeurs X augmentant de la gauche vers la droite et des valeurs Y augmentant du haut vers le bas
x1InitialView	0..1	Float	Coordonnées X du premier coin de la vue initiale.
x2InitialView	0..1	Float	Coordonnées X du deuxième coin de la vue initiale.
y1InitialView	0..1	Float	Coordonnées Y du premier coin de la vue initiale.
y2InitialView	0..1	Float	Coordonnées Y du deuxième coin de la vue initiale.
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 623 présente toutes les extrémités d'association de Diagram avec d'autres classes.

Tableau 623 – Extrémités d'association de DiagramLayout::Diagram avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..1	DiagramElements	0..*	DiagramObject	Un diagramme est constitué de plusieurs objets de diagramme.
0..*	DiagramStyle	0..1	DiagramStyle	Un Diagram peut avoir un DiagramStyle.
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.12.3 DiagramObject

Objet qui définit un ou plusieurs points dans un espace donné. Cet objet peut être associé à tout ce qui spécialise IdentifiedObject. Pour des schémas unifilaires, ces objets comprennent généralement des éléments comme des valeurs analogiques, des disjoncteurs, des sectionneurs, des transformateurs de puissance et des lignes de transport.

Le Tableau 624 présente tous les attributs de DiagramObject.

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Tableau 624 – Attributs de DiagramLayout::DiagramObject

nom	mult	type	description
drawingOrder	0..1	Integer	Ordre de dessin dans cet élément. Plus le nombre est élevé, plus l'élément est dessiné tard dans la séquence. Il est utilisé pour vérifier que les éléments qui se chevauchent sont rendus dans le bon ordre.
isPolygon	0..1	Boolean	Définit si les points des objets du diagramme définissent ou non les limites d'un polygone ou le tracé d'une polyligne. Si cette valeur est vraie, il convient que l'application de réception prenne en compte le premier et le dernier point à connecter.
offsetX	0..1	Float	Décalage en direction X. Il sert à définir le décalage depuis le centre pour le rendu d'une icône (par défaut un point unique spécifie le centre de l'icône). Le décalage est exprimé par unité, 0 indique qu'il n'y a aucun décalage à partir du centre horizontal de l'icône. -0,5 indique que le décalage est de 50 % vers la gauche et 0,5 indique un décalage de 50 % vers la droite.
offsetY	0..1	Float	Décalage en direction Y. Il sert à définir le décalage depuis le centre pour le rendu d'une icône (par défaut un point unique spécifie le centre de l'icône). Le décalage est exprimé par unité, 0 indique qu'il n'y a aucun décalage à partir du centre vertical de l'icône. La direction du décalage dépend de l'orientation du diagramme, -0,5 et 0,5 indiquent un décalage de +/- 50 % sur l'axe vertical.
rotation	0..1	AngleDegrees	Définit l'angle de rotation de l'objet de diagramme. Zéro degré signifie que l'axe se dirige vers le haut du diagramme. La rotation s'effectue dans le sens des aiguilles d'une montre. La signification de DiagramObject.rotation=0 est la suivante: Le point de connexion d'un élément qui a une borne pointe vers le haut du diagramme. Le point de connexion "From side" (Depuis le côté) d'un élément qui a plusieurs bornes pointe vers le haut du diagramme. La signification de DiagramObject.rotation=90 est la suivante: Le point de connexion d'un élément qui a une borne pointe vers le côté droit du diagramme. Le point de connexion "From side" 'Depuis le côté) d'un élément qui a plusieurs bornes pointe vers le côté droit du diagramme.
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 625 présente toutes les extrémités d'association de DiagramObject avec d'autres classes.

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Tableau 625 – Extrémités d'association de DiagramLayout::DiagramObject avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..*	Diagram	0..1	Diagram	Un objet de diagramme fait partie d'un diagramme.
0..*	VisibilityLayers	0..*	VisibilityLayer	Un objet de diagramme peut faire partie de plusieurs couches de visibilité.
1..1	DiagramObjectPoints	0..*	DiagramObjectPoint	Un objet de diagramme peut avoir 0 ou plusieurs points pour refléter la position de sa présentation, son tracé (pour des polylignes) ou sa limite (pour des polygones).
0..*	DiagramObjectStyle	0..1	DiagramObjectStyle	Un objet de diagramme a un style associé qui fournit une référence pour le style utilisé dans le système d'origine.
0..*	IdentifiedObject	0..1	IdentifiedObject	Objet de domaine auquel est associé cet objet de diagramme.
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.12.4 Classe racine DiagramObjectGluePoint

Celle-ci est utilisée pour regrouper des points d'un objet de diagramme à partir de différents objets de diagramme qui sont considérés comme indissociables l'un de l'autre ("collés") dans un diagramme, même s'ils ne se trouvent pas exactement aux mêmes coordonnées.

Le Tableau 626 présente toutes les extrémités d'association de DiagramObjectGluePoint avec d'autres classes.

Tableau 626 – Extrémités d'association de DiagramLayout::DiagramObjectGluePoint avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..1	DiagramObjectPoints	2..*	DiagramObjectPoint	Un point de collage d'un objet de diagramme est associé à 2 points d'objet ou davantage qui sont considérés comme collés l'un à l'autre.

6.12.5 Classe racine DiagramObjectPoint

Un point dans un espace donné défini par 3 coordonnées et associé à un objet de diagramme. Les coordonnées peuvent être positives ou négatives puisque l'origine ne se trouve pas nécessairement dans le coin d'un diagramme.

Le Tableau 627 présente tous les attributs de DiagramObjectPoint.

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Tableau 627 – Attributs de DiagramLayout::DiagramObjectPoint

nom	mult	type	description
sequenceNumber	0..1	Integer	La position séquentielle du point, utilisée pour définir l'ordre des points pour des objets de diagramme qui forment une polyligne ou un polygone ayant plus d'un point. La valeur de l'attribut doit être positive.
xPosition	0..1	Float	Coordonnée X de ce point.
yPosition	0..1	Float	Coordonnée Y de ce point.
zPosition	0..1	Float	Coordonnée Z de ce point.

Le Tableau 628 présente toutes les extrémités d'association de DiagramObjectPoint avec d'autres classes.

Tableau 628 – Extrémités d'association de DiagramLayout::DiagramObjectPoint avec d'autres classes

mult à partir de	nom	mult vers	type	description
2..*	DiagramObjectGluePoint	0..1	DiagramObjectGluePoint	Point de collage auquel est associé ce point.
0..*	DiagramObject	1..1	DiagramObject	Objet de diagramme auquel sont associés les points.

6.12.6 DiagramObjectStyle

Référence à un style utilisé par le système d'origine pour un objet de diagramme. Un style d'objet de diagramme décrit des informations comme l'épaisseur de la ligne, la forme, comme un cercle ou un rectangle, etc., et la couleur.

Le Tableau 629 présente tous les attributs de DiagramObjectStyle.

Tableau 629 – Attributs de DiagramLayout::DiagramObjectStyle

nom	mult	type	description
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 630 présente toutes les extrémités d'association de DiagramObjectStyle avec d'autres classes.

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Tableau 630 – Extrémités d'association de DiagramLayout::DiagramObjectStyle avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..1	StyledObjects	0..*	DiagramObject	Un style peut être attribué à plusieurs objets de diagramme.
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.12.7 DiagramStyle

Le style de diagramme fait référence à un style utilisé par le système d'origine pour un diagramme. Un style de diagramme décrit des informations telles que les informations schématiques, géographiques, etc.

Le Tableau 631 présente tous les attributs de DiagramStyle.

Tableau 631 – Attributs de DiagramLayout::DiagramStyle

nom		mult	type	description
aliasName		0..1	String	hérité de: IdentifiedObject
description		0..1	String	hérité de: IdentifiedObject
mRID		0..1	String	hérité de: IdentifiedObject
name		0..1	String	hérité de: IdentifiedObject

Le Tableau 632 présente toutes les extrémités d'association de DiagramStyle avec d'autres classes.

Tableau 632 – Extrémités d'association de DiagramLayout::DiagramStyle avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..1	Diagram	0..*	Diagram	Un DiagramStyle peut être utilisé par plusieurs Diagrams.
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.12.8 Enumération OrientationKind

L'orientation du système de coordonnées par rapport au sommet, à la gauche et au système de numérotation des coordonnées.

Le Tableau 633 présente tous les libellés de OrientationKind.

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Tableau 633 – Libellés de DiagramLayout::OrientationKind

libellé	value	description
positive		Pour des diagrammes en 2D, une orientation positive implique que les valeurs X croissent de la gauche vers la droite et les valeurs Y croissent du bas vers le haut. Cette orientation est également appelée orientation à droite.
negative		Pour des diagrammes en 2D, une orientation négative donne une orientation à gauche (tel que se présente généralement l'affichage graphique sur ordinateur), les valeurs X croissent de la gauche vers la droite et les valeurs Y croissent du haut vers le bas. Cette orientation est également appelée orientation à gauche.

6.12.9 TextDiagramObject

Un objet de diagramme pour placer un texte libre ou un texte dérivé d'un objet de domaine associé.

Le Tableau 634 présente tous les attributs de TextDiagramObject.

Tableau 634 – Attributs de DiagramLayout::TextDiagramObject

nom	mult	type	description
text	0..1	String	Texte qui est affiché par cet objet de diagramme de texte.
drawingOrder	0..1	Integer	hérité de: DiagramObject
isPolygon	0..1	Boolean	hérité de: DiagramObject
offsetX	0..1	Float	hérité de: DiagramObject
offsetY	0..1	Float	hérité de: DiagramObject
rotation	0..1	AngleDegrees	hérité de: DiagramObject
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 635 présente toutes les extrémités d'association de TextDiagramObject avec d'autres classes.

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Tableau 635 – Extrémités d'association de DiagramLayout::TextDiagramObject avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..*	Diagram	0..1	Diagram	hérité de: DiagramObject
0..*	VisibilityLayers	0..*	VisibilityLayer	hérité de: DiagramObject
1..1	DiagramObjectPoints	0..*	DiagramObjectPoint	hérité de: DiagramObject
0..*	DiagramObjectStyle	0..1	DiagramObjectStyle	hérité de: DiagramObject
0..*	IdentifiedObject	0..1	IdentifiedObject	hérité de: DiagramObject
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.12.10 VisibilityLayer

Les couches sont généralement utilisées pour regrouper des objets de diagramme d'après des thèmes et des échelles. Les thèmes sont utilisés pour afficher ou masquer certaines informations (par exemple des lacs, des frontières) tandis que les échelles sont utilisées pour masquer ou afficher des informations qui dépendent du niveau réel de zoom (masquer le texte quand il est trop petit pour être lisible ou quand il dépasse la taille de l'écran). Cela s'appelle également la mise au net.

L'échange de graphique fondé sur le CIM prend en charge une relation m:n entre les objets de diagramme et les couches. Il est du ressort du système d'importation de convertir un cas m:n en représentation 1:n appropriée si le système d'importation ne prend pas en charge m:n.

Le Tableau 636 présente tous les attributs de VisibilityLayer.

Tableau 636 – Attributs de DiagramLayout::VisibilityLayer

nom	mult	type	description
drawingOrder	0..1	Integer	Ordre de dessin pour cette couche. Plus le nombre est grand, plus la couche et les objets qui s'y trouvent sont rendus tard.
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 637 présente toutes les extrémités d'association de VisibilityLayer avec d'autres classes.

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Tableau 637 – Extrémités d'association de DiagramLayout::VisibilityLayer avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..*	VisibleObjects	0..*	DiagramObject	Une couche de visibilité peut contenir un ou plusieurs objets de diagramme.
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.13 Paquetage OperationalLimits

6.13.1 Généralités

Ce paquetage modélise une spécification des limites associées à des entités d'équipement et à d'autres entités opérationnelles.

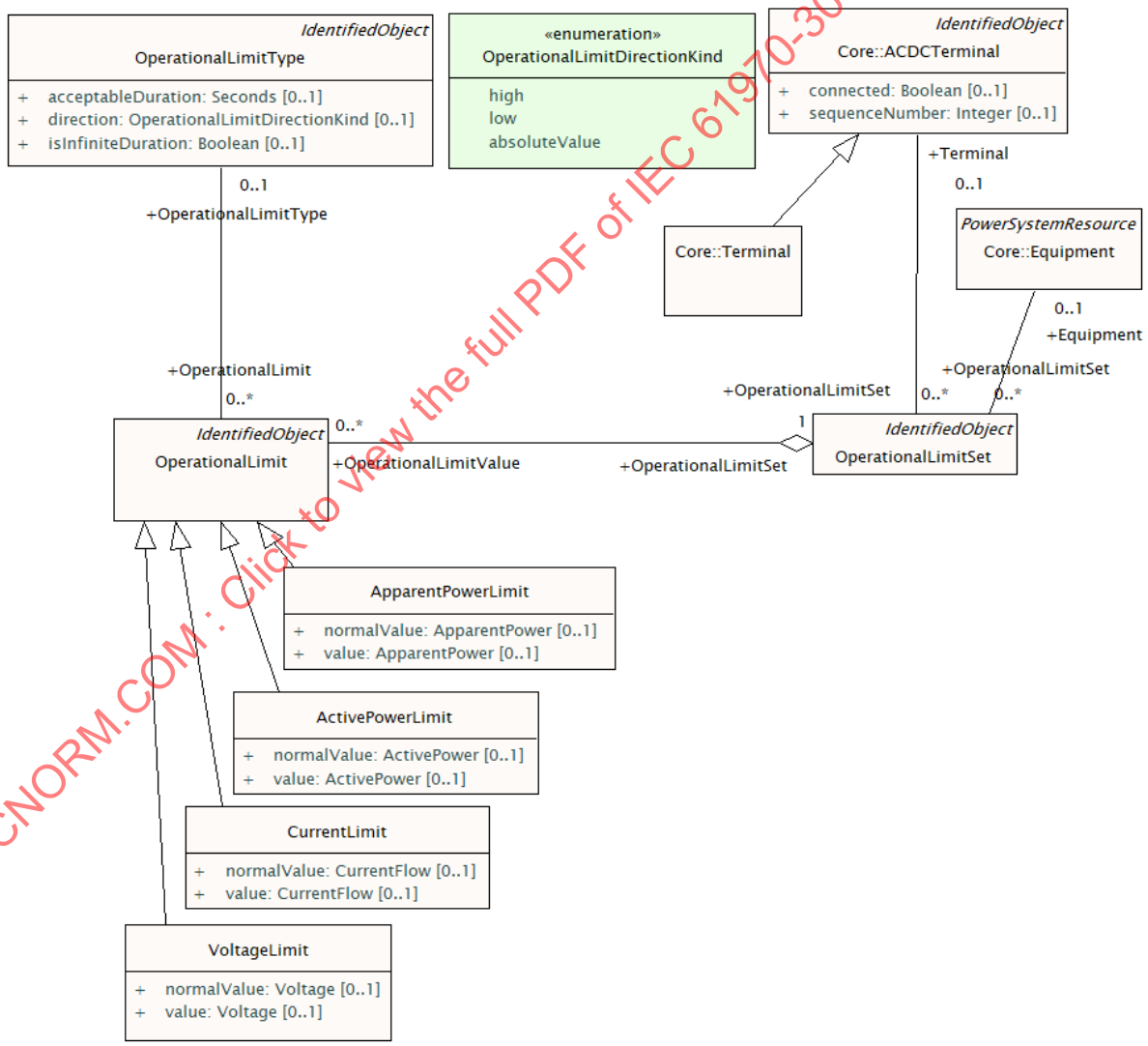


Figure 127 – Diagramme de classe OperationalLimits::OperationalLimits

Figure 127: Ce diagramme représente les limites opérationnelles telles qu'elles se rattachent dans le modèle central.

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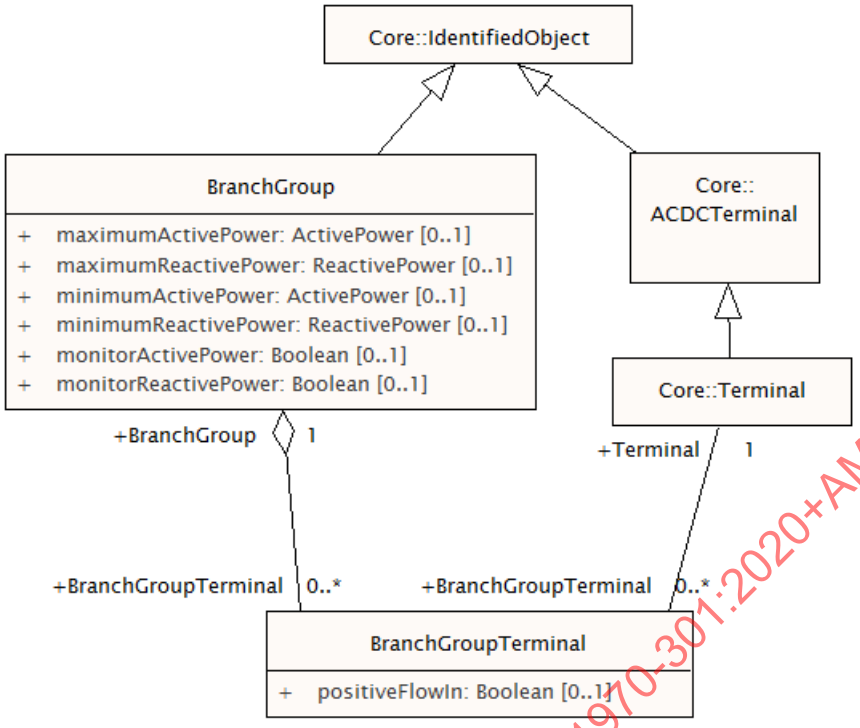


Figure 128 – Diagramme de classe OperationalLimits::BranchGroup

Figure 128: Ce diagramme représente le modèle pour contrôler des flux combinés sur des groupes de branches.

6.13.2 ActivePowerLimit

Limite sur le flux de puissance active.

Le Tableau 638 présente tous les attributs de ActivePowerLimit.

Tableau 638 – Attributs de OperationalLimits::ActivePowerLimit

nom	mult	type	description
normalValue	0..1	ActivePower	Valeur normale de la limite de puissance active. La valeur de l'attribut doit être positive ou égale à zéro.
value	0..1	ActivePower	Valeur de la limite de puissance active. La valeur de l'attribut doit être positive ou égale à zéro.
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 639 présente toutes les extrémités d'association de ActivePowerLimit avec d'autres classes.

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Tableau 639 – Extrémités d'association de OperationalLimits::ActivePowerLimit avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..*	OperationalLimitSet	1..1	OperationalLimitSet	hérité de: OperationalLimit
0..*	OperationalLimitType	0..1	OperationalLimitType	hérité de: OperationalLimit
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.13.3 ApparentPowerLimit

Limite de puissance apparente.

Le Tableau 640 présente tous les attributs de ApparentPowerLimit.

Tableau 640 – Attributs de OperationalLimits::ApparentPowerLimit

nom	mult	type	description
normalValue	0..1	ApparentPower	Limite de puissance apparente normale. La valeur de l'attribut doit être positive ou égale à zéro.
value	0..1	ApparentPower	Limite de puissance apparente. La valeur de l'attribut doit être positive ou égale à zéro.
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 641 présente toutes les extrémités d'association de ApparentPowerLimit avec d'autres classes.

Tableau 641 – Extrémités d'association de OperationalLimits::ApparentPowerLimit avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..*	OperationalLimitSet	1..1	OperationalLimitSet	hérité de: OperationalLimit
0..*	OperationalLimitType	0..1	OperationalLimitType	hérité de: OperationalLimit
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.13.4 BranchGroup

Groupe de bornes de branches dont la sommation des flux orientés doit être surveillée. Il n'est pas nécessaire qu'un groupe de branches forme un ensemble de coupure du réseau.

Le Tableau 642 présente tous les attributs de BranchGroup.

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Tableau 642 – Attributs de OperationalLimits::BranchGroup

nom	mult	type	description
maximumActivePower	0..1	ActivePower	Flux maximal de puissance active.
maximumReactivePower	0..1	ReactivePower	Flux maximal de puissance réactive.
minimumActivePower	0..1	ActivePower	Flux minimal de puissance active.
minimumReactivePower	0..1	ReactivePower	Flux minimal de puissance réactive.
monitorActivePower	0..1	Boolean	Surveiller le flux de puissance active.
monitorReactivePower	0..1	Boolean	Surveiller le flux de puissance réactive.
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 643 présente toutes les extrémités d'association de BranchGroup avec d'autres classes.

Tableau 643 – Extrémités d'association de OperationalLimits::BranchGroup avec d'autres classes

mult à partir de	nom	mult vers	type	description
1..1	BranchGroupTerminal	0..*	BranchGroupTerminal	Bornes de groupe de branches orientées devant être sommées.
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.13.5 Classe racine BranchGroupTerminal

Flux spécifique de bornes orienté pour un groupe de branches.

Le Tableau 644 présente tous les attributs de BranchGroupTerminal.

Tableau 644 – Attributs de OperationalLimits::BranchGroupTerminal

nom	mult	type	description
positiveFlowIn	0..1	Boolean	S'il est défini sur true (vrai), le flux pénétrant dans la borne est sommé. S'il est défini sur false (faux), le flux sortant de la borne est sommé.

Le Tableau 645 présente toutes les extrémités d'association de BranchGroupTerminal avec d'autres classes.

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Tableau 645 – Extrémités d'association de OperationalLimits::BranchGroupTerminal avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..*	Terminal	1..1	Terminal	Borne devant être sommée.
0..*	BranchGroup	1..1	BranchGroup	Groupe de branches auquel appartiennent les bornes de groupe de branches orientées.

6.13.6 CurrentLimit

Limite opérationnelle sur le courant.

Le Tableau 646 présente tous les attributs de CurrentLimit.

Tableau 646 – Attributs de OperationalLimits::CurrentLimit

nom	mult	type	description
normalValue	0..1	CurrentFlow	Valeur normale de la limite sur le flux de courant. La valeur de l'attribut doit être positive ou égale à zéro.
value	0..1	CurrentFlow	Limite sur le flux de courant. La valeur de l'attribut doit être positive ou égale à zéro.
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 647 présente toutes les extrémités d'association de CurrentLimit avec d'autres classes.

Tableau 647 – Extrémités d'association de OperationalLimits::CurrentLimit avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..*	OperationalLimitSet	1..1	OperationalLimitSet	hérité de: OperationalLimit
0..*	OperationalLimitType	0..1	OperationalLimitType	hérité de: OperationalLimit
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.13.7 OperationalLimit

Valeur normale et valeur associée à une sorte spécifique de limite.

Les attributs de valeur de sous-classe et de normalValue varient inversement à la OperationalLimitType.acceptableDuration (acceptableDuration en abrégé) associée.

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Si une partie spécifique de l'équipement comporte plusieurs limites opérationnelles de la même sorte (puissance apparente, courant, etc.), la limite présentant la plus grande acceptableDuration doit présenter la plus petite valeur limite et la limite présentant la plus petite acceptableDuration doit présenter la plus grande valeur limite. Note: Seul un courant de forte intensité peut s'écouler dans une partie de l'équipement pendant une courte durée sans provoquer de dommage. En revanche, un courant de moins forte intensité peut s'écouler pendant une durée plus longue.

Le Tableau 648 présente tous les attributs de OperationalLimit.

Tableau 648 – Attributs de OperationalLimits::OperationalLimit

nom	mult	type	description
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 649 présente toutes les extrémités d'association de OperationalLimit avec d'autres classes.

Tableau 649 – Extrémités d'association de OperationalLimits::OperationalLimit avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..*	OperationalLimitSet	1..1	OperationalLimitSet	Jeu de limites auquel les valeurs limites appartiennent.
0..*	OperationalLimitType	0..1	OperationalLimitType	Le type de limite associé à cette limite.
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.13.8 Enumération OperationalLimitDirectionKind

L'attribut de sens décrit le côté d'une limite qui constitue une infraction.

Le Tableau 650 présente tous les libellés de OperationalLimitDirectionKind.

Tableau 650 – Libellés de OperationalLimits::OperationalLimitDirectionKind

libellé	value	description
high		"High" signifie qu'une valeur surveillée supérieure à la valeur limite constitue une infraction. Si elle est appliquée au flux d'une borne, le sens positif est celui pénétrant dans la borne.
low		"Low" signifie qu'une valeur surveillée inférieure à la valeur limite constitue une infraction. Si elle est appliquée au flux d'une borne, le sens positif est celui pénétrant dans la borne.
absoluteValue		Une limite absoluteValue signifie qu'une valeur absolue surveillée supérieure à la valeur limite constitue une infraction.

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6.13.9 OperationalLimitSet

Jeu de limites associées à un équipement. Les jeux de limites peuvent s'appliquer à une température spécifique, ou à une saison, par exemple. Un jeu de limites peut contenir des sévérités différentes pour les niveaux limites qui s'appliquent au même équipement. Le jeu peut contenir des limites de types différents telles que des limites de puissance apparente et des limites de courant ou bien des limites de tension haute et basse qui sont logiquement appliquées ensemble comme un jeu.

Le Tableau 651 présente tous les attributs de OperationalLimitSet.

Tableau 651 – Attributs de OperationalLimits::OperationalLimitSet

nom	mult	type	description
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 652 présente toutes les extrémités d'association de OperationalLimitSet avec d'autres classes.

Tableau 652 – Extrémités d'association de OperationalLimits::OperationalLimitSet avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..*	Terminal	0..1	ACDCTerminal	Borne à laquelle le jeu de limites opérationnelles s'applique.
0..*	Equipment	0..1	Equipment	Équipement auquel le jeu de limites s'applique.
1..1	OperationalLimitValue	0..*	OperationalLimit	Valeurs des limites de l'équipement.
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.13.10 OperationalLimitType

Signification opérationnelle d'une catégorie de limites.

Le Tableau 653 présente tous les attributs de OperationalLimitType.

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Tableau 653 – Attributs de OperationalLimits::OperationalLimitType

nom	mult	type	description
acceptableDuration	0..1	Seconds	Durée acceptable nominale de la limite. Les limites sont communément exprimées en termes de limites temporelles pour lesquelles la limite est normalement acceptable. La durée acceptable réelle d'une limite spécifique dépend d'autres facteurs locaux tels que la température ou la vitesse du vent. L'attribut n'a de signification que si l'indicater isInfiniteDuration est réglé sur false, il ne doit donc pas être échangé lorsque isInfiniteDuration est réglé sur true.
direction	0..1	OperationalLimitDirectionKind	Sens de la limite.
isInfiniteDuration	0..1	Boolean	Définit si le type de limite opérationnelle présente une durée infinie. Si true, la limite présente une durée infinie. Si false, la limite présente une durée déterminée qui est définie par l'attribut acceptableDuration.
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 654 présente toutes les extrémités d'association de OperationalLimitType avec d'autres classes.

Tableau 654 – Extrémités d'association de OperationalLimits::OperationalLimitType avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..1	OperationalLimit	0..*	OperationalLimit	Limites opérationnelles associées à ce type de limite.
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.13.11 VoltageLimit

Limite opérationnelle appliquée à la tension.

L'utilisation de la VoltageLimit opérationnelle est privilégiée par rapport aux limites définies au VoltageLevel. Si elles existent, les VoltageLimits opérationnelles sont utilisées.

Le Tableau 655 présente tous les attributs de VoltageLimit.

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Tableau 655 – Attributs de OperationalLimits::VoltageLimit

nom	mult	type	description
normalValue	0..1	Voltage	Limite normale sur la tension. La nature basse ou haute de la limite dépend des propriétés du type de limite opérationnelle. La valeur de l'attribut doit être positive.
value	0..1	Voltage	Limite sur la tension. La nature basse ou haute de la limite dépend des propriétés du type de limite opérationnelle. La valeur de l'attribut doit être positive.
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 656 présente toutes les extrémités d'association de VoltageLimit avec d'autres classes.

Tableau 656 – Extrémités d'association de OperationalLimits::VoltageLimit avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..*	OperationalLimitSet	1..1	OperationalLimitSet	hérité de: OperationalLimit
0..*	OperationalLimitType	0..1	OperationalLimitType	hérité de: OperationalLimit
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.14 Paquetage ControlArea

6.14.1 Généralités

Le paquetage ControlArea modélise les spécifications relatives aux zones qui peuvent être utilisées à des fins diverses. Le paquetage dans son ensemble modélise les spécifications de zones de commande qui se chevauchent potentiellement, à des fins de commande de la production réelle, de saisie de charge dans des zones de prévision de charge, ou d'analyse fondée sur le flux de puissance.

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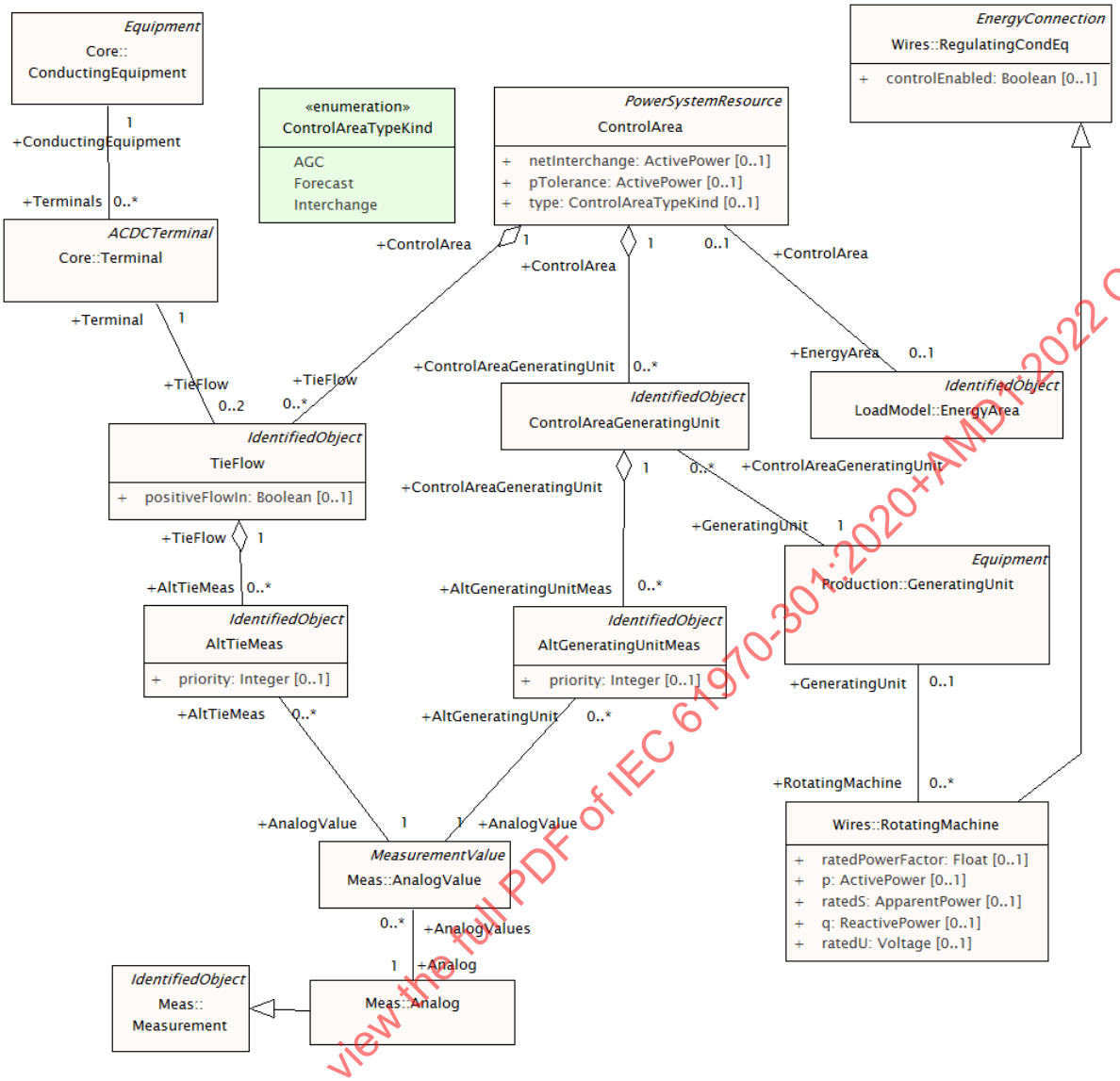


Figure 129 – Diagramme de classe ControlArea::ControlArea

Figure 129: Ce diagramme représente la spécification relative aux zones de commande et un certain nombre de classes liées. Les liaisons Terminal à AnalogValue sont représentées par souci de clarté pour comprendre la spécification relative aux zones de commande. Les liaisons GeneratingUnit à Terminal sont également représentées pour expliquer la façon dont les flux de production sont spécifiquement attachés au réseau.

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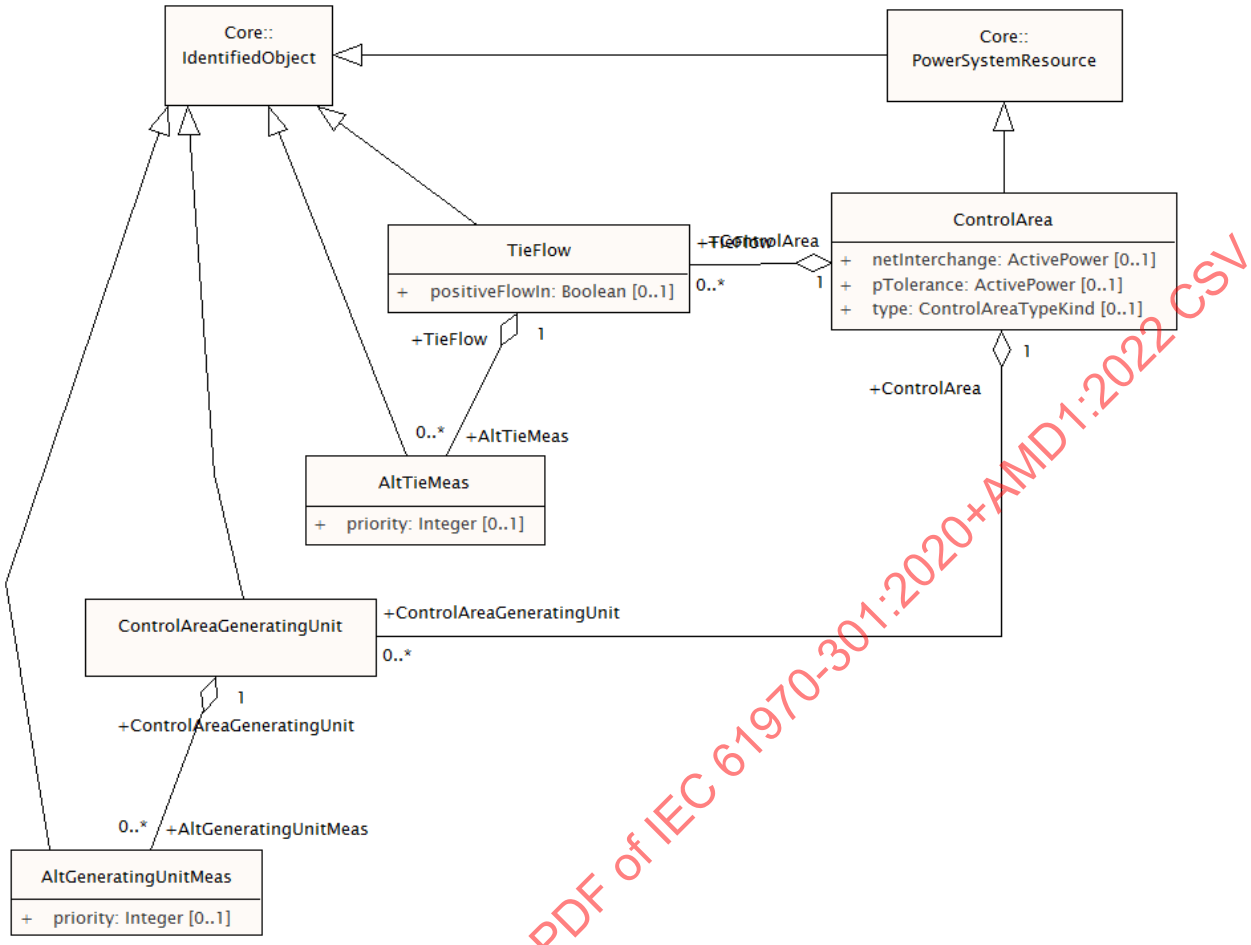


Figure 130 – Diagramme de classe ControlArea::ControlAreaInheritance

Figure 130: Représente l'héritage des classes dans ce paquetage.

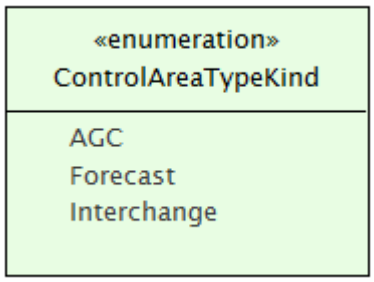


Figure 131 – Diagramme de classe ControlArea::Datatypes

Figure 131: Représente les types de données pour des zones de commande.

6.14.2 AltGeneratingUnitMeas

Measurement hiérarchisé par ordre de priorité à utiliser pour l'unité de production dans la spécification relative aux zones de commande.

Le Tableau 657 présente tous les attributs de AltGeneratingUnitMeas.

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Tableau 657 – Attributs de ControlArea::AltGeneratingUnitMeas

nom	mult	type	description
priority	0..1	Integer	Priorité d'une utilisation de mesure. Les nombres plus petits ont la première priorité.
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 658 présente toutes les extrémités d'association de AltGeneratingUnitMeas avec d'autres classes.

Tableau 658 – Extrémités d'association de ControlArea::AltGeneratingUnitMeas avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..*	AnalogValue	1..1	AnalogValue	Valeur analogique spécifique utilisée comme source.
0..*	ControlAreaGeneratingUnit	1..1	ControlAreaGeneratingUnit	Unité de production de zone de commande à laquelle est appliquée l'affectation de Measurement hiérarchisé par ordre de priorité.
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.14.3 AltTieMeas

Measurement hiérarchisé par ordre de priorité à utiliser pour le flux d'interconnexion comme partie de la spécification relative aux zones de commande.

Le Tableau 659 présente tous les attributs de AltTieMeas.

Tableau 659 – Attributs de ControlArea::AltTieMeas

nom	mult	type	description
priority	0..1	Integer	Priorité d'une utilisation de mesure. Les nombres plus petits ont la première priorité.
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 660 présente toutes les extrémités d'association de AltTieMeas avec d'autres classes.

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Tableau 660 – Extrémités d'association de ControlArea::AltTieMeas avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..*	AnalogValue	1..1	AnalogValue	Valeur analogique spécifique utilisée comme source.
0..*	TieFlow	1..1	TieFlow	Flux d'interconnexion des Measurements alternatifs.
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.14.4 ControlArea

Une "control area" (zone de commande) est un groupement de "generating units" (unités de production) et/ou de charge et un ensemble de coupure de lignes d'interconnexion (comme des bornes) qui peut être utilisé à des fins diverses, y compris le contrôle automatique de production, la spécification de la commande des échanges de zone des calculs de répartition, et injecté comme entrée à la prévision de charge. Toutes les productions et charges se trouvant à l'intérieur de la zone définies par les bornes sur la limite sont prises en considération dans la commande des échanges de zone. Noter que n'importe quel nombre de spécifications de zones de commande se chevauchant peuvent être superposées sur le modèle physique. Les principes généraux suivants s'appliquent à ControlArea:.

1) l'orientation de la zone de commande pour un échange net est positive pour une importation et négative pour une exportation;
2) l'échange net de la zone de commande est déterminé en faisant la somme des flux dans les Terminals. Les Terminals sont identifiées en créant un ensemble d'objets TieFlow associés à un objet ControlArea. Chaque objet TieFlow identifie une Terminal;
3) dans un modèle de réseau simple, une interconnexion entre deux zones de commande doit être modélisée dans les deux spécifications de zone de commande de sorte que les deux représentations du flux d'interconnexion soient égales à zéro;
4) l'orientation normale du flux de Terminal est positive pour le flux vers l'appareil conducteur qui détient la Terminal (c'est-à-dire que le flux d'un bus vers un appareil est positif). Cependant, l'orientation de chaque flux dans la spécification de zone de commande doit correspondre à la convention de la zone de commande, c'est-à-dire l'importation est positive. Si l'orientation du flux de Terminal référencée par un TieFlow est positive vers la zone de commande, ceci est alors confirmé en réglant l'indicateur TieFlow.positiveFlowIn sur TRUE. Dans le cas contraire, l'orientation doit être inversée en réglant l'indicateur TieFlow.positiveFlowIn sur FALSE.

Le Tableau 661 présente tous les attributs de ControlArea.

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Tableau 661 – Attributs de ControlArea::ControlArea

nom	mult	type	description
netInterchange	0..1	ActivePower	Echange net positif spécifié dans la zone de commande, c'est-à-dire que le signe positif signifie un flux vers la zone.
pTolerance	0..1	ActivePower	Tolérance sur l'échange net de puissance active. La valeur de l'attribut doit être positive ou égale à zéro.
type	0..1	ControlAreaTypeKind	Type primaire de définition de zone de commande utilisé pour déterminer s'il est utilisé pour le contrôle automatique de production, pour planifier la commande des échanges ou pour d'autres fins. Une zone de commande spécifiée avec un type primaire de contrôle automatique de production peut néanmoins être prévue et utilisée comme zone d'échange dans l'analyse du flux de puissance.
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 662 présente toutes les extrémités d'association de ControlArea avec d'autres classes.

Tableau 662 – Extrémités d'association de ControlArea::ControlArea avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..1	EnergyArea	0..1	EnergyArea	Zone d'énergie qui est prévue à partir de la spécification de cette zone de commande.
1..1	ControlAreaGeneratingUnit	0..*	ControlAreaGeneratingUnit	Spécifications d'unité de production applicables à la zone de commande.
1..1	TieFlow	0..*	TieFlow	Flux d'interconnexion associés à la zone de commande.
0..*	PSRType	0..1	PSRType	hérité de: PowerSystemResource
0..1	Controls	0..*	Control	hérité de: PowerSystemResource
0..1	Measurements	0..*	Measurement	hérité de: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	hérité de: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	hérité de: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.14.5 ControlAreaGeneratingUnit

Unité de production de la zone de commande. Cette classe est nécessaire afin que les définitions alternatives de zone de commande puissent inclure la même unité de production. Il convient de noter qu'il convient qu'une seule instance dans la zone de commande référence une unité de production spécifique.

Le Tableau 663 présente tous les attributs de ControlAreaGeneratingUnit.

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Tableau 663 – Attributs de ControlArea::ControlAreaGeneratingUnit

nom	mult	type	description
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 664 présente toutes les extrémités d'association de ControlAreaGeneratingUnit avec d'autres classes.

Tableau 664 – Extrémités d'association de ControlArea::ControlAreaGeneratingUnit avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..*	GeneratingUnit	1..1	GeneratingUnit	Unité de production spécifiée pour cette zone de commande. Noter qu'il convient qu'une zone de commande inclue un GeneratingUnit une seule fois.
0..*	ControlArea	1..1	ControlArea	Zone de commande parente pour les spécifications relatives à l'unité de production.
1..1	AltGeneratingUnitMeas	0..*	AltGeneratingUnitMeas	Liaison à des Measurements hiérarchisés par ordre de priorité pour cette GeneratingUnit.
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.14.6 Enumération ControlAreaTypeKind

Type de zone de commande.

Le Tableau 665 présente tous les libellés de ControlAreaTypeKind.

Tableau 665 – Libellés de ControlArea::ControlAreaTypeKind

libellé	value	description
AGC		Utilisé pour le contrôle automatique de production.
Forecast		Utilisé pour la prévision de charge.
Interchange		Utilisé pour la spécification ou la commande des échanges.

6.14.7 TieFlow

Définit la structure (en matière d'emplacement et de sens) de la contrainte d'échange net pour une zone de commande. Cette contrainte peut être appliquée par AGC ou le flux de puissance.

Le Tableau 666 présente tous les attributs de TieFlow.

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Tableau 666 – Attributs de ControlArea::TieFlow

nom	mult	type	description
positiveFlowIn	0..1	Boolean	Spécifie le signe du flux d'interconnexion associé à une zone de commande. True (vrai) si le flux positif se dirigeant vers la borne (convention de charge) est également le flux positif se dirigeant vers la zone de commande. Voir la description de ControlArea pour de plus amples informations sur la manière d'utiliser TieFlow.positiveFlowIn.
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 667 présente toutes les extrémités d'association de TieFlow avec d'autres classes.

Tableau 667 – Extrémités d'association de ControlArea::TieFlow avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..2	Terminal	1..1	Terminal	Borne à laquelle ce flux d'interconnexion appartient.
0..*	ControlArea	1..1	ControlArea	Zone de commande des flux d'interconnexion.
1..1	AltTieMeas	0..*	AltTieMeas	Measurements du flux d'interconnexion primaire et alternatif associées au flux d'interconnexion.
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.15 Paquetage Contingency

6.15.1 Généralités

Contingences devant être étudiées.

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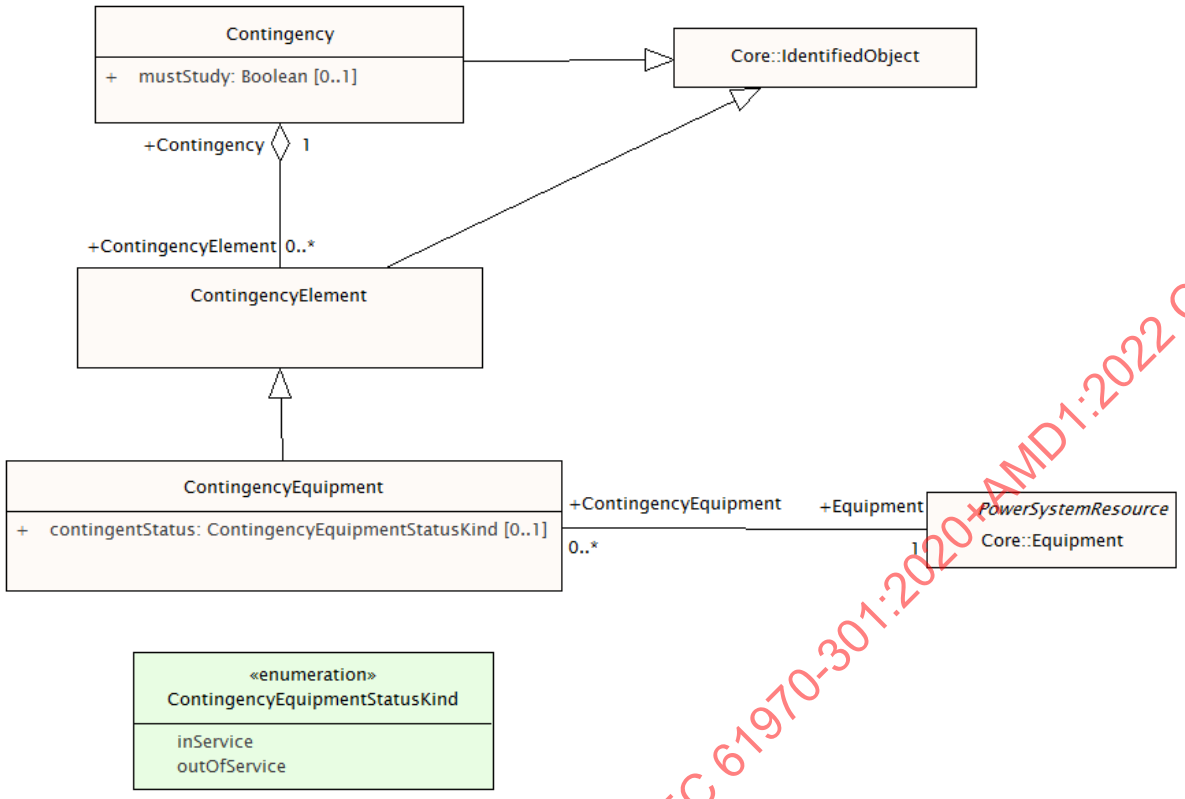


Figure 132 – Diagramme de classe Contingency::Contingency

Figure 132: Ce diagramme représente les associations et l'héritage du modèle de contingence.

6.15.2 Contingency

Événement menaçant la fiabilité du système, constitué d'un ou de plusieurs éléments de contingence.

Le Tableau 668 présente tous les attributs de Contingency.

Tableau 668 – Attributs de Contingency::Contingency

nom	mult	type	description
mustStudy	0..1	Boolean	Définit sur true lorsque cette contingence doit être étudiée.
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 669 présente toutes les extrémités d'association de Contingency avec d'autres classes.

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Tableau 669 – Extrémités d'association de Contingency::Contingency avec d'autres classes

mult à partir de	nom	mult vers	type	description
1..1	ContingencyElement	0..*	ContingencyElement	Une contingence peut avoir un nombre quelconque d'éléments de contingence.
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.15.3 ContingencyElement

Élément d'un événement système à étudier par analyse de contingence, représentant un changement de statut d'un seul équipement.

Le Tableau 670 présente tous les attributs de ContingencyElement.

Tableau 670 – Attributs de Contingency::ContingencyElement

nom	mult	type	description
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 671 présente toutes les extrémités d'association de ContingencyElement avec d'autres classes.

Tableau 671 – Extrémités d'association de Contingency::ContingencyElement avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..*	Contingency	1..1	Contingency	Un élément de contingence appartient à une contingence.
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.15.4 ContingencyEquipment

Équipement dont le statut en service doit changer, tel qu'un transformateur de puissance ou un segment de ligne à courant alternatif.

Le Tableau 672 présente tous les attributs de ContingencyEquipment.

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Tableau 672 – Attributs de Contingency::ContingencyEquipment

nom	mult	type	description
contingentStatus	0..1	ContingencyEquipment StatusKind	Statut pour l'équipement associé lorsqu'il est dans l'état de contingence. Ce statut est indépendant du cas auquel la contingence est appliquée initialement, mais il définit le statut de l'équipement lorsque la contingence est appliquée.
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 673 présente toutes les extrémités d'association de ContingencyEquipment avec d'autres classes.

Tableau 673 – Extrémités d'association de Contingency::ContingencyEquipment avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..*	Equipment	1..1	Equipment	Équipement unique auquel appliquer la contingence.
0..*	Contingency	1..1	Contingency	hérité de: ContingencyElement
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.15.5 Enumération ContingencyEquipmentStatusKind

Indique le statut dans lequel l'équipement de contingence doit se trouver lorsque la contingence est appliquée.

Le Tableau 674 présente tous les libellés de ContingencyEquipmentStatusKind.

Tableau 674 – Libellés de Contingency::ContingencyEquipmentStatusKind

libellé	value	description
inService		L'équipement doit être mis en service.
outOfService		L'équipement doit être mis hors service.

6.16 Paquetage StateVariables

6.16.1 Généralités

Variables d'état pour des solutions d'analyse telles que le flux de puissance.

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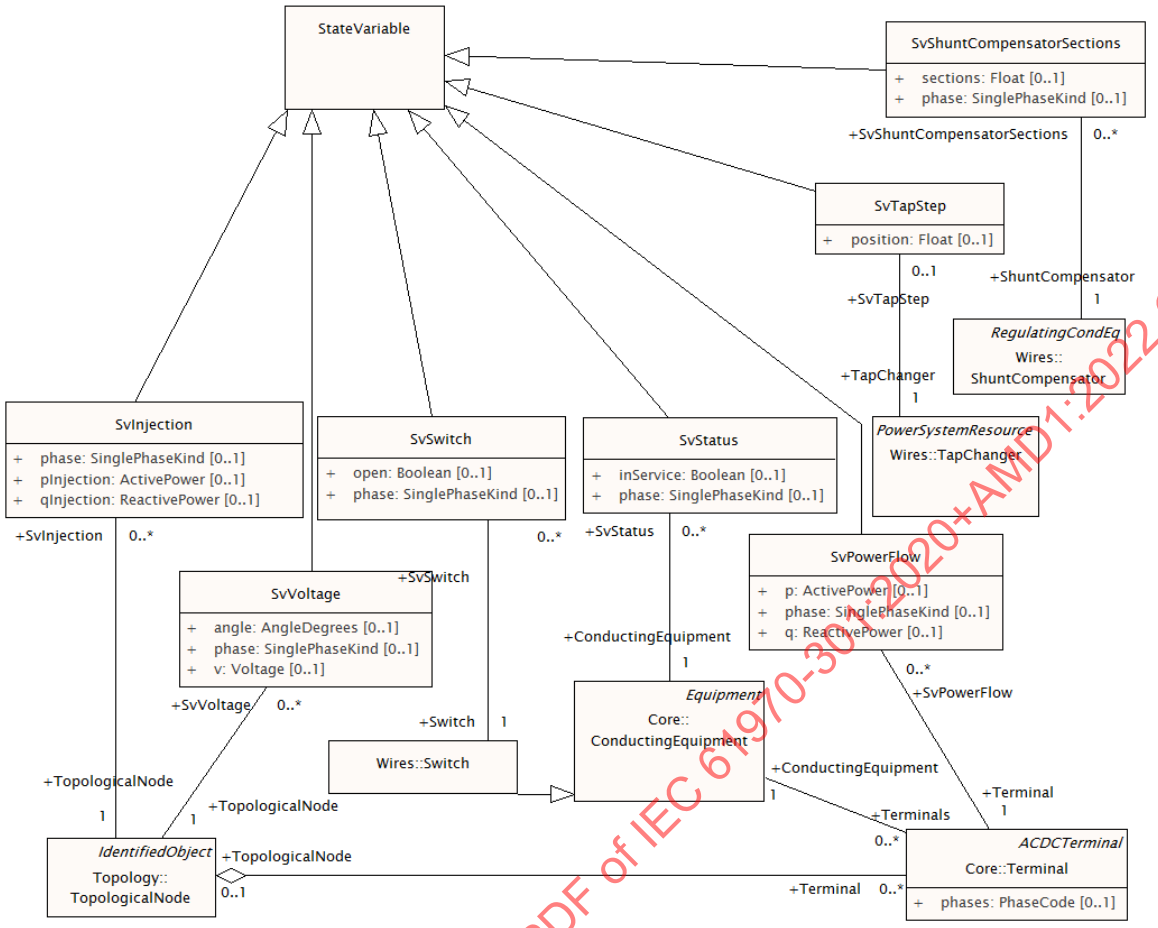


Figure 133 – Diagramme de classe StateVariables::StateVariables

Figure 133: Variables d'état de solutions telles que dérivées de la classe StateVariable de base. Noter que les variables d'état spécialisées sont associées à des objets dérivés de l'IdentifiedObject, mais StateVariable ne dérive pas de IdentifiedObject.

6.16.2 Classe racine StateVariable

Une classe abstraite pour variables d'état.

6.16.3 SvInjection

La SvInjection communique l'injection de bus calculée moins la somme des flux de bornes. Le flux de borne est positif lorsqu'il provient du bus (convention de signe de charge) et que l'injection de bus a un flux positif en direction du bus. SvInjection peut avoir le reste après une estimation d'état ou une marge après un calcul de flux de puissance.

Le Tableau 675 présente tous les attributs de SvInjection.

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Tableau 675 – Attributs de StateVariables::SvInjection

nom	mult	type	description
phase	0..1	SinglePhaseKind	Phase de borne à laquelle la connexion est appliquée. Si elle est absente, l'injection est par hypothèse équilibrée entre les phases non neutres.
pInjection	0..1	ActivePower	Différence de puissance active entre l'injection calculée et l'injection initiale. Un signe positif signifie une injection vers le TopologicalNode (bus).
qInjection	0..1	ReactivePower	Différence de puissance réactive entre l'injection calculée et l'injection initiale. Un signe positif signifie une injection vers le TopologicalNode (bus).

Le Tableau 676 présente toutes les extrémités d'association de SvInjection avec d'autres classes.

Tableau 676 – Extrémités d'association de StateVariables::SvInjection avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..*	TopologicalNode	1..1	TopologicalNode	Nœud topologique associé à la variable d'état d'injection de flux.

6.16.4 SvPowerFlow

Variable d'état pour le flux de puissance. La convention de charge est utilisée pour le sens du flux. Cela signifie que le flux qui circule du TopologicalNode jusque dans l'équipement est positif.

Le Tableau 677 présente tous les attributs de SvPowerFlow.

Tableau 677 – Attributs de StateVariables::SvPowerFlow

nom	mult	type	description
p	0..1	ActivePower	Flux de puissance active. La convention de signe charge est utilisée, c'est-à-dire que le signe positif signifie un flux à partir d'un TopologicalNode (bus) vers l'équipement conducteur.
phase	0..1	SinglePhaseKind	Phase individuelle du flux. Si elle n'est pas spécifiée, elle est par hypothèse équilibrée entre les phases.
q	0..1	ReactivePower	Flux de puissance réactive. La convention de signe charge est utilisée, c'est-à-dire que le signe positif signifie un flux à partir d'un TopologicalNode (bus) vers l'équipement conducteur.

Le Tableau 678 présente toutes les extrémités d'association de SvPowerFlow avec d'autres classes.

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Tableau 678 – Extrémités d'association de StateVariables::SvPowerFlow avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..*	Terminal	1..1	Terminal	Borne associée à la variable d'état de flux de puissance.

6.16.5 SvShuntCompensatorSections

Variable d'état pour le nombre de sections en service pour un compensateur shunt.

Le Tableau 679 présente tous les attributs de SvShuntCompensatorSections.

Tableau 679 – Attributs de StateVariables::SvShuntCompensatorSections

nom	mult	type	description
sections	0..1	Float	Nombre de sections en service comme variable continue. La valeur de l'attribut doit être positive ou égale à zéro. Pour obtenir une échelle de valeur entière avec ShuntCompensator.bPerSection.
phase	0..1	SinglePhaseKind	Phase de borne à laquelle la connexion est appliquée. Si elle est absente, l'injection est par hypothèse équilibrée entre les phases non neutres.

Le Tableau 680 présente toutes les extrémités d'association de SvShuntCompensatorSections avec d'autres classes.

Tableau 680 – Extrémités d'association de StateVariables::SvShuntCompensatorSections avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..*	ShuntCompensator	1..1	ShuntCompensator	Compensateur shunt pour lequel l'état s'applique.

6.16.6 SvStatus

Variable d'état pour le statut.

Le Tableau 681 présente tous les attributs de SvStatus.

Tableau 681 – Attributs de StateVariables::SvStatus

nom	mult	type	description
inService	0..1	Boolean	Statut en service comme résultat d'un traitement de topologie. Il indique si l'équipement est considéré comme étant alimenté par le flux de puissance. Il reflète si l'équipement est connecté à l'intérieur d'un îlot solvable. Il ne reflète pas nécessairement si l'îlot a été résolu ou pas par le flux de puissance.
phase	0..1	SinglePhaseKind	Statut de la phase individuelle. Si l'attribut n'est pas spécifié, le modèle triphasé est pris par hypothèse.

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Le Tableau 682 présente toutes les extrémités d'association de SvStatus avec d'autres classes.

Tableau 682 – Extrémités d'association de StateVariables::SvStatus avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..*	ConductingEquipment	1..1	ConductingEquipment	Équipement conducteur associé à la variable d'état de statut.

6.16.7 SvSwitch

Variable d'état pour le commutateur.

Le Tableau 683 présente tous les attributs de SvSwitch.

Tableau 683 – Attributs de StateVariables::SvSwitch

nom	mult	type	description
open	0..1	Boolean	L'attribut indique si l'état calculé du commutateur est considéré comme ouvert.
phase	0..1	SinglePhaseKind	Phase de borne à laquelle la connexion est appliquée. Si elle est absente, l'injection est par hypothèse équilibrée entre les phases non neutres.

Le Tableau 684 présente toutes les extrémités d'association de SvSwitch avec d'autres classes.

Tableau 684 – Extrémités d'association de StateVariables::SvSwitch avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..*	Switch	1..1	Switch	Commutateur associé à l'état du commutateur.

6.16.8 SvTapStep

Variable d'état pour l'échelon de prise de transformateur.

Le Tableau 685 présente tous les attributs de SvTapStep.

Tableau 685 – Attributs de StateVariables::SvTapStep

nom	mult	type	description
position	0..1	Float	Position de prise virgule flottante. Il ne s'agit pas du rapport de prise, mais plutôt de la position du rapport de prise, comme défini par le modèle du changeur de prises associé. Elle est normalement contrainte à rester dans la plage des positions minimale et maximale de prise.

Le Tableau 686 présente toutes les extrémités d'association de SvTapStep avec d'autres classes.

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Tableau 686 – Extrémités d'association de StateVariables::SvTapStep avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..1	TapChanger	1..1	TapChanger	Changeur de prises associé à l'état d'échelon de prise.

6.16.9 SvVoltage

Variable d'état pour la tension.

Le Tableau 687 présente tous les attributs de SvVoltage.

Tableau 687 – Attributs de StateVariables::SvVoltage

nom	mult	type	description
angle	0..1	AngleDegrees	Angle de tension de la tension complexe au nœud topologique par rapport à la référence du système.
phase	0..1	SinglePhaseKind	Si spécifié, la tension est la tension phase à terre de la phase individuelle. Sinon, la tension est par hypothèse équilibrée.
v	0..1	Voltage	Valeur de la tension au nœud topologique. La valeur de l'attribut doit être positive.

Le Tableau 688 présente toutes les extrémités d'association de SvVoltage avec d'autres classes.

Tableau 688 – Extrémités d'association de StateVariables::SvVoltage avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..*	TopologicalNode	1..1	TopologicalNode	Nœud topologique associé à l'état de tension.

6.17 Paquetage Protection

6.17.1 Généralités

Extension des paquetages Core (noyau) et Wires (fils) qui modélise les informations relatives à l'équipement de protection tel que les relais. Ces entités sont utilisées dans les simulateurs de formation et les applications de localisation de défauts d'un réseau de distribution.

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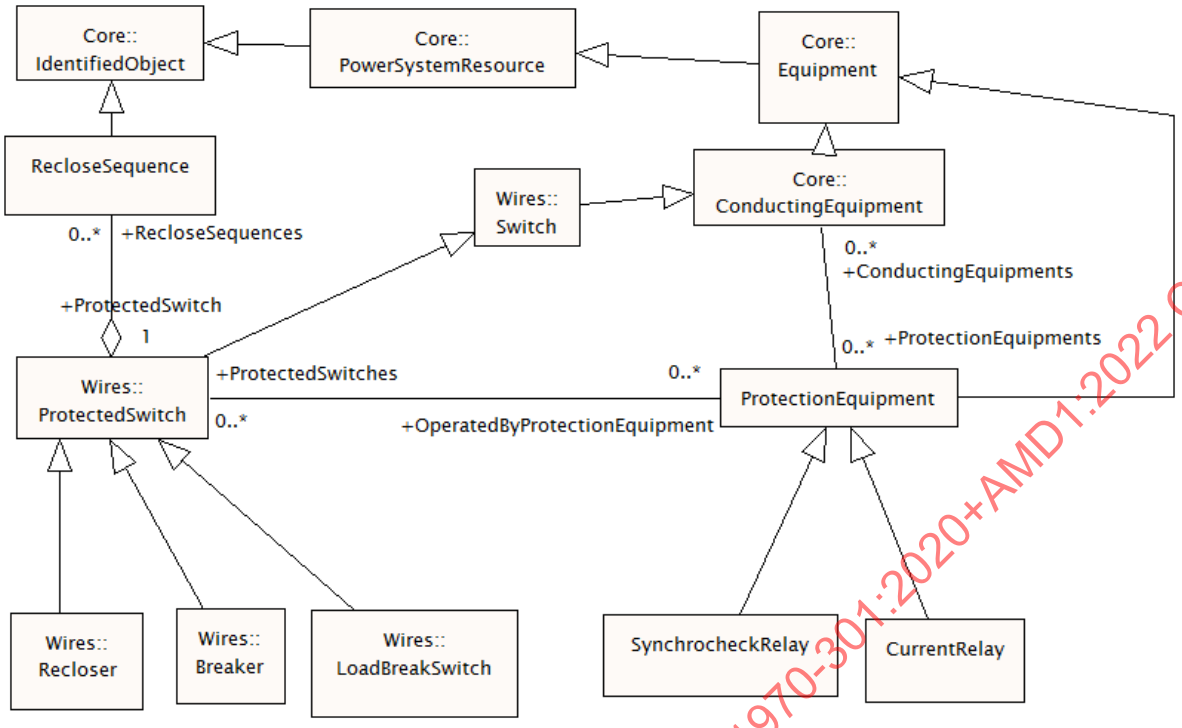


Figure 134 – Diagramme de classe Protection::Main

Figure 134: Ce diagramme représente toutes les classes incluses dans le paquetage Protection, de même que les classes-clés externes qui ont des associations avec des classes Protection.

6.17.2 CurrentRelay

Appareil contrôlant les valeurs de circulation du courant dans n'importe quel sens ou dans un sens déterminé.

Le Tableau 689 présente tous les attributs de CurrentRelay.

Tableau 689 – Attributs de Protection::CurrentRelay

nom	mult	type	description
currentLimit1	0..1	CurrentFlow	Courant-limite numéro 1 de lecture du temps inverse.
currentLimit2	0..1	CurrentFlow	Courant-limite numéro 2 de lecture du temps inverse.
currentLimit3	0..1	CurrentFlow	Courant-limite numéro 3 de lecture du temps inverse.
inverseTimeFlag	0..1	Boolean	Défini sur true (vrai) si le relais du courant possède une caractéristique de temps inverse.
timeDelay1	0..1	Seconds	Retard de temps inverse n°1 du courant limite n°1.
timeDelay2	0..1	Seconds	Retard de temps inverse n°2 du courant limite n°2.
timeDelay3	0..1	Seconds	Retard de temps inverse n°3 du courant limite n°3.
relayDelayTime	0..1	Seconds	hérité de: ProtectionEquipment
highLimit	0..1	Float	hérité de: ProtectionEquipment
lowLimit	0..1	Float	hérité de: ProtectionEquipment
powerDirectionFlag	0..1	Boolean	hérité de: ProtectionEquipment
unitSymbol	0..1	UnitSymbol	hérité de: ProtectionEquipment

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nom	mult	type	description
unitMultiplier	0..1	UnitMultiplier	hérité de: ProtectionEquipment
aggregate	0..1	Boolean	hérité de: Equipment
inService	0..1	Boolean	hérité de: Equipment
networkAnalysisEnabled	0..1	Boolean	hérité de: Equipment
normallyInService	0..1	Boolean	hérité de: Equipment
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 690 présente toutes les extrémités d'association de CurrentRelay avec d'autres classes.

Tableau 690 – Extrémités d'association de Protection::CurrentRelay avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..*	ConductingEquipments	0..*	ConductingEquipment	hérité de: ProtectionEquipment
0..*	ProtectedSwitches	0..*	ProtectedSwitch	hérité de: ProtectionEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	hérité de: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	hérité de: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	hérité de: Equipment
0..1	Faults	0..*	Fault	hérité de: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	hérité de: Equipment
0..*	PSRType	0..1	PSRType	hérité de: PowerSystemResource
0..1	Controls	0..*	Control	hérité de: PowerSystemResource
0..1	Measurements	0..*	Measurement	hérité de: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	hérité de: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	hérité de: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.17.3 ProtectionEquipment

Appareil électrique visant à répondre de façon déterminée aux conditions d'entrée à condition que des conditions spécifiées entraînant une opération de contact ou une modification extrême équivalente dans les circuits de commande électrique associés, ou visant simplement à afficher la condition détectée, aient été remplies. L'équipement de protection est associé à l'équipement conducteur et fait généralement fonctionner les disjoncteurs.

Le Tableau 691 présente tous les attributs de ProtectionEquipment.

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Tableau 691 – Attributs de Protection::ProtectionEquipment

nom	mult	type	description
relayDelayTime	0..1	Seconds	Retard entre la détection de conditions anormales et le fonctionnement du relais.
highLimit	0..1	Float	Valeur maximale admissible.
lowLimit	0..1	Float	Valeur minimale admissible.
powerDirectionFlag	0..1	Boolean	Direction identique à la valeur de flux de puissance active et positive.
unitSymbol	0..1	UnitSymbol	Unité de mesure de la valeur.
unitMultiplier	0..1	UnitMultiplier	Multiplicateur d'unité de la valeur.
aggregate	0..1	Boolean	hérité de: Equipment
inService	0..1	Boolean	hérité de: Equipment
networkAnalysisEnabled	0..1	Boolean	hérité de: Equipment
normallyInService	0..1	Boolean	hérité de: Equipment
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 692 présente toutes les extrémités d'association de ProtectionEquipment avec d'autres classes.

Tableau 692 – Extrémités d'association de Protection::ProtectionEquipment avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..*	ConductingEquipments	0..*	ConductingEquipment	L'équipement de protection peut être utilisé pour protéger un équipement conducteur spécifique.
0..*	ProtectedSwitches	0..*	ProtectedSwitch	Commutateurs protégés actionnés par ce ProtectionEquipment (équipement de protection).
0..1	OperationalLimitSet	0..*	OperationalLimitSet	hérité de: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	hérité de: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	hérité de: Equipment
0..1	Faults	0..*	Fault	hérité de: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	hérité de: Equipment
0..*	PSRType	0..1	PSRType	hérité de: PowerSystemResource
0..1	Controls	0..*	Control	hérité de: PowerSystemResource
0..1	Measurements	0..*	Measurement	hérité de: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	hérité de: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	hérité de: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

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6.17.4 RecloseSequence

Une séquence de réenclenchement (ouvrir et interrompre le courant) est définie pour chaque nouvelle fermeture possible d'un disjoncteur.

Le Tableau 693 présente tous les attributs de RecloseSequence.

Tableau 693 – Attributs de Protection::RecloseSequence

nom	mult	type	description
recloseDelay	0..1	Seconds	Indique le laps de temps avant que l'étape de réenclenchement se réalise.
recloseStep	0..1	Integer	Indique la position ordinale de l'étape de réenclenchement par rapport à d'autres étapes de la séquence.
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 694 présente toutes les extrémités d'association de RecloseSequence avec d'autres classes.

Tableau 694 – Extrémités d'association de Protection::RecloseSequence avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..*	ProtectedSwitch	1..1	ProtectedSwitch	Un disjoncteur peut avoir zéro ou plusieurs réenclenchements automatiques après un déclenchement.
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.17.5 SynchrocheckRelay

Appareil fonctionnant lorsque deux circuits à courant alternatif se situent dans les limites souhaitées de fréquence, d'angle de phase et de tension afin de permettre ou d'entraîner la mise en parallèle de ces deux circuits. Utilisé pour éviter la mise en parallèle d'îlots topologiques asynchrones.

Le Tableau 695 présente tous les attributs de SynchrocheckRelay.

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Tableau 695 – Attributs de Protection::SynchrocheckRelay

nom	mult	type	description
maxAngleDiff	0..1	AngleRadians	Différence maximale admissible de l'angle de phase du vecteur de tension aux bornes de l'appareil ouvert.
maxFreqDiff	0..1	Frequency	Différence de fréquence maximale admissible aux bornes de l'appareil ouvert.
maxVoltDiff	0..1	Voltage	Tension de différence maximale admissible aux bornes de l'appareil ouvert.
relayDelayTime	0..1	Seconds	hérité de: ProtectionEquipment
highLimit	0..1	Float	hérité de: ProtectionEquipment
lowLimit	0..1	Float	hérité de: ProtectionEquipment
powerDirectionFlag	0..1	Boolean	hérité de: ProtectionEquipment
unitSymbol	0..1	UnitSymbol	hérité de: ProtectionEquipment
unitMultiplier	0..1	UnitMultiplier	hérité de: ProtectionEquipment
aggregate	0..1	Boolean	hérité de: Equipment
inService	0..1	Boolean	hérité de: Equipment
networkAnalysisEnabled	0..1	Boolean	hérité de: Equipment
normallyInService	0..1	Boolean	hérité de: Equipment
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 696 présente toutes les extrémités d'association de SynchrocheckRelay avec d'autres classes.

Tableau 696 – Extrémités d'association de Protection::SynchrocheckRelay avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..*	ConductingEquipments	0..*	ConductingEquipment	hérité de: ProtectionEquipment
0..*	ProtectedSwitches	0..*	ProtectedSwitch	hérité de: ProtectionEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	hérité de: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	hérité de: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	hérité de: Equipment
0..1	Faults	0..*	Fault	hérité de: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	hérité de: Equipment
0..*	PSRType	0..1	PSRType	hérité de: PowerSystemResource
0..1	Controls	0..*	Control	hérité de: PowerSystemResource
0..1	Measurements	0..*	Measurement	hérité de: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	hérité de: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	hérité de: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

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6.18 Paquetage Faults

6.18.1 Généralités

Le paquetage décrit les défauts qui peuvent se produire sur les équipements conducteurs, par exemple un arbre qui tombe sur une ligne électrique.

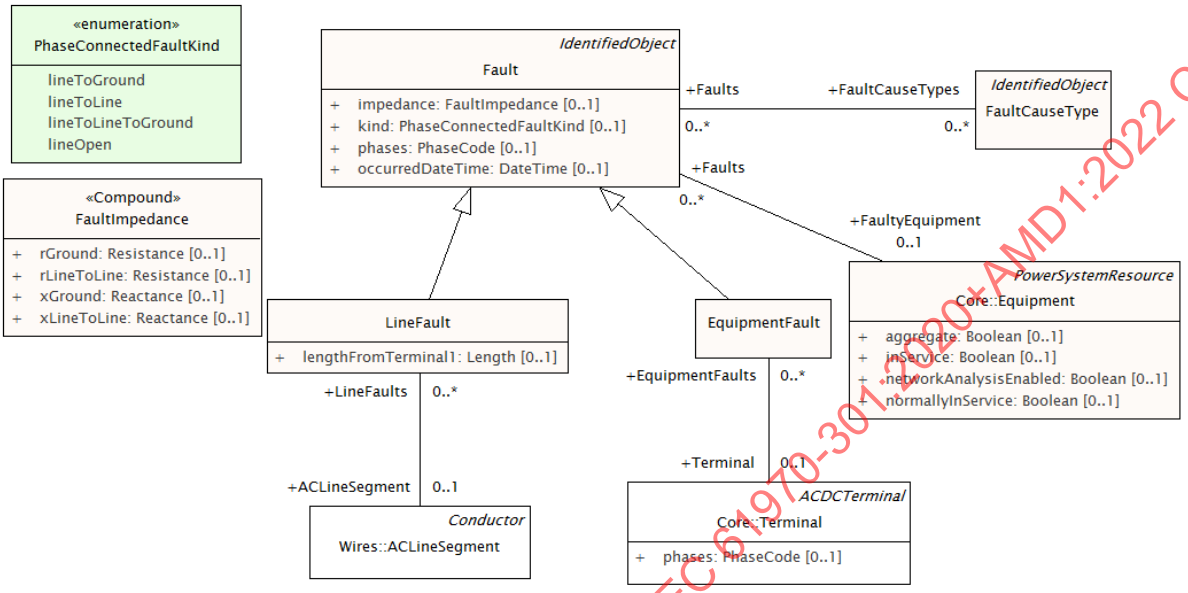


Figure 135 – Diagramme de classe Faults::Faults

Figure 135: Classes utilisées pour les défauts de modèles.

6.18.2 EquipmentFault

Un défaut appliqué à la borne, en dehors de l'équipement. Cette classe n'est pas utilisée pour spécifier les défauts internes à l'équipement.

Le Tableau 697 représente tous les attributs de EquipmentFault.

Tableau 697 – Attributs de Faults::EquipmentFault

nom	mult	type	description
impedance	0..1	FaultImpedance	hérité de: Fault
kind	0..1	PhaseConnectedFaultKind	hérité de: Fault
phases	0..1	PhaseCode	hérité de: Fault
occurredDateTime	0..1	DateTime	hérité de: Fault
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 698 présente toutes les extrémités d'association de EquipmentFault avec d'autres classes.

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Tableau 698 – Extrémités d'association de Faults::EquipmentFault avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..*	Terminal	0..1	Terminal	Borne qui se connecte au bus auquel le défaut est appliqué.
0..*	FaultyEquipment	0..1	Equipment	hérité de: Fault
0..*	FaultCauseTypes	0..*	FaultCauseType	hérité de: Fault
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.18.3 Fault

Condition anormale qui provoque un flux de courant dans l'équipement conducteur, par exemple provoqué par un équipement défaillant ou des courts-circuits provenant d'objets non généralement modélisés (par exemple, un arbre tombant sur une ligne électrique).

Le Tableau 699 présente tous les attributs de Fault.

Tableau 699 – Attributs de Faults::Fault

nom	mult	type	description
impedance	0..1	FaultImpedance	Impédance de défaut. Son utilisation est décrite par 'kind' (genre).
kind	0..1	PhaseConnectedFaultKind	Genre de défaut de phase.
phases	0..1	PhaseCode	Phases qui participent au défaut. Les connexions défectueuses dans ces phases sont en outre spécifiées en fonction du type de défaut.
occurredDateTime	0..1	DateTime	Date et heure auxquelles le défaut s'est produit.
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 700 présente toutes les extrémités d'association de Fault avec d'autres classes.

Tableau 700 – Extrémités d'association de Faults::Fault avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..*	FaultyEquipment	0..1	Equipment	Equipement portant ce défaut.
0..*	FaultCauseTypes	0..*	FaultCauseType	Tous les types de causes de défauts.
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

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6.18.4 FaultCauseType

Type de cause du défaut.

Le Tableau 701 présente tous les attributs de FaultCauseType.

Tableau 701 – Attributs de Faults::FaultCauseType

nom	mult	type	description
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 702 présente toutes les extrémités d'association de FaultCauseType avec d'autres classes.

Tableau 702 – Extrémités d'association de Faults::FaultCauseType avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..*	Faults	0..*	Fault	Tous les défauts ayant ce type de cause.
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.18.5 Compound FaultImpedance

Description de l'impédance correspondant au défaut.

Le Tableau 703 présente tous les attributs de FaultImpedance.

Tableau 703 – Attributs de Faults::FaultImpedance

nom	mult	type	description
rGround	0..1	Resistance	Résistance du défaut entre les phases et la terre.
rLineToLine	0..1	Resistance	Résistance du défaut entre les phases.
xGround	0..1	Reactance	Réactance du défaut entre les phases et la terre.
xLineToLine	0..1	Reactance	Réactance du défaut entre les phases.

6.18.6 LineFault

Défaut qui se produit sur un segment de ligne de courant alternatif en un point quelconque de la longueur.

Le Tableau 704 présente tous les attributs de LineFault.

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Tableau 704 – Attributs de Faults::LineFault

nom	mult	type	description
lengthFromTerminal1	0..1	Length	Longueur à placer à l'emplacement du défaut à partir d'une borne de numéro d'ordre 1 du segment de ligne défectueux.
impedance	0..1	FaultImpedance	hérité de: Fault
kind	0..1	PhaseConnectedFaultKind	hérité de: Fault
phases	0..1	PhaseCode	hérité de: Fault
occurredDateTime	0..1	DateTime	hérité de: Fault
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 705 présente toutes les extrémités d'association de LineFault avec d'autres classes.

Tableau 705 – Extrémités d'association de Faults::LineFault avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..*	ACLineSegment	0..1	ACLineSegment	Segment de ligne de ce défaut de ligne.
0..*	FaultyEquipment	0..1	Equipment	hérité de: Fault
0..*	FaultCauseTypes	0..*	FaultCauseType	hérité de: Fault
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.18.7 Enumération PhaseConnectedFaultKind

Type de connexion défectueuse parmi les phases.

Le Tableau 706 présente tous les libellés de PhaseConnectedFaultKind.

Tableau 706 – Libellés de Faults::PhaseConnectedFaultKind

libellé	value	description
lineToGround		Le défaut connecte les phases indiquées à la terre. L'impédance de défaut ligne à ligne n'est pas utilisée et est considérée comme infinie. L'impédance totale de terre est connectée entre chaque phase spécifiée dans le défaut et dans la terre, pas entre les phases.
lineToLine		Le défaut connecte les phases spécifiées ensemble sans connexion à la terre. L'impédance de terre de ce défaut est ignorée. L'impédance ligne à ligne est connectée entre chacune des phases spécifiées dans le défaut. Par exemple, trois fois pour un défaut triphasé, une fois pour un défaut biphasé. Il convient de ne pas spécifier un défaut monophasé.

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libellé	value	description
lineToLineToGround		Le défaut connecte les phases indiquées à la terre et les unes aux autres. L'impédance ligne à ligne est connectée entre chacune des phases spécifiées dans le défaut dans un maillage complet. Par exemple, trois fois pour un défaut triphasé, une fois pour un défaut biphasé. Il convient de ne pas spécifier un défaut monophasé. L'impédance totale de terre est connectée entre chaque phase spécifiée dans le défaut et dans la terre.
lineOpen		Le défaut se produit lorsque le chemin du conducteur est interrompu entre deux bornes. Des défauts coexistant supplémentaires peuvent être exigés si le conducteur interrompu provoque également des connexions à la terre ou à d'autres lignes ou phases.

6.19 Paquetage SCADA

6.19.1 Généralités

Contient des entités pour modéliser les informations utilisées par les applications de commande de surveillance et acquisition de données (SCADA, supervisory control and data acquisition). La commande de surveillance prend en charge la commande de l'équipement par l'opérateur, telle qu'ouverture ou fermeture d'un disjoncteur. L'acquisition de données rassemble les données télémesurées provenant de diverses sources. Les sous-types de l'entité Telemetry correspondent délibérément aux définitions de l'UCA et de l'IEC 61850.

Ce paquetage prend également en charge la présentation d'alarmes, mais n'est pas réputé être utilisé par d'autres applications.

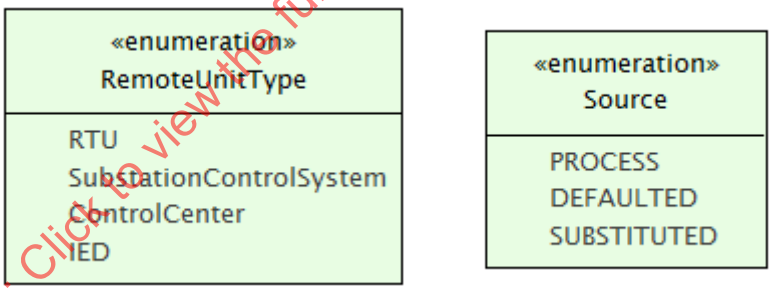


Figure 136 – Diagramme de classe SCADA::Datatypes

Figure 136: Représente les types de données pour un modèle SCADA.

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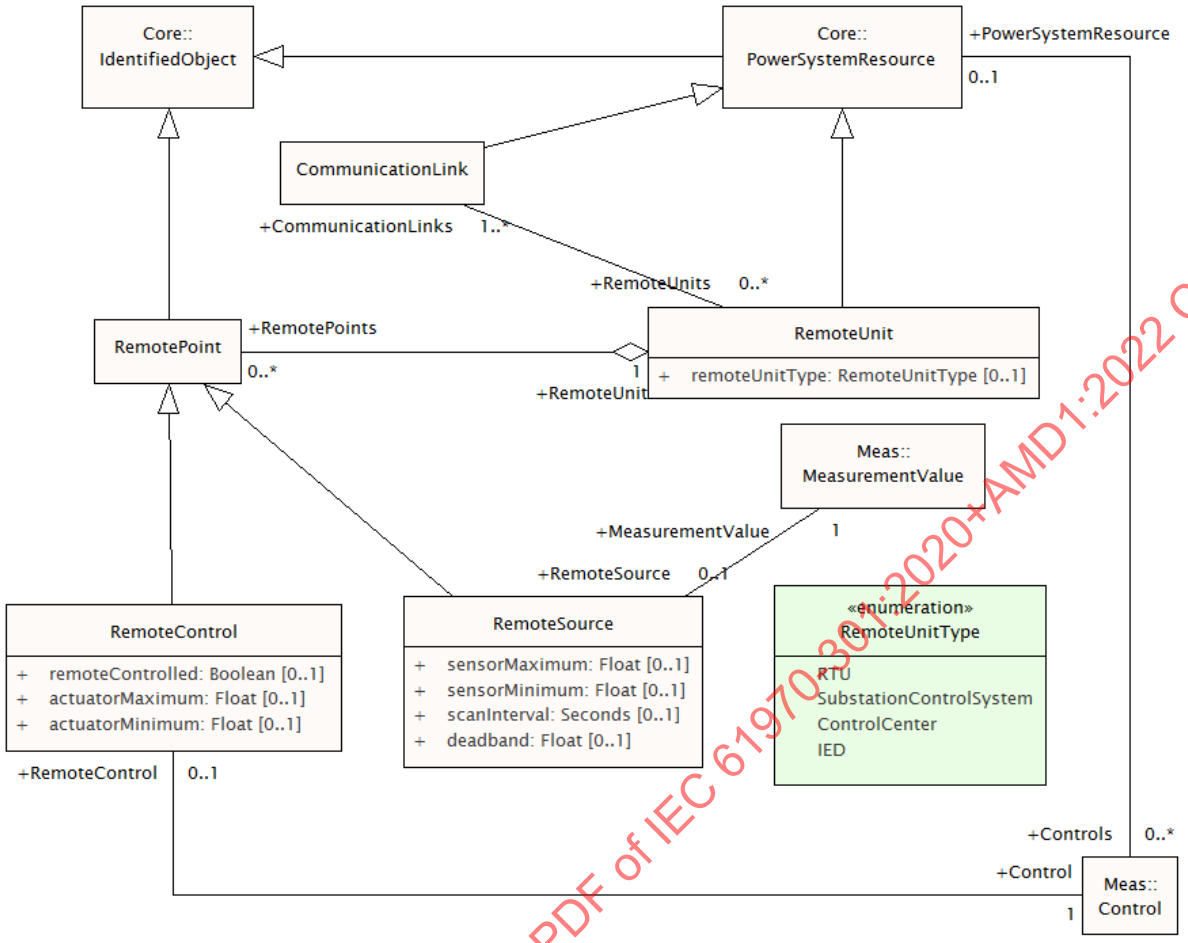


Figure 137 – Diagramme de classe SCADA::Main

Figure 137: dans le paquetage SCADA, de même que les classes-clés externes qui ont des associations avec des classes SCADA.

6.19.2 CommunicationLink

La connexion à des unités distantes se fait par l'intermédiaire d'une ou de plusieurs liaisons de communication. Des liaisons redondantes peuvent exister. La classe CommunicationLink hérite de PowerSystemResource. L'intention est de permettre aux CommunicationLinks (liaisons de communication) d'avoir des Measurements. Ces Measurements peuvent être utilisés pour modéliser l'état de la liaison comme étant opérationnel, hors service, défaillance d'unité, etc.

Le Tableau 707 présente tous les attributs de CommunicationLink.

Tableau 707 – Attributs de SCADA::CommunicationLink

nom	mult	type	description
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

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Le Tableau 708 présente toutes les extrémités d'association de CommunicationLink avec d'autres classes.

Tableau 708 – Extrémités d'association de SCADA::CommunicationLink avec d'autres classes

mult à partir de	nom	mult vers	type	description
1..*	RemoteUnits	0..*	RemoteUnit	Des unités distantes RTU peuvent être jointes à des liaisons de communication.
0..n	BilateralExchangeActor	0..1	BilateralExchangeActor	Fournisseur de données ou utilisateur ICCP utilisant l'adressage de communication pour une table Bilateral (bilatérale).
0..*	PSRType	0..1	PSRType	hérité de: PowerSystemResource
0..1	Controls	0..*	Control	hérité de: PowerSystemResource
0..1	Measurements	0..*	Measurement	hérité de: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	hérité de: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	hérité de: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.19.3 RemoteControl

Les commandes distantes sont des sorties envoyées par l'unité distante à des actionneurs dans le processus.

Le Tableau 709 présente tous les attributs de RemoteControl.

Tableau 709 – Attributs de SCADA::RemoteControl

nom	mult	type	description
remoteControlled	0..1	Boolean	Défini sur true (vrai) si l'actionneur est commandé à distance.
actuatorMaximum	0..1	Float	Valeur maximale de point de consigne acceptée par le point de commande à distance.
actuatorMinimum	0..1	Float	Valeur minimale de point de consigne acceptée par le point de commande à distance.
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 710 présente toutes les extrémités d'association de RemoteControl avec d'autres classes.

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Tableau 710 – Extrémités d'association de SCADA::RemoteControl avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..1	Control	1..1	Control	Control (commande) pour le point RemoteControl (commande à distance).
0..*	RemoteUnit	1..1	RemoteUnit	hérité de: RemotePoint
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.19.4 RemotePoint

Pour une RTU, les points distants correspondent à des valeurs télémesurées ou des sorties de commande. D'autres unités (par exemple, centres de conduite) aussi contiennent habituellement des valeurs calculées.

Le Tableau 711 présente tous les attributs de RemotePoint.

Tableau 711 – Attributs de SCADA::RemotePoint

nom	mult	type	description
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 712 présente toutes les extrémités d'association de RemotePoint avec d'autres classes.

Tableau 712 – Extrémités d'association de SCADA::RemotePoint avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..*	RemoteUnit	1..1	RemoteUnit	Unité distante à laquelle ce point appartient.
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.19.5 RemoteSource

Les sources distantes sont des variables d'état qui sont télémesurées ou calculées au sein de l'unité distante.

Le Tableau 713 présente tous les attributs de RemoteSource.

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Tableau 713 – Attributs de SCADA::RemoteSource

nom	mult	type	description
sensorMaximum	0..1	Float	Valeur maximale que peut retourner l'entité de télémesure.
sensorMinimum	0..1	Float	Valeur minimale que peut retourner l'entité de télémesure.
scanInterval	0..1	Seconds	Intervalle de temps entre balayages.
deadband	0..1	Float	Plus petite variation de valeur devant être communiquée.
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 714 présente toutes les extrémités d'association de RemoteSource avec d'autres classes.

Tableau 714 – Extrémités d'association de SCADA::RemoteSource avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..1	MeasurementValue	1..1	MeasurementValue	Lien avec le point physique de télémesure associé à ce Measurement.
0..*	RemoteUnit	1..1	RemoteUnit	hérité de: RemotePoint
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.19.6 RemoteUnit

Une unité distante peut être une RTU, un IED (Intelligent Electronic Device – appareil électronique intelligent), un système de commande de poste, un centre de conduite, etc. La communication avec l'unité distante peut être effectuée par divers protocoles normalisés (par exemple IEC 61870, IEC 61850) ou protocoles non normalisés (par exemple DNP, RP570, etc.). Une unité distante contient des points de données distants qui peuvent être télémesurés, recueillis ou calculés. La classe RemoteUnit hérite de PowerSystemResource. L'intention est de permettre aux RemoteUnits (unités distantes) d'avoir des Measurements. Ces Measurements peuvent être utilisées pour modéliser l'état de l'unité comme étant opérationnel, hors service, défaillance d'unité, etc.

Le Tableau 715 présente tous les attributs de RemoteUnit.

Tableau 715 – Attributs de SCADA::RemoteUnit

nom	mult	type	description
remoteUnitType	0..1	RemoteUnitType	Type d'unité distante.
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

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Le Tableau 716 présente toutes les extrémités d'association de RemoteUnit avec d'autres classes.

Tableau 716 – Extrémités d'association de SCADA::RemoteUnit avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..*	CommunicationLinks	1..*	CommunicationLink	Des unités distantes RTU peuvent être jointes à des liaisons de communication.
1..1	RemotePoints	0..*	RemotePoint	Points distants que contient cette unité distante.
0..*	PSRType	0..1	PSRType	hérité de: PowerSystemResource
0..1	Controls	0..*	Control	hérité de: PowerSystemResource
0..1	Measurements	0..*	Measurement	hérité de: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	hérité de: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	hérité de: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.19.7 Enumération RemoteUnitType

Type d'unité distante.

Le Tableau 717 présente tous les libellés de RemoteUnitType.

Tableau 717 – Libellés de SCADA::RemoteUnitType

libellé	value	description
RTU		Unité de borne distante.
SubstationControlSystem		Système de commande de poste.
ControlCenter		Centre de conduite.
IED		Appareil électronique intelligent (IED – Intelligent Electronic Device).

6.19.8 Enumération Source

Source donne des informations relatives à l'origine de la valeur.

Le Tableau 718 présente tous les libellés de Source.

Tableau 718 – Libellés de SCADA::Source

libellé	value	description
PROCESS		La valeur est fournie par une entrée du processus E/S ou calculée par une fonction.
DEFAULTED		La valeur contient une valeur par défaut.
SUBSTITUTED		La valeur est fournie par entrée de l'opérateur ou par une source automatique.

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6.20 Paquetage ICCPConfiguration

6.20.1 Généralités

Ce paquetage modélise la configuration d'ICCP exigée pour les échanges bilatéraux.

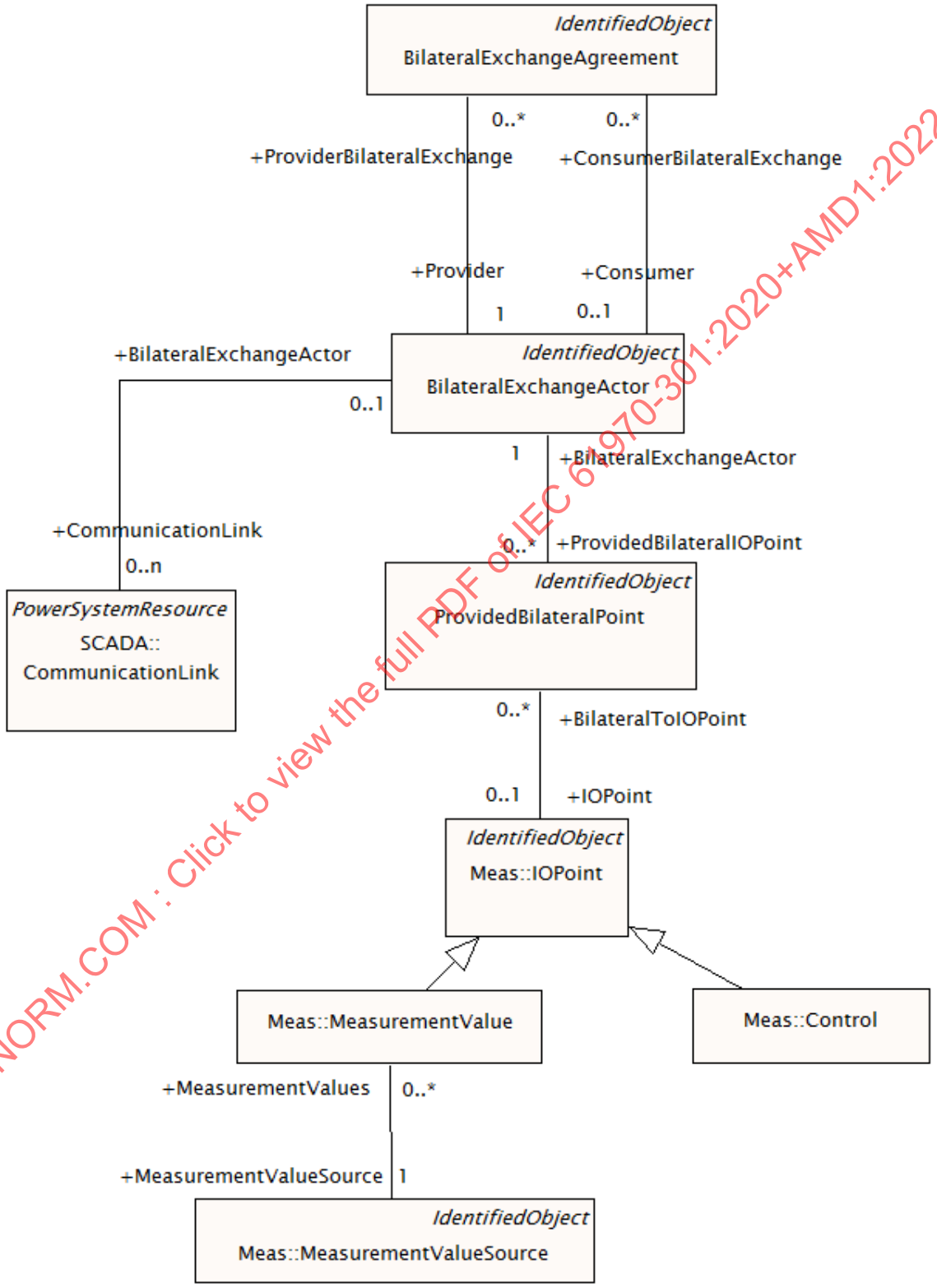


Figure 138 – Diagramme de classe ICCPConfiguration::GenericBilateralExchange

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Figure 138: Classes utilisées pour modéliser l'échange ICCP bilatéral.

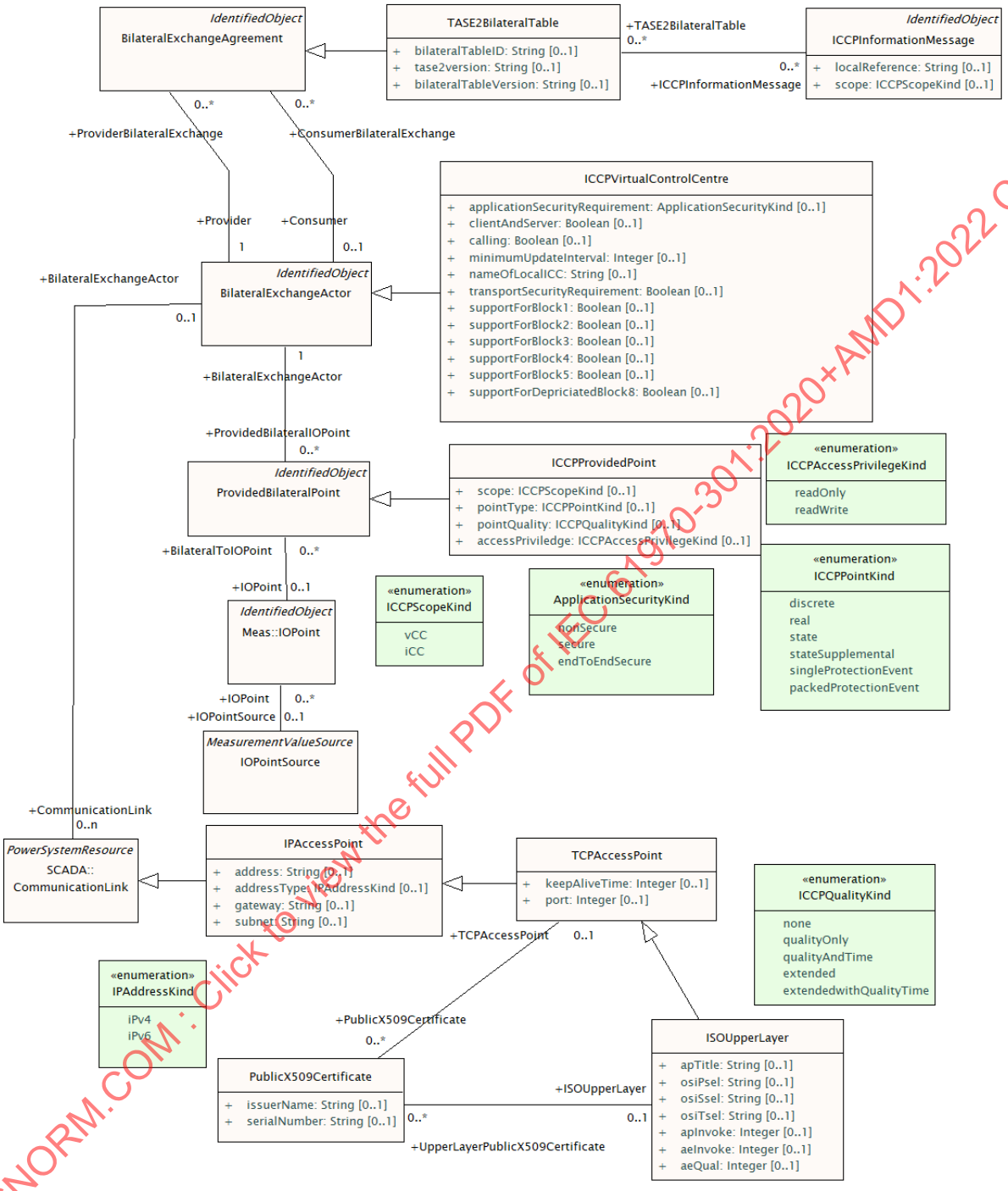


Figure 139 – Diagramme de classe ICCPConfiguration::ICCP

Figure 139: Classes utilisées pour la configuration ICCP.

6.20.2 Enumération ApplicationSecurityKind

Spécifie le mécanisme de sécurité prévu, conformément à l'IEC 62351-4, à utiliser.

Le Tableau 719 présente tous les libellés de ApplicationSecurityKind.

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Tableau 719 – Libellés de ICCPConfiguration::ApplicationSecurityKind

libellé	value	description
nonSecure		Indique qu'une sécurité d'application ne doit pas être utilisée afin de pouvoir établir une association MSS.
secure		Indique qu'un profil de sécurité A tel que spécifié à l'Article 11 (ou dans l'IEC TS 62351-4:2007) doit être utilisé pour pouvoir établir une association MMS.
endToEndSecure		Indique qu'une sécurité E2E ne doit pas être utilisée afin de pouvoir établir une association MMS.

6.20.3 BilateralExchangeActor

BilateralExchangeActor décrit un acteur qui fournit des données ICCP et/ou consomme des données ICCP. Le fournisseur de données ICCP répertorie les données qu'il met à la disposition d'un consommateur de données ICCP. Ces données sont écrites par ProvidedBilateralPoints. La relation entre un fournisseur de données ICCP et un consommateur est établie par un BilateralExchangeAgreement. Il revient au consommateur de données ICCP de choisir le ProvidedBilateralPoints à utiliser. Le choix réalisé n'est pas décrit dans ce modèle d'informations.

Le Tableau 720 présente tous les attributs de BilateralExchangeActor.

Tableau 720 – Attributs de ICCPConfiguration::BilateralExchangeActor

nom	mult	type	description
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 721 présente toutes les extrémités d'association de BilateralExchangeActor avec d'autres classes.

Tableau 721 – Extrémités d'association de ICCPConfiguration::BilateralExchangeActor avec d'autres classes

mult à partir de	nom	mult vers	type	description
1..1	ProviderBilateralExchange	0..*	BilateralExchangeAgreement	Accord avec le fournisseur d'informations.
0..1	CommunicationLink	0..n	CommunicationLink	Adressage de communication pour une table bilatérale utilisée par un fournisseur ou utilisateur de données ICCP.
0..1	ConsumerBilateralExchange	0..*	BilateralExchangeAgreement	Accord avec l'abonné aux informations.
1..1	ProvidedBilateralIOPoint	0..*	ProvidedBilateralPoint	Informations ICCP dans une table bilatérale qui sont présentées à un homologue distant.
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

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6.20.4 BilateralExchangeAgreement

Il s'agit d'une représentation de l'accord d'échange d'informations entre des homologues.

Le Tableau 722 présente tous les attributs de BilateralExchangeAgreement.

Tableau 722 – Attributs de ICCPConfiguration::BilateralExchangeAgreement

nom	mult	type	description
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 723 présente toutes les extrémités d'association de BilateralExchangeAgreement avec d'autres classes.

Tableau 723 – Extrémités d'association de ICCPConfiguration::BilateralExchangeAgreement avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..*	Consumer	0..1	BilateralExchangeActor	Abonné aux informations provenant d'un homologue distant.
0..*	Provider	1..1	BilateralExchangeActor	Fournisseur d'informations à un homologue distant.
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.20.5 Enumération ICCPAccessPrivilegeKind

Donne des informations de privilège d'accès concernant un point ICCP.

Le Tableau 724 présente tous les libellés de ICCPAccessPrivilegeKind.

Tableau 724 – Libellés de ICCPConfiguration::ICCPAccessPrivilegeKind

libellé	value	description
readOnly		Indique que l'unité distance n'est pas autorisée à modifier la valeur de ICCPPoint.
readWrite		Indique que l'unité distante ne peut pas uniquement obtenir la valeur, mais qu'elle peut également modifier la valeur de ICCP Point.

6.20.6 ICCPInformationMessage

Cette classe représente l'objet de message d'informations TASE.2. L'attribut IdentifiedObject.name doit être non nul. La valeur de l'attribut doit être utilisée comme référence d'informations TASE.2 (voir l'IEC 60870-6-503).

Le Tableau 725 présente tous les attributs de ICCPInformationMessage.

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Tableau 725 – Attributs de ICCPConfiguration::ICCPInformationMessage

nom	mult	type	description
localReference	0..1	String	L'attribut local Reference spécifie une valeur convenue entre l'émetteur et le récepteur du message d'informations. En outre, il identifie le message d'informations.
scope	0..1	ICCPScopeKind	Indique si le Point est global (VCC, par exemple) ou uniquement accessible à l'homologue de la table bilatérale (ICC, par exemple).
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 726 présente toutes les extrémités d'association de ICCPInformationMessage avec d'autres classes.

Tableau 726 – Extrémités d'association de ICCPConfiguration::ICCPInformationMessage avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..*	TASE2BilateralTable	0..*	TASE2BilateralTable	Accord de table bilatérale qui inclut le message d'informations.
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.20.7 Enumération ICCPPointKind

Type de point ICCP à acheminer.

Le Tableau 727 présente tous les libellés de ICCPPointKind.

Tableau 727 – Libellés de ICCPConfiguration::ICCPPointKind

libellé	value	description
discrete		Indique qu'un type discret ICCP doit être acheminé.
real		Indique qu'un type réel ICCP doit être acheminé.
state		Indique qu'un type d'état ICCP doit être acheminé.
stateSupplemental		Indique qu'un type supplémentaire d'état ICCP doit être acheminé.
singleProtectionEvent		Indique qu'un type d'événement de protection simple ICCP doit être acheminé.
packedProtectionEvent		Indique qu'un événement de protection empaqueté ICCP doit être acheminé.

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6.20.8 ICCPProvidedPoint

L'attribut IdentifiedObject.name doit avoir une valeur. L'attribut name doit être utilisé comme le nom DataValue utilisé pour l'échange.

Le Tableau 728 présente tous les attributs de ICCPProvidedPoint.

Tableau 728 – Attributs de ICCPConfiguration::ICCPProvidedPoint

nom	mult	type	description
scope	0..1	ICCPScopeKind	Indique si le Point est global (VCC, par exemple) ou uniquement accessible à l'homologue de la table bilatérale (ICC, par exemple).
pointType	0..1	ICCPPointKind	Indique le type de point ICCP qui doit être acheminé. Un CIM AccumlatorValue doit être mis en correspondance à un ICCP réel. Un CIM AnalogValue doit être mis en correspondance à un ICCP réel. Un CIM DiscreteValue doit être mis en correspondance à un ICCP réel, un état, un stateSupplemental ou à un type d'événement de protection. Un CIM StringMeasurementValue ne doit pas comporter de mise en correspondance normalisé.
pointQuality	0..1	ICCPQualityKind	Spécifie le type de qualité ICCP qui est acheminé dans le cadre du point ICCP.
accessPriviledge	0..1	ICCPAccessPrivilegeKind	Donne des informations relatives aux privilèges d'accès accordés au point ICCP.
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 729 présente toutes les extrémités d'association de ICCPProvidedPoint avec d'autres classes.

Tableau 729 – Extrémités d'association de ICCPConfiguration::ICCPProvidedPoint avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..*	BilateralExchangeActor	1..1	BilateralExchangeActor	hérité de: ProvidedBilateralPoint
0..*	IOPoint	0..1	IOPoint	hérité de: ProvidedBilateralPoint
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.20.9 Enumération ICCPQualityKind

Indique le type d'informations de qualité à échanger. Pour les événements de protection, la valeur doit être "none" (aucun).

Le Tableau 730 présente tous les libellés de ICCPQualityKind.

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Tableau 730 – Libellés de ICCPConfiguration::ICCPQualityKind

libellé	value	description
none		Indique qu'aucune qualité n'est acheminée avec le point ICCP.
qualityOnly		Indique que seule la qualité doit être fournie.
qualityAndTime		Indique que cette qualité et un horodatage doivent être fournis.
extended		Indique que seules les informations étendues doivent être fournies.
extendedwithQualityTime		Donne des informations relatives à la qualité et à l'horodatage, ainsi que des informations étendues.

6.20.10 Enumération ICCPScopeKind

Spécifie le domaine d'application du centre de conduite.

Le Tableau 731 présente tous les libellés de ICCPScopeKind.

Tableau 731 – Libellés de ICCPConfiguration::ICCPScopeKind

libellé	value	description
vCC		Domaine d'application du centre de conduite virtuel – globalement disponible.
iCC		Domaine d'application inter-centre de conduites – disponible pour l'échange entre les centres de conduite dans la table bilatérale.

6.20.11 ICCPVCC

Indique que les informations ICCP sont par nature globales et en principe disponibles à tous les homologues autorisés.

Le Tableau 732 présente tous les attributs de ICCPVCC.

Tableau 732 – Attributs de ICCPConfiguration::ICCPVCC

nom	mult	type	description
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 733 présente toutes les extrémités d'association de ICCPVCC avec d'autres classes.

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Tableau 733 – Extrémités d'association de ICCPConfiguration::ICCPVCC avec d'autres classes

mult à partir de	nom	mult vers	type	description
1..1	ProviderBilateralExchange	0..*	BilateralExchangeAgreement	hérité de: BilateralExchangeActor
0..1	CommunicationLink	0..n	CommunicationLink	hérité de: BilateralExchangeActor
0..1	ConsumerBilateralExchange	0..*	BilateralExchangeAgreement	hérité de: BilateralExchangeActor
1..1	ProvidedBilateralIOPoint	0..*	ProvidedBilateralPoint	hérité de: BilateralExchangeActor
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.20.12 ICCPVirtualControlCentre

Contient les informations qu'un acteur particulier expose dans le cadre d'un accord particulier dans le tableau bilatéral ICCP.

Le Tableau 734 présente tous les attributs de ICCPVirtualControlCentre.

Tableau 734 – Attributs de ICCPConfiguration::ICCPVirtualControlCentre

nom	mult	type	description
applicationSecurityRequirement	0..1	ApplicationSecurityKind	Spécifie le mécanisme de sécurité prévu, conformément à l'IEC 62351-4, à utiliser.
clientAndServer	0..1	Boolean	Si True, la valeur indique que l'entité représentée par la table bilatérale peut formuler des demandes et répondre à une demande (prise en charge bidirectionnelle des demandes ICCP, par exemple). Si False, indique qu'une entité appelante (par exemple, calling=True) ne peut pas répondre aux demandes ICCP. Si False, et que calling=False, indique que l'entité répond uniquement aux demandes ICCP, mais n'en formule pas.
calling	0..1	Boolean	Utilisé pour indiquer si le fournisseur est chargé d'initier la connexion TASE.2. Si la valeur est TRUE, le fournisseur est chargé d'établir l'association. Si la valeur est FALSE, le fournisseur homologue de la table bilatérale a besoin d'établir l'association.
minimumUpdateInterval	0..1	Integer	Spécifie l'intervalle de mise à jour le plus rapide qui peut être proposé pour les informations d'intégrité et la création d'un groupe de transferts. La valeur est exprimée en secondes.
nameOfLocalICC	0..1	String	Spécifie le nom de domaine d'application ICC que l'unité distante peut utiliser pour accéder aux informations dans la table bilatérale si les informations ne sont pas VCC. Cette valeur peut ne pas être nulle.
transportSecurityRequirement	0..1	Boolean	Si true, la sécurité du niveau de transport spécifiée dans l'IEC 62351-6 est exigée.
supportForBlock1	0..1	Boolean	Conformément à l'IEC 60870-6-702: Si true, indique la prise en charge des services de base. Doit toujours être true.
supportForBlock2	0..1	Boolean	Conformément à l'IEC 60870-6-702: Si true, indique la prise en charge des conditions étendues.

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nom	mult	type	description
supportForBlock3	0..1	Boolean	Conformément à l'IEC 60870-6-702: Si true, indique la prise en charge des transferts bloqués.
supportForBlock4	0..1	Boolean	Conformément à l'IEC 60870-6-702: Si true, indique la prise en charge des messages d'informations.
supportForBlock5	0..1	Boolean	Conformément à l'IEC 60870-6-702: Si true, indique la prise en charge de la commande des appareils.
supportForDepriciatedBlock8	0..1	Boolean	Conformément à l'IEC 60870-6-702: Si true, indique la prise en charge des comptes. L'utilisation de ce bloc a été déconseillée dans l'Édition 3.
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 735 présente toutes les extrémités d'association de ICCPVirtualControlCentre avec d'autres classes.

Tableau 735 – Extrémités d'association de ICCPConfiguration::ICCPVirtualControlCentre avec d'autres classes

mult à partir de	nom	mult vers	type	description
1..1	ProviderBilateralExchange	0..*	BilateralExchangeAgreement	hérité de: BilateralExchangeActor
0..1	CommunicationLink	0..n	CommunicationLink	hérité de: BilateralExchangeActor
0..1	ConsumerBilateralExchange	0..*	BilateralExchangeAgreement	hérité de: BilateralExchangeActor
1..1	ProvidedBilateralIOPoint	0..*	ProvidedBilateralPoint	hérité de: BilateralExchangeActor
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.20.13 IOPointSource

Indique la source d'un point E/S.

Le Tableau 736 présente tous les attributs de IOPointSource.

Tableau 736 – Attributs de ICCPConfiguration::IOPointSource

nom	mult	type	description
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 737 présente toutes les extrémités d'association de IOPointSource avec d'autres classes.

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Tableau 737 – Extrémités d'association de ICCPConfiguration::IOPointSource avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..1	IOPoint	0..*	IOPoint	Point ICCP d'une source locale de valeur de mesure.
1..1	MeasurementValues	0..*	MeasurementValue	hérité de: MeasurementValueSource
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.20.14 IPAccessPoint

Point d'accès de protocole Internet – Utilisé pour représenter une structure d'adressage reposant sur une Adresse IP (Internet Protocol).

Le Tableau 738 présente tous les attributs de IPAccessPoint.

Tableau 738 – Attributs de ICCPConfiguration::IPAccessPoint

nom	mult	type	description
address	0..1	String	Adresse IP décimale à points qui résout l'adresse IP. Le format est commandé par la valeur de addressType.
addressType	0..1	IPAddressKind	Type d'adresse IP.
gateway	0..1	String	Adresse IP décimale à points du premier routeur de saut. Le format est commandé par addressType.
subnet	0..1	String	Il s'agit du masque de sous-réseau IP qui commande le routage local par opposition au routage non local.
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 739 présente toutes les extrémités d'association de IPAccessPoint avec d'autres classes.

Tableau 739 – Extrémités d'association de ICCPConfiguration::IPAccessPoint avec d'autres classes

mult à partir de	nom	mult vers	type	description
1..*	RemoteUnits	0..*	RemoteUnit	hérité de: CommunicationLink
0..n	BilateralExchangeActor	0..1	BilateralExchangeActor	hérité de: CommunicationLink
0..*	PSRType	0..1	PSRType	hérité de: PowerSystemResource
0..1	Controls	0..*	Control	hérité de: PowerSystemResource
0..1	Measurements	0..*	Measurement	hérité de: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	hérité de: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	hérité de: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

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6.20.15 Enumération IPAddressKind

Indique si l'adressage de l'IPAccessPoint, de la passerelle et du sous-réseau sont conformes à IPv4 ou IPv6.

Le Tableau 740 présente tous les libellés de IPAddressKind.

Tableau 740 – Libellés de ICCPConfiguration::IPAddressKind

libellé	value	description
iPv4		Indique que la notation décimale à points IPv4 est utilisée.
iPv6		Indique qu'une décimale à points IPv6 est utilisée.

6.20.16 ISOUpperLayer

Ensemble d'informations d'adressage de configuration exigé, étant donné que ICCP utilise un adressage autre qu'un accès TCP.

Le Tableau 741 présente tous les attributs de ISOUpperLayer.

Tableau 741 – Attributs de ICCPConfiguration::ISOUpperLayer

nom	mult	type	description
apTitle	0..1	String	Séquence de chaînes d'entiers séparés par ".". La valeur est utilisée conjointement avec d'autres attributs d'adressage d'application (d'autres AP, par exemple) pour choisir une application spécifique (l'entité d'application ICCP, par exemple) selon le modèle de référence OSI. La séquence et ses valeurs représentent un espace de noms dont les valeurs sont régies par l'ISO/IEC 7498-3.
osiPsel	0..1	String	Sélecteur d'adressage pour l'adressage de présentation OSI.
osiSsel	0..1	String	Informations relatives à l'adressage de couche de session OSI.
osiTsel	0..1	String	Informations relatives à l'adressage de couche de transport OSI.
apInvoke	0..1	Integer	Paramètre d'adressage OSI de niveau d'application supplémentaire.
aeInvoke	0..1	Integer	Fait partie de l'adressage d'entité d'application tel que spécifié par l'adressage ISO.
aeQual	0..1	Integer	Qualificatif AE et représente d'autres informations d'adressage de niveau d'application.
keepAliveTime	0..1	Integer	hérité de: TCPAccessPoint
port	0..1	Integer	hérité de: TCPAccessPoint
address	0..1	String	hérité de: IPAccessPoint
addressType	0..1	IPAddressKind	hérité de: IPAccessPoint
gateway	0..1	String	hérité de: IPAccessPoint
subnet	0..1	String	hérité de: IPAccessPoint
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

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Le Tableau 742 présente toutes les extrémités d'association de ISOUpperLayer avec d'autres classes.

Tableau 742 – Extrémités d'association de ICCPConfiguration::ISOUpperLayer avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..1	UpperLayerPublicX509 Certificate	0..*	PublicX509Certificate	Certificat à lier pour assurer une authentification mutuelle de couche Application.
0..1	PublicX509Certificate	0..*	PublicX509Certificate	hérité de: TCPAccessPoint
1..*	RemoteUnits	0..*	RemoteUnit	hérité de: CommunicationLink
0..n	BilateralExchangeActor	0..1	BilateralExchangeActor	hérité de: CommunicationLink
0..*	PSRType	0..1	PSRType	hérité de: PowerSystemResource
0..1	Controls	0..*	Control	hérité de: PowerSystemResource
0..1	Measurements	0..*	Measurement	hérité de: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	hérité de: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	hérité de: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.20.17 ProvidedBilateralPoint

Permet de déclarer des points ICCP à fournir dans le cadre d'un accord de table bilatérale.

Le Tableau 743 présente tous les attributs de ProvidedBilateralPoint.

Tableau 743 – Attributs de ICCPConfiguration::ProvidedBilateralPoint

nom	mult	type	description
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 744 présente toutes les extrémités d'association de ProvidedBilateralPoint avec d'autres classes.

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Tableau 744 – Extrémités d'association de ICCPConfiguration::ProvidedBilateralPoint avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..*	BilateralExchangeActor	1..1	BilateralExchangeActor	Homologue distant qui reçoit les informations ICCP dans une table bilatérale.
0..*	IOPoint	0..1	IOPoint	Mesure ou commande du point ICCP bilatéral.
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.20.18 Classe racine PublicX509Certificate

Utilisé pour acheminer les informations qui permettent la mise en correspondance, afin de déterminer le certificat à utiliser. Les certificats réels sont échangés en externe au cours de l'échange CI.

Le Tableau 745 présente tous les attributs de PublicX509Certificate.

Tableau 745 – Attributs de ICCPConfiguration::PublicX509Certificate

nom	mult	type	description
issuerName	0..1	String	Représente la CA qui a émis le certificat. Définie pour être conforme à X.509.
serialNumber	0..1	String	Numéro de série du certificat selon la définition X.509.

Le Tableau 746 présente toutes les extrémités d'association de PublicX509Certificate avec d'autres classes.

Tableau 746 – Extrémités d'association de ICCPConfiguration::PublicX509Certificate avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..*	ISOUpperLayer	0..1	ISOUpperLayer	Couche d'application utilisée avec le certificat pour l'authentification mutuelle.
0..*	TCPAccessPoint	0..1	TCPAccessPoint	L'association permet de lier un certificat à utiliser par TLS.

6.20.19 TASE2BilateralTable

Cette classe décrit le côté émetteur (fournisseur) d'un échange de données ICCP bilatéral. Les descriptions bilatérales ICCP (table) sont donc créées en échangeant les données de fournisseur ICCP entre les parties.

Le Tableau 747 présente tous les attributs de TASE2BilateralTable.

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Tableau 747 – Attributs de ICCPConfiguration::TASE2BilateralTable

nom	mult	type	description
bilateralTableID	0..1	String	Spécifie la version de la configuration de table bilatérale échangée.
tase2version	0..1	String	Spécifie la version de TASE.2 nécessaire pour accéder aux informations de table bilatérale par l'intermédiaire de TASE.2. Pour établir un lien, les deux côtés doivent avoir la même valeur.
bilateralTableVersion	0..1	String	L'attribut Version identifie une version unique de la table bilatérale. Si des modifications sont apportées à une table bilatérale, une nouvelle valeur unique doit être générée pour cet attribut.
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 748 présente toutes les extrémités d'association de TASE2BilateralTable avec d'autres classes.

Tableau 748 – Extrémités d'association de ICCPConfiguration::TASE2BilateralTable avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..*	ICCPInformationMessage	0..*	ICCPInformationMessage	Message d'informations à inclure dans un accord de table bilatérale.
0..*	Consumer	0..1	BilateralExchangeActor	hérité de: BilateralExchangeAgreement
0..*	Provider	1	BilateralExchangeActor	hérité de: BilateralExchangeAgreement
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

6.20.20 TCPAccessPoint

Autorise des informations d'adressage et de comportement relatives à l'utilisation de TCP par les liens ICCP.

Le Tableau 749 présente tous les attributs de TCPAccessPoint.

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Tableau 749 – Attributs de ICCPConfiguration::TCPAccessPoint

nom	mult	type	description
keepAliveTime	0..1	Integer	Indique l'intervalle par défaut auquel TCP vérifie si la connexion TCP est toujours valable.
port	0..1	Integer	Cette valeur peut uniquement être spécifiée pour les nœuds appelés (ceux qui répondent à une demande TCP.Open, par exemple). Cette valeur spécifie l'accès TCP à utiliser. Des accès connus et "enregistrés" sont préférentiels et peuvent être trouvés à l'adresse suivante: http://www.iana.org/assignments/service-names-port-numbers/service-names-port-numbers.xhtml Pour l'IEC 60870-6 TASE.2 (ICCP, par exemple) et l'IEC 61850, la valeur utilisée doit être 102 pour les échanges protégés non TLS. La valeur doit être 3782 pour les échanges ICCP et 61850 transportés par TLS.
address	0..1	String	hérité de: IPAccessPoint
addressType	0..1	IPAddressKind	hérité de: IPAccessPoint
gateway	0..1	String	hérité de: IPAccessPoint
subnet	0..1	String	hérité de: IPAccessPoint
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject

Le Tableau 750 présente toutes les extrémités d'association de TCPAccessPoint avec d'autres classes.

Tableau 750 – Extrémités d'association de ICCPConfiguration::TCPAccessPoint avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..1	PublicX509Certificate	0..*	PublicX509Certificate	Certificat public utilisé pour l'authentification mutuelle entre homologues.
1..*	RemoteUnits	0..*	RemoteUnit	hérité de: CommunicationLink
0..n	BilateralExchangeActor	0..1	BilateralExchangeActor	hérité de: CommunicationLink
0..*	PSRType	0..1	PSRType	hérité de: PowerSystemResource
0..1	Controls	0..*	Control	hérité de: PowerSystemResource
0..1	Measurements	0..*	Measurement	hérité de: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	hérité de: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	hérité de: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

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Annexe A
(normative)

Extensions personnalisées

A.1 Vue d'ensemble

L'Annexe A est normative. Elle comprend des extensions personnalisées largement utilisées qui peuvent être utiles à des personnes sortant du cadre des organisations qui les ont créées.

A.2 Extensions européennes

A.2.1 Généralités

~~[nsuri = http://iec.ch/TC57/CIM100-EuropeanExtension/1/0#, nsprefix = eu]~~

[nsuri = http://iec.ch/TC57/CIM100-European#, nsprefix = eu]

Ce paquetage contient les extensions européennes au paquetage de base du modèle CIM canonique.

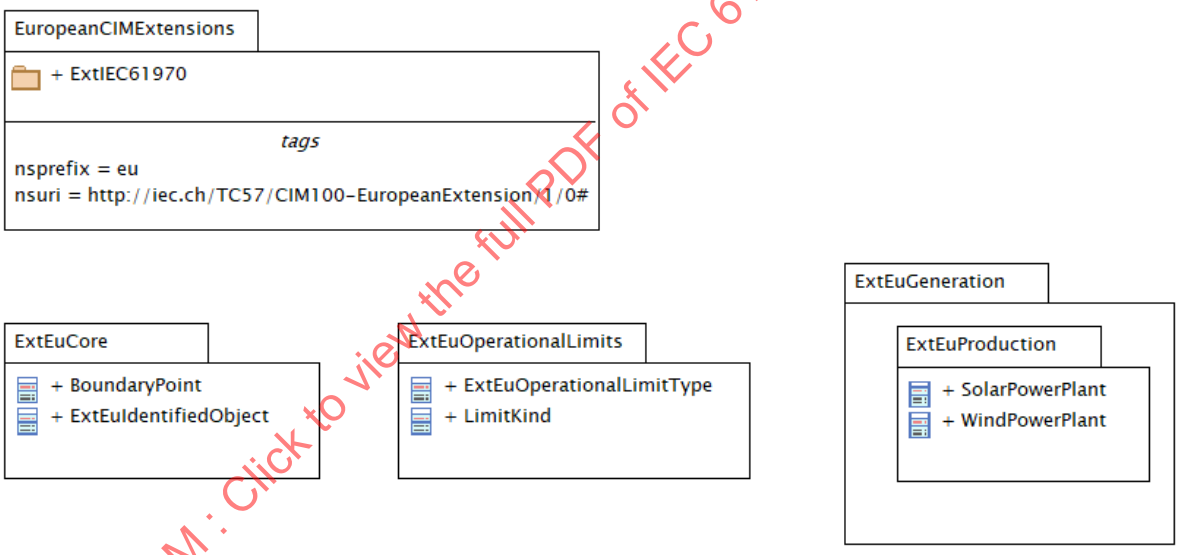


Figure A.1 – Diagramme de classe ExtEuBase::ExtEuBase

Figure A.1: Le diagramme donne un aperçu des paquetages d'extensions européennes.

A.2.2 Paquetage ExtEuCore

A.2.2.1 Généralités

Extensions européennes au paquetage Core.

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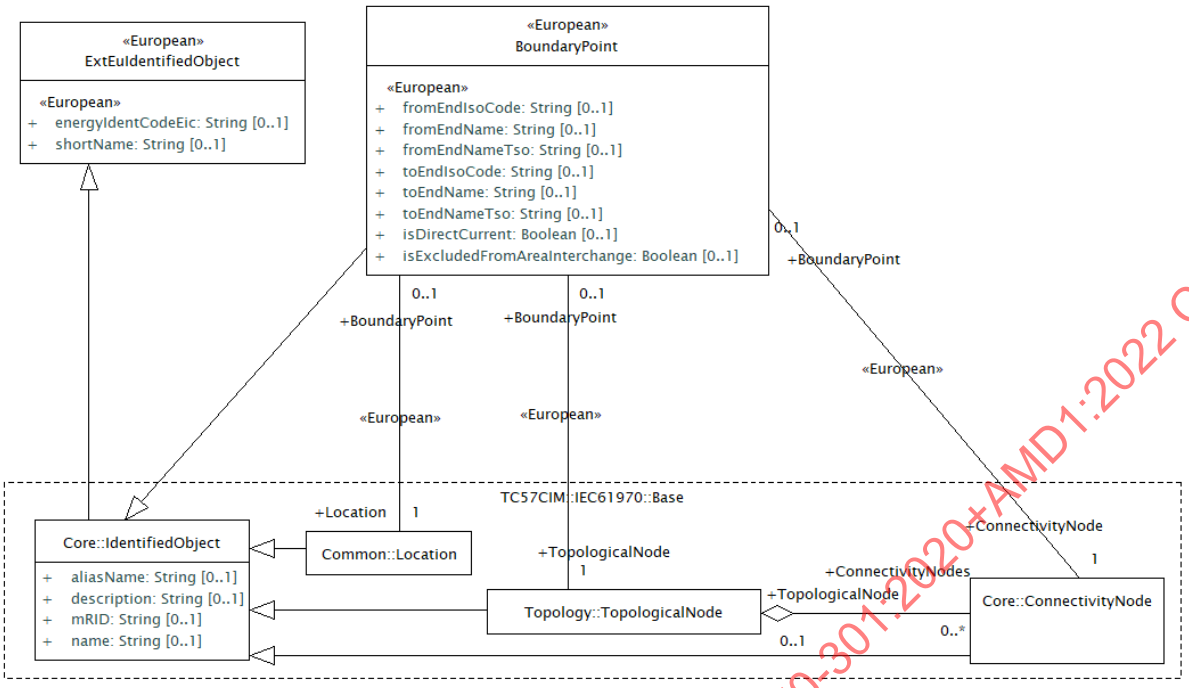


Figure A.2 – Diagramme de classe ExtEuCore::ExtEuCore

Figure A.2: Le diagramme présente les extensions européennes liées aux définitions de limite et à la dénomination.

A.2.2.2 (Européen) BoundaryPoint

Désigne un point de connexion auquel doivent se connecter un ou plusieurs ensembles d'autorités de modèles. L'emplacement du point de connexion ainsi que d'autres propriétés font l'objet d'un accord entre les organisations responsables de l'interconnexion, par conséquent, tous les attributs de la classe représentent cet accord. Il est principalement utilisé dans un ensemble d'autorités de modèles boundary (limites) qui peut contenir un ou plusieurs BoundaryPoint-s entre autres Equipment-s et leurs connexions.Le Tableau A.1 présente tous les attributs de BoundaryPoint.

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Tableau A.1 – Attributs de ExtEuCore::BoundaryPoint

nom	mult	type	description
fromEndIsoCode	0..1	String	(Européen) Code ISO de la région à laquelle le côté "From" (de) du point Boundary (limite) appartient ou est raccordé. Le code ISO est un code de pays à deux caractères, comme défini par l'ISO 3166 (http://www.iso.org/iso/country_codes). La longueur de la chaîne de caractères est de 2 caractères au maximum.
fromEndName	0..1	String	(Européen) Nom lisible par l'homme d'une longueur de chaîne de 64 caractères au maximum. Il couvre les deux cas suivants: – si le point limite (Boundary) est placé sur une ligne d'interconnexion, il s'agit du nom (IdentifiedObject.name) du poste auquel le côté ~~"From" (de)~~ "To" (vers) de la ligne d'interconnexion est raccordé. – si le point limite (Boundary) est placé dans un poste, il s'agit du nom (IdentifiedObject.name) de l'élément (par exemple, PowerTransformer, ACLineSegment, Switch, etc.) auquel le côté ~~"From" (de)~~ "To" (vers) du point limite est raccordé.
fromEndNameTso	0..1	String	(Européen) Identifie le nom du gestionnaire de réseau de transport, du gestionnaire du réseau de distribution ou autre organisme auquel le côté "From" (de) de l'interconnexion est raccordé. La longueur de la chaîne de caractères est de 64 caractères au maximum.
toEndIsoCode	0..1	String	(Européen) Code ISO de la région à laquelle le côté "To" (vers) du point Boundary (limite) appartient ou est raccordé. Le code ISO est un code de pays à deux caractères, comme défini par l'ISO 3166 (http://www.iso.org/iso/country_codes). La longueur de la chaîne de caractères est de 2 caractères au maximum.
toEndName	0..1	String	(Européen) Nom lisible par l'homme d'une longueur de chaîne de 32 caractères au maximum. Il couvre les deux cas suivants: - si le point limite (Boundary) est placé sur une ligne d'interconnexion, il s'agit du nom (IdentifiedObject.name) du poste auquel le côté "To" (vers) de la ligne d'interconnexion est raccordé. - si le point limite (Boundary) est placé dans un poste, il s'agit du nom (IdentifiedObject.name) de l'élément (par exemple, PowerTransformer, ACLineSegment, Switch, etc.) auquel le côté "To" (vers) du point limite est raccordé.
toEndNameTso	0..1	String	(Européen) Identifie le nom du gestionnaire de réseau de transport, du gestionnaire du réseau de distribution ou autre organisme auquel le côté "From" (de) de l'interconnexion est raccordé. La longueur de la chaîne de caractères est de 64 caractères au maximum.
isDirectCurrent	0..1	Boolean	(Européen) Si true, ce point limite est un point de couplage commun (PCC) d'une interconnexion en courant continu (DC), sinon l'interconnexion est en courant alternatif (par défaut).
isExcludedFromAreaInterchange	0..1	Boolean	(Européen) Si true, ce point limite se situe sur l'interconnexion qui est exclue du calcul d'échange de zone de commande et n'a par conséquent aucun flux d'interconnexion associé. Sinon, l'interconnexion est incluse dans l'échange de zone de commande et un TieFlow est exigé de tous les côtés du point limite (par défaut).
aliasName	0..1	String	hérité de: IdentifiedObject

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nom	mult	type	description
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject
energyIdentCodeEic	0..1	String	(Européen) hérité de: ExtEuIdentifiedObject
shortName	0..1	String	(Européen) hérité de: ExtEuIdentifiedObject

Le Tableau A.2 présente toutes les extrémités d'association de BoundaryPoint avec d'autres classes.

Tableau A.2 – Extrémités d'association de ExtEuCore::BoundaryPoint avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..1	ConnectivityNode	1..1	ConnectivityNode	(Européen) Nœud de connectivité désigné comme un point limite.
~~0..1~~	~~TopologicalNode~~	~~1..1~~	~~TopologicalNode~~	~~(Européen) Nœud topologique désigné comme un point limite~~
~~0..1~~	~~Location~~	~~1..1~~	~~Location~~	~~(Européen) Emplacement du point limite associé.~~
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject
0..*	PSRType	0..1	PSRType	hérité de: PowerSystemResource
0..1	Controls	0..*	Control	hérité de: PowerSystemResource
0..1	Measurements	0..*	Measurement	hérité de: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	hérité de: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	hérité de: PowerSystemResource

A.2.2.3 (Européen) Classe racine ExtEuIdentifiedObject

Contient les attributs permettant de mapper les différents schémas d'identification européens.

Le Tableau A.3 présente tous les attributs de ExtEuIdentifiedObject.

Tableau A.3 – Attributs de ExtEuCore::ExtEuIdentifiedObject

nom	mult	type	description
energyIdentCodeEic	0..1	String	(Européen) Attribut utilisé pour un échange du code d'identification EIC (Energy Identification Code). La longueur de la chaîne de caractères est de 16 caractères, comme défini par le code EIC. Pour de plus amples informations sur le schéma EIC, voir le site Web ENTSO-E.
shortName	0..1	String	(Européen) L'attribut est utilisé pour échanger un raccourci lisible par l'homme d'une longueur de chaîne de 12 caractères au maximum.

A.2.3 Paquetage ExtEuOperationalLimits

A.2.3.1 Généralités

Extensions européennes au paquetage OperationalLimits.

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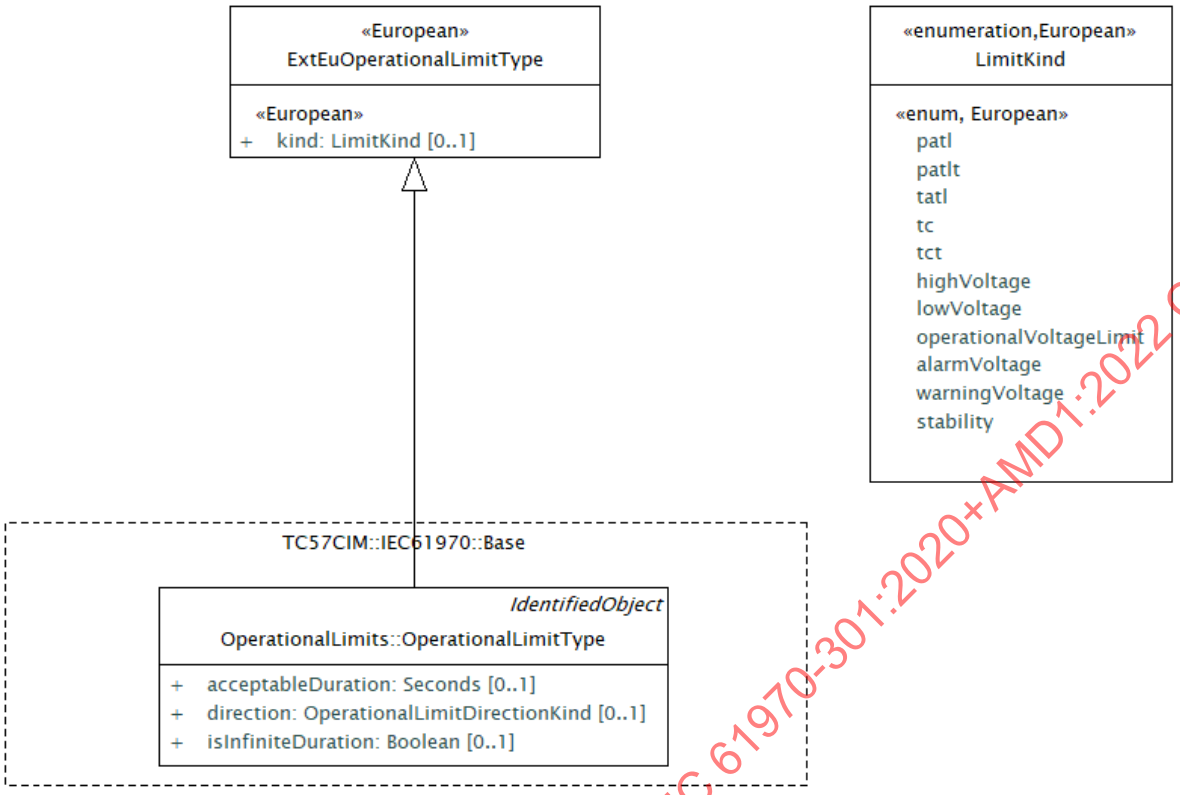


Figure A.3 – Diagramme de classe ExtEuOperationalLimits::ExtEuOperationalLimits

Figure A.3: Le diagramme présente les extensions européennes au paquetage OperationalLimits.

A.2.3.2 (Européen) Classe racine ExtEuOperationalLimitType

Contient un attribut qui étend l'OperationalLimit en lui attribuant un type spécifique.

Le Tableau A.4 présente tous les attributs de ExtEuOperationalLimitType.

Tableau A.4 – Attributs de ExtEuOperationalLimits::ExtEuOperationalLimitType

nom	mult	type	description
kind	0..1	LimitKind	(Européen) Types de limites définies dans la Politique 3 du manuel d'exploitation de l'ENTSO-E.

A.2.3.3 Enumération LimitKind

Types de limites.

Le Tableau A.5 présente tous les libellés de LimitKind.

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Tableau A.5 – Libellés de ExtEuOperationalLimits::LimitKind

libellé	value	description
patl		(Européen) La charge permanente admissible de transport (PATL – Permanent Admissible Transmission Loading) est la charge, en ampères, MVA ou MW, qui peut être acceptée par une branche d'un réseau pendant une durée illimitée sans risque pour le matériel. OperationnalLimitType.isInfiniteDuration est réglé sur true. Il ne doit exister qu'un seul OperationalLimitType de type PATL par OperationalLimitSet si PATL est ApparentPowerLimit, ActivePowerLimit, ou CurrentLimit pour un Terminal ou Equipment donné.
patlt		(Européen) Le seuil de charge permanente admissible de transport (PATLT – Permanent Admissible Transmission Loading Threshold) est une valeur d'unités techniques définie pour la PATL et calculée à l'aide d'un pourcentage inférieur à 100 % du type PATL destiné à avertir les opérateurs d'une nouvelle condition émergente. Il convient que le pourcentage soit donné au nom de OperationalLimitSet. L'aceptableDuration (durée acceptable) est une autre manière d'exprimer la sévérité de la limite.
tatl		(Européen Charge temporaire admissible de transport (TATL – Temporarily Admissible Transmission Loading) qui est la charge en ampères, MVA ou MW, qui peut être acceptée par une branche pendant une certaine durée limitée. La TATL peut être définie de plusieurs manières: – comme pourcentage fixe de la PATL pendant une période de temps donnée (par exemple, 115 % de la PATL qui peut être acceptée pendant 15 min), – somme de TATL et de la durée calculée pour chaque ligne en tenant compte de sa configuration particulière et de ses conditions de fonctionnement (par exemple, elle peut définir une TATL acceptable pendant une période de 20 min et une autre acceptable pendant une période de 10 min). Une telle définition de la TATL peut dépendre des conditions initiales de fonctionnement de l'élément du réseau (ligne fléchée). L'attribut de durée peut être utilisé pour définir plusieurs types de limites TATL. Par conséquent, plusieurs valeurs limites TATL peuvent exister avec différentes durées.

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libellé	value	description
tc		(Européen) Le courant de déclenchement (TC – Tripping Current) est l'intensité ultime sans retard. Il est défini comme seuil de la ligne qui se déclenche sans mesure correctrice possible. Le déclenchement de l'élément de réseau est ordonné par des protections contre les courts-circuits ou par des protections contre les surcharges. Cependant, dans tous les cas, le retard d'activation de ces protections n'est pas compatible avec le retard de réaction d'un opérateur (inférieur à une minute). La durée est toujours "zero" si OperationalLimitType.acceptableDuration est échangée. Seule une valeur limite existe pour le type TC.
tct		(Européen) Le seuil de courant de déclenchement (TCT – Tripping Current Threshold) est une valeur d'unités techniques définie pour le TC et calculée à l'aide d'un pourcentage inférieur à 100 % du type TC destiné à avertir les opérateurs d'une nouvelle condition émergente. Il convient que le pourcentage soit donné au nom de OperationalLimitSet. L'aceptableDuration (durée acceptable) est une autre manière d'exprimer la sévérité de la limite.
highVoltage		(Européen) En référence aux caractéristiques assignées des équipements, une tension trop élevée peut se traduire par un vieillissement accéléré ou la destruction de l'équipement. Le type de limite peut ou peut ne pas avoir de durée.
lowVoltage		(Européen) Une tension trop faible peut perturber le fonctionnement normal de certaines protections, des transformateurs équipés de changeurs de prises en charge et des appareils électroniques de puissance ou peut affecter le comportement des auxiliaires d'unités de production. Le type de limite peut ou peut ne pas avoir de durée.
operationalVoltageLimit		(Européen) Limite de tension opérationnelle.
alarmVoltage		(Européen) Alarme de tension.
warningVoltage		(Européen) Mise en garde de tension.
stability		(Européen) Stabilité.

A.2.4 Paquetage ExtEuGeneration

A.2.4.1 Généralités

Extensions européennes au paquetage Generation.

A.2.4.2 Paquetage ExtEuProduction

A.2.4.2.1 Généralités

Extensions européennes au paquetage Production.

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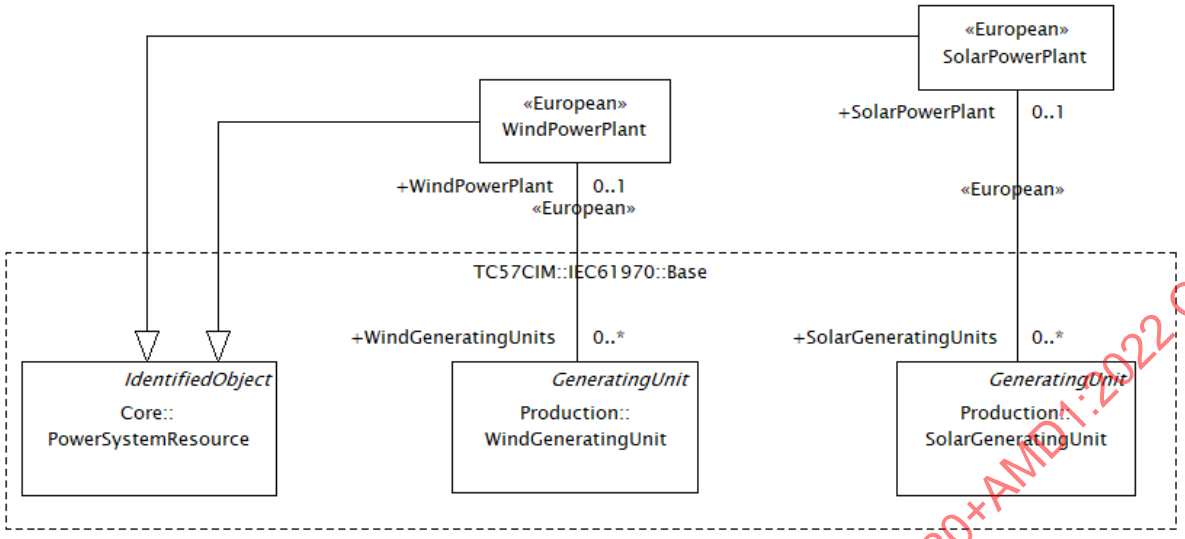


Figure A.4 – Diagramme de classe ExtEuProduction::ExtEuProduction

Figure A.4: Le diagramme présente les extensions européennes au paquetage Production.

A.2.4.2.2 (Européen) SolarPowerPlant

Centrale solaire.

Le Tableau A.6 présente tous les attributs de SolarPowerPlant.

Tableau A.6 – Attributs de ExtEuProduction::SolarPowerPlant

nom	mult	type	description
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject
energyIdentCodeEic	0..1	String	(Européen) hérité de: ExtEuIdentifiedObject
shortName	0..1	String	(Européen) hérité de: ExtEuIdentifiedObject

Le Tableau A.7 présente toutes les extrémités d'association de SolarPowerPlant avec d'autres classes.

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Tableau A.7 – Extrémités d'association de ExtEuProduction::SolarPowerPlant avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..1	SolarGeneratingUnits	0..*	SolarGeneratingUnit	(Européen) Une unité ou des unités de production solaire peut faire partie d'une centrale solaire.
0..*	PSRType	0..1	PSRType	hérité de: PowerSystemResource
0..1	Controls	0..*	Control	hérité de: PowerSystemResource
0..1	Measurements	0..*	Measurement	hérité de: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	hérité de: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	hérité de: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

A.2.4.2.3 (Européen) WindPowerPlant

Centrale éolienne.

Le Tableau A.8 présente tous les attributs de WindPowerPlant.

Tableau A.8 – Attributs de ExtEuProduction::WindPowerPlant

nom	mult	type	description
aliasName	0..1	String	hérité de: IdentifiedObject
description	0..1	String	hérité de: IdentifiedObject
mRID	0..1	String	hérité de: IdentifiedObject
name	0..1	String	hérité de: IdentifiedObject
energyIdentCodeEic	0..1	String	(Européen) hérité de: ExtEuIdentifiedObject
shortName	0..1	String	(Européen) hérité de: ExtEuIdentifiedObject

Le Tableau A.9 présente toutes les extrémités d'association de WindPowerPlant avec d'autres classes.

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Tableau A.9 – Extrémités d'association de ExtEuProduction::WindPowerPlant avec d'autres classes

mult à partir de	nom	mult vers	type	description
0..1	WindGeneratingUnits	0..*	WindGeneratingUnit	(Européen) Une unité ou des unités de production éolienne peut faire partie d'une centrale éolienne.
0..*	PSRType	0..1	PSRType	hérité de: PowerSystemResource
0..1	Controls	0..*	Control	hérité de: PowerSystemResource
0..1	Measurements	0..*	Measurement	hérité de: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	hérité de: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	hérité de: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	hérité de: IdentifiedObject
1..1	Names	0..*	Name	hérité de: IdentifiedObject

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Annexe B
(Informative)

Exemples de modélisation de transformateur PST

B.1 Généralités

La présente annexe donne des exemples de modélisation de transformateurs-déphaseurs (PST) en fonction du type et de la technologie de l'équipement (voir 4.5.7).

B.2 Calculs et exemples détaillés

B.2.1 Déphaseurs symétriques avec deux noyaux

La Figure B.1 représente des déphaseurs symétriques avec deux noyaux.

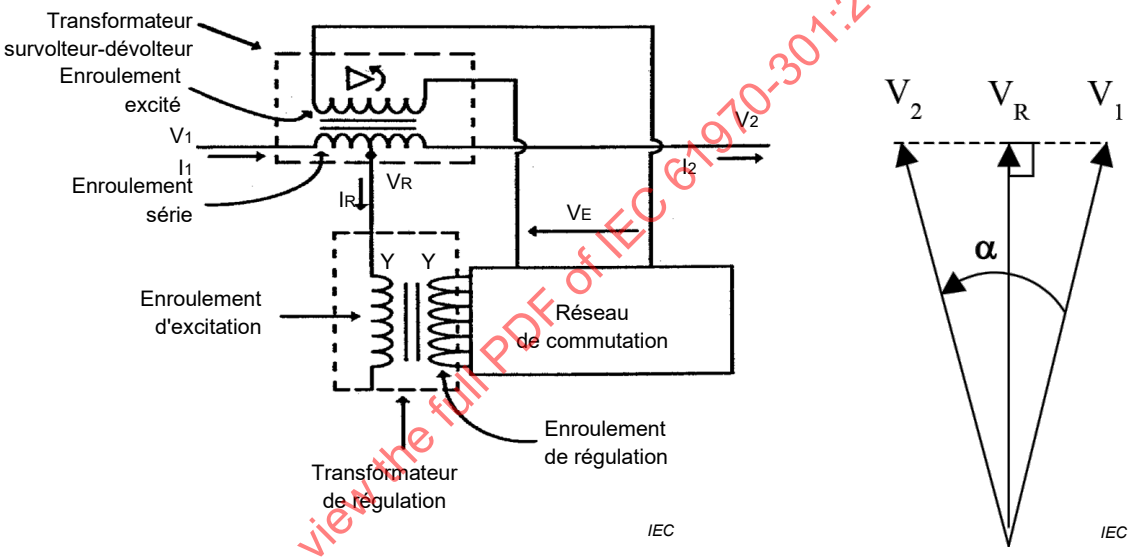
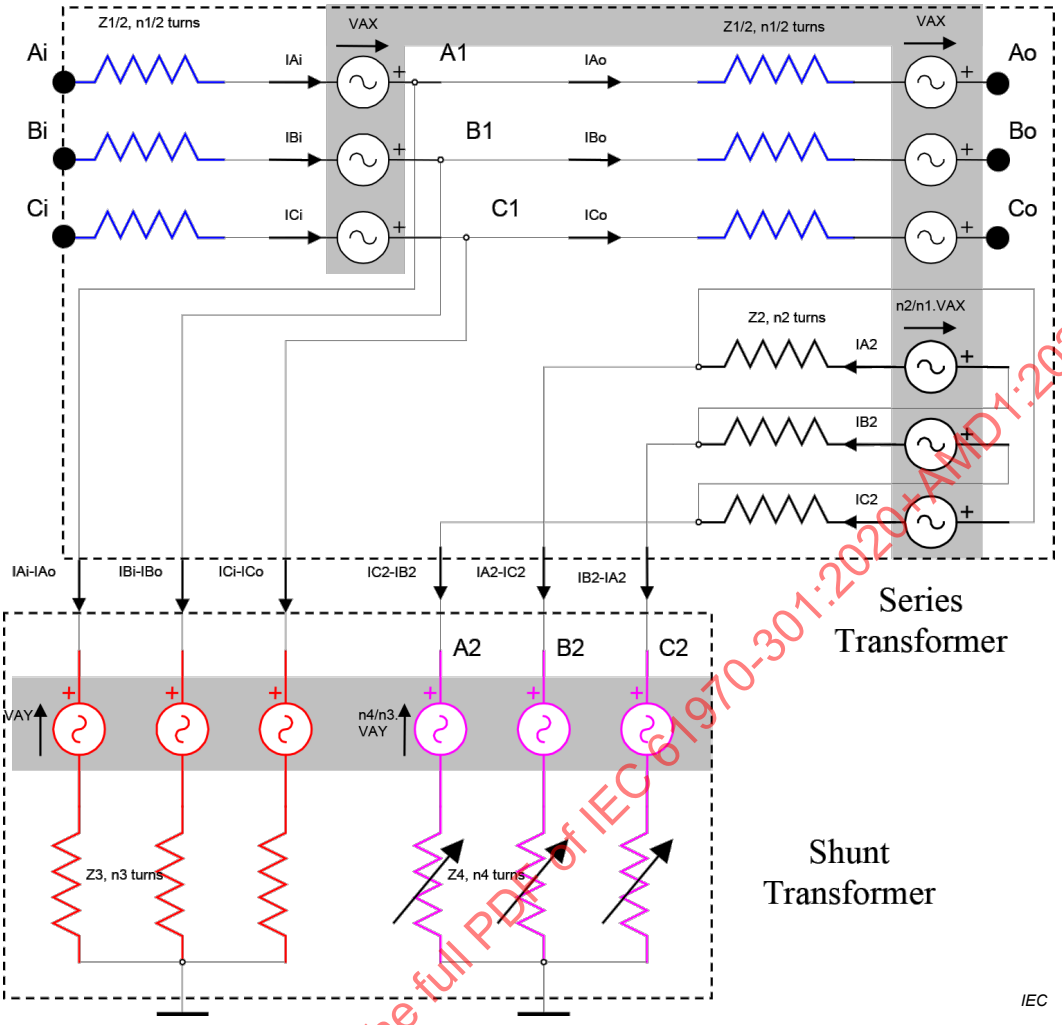


Figure B.1 – Déphaseurs symétriques avec deux noyaux

Figure B.1 présente un schéma triphasé détaillé.

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Anglais	Français
Shunt transformer	Transformateur shunt
Series transformer	Transformateur survolteur-dévolteur

Figure B.2 – Schéma triphasé détaillé

Seul n4 varie.

Exemple de valeurs numériques:

n1 = 120

n2 = 318

n3 = 680

$n4_{max}$ = 182

X1 = 1,23 Ω

X2 = 8,64 Ω

X3 = 101 Ω

Expression du courant de sortie Io et du courant shunt I3=Ii-Io:

Si un déphaseur idéal est pris en considération, la conservation de la puissance électrique s'écrit: $Si = 3ViIi^* = 3VoIo^*$

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Comme l'angle de tension est décalé de alpha: $Vo = e^{j\alpha}Vi$

L'angle de courant doit également être décalé de: $Io = e^{j\alpha}Ii$

Puis, le courant shunt $I3 = Ii - Io = (1 - e^{j\alpha})Ii$

Expression de la réactance équivalente shunt

La réactance shunt Xshunt(α) est définie comme étant la réactance équivalente qui, lorsqu'elle est coupée par le courant d'entrée série (*Ii*), génère les pertes réactives du transformateur shunt:

$$Qshunt = 3.Xshunt(\alpha).|Ii|^2$$

avec:

$$Qshunt = 3.X3.|I3|^2 + 3.X4.|I4|^2$$

$$|I3|^2 = |Ii|^2|1 - e^{j\alpha}|^2 = 2(1 - \cos\alpha)|Ii|^2 = 4(\sin(\alpha/2))^2$$

$$|I4|^2 = \frac{n3^2}{n4^2}|I3|^2$$

$$Xshunt(\alpha) = 4(\sin(\alpha/2))^2\left(X3 + X4\left(\frac{n3}{n4}\right)^2\right)$$

Hypothèse: $X4 = X4_{\max}\left(\frac{n4}{n4_{\max}}\right)^2$

Alors $Xshunt(\alpha) = 4(\sin(\alpha/2))^2\left(X3 + X4_{\max}\frac{n3^2}{n4_{\max}^2}\right)$

Expression de la réactance série équivalente

La réactance série Xseries(α) est définie comme étant la réactance équivalente qui, lorsqu'elle est coupée par le courant d'entrée série (*Ii*), génère les pertes réactives du transformateur survolteur-dévolteur:

$$Qseries = 3.Xseries(\alpha).|Ii|^2$$

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avec:

$$Qseries = 3.\frac{X1}{2}.|Ii|^2 + 3.\frac{X1}{2}.|Io|^2 + 3.X2.|I2|^2$$

comme vu précédemment: $Io = e^{j\alpha} Ii$

Relation de courant du transformateur survolteur-dévolteur: $\frac{n1}{2}.Ii + \frac{n1}{2}.Io = +n2.I2$

alors

$$I2 = \frac{n1}{2n2}\left(1 + e^{j\alpha}\right)Ii \text{ et } |I2|^2 = \left(\frac{n1}{2n2}\right)^2 |Ii|^2 \left|1 + e^{j\alpha}\right|^2 = \frac{1}{2}\frac{n1^2}{n2^2}(1+\cos\alpha)|Ii|^2$$

alors

$$Xseries(\alpha) = X1 + \frac{1}{2}\left(\frac{n1}{n2}\right)^2 (1+\cos\alpha)X2 = X1 + \left(\frac{n1}{n2}\right)^2 (1-\sin(\alpha/2))X2$$

$$Xseries(\alpha) = \left(X1 + \left(\frac{n1}{n2}\right)^2 X2\right) - \left(\frac{n1}{n2}\right)^2 X2\left(\sin(\alpha/2)\right)^2$$

Expression de la réactance équivalente totale X

$$X(\alpha) = \left(X1 + \left(\frac{n1}{n2}\right)^2 X2\right) + 4\left(\sin(\alpha/2)\right)^2 \left(X3 + X4_{\max}\frac{n3^2}{n4_{\max}^2} - \left(\frac{n1}{2n2}\right)^2 X2\right)$$

ou

$$X(\alpha) = X(0) + \left(X(\alpha_{\max}) - X(0)\right)\left(\frac{\sin(\alpha/2)}{\sin(\alpha_{\max}/2)}\right)^2$$

avec:

$$X(0) = \left(X1 + \left(\frac{n1}{n2}\right)^2 X2\right)$$

$$X(\alpha_{\max}) - X(0) = 4\left(\sin(\alpha_{\max}/2)\right)^2 \left(X3 + X4_{\max}\frac{n3^2}{n4_{\max}^2} - \left(\frac{n1}{2n2}\right)^2 X2\right)$$

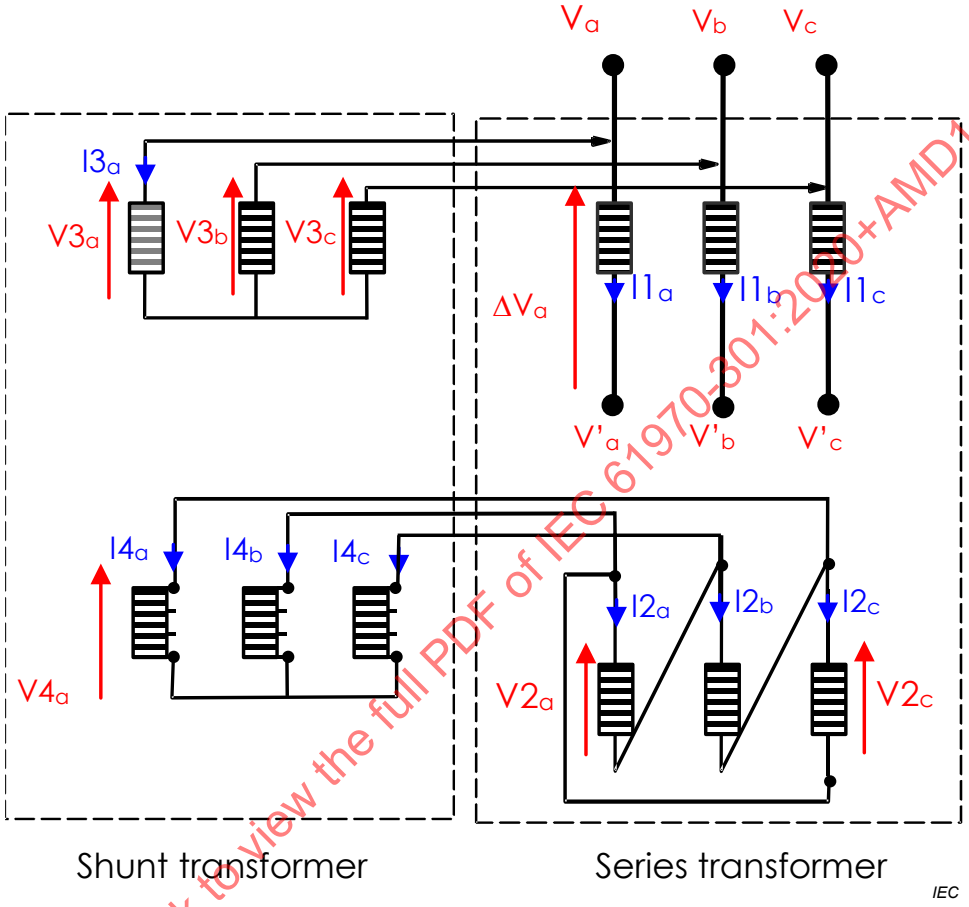
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Remarque: seul α varie.

B.2.2 Transformateurs déphaseurs en quadrature

B.2.2.1 Transformateurs déphaseurs en quadrature avec deux noyaux

La Figure B.3 présente un schéma triphasé détaillé. Le schéma monophasé est présenté à la Figure B.4.



Anglais	Français
Shunt transformer	Transformateur shunt
Series transformer	Transformateur survolteur-dévolteur

Figure B.3 – Schéma triphasé détaillé

Pour chaque valeur physique X (X=V ou I) $X = X_a = aX_b = a^2X_c$ avec $a = e^{j\frac{2\pi}{3}}$

Transformateur shunt avec rapport n4/n3 variable avec réactance X3 sur l'enroulement primaire et X4 sur l'enroulement secondaire:

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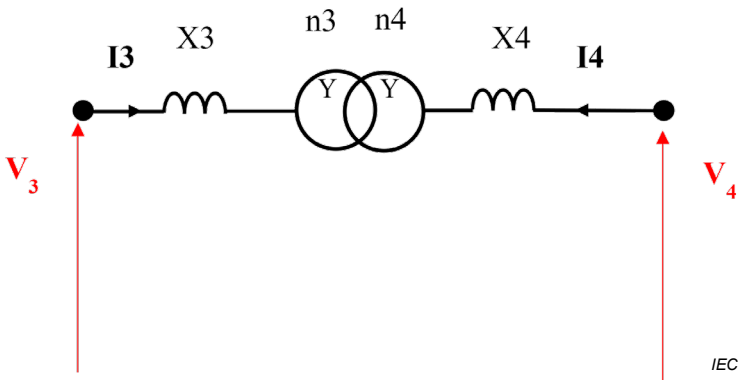


Figure B.4 – Schéma monophasé

$$V4 - jX4.I4 = \frac{n4}{n3}(V3 - jX3.I3) \qquad I3 = -\frac{n4}{n3}I4$$

$$V4 = \frac{n4}{n3}V3 + j\left(X_4 + X_3\left(\frac{n4}{n3}\right)^2\right)I4$$

Hypothèse: la réactance X4 varie comme le carré du nombre de spires n4:

$$X_4 = X_4^{\max}\left(\frac{n4}{n4_{\max}}\right)^2$$

Transformateur survolteur-dévolteur de rapport n1/n2 fixe avec réactance X1 sur l'enroulement primaire et X2 sur l'enroulement secondaire:

$$\Delta V = \frac{n1}{n2}V2 + j\left(X1 + \left(\frac{n1}{n2}\right)^2 X2\right)I1$$

$$I2 = -\frac{n1}{n2}I1$$

Lien entre les transformateurs survolteurs-dévolteurs et les transformateurs série:

- Enroulements primaires:

$$V3 = V$$

- Enroulements secondaires:

$$I4 = I4_a = I2_b - I2_c = (a^2 - a)I2_a = -j\sqrt{3}I2$$

$$V2 = V2_a = V4_b - V4_c = (a^2 - a)V4 = -j\sqrt{3}V4$$

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Calcul:

$$\Delta V = -j\frac{n4.n1}{n3.n2}\sqrt{3}V + j\left(X1+\left(\frac{n1}{n2}\right)^2 X2 + 3\left(\frac{n1}{n2}\right)^2 n4^2\left(\frac{X4^{\max}}{n4_{\max}^2}+\frac{X3}{n3^2}\right)\right)I1$$

$$I3 = -j\frac{n4.n1}{n3.n2}\sqrt{3}I1$$

Conditions à vide (I=0):

$$\Delta V = -j\frac{n4.n1}{n3.n2}\sqrt{3}V$$

Et géométriquement, représenté à la Figure B.5:

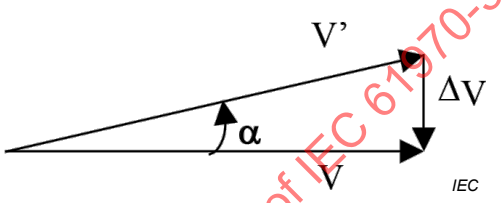


Figure B.5 – Schéma du phaseur

$\Delta V = -jV\tan\alpha$

Donc $\frac{n4}{n4^{\max}} = \frac{\tan\alpha}{\tan\alpha_{\max}}$

Et $\Delta V = -j\frac{n4.n1}{n3.n2}\sqrt{3}V + j\left(X1+\left(\frac{n1}{n2}\right)^2 X2 + 3n4_{\max}^2\left(\frac{n1}{n2}\right)^2\left(\frac{X4^{\max}}{n4_{\max}^2}+\frac{X3}{n3^2}\right)\left(\frac{\tan\alpha}{\tan\alpha_{\max}}\right)^2\right)I1$

devient:

$\Delta V = -j\frac{n4.n1}{n3.n2}\sqrt{3}V + jXI$ avec $X(\alpha) = X(0) + \left(X(\alpha_{\max}) - X(0)\right)\left(\frac{\tan(\alpha)}{\tan(\alpha_{\max})}\right)^2$

B.2.2.2 Transformateurs déphaseurs en quadrature avec un seul noyau

La Figure B.6 présente un schéma triphasé détaillé.

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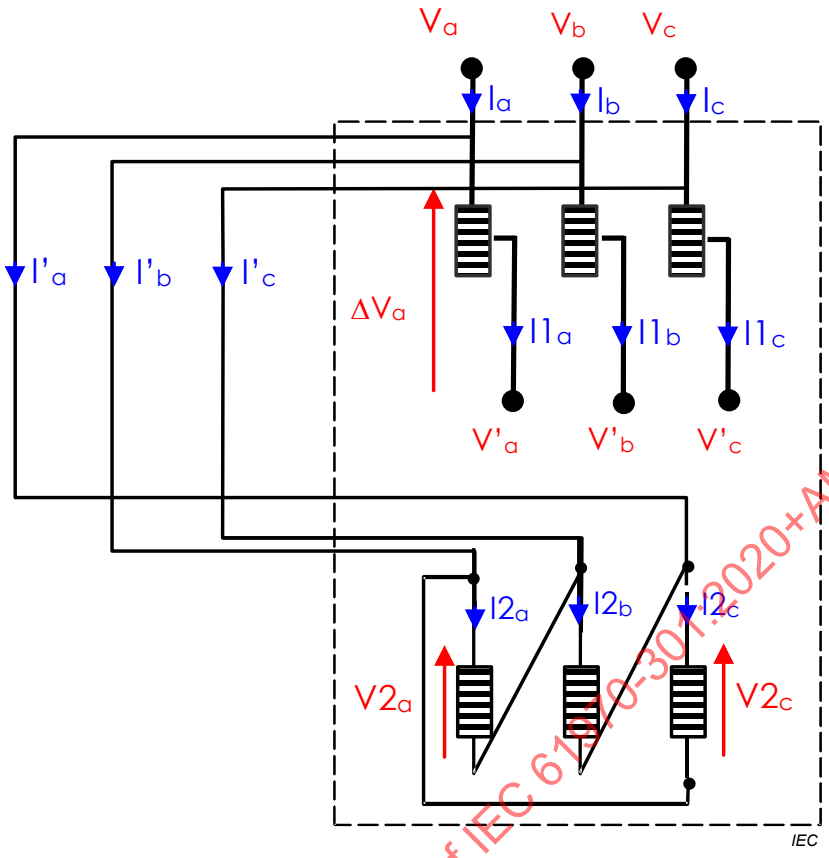


Figure B.6 – Schéma triphasé détaillé

n1 varie.

$$I' = j\sqrt{3}I2$$

$$V2 = -j\sqrt{3}V$$

$$\Delta V = \frac{n1}{n2}V2 + j\left(X1 + \left(\frac{n1}{n2}\right)^2 X2\right)I1$$

$$\Delta V = -j\sqrt{3}\frac{n1}{n2}V + j\left(X1 + \left(\frac{n1}{n2}\right)^2 X2\right)I1$$

En prenant pour hypothèse $X1 = X1_{max}\left(\frac{n1}{n1_{max}}\right)^2$

$$\Delta V = -j\sqrt{3}\frac{n1}{n2}V + j\left(\frac{X1_{max}}{n1_{max}} + \frac{X2}{n2^2}\right)n1^2 I1$$

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A vide: $\Delta V = -j\sqrt{3}\frac{n1}{n2}V$

Et géométriquement, représenté à la Figure B.7:

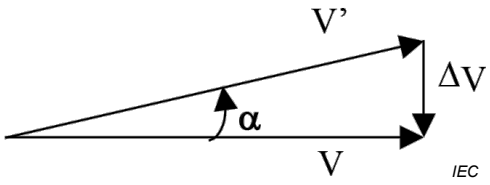


Figure B.7 – Schéma du phaseur

$\Delta V = -jV\tan\alpha$

Donc $\frac{n1}{n1^{\max}} = \frac{\tan\alpha}{\tan\alpha_{\max}}$

$$X(\alpha) = \left(X1_{\max} + X2\frac{n1_{\max}^2}{n2^2}\right)\left(\frac{\tan\alpha}{\tan\alpha_{\max}}\right)^2$$

$$X(\alpha) = X(\alpha_{\max})\left(\frac{\tan\alpha}{\tan\alpha_{\max}}\right)^2$$

B.2.3 Déphaseur asymétrique

B.2.3.1 Déphaseur asymétrique avec deux noyaux

La Figure B.8 représente un déphaseur asymétrique avec deux noyaux

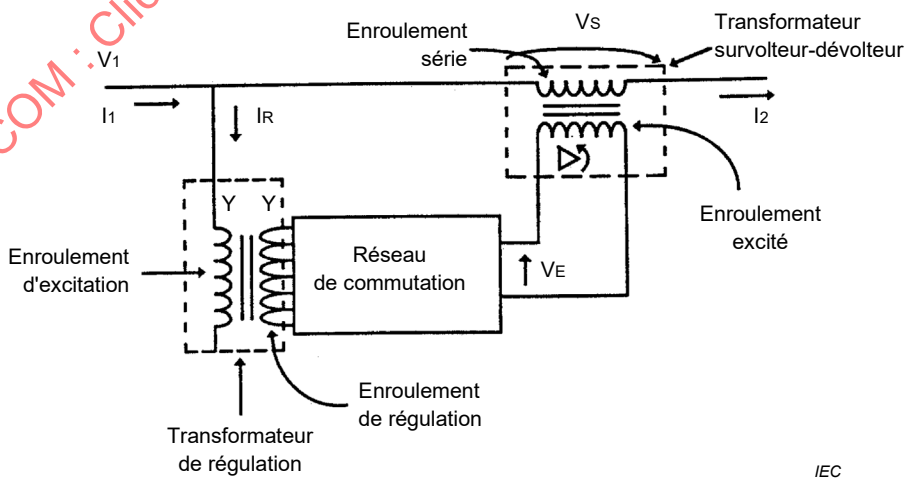
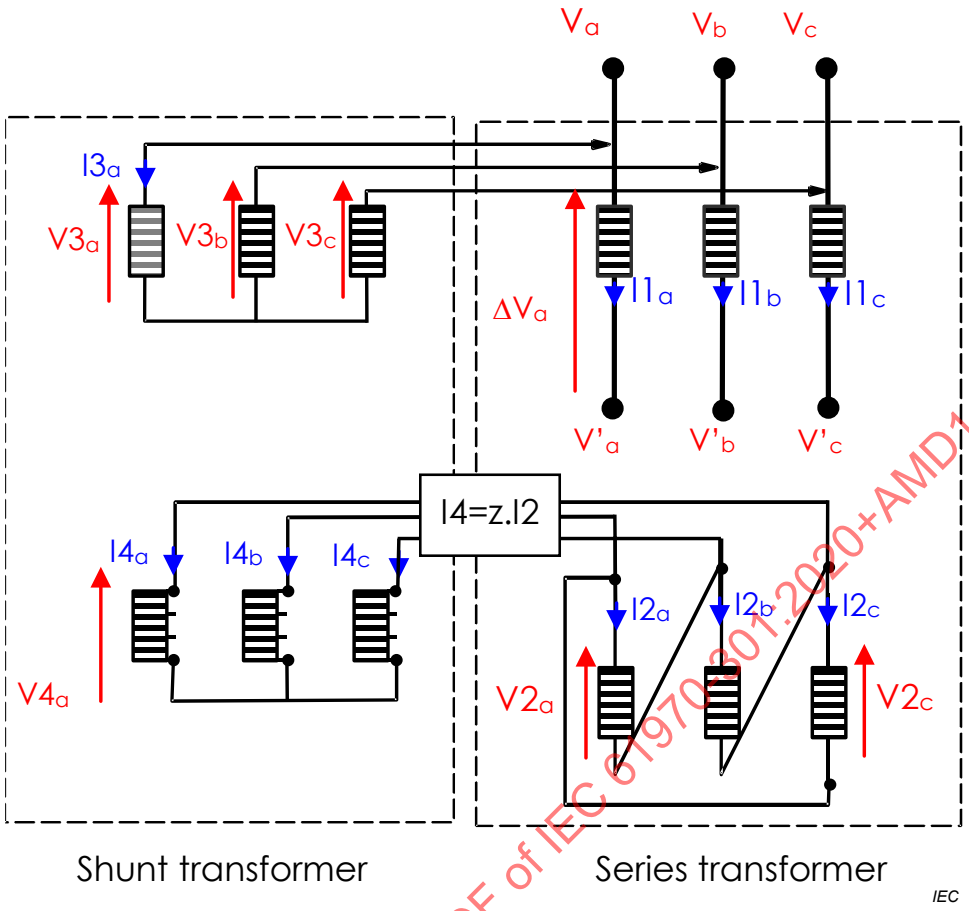


Figure B.8 – Déphaseur asymétrique avec deux noyaux

La Figure B.9 présente un schéma triphasé détaillé:

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Anglais	Français
Shunt transformer	Transformateur shunt
Series transformer	Transformateur survolteur-dévolteur

Figure B.9 – Schéma triphasé détaillé

Pour chaque valeur physique X (X=V ou I) $X = X_a = aX_b = a^2X_c$ avec $a = e^{j\frac{2\pi}{3}}$

équations pour le transformateur shunt:

$$V4 = \frac{n4}{n3}V3 + j\left(X_4 + X_3\left(\frac{n4}{n3}\right)^2\right)I4$$

$$I3 = -\frac{n4}{n3}I4$$

Hypothèse: la réactance X2 varie comme le carré du rapport k1:

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$$X_4 = X_4^{\max}\left(\frac{n4}{n4_{\max}}\right)^2$$

Transformateur survolteur-dévolteur de rapport k_2 fixe avec réactance X_{series} sur l'enroulement primaire:

$$\Delta V = \frac{n1}{n2}V2 + j\left(X1 + \left(\frac{n1}{n2}\right)^2 X2\right)I1$$

$$I2 = -\frac{n1}{n2}I1$$

Lien entre les transformateurs survolteurs-dévolteurs et les transformateurs série:

- Enroulements primaires:

  $V3 = V$

- "z", qui est un nombre complexe, détermine le couplage entre les enroulements secondaires du transformateur survolteur-dévolteur et du transformateur shunt:

  $I4 = I4_a = z.I2$

  $V2 = z.V4$

  pour un transformateur déphaseur en quadrature $z = -j\sqrt{3}$

Calcul:

$$\Delta V = \frac{n4.n1}{n3.n2}.z.V + j\left(X1 + \left(\frac{n1}{n2}\right)^2 X2 - z^2\left(\frac{n1}{n2}\right)^2 n4^2\left(\frac{X4^{\max}}{n4^2_{\max}} + \frac{X3}{n3^2}\right)\right)I1$$

$$I3 = \frac{n4.n1}{n3.n2}.z.I1$$

Conditions à vide (I = 0):

$$\Delta V = \frac{n4.n1}{n3.n2}.z.V$$

Et géométriquement, représenté à la Figure B.10:

$$\Delta V = -e^{j\theta}.V\frac{\tan\alpha}{\sin\theta - \tan\alpha\cos\theta}$$

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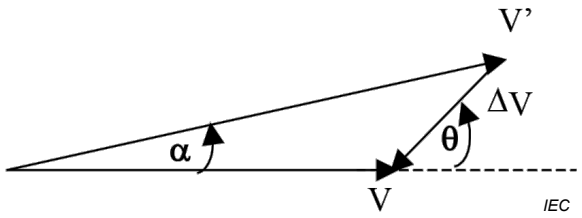


Figure B.10 – Schéma du phaseur

Donc $\frac{n4}{n4^{\max}} = \frac{\tan\alpha}{\tan\alpha_{\max}} \frac{\sin\theta - \tan\alpha_{\max}\cos\theta}{\sin\theta - \tan\alpha\cos\theta}$

Et

$$\Delta V = -j\frac{n4.n1}{n3.n2}\sqrt{3}V + j\left(X1 + \left(\frac{n1}{n2}\right)^2 X2 - z^2 n4_{\max}^2 \left(\frac{n1}{n2}\right)^2 \left(\frac{X4^{\max}}{n4_{\max}^2} + \frac{X3}{n3^2}\right)\left(\frac{\tan\alpha}{\tan\alpha_{\max}}\frac{\sin\theta - \tan\alpha_{\max}\cos\theta}{\sin\theta - \tan\alpha\cos\theta}\right)^2\right) I1$$

devient:

$$\Delta V = z\frac{n4.n1}{n3.n2}V + jXI \text{ avec } X(\alpha) = X(0) + \left(X(\alpha_{\max}) - X(0)\right)\left(\frac{\tan\alpha}{\tan\alpha_{\max}}\frac{\sin\theta - \tan\alpha_{\max}\cos\theta}{\sin\theta - \tan\alpha\cos\theta}\right)^2$$

B.2.3.2 Déphaseur asymétrique avec un seul noyau

La Figure B.11 représente un déphaseur asymétrique avec un seul noyau

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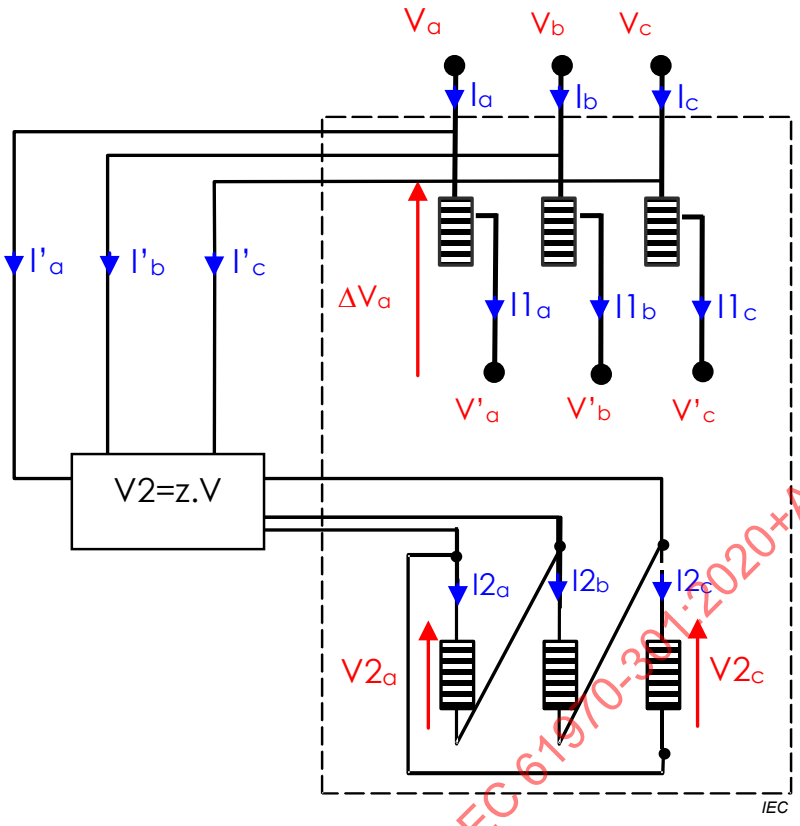


Figure B.11 – Déphaseur asymétrique avec un seul noyau

Seul n1 varie.

$$I' = -z.I2$$

$$V2 = z.V$$

$$\Delta V = \frac{n1}{n2}V2 + j\left(X1 + \left(\frac{n1}{n2}\right)^2 X2\right)I1$$

$$\Delta V = z.\frac{n1}{n2}V + j\left(X1 + \left(\frac{n1}{n2}\right)^2 X2\right)I1$$

En prenant pour hypothèse $X1 = X1_{max}\left(\frac{n1}{n1_{max}}\right)^2$

$$\Delta V = z.\frac{n1}{n2}V + j\left(\frac{X1_{max}}{n1_{max}} + \frac{X2}{n2^2}\right)n1^2 I1$$

A vide: $\Delta V = z.\frac{n1}{n2}V$

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Et géométriquement, représenté à la Figure B.12:

$$\Delta V = -e^{j\theta}.V\frac{\tan\alpha}{\sin\theta - \tan\alpha\cos\theta}$$

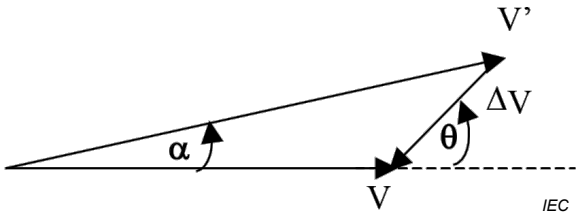


Figure B.12 – Schéma du phaseur

Donc $\frac{n1}{n1_{max}} = \frac{\tan\alpha}{\tan\alpha_{max}}\frac{\sin\theta - \tan\alpha_{max}\cos\theta}{\sin\theta - \tan\alpha\cos\theta}$

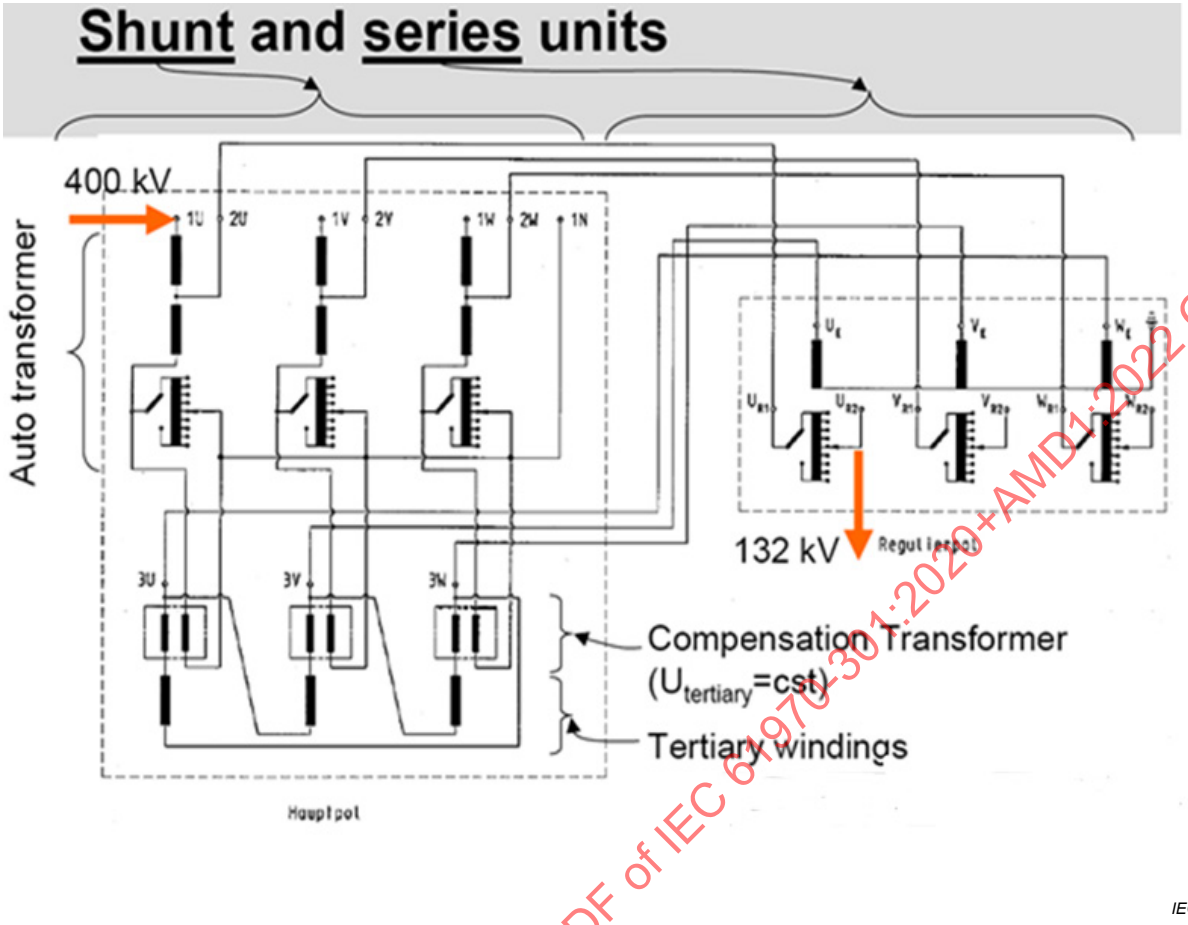
$$X(\alpha) = \left(X1_{max} + X2\frac{n1_{max}^2}{n2^2}\right)\left(\frac{\tan\alpha}{\tan\alpha_{max}}\frac{\sin\theta - \tan\alpha_{max}\cos\theta}{\sin\theta - \tan\alpha\cos\theta}\right)^2$$

$$X(\alpha) = X(\alpha_{max})\left(\frac{\tan\alpha}{\tan\alpha_{max}}\frac{\sin\theta - \tan\alpha_{max}\cos\theta}{\sin\theta - \tan\alpha\cos\theta}\right)^2$$

B.2.3.3 Transformateur en phase et déphaseur asymétrique

La Figure B.13 et la Figure B.14 donnent des exemples de schémas triphasés détaillés d'un autotransformateur et d'un transformateur déphaseur en quadrature à régulation de tension.

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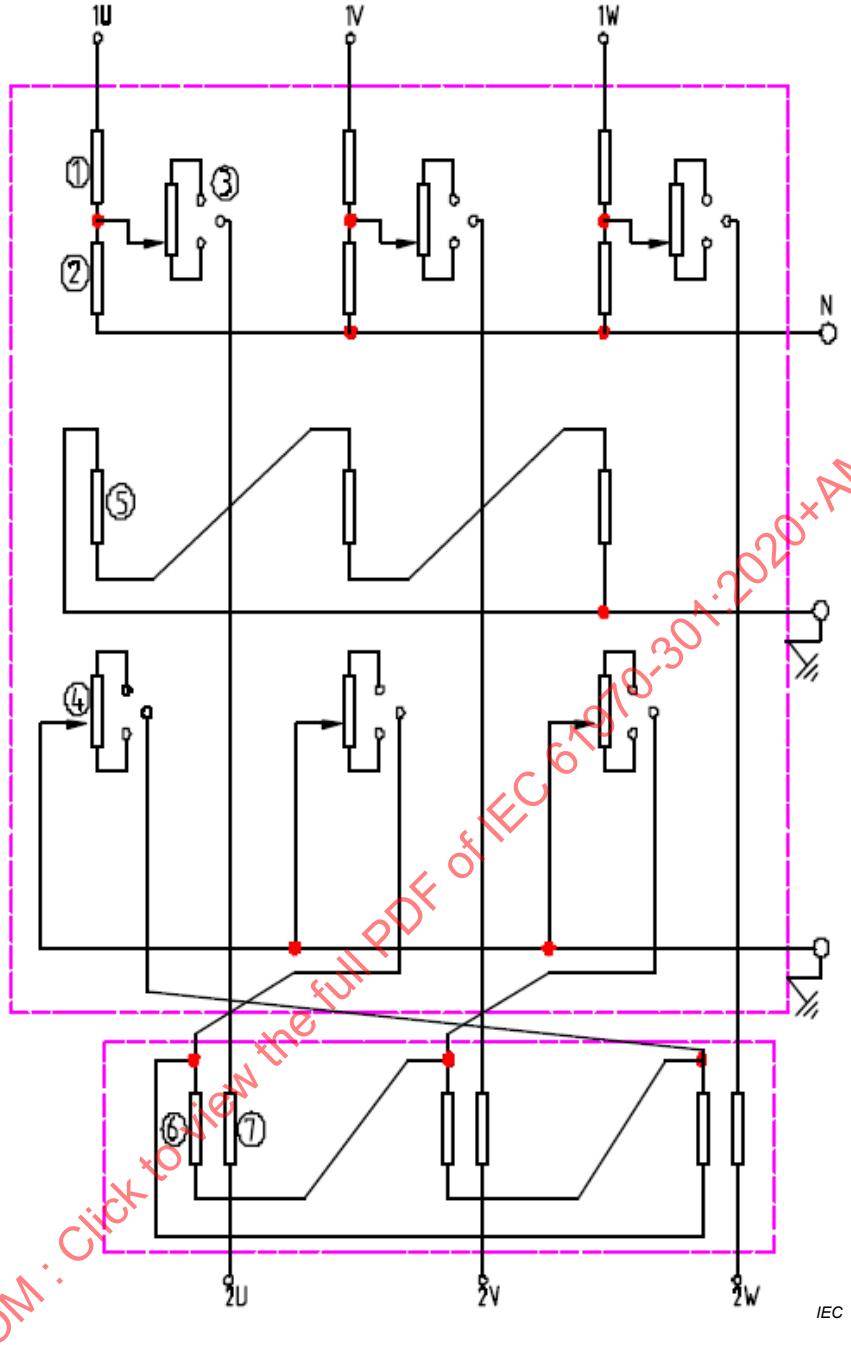


Anglais	Français
Shunt and series units	Unités shunt et série
Auto transformer	Autotransformateur
Compensation transformer	Transformateur de compensation
Tertiary windings	Enroulements tertiaires

Figure B.13 – Exemple de schéma triphasé détaillé d'un autotransformateur et d'un transformateur déphaseur en quadrature à régulation de tension

Autotransformateur et d'un transformateur déphaseur en quadrature à régulation de tension:

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1) Enroulement THT
2) Enroulement HT
3) Enroulement à régulation de tension EV
4) Enroulement à régulation de déphasage
5) Enroulement tertiaire
6) Enroulement primaire du transformateur survolteur-dévolteur
7) Enroulement secondaire du transformateur survolteur-dévolteur

Figure B.14 – Exemple de schéma d'enroulement détaillé d'un autotransformateur et d'un transformateur déphaseur en quadrature à régulation de tension

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Annexe C
(informative)

Représentation des cas d'utilisation CCHT

C.1 Aperçu

L'Annexe C est informative et comprend des informations relatives aux cas d'utilisation associés à la représentation CCHT.

C.2 Installations dos à dos

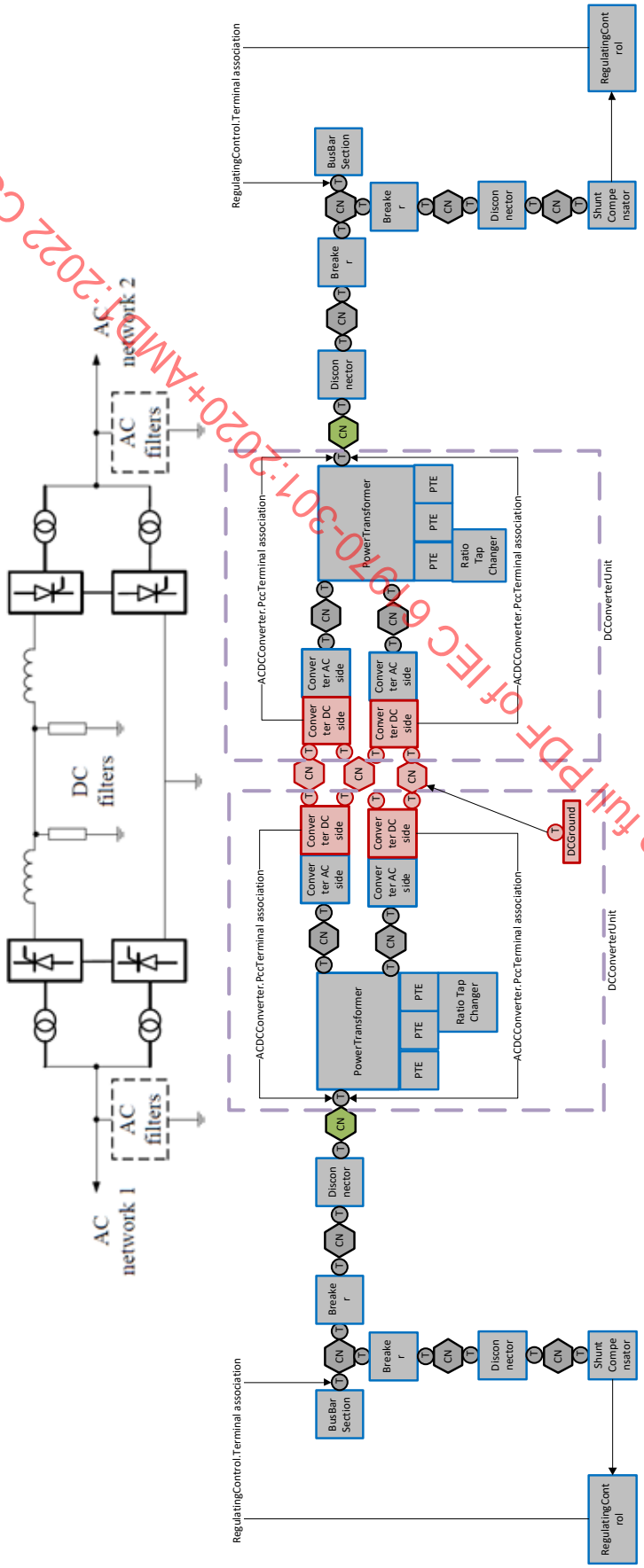
L'expression " dos à dos " implique que le redresseur et l'onduleur sont installés dans le même poste. Les convertisseurs dos à dos sont principalement utilisés pour transporter la puissance entre les réseaux en courant alternatif adjacents qui ne peuvent pas être synchronisés. Ils peuvent également être utilisés dans un réseau maillé afin d'obtenir un flux de puissance défini.

Dans cet exemple, le filtre de courant continu et l'inductance de lissage ne sont pas modélisés de manière explicite bien qu'il convienne de le faire lors du calcul des types spéciaux de courts-circuits et/ou de réponse dynamique. Les composantes de courant continu sont repérées en rouge, les candidats pour les points limites sont repérés en vert. En cas d'échange d'installation dos à dos dans un MAS séparé, les deux points limites sont utilisés.

La borne de point de couplage commun associée au point limite est également représentée comme une TieFlow.Terminal si le flux se situe dans la position nette de la ControlArea. La Figure C.1 représente une installation à 12 impulsions dos à dos.

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Anglais	Français
AC network	Réseau à courant alternatif
DC filters	Filtres de courant continu
Breaker	disjoncteur
Converter AC side	Convertisseur côté courant alternatif
Converter DC side	Convertisseur côté courant continu
Ratio tap changer	Changeur de rapport de prises
Disconnector	sectionneur
Shunt compensator	Compensateur shunt

Figure C.1 – Représentation d'une installation à 12 impulsions dos à dos

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C.3 Monopole avec retour par la terre

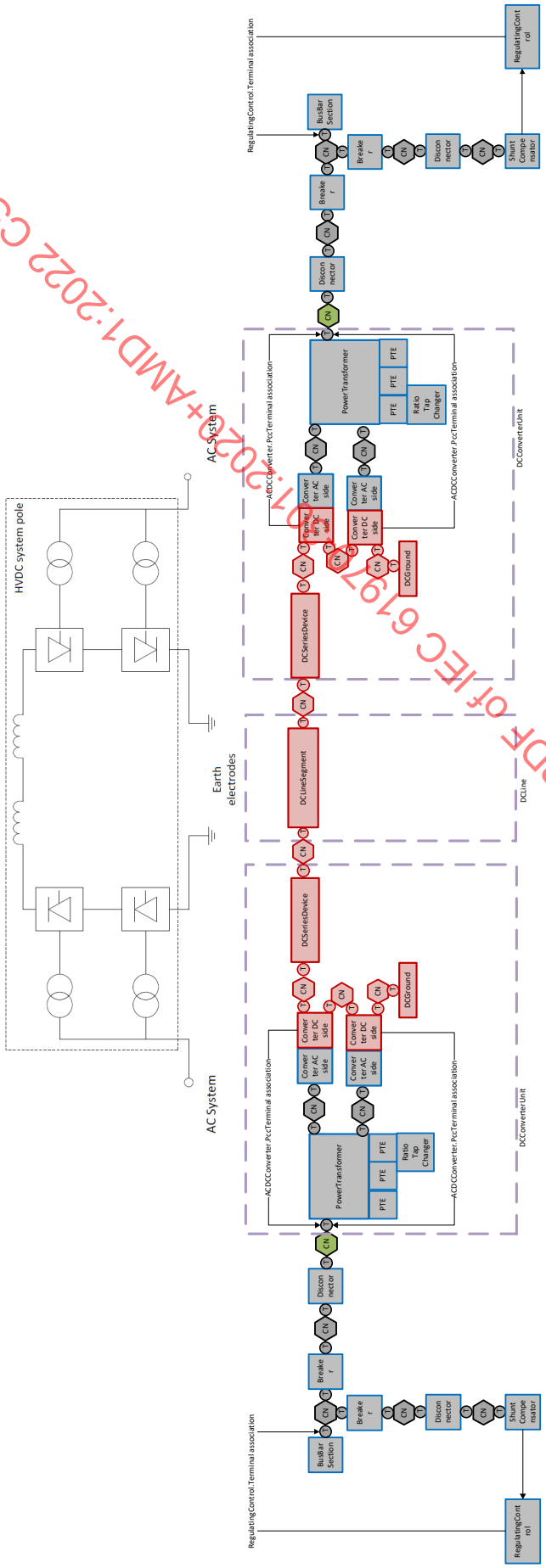
La Figure C.2 donne un exemple de modélisation et de sérialisation d'une installation monopolaire à 12 impulsions avec retour par la terre.

Dans cet exemple, le filtre de courant continu n'est pas modélisé de manière explicite bien qu'il convienne de le faire lors du calcul des types spéciaux de courts-circuits et/ou de réponse dynamique. Les composantes de courant continu sont repérées en rouge, les candidats pour les points limites sont repérés en vert. En cas d'échange d'installation dans un MAS séparé, les deux points limites sont utilisés.

La borne de point de couplage commun associée au point limite est également représentée comme une TieFlow.Terminal si le flux se situe dans la position nette de la ControlArea.

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Anglais	Français
HVDC system pole	Pôle du système CCHT
AC system	Système à courant alternatif
Earth electrodes	Electrodes de terre
Breaker	disjoncteur
Converter AC side	Convertisseur côté courant alternatif
Converter DC side	Convertisseur côté courant continu
Ratio tap changer	Changeur de rapport de prises
Disconnector	sectionneur
Shunt compensator	Compensateur shunt

Figure C.2 – Représentation d'une installation monopolaire à 12 impulsions avec retour par la terre

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C.4 Monopole avec retour métallique

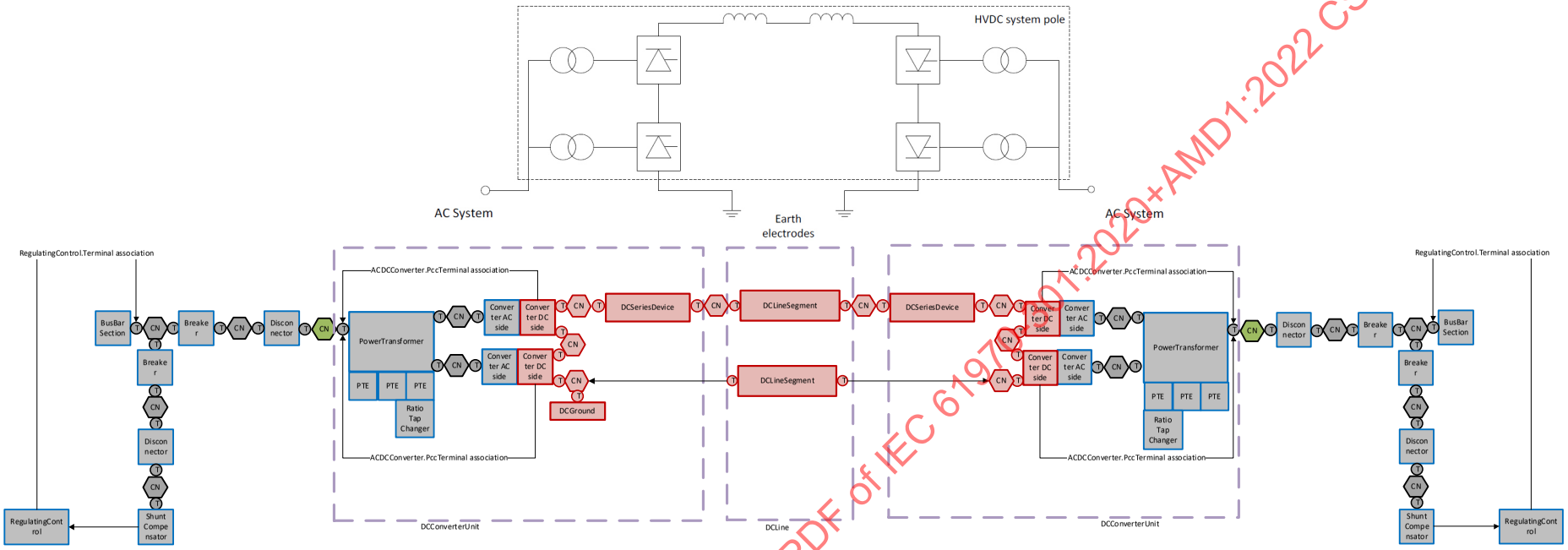
La Figure C.3 donne un exemple de modélisation et de sérialisation d'une installation monopolaire à 12 impulsions avec retour métallique.

Dans cet exemple, le filtre de courant continu n'est pas modélisé de manière explicite bien qu'il convienne de le faire lors du calcul des types spéciaux de courts-circuits et/ou de réponse dynamique. Les composantes de courant continu sont repérées en rouge, les candidats pour les points limites sont repérés en vert. En cas d'échange d'installation dans un MAS séparé, les deux points limites sont utilisés.

La borne de point de couplage commun associée au point limite est également représentée comme une TieFlow.Terminal si le flux se situe dans la position nette de la ControlArea.

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Anglais	Français
HVDC system pole	Pôle du système CCHT
AC system	Système à courant alternatif
Earth electrodes	Electrodes de terre
Breaker	Disjoncteur
Converter AC side	Convertisseur côté courant alternatif
Converter DC side	Convertisseur côté courant continu
Ratio tap changer	Changeur de rapport de prises
Disconnector	Sectionneur
Shunt compensator	Compensateur shunt

Figure C.3 – Représentation d'une installation monopolaire à 12 impulsions avec retour métallique

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C.5 Convertisseur de source de tension

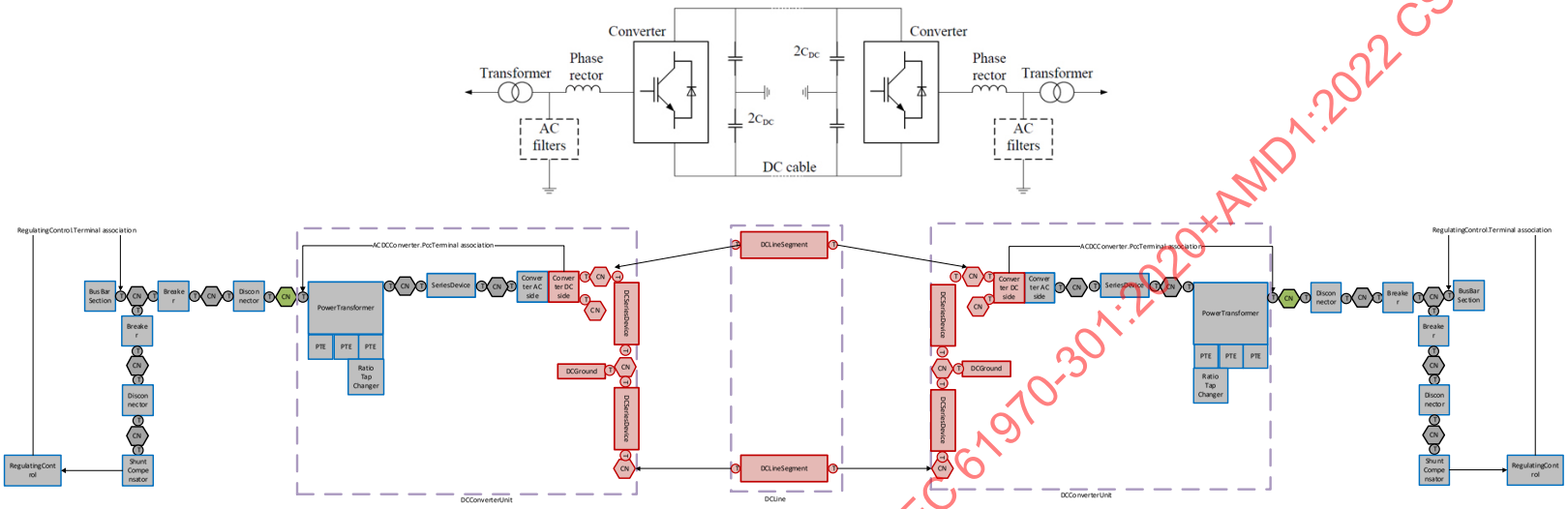
La Figure C.4 donne un exemple de modélisation et de sérialisation d'un convertisseur de source de tension (VSC).

Dans cet exemple, le filtre de courant continu n'est pas modélisé de manière explicite bien qu'il convienne de le faire lors du calcul des types spéciaux de courts-circuits et/ou de réponse dynamique. Les composantes de courant continu sont repérées en rouge, les candidats pour les points limites sont repérés en vert. En cas d'échange d'installation dans un MAS séparé, les deux points limites sont utilisés.

La borne de point de couplage commun associée au point limite est également représentée comme une TieFlow.Terminal si le flux se situe dans la position nette de la ControlArea.

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Anglais	Français
Converter	convertisseur
Transformer	Transformateur
Phase rector	Composant réactif de phase
AC filters	Filtres de courant alternatif
DC cable	Câble de courant continu
Breaker	disjoncteur
Converter AC side	Convertisseur côté courant alternatif
Converter DC side	Convertisseur côté courant continu
Ratio tap changer	Changeur de rapport de prises
Disconnector	sectionneur
Shunt compensator	Compensateur shunt

Figure C.4 – Représentation d'un convertisseur de source de courant

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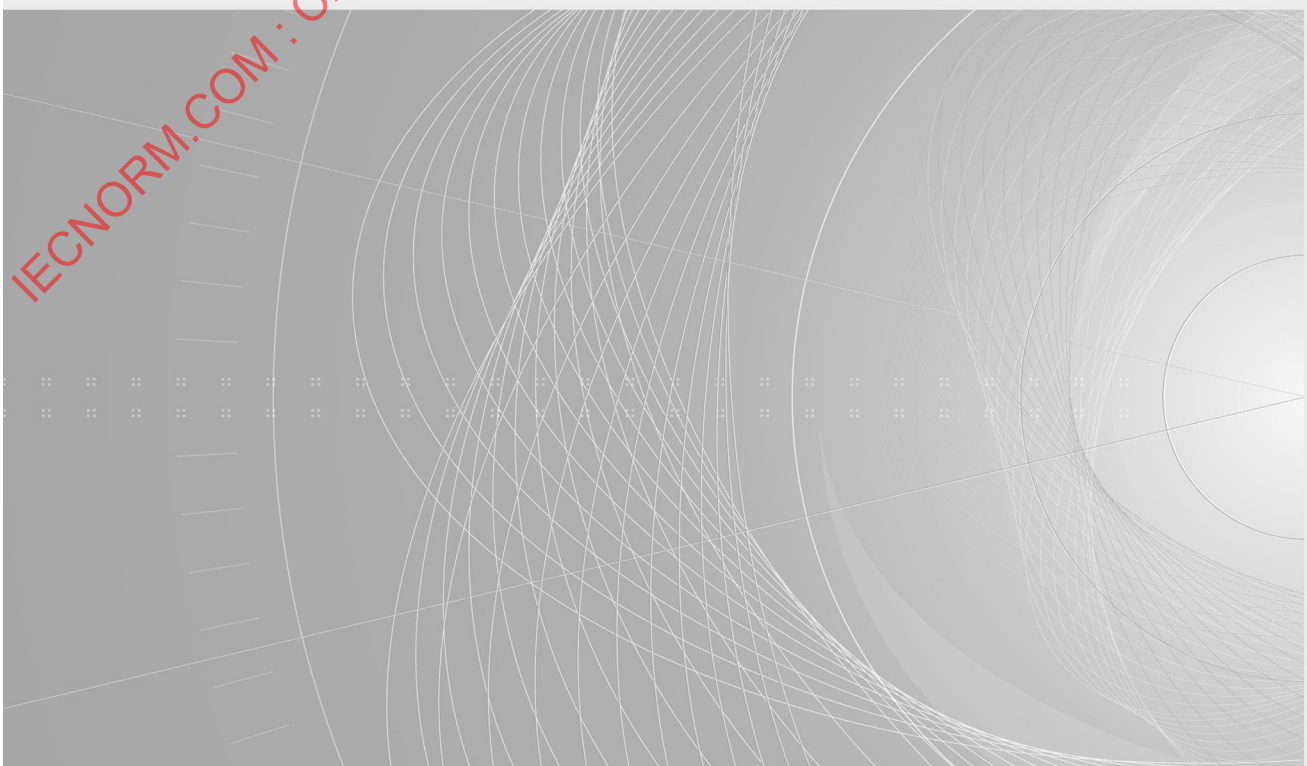
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Energy management system application program interface (EMS-API) – Part 301: Common information model (CIM) base

Interface de programmation d'application pour système de gestion d'énergie (EMS-API) –
Partie 301: Base de modèle d'information commun (CIM)

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IEC 61970-301:2020-06+AMD1:2022-02 CSV(en-fr)

CONTENTS

FOREWORD 35
INTRODUCTION 37
1 Scope 39
2 Normative references 39
3 Terms and definitions 40
4 CIM specification 40
4.1 Overview 40
4.2 CIM modelling notation 41
4.3 CIM packages 41
4.4 CIM classes and relationships 43
4.4.1 Classes 43
4.4.2 Generalization 44
4.4.3 Simple association 45
4.4.4 Aggregation 46
4.5 CIM model concepts and examples 46
4.5.1 Concepts 46
4.5.2 Containment, equipment hierarchies and naming 47
4.5.3 Names model 48
4.5.4 Connectivity model 49
4.5.5 Inheritance hierarchy 52
4.5.6 Transformer model 54
4.5.7 Transformer tap modelling 56
4.5.8 Phase wire modelling 69
4.5.9 Grounding devices modelling 71
4.5.10 Cuts, clamps and jumpers model 75
4.5.11 Measurements and controls 79
4.5.12 Regulating control models 84
4.5.13 DC model for CIM 85
4.5.14 Static Var Compensator Voltage Regulation 107
4.5.15 ICCP Configuration Model 108
4.5.16 Feeder Model 115
4.5.17 Control area modelling 115
4.6 Modelling guidelines 117
4.6.1 Modelling for change 117
4.6.2 Process for amendments to the CIM 117
4.6.3 Changes to the CIM UML model 118
4.6.4 Changes to the CIM standards documents 118
4.6.5 Deprecations 118
4.6.6 CIM profiles 118
4.7 Modelling tools 119
4.8 User implementation conventions 119
4.8.1 Conventions beyond UML 119
4.8.2 Number of terminals for ConductingEquipment objects 119
4.8.3 Nominal quantities 120
4.8.4 Datatypes 120
4.9 CIM modelling examples 120

IECNORM.COM : Click to view the full PDF of IEC 61970-301:2020+AMD1:2022 CSV

5 Detailed model 120
5.1 Overview 120
5.2 Context 120
6 Package Base 122
6.1 General 122
6.2 Package Domain 122
6.2.1 General 122
6.2.2 ActivePower datatype 128
6.2.3 ActivePowerChangeRate datatype 129
6.2.4 ActivePowerPerCurrentFlow datatype 129
6.2.5 ActivePowerPerFrequency datatype 129
6.2.6 Admittance datatype 129
6.2.7 AngleDegrees datatype 130
6.2.8 AngleRadians datatype 130
6.2.9 ApparentPower datatype 130
6.2.10 Area datatype 130
6.2.11 Boolean primitive 131
6.2.12 Capacitance datatype 131
6.2.13 CapacitancePerLength datatype 131
6.2.14 Classification datatype 131
6.2.15 Conductance datatype 131
6.2.16 ConductancePerLength datatype 132
6.2.17 CostPerEnergyUnit datatype 132
6.2.18 CostPerHeatUnit datatype 132
6.2.19 CostPerVolume datatype 132
6.2.20 CostRate datatype 133
6.2.21 Currency enumeration 133
6.2.22 CurrentFlow datatype 137
6.2.23 Damping datatype 137
6.2.24 Date primitive 137
6.2.25 DateInterval compound 137
6.2.26 DateTime primitive 138
6.2.27 DateTimeInterval compound 138
6.2.28 Decimal primitive 138
6.2.29 DecimalQuantity compound 138
6.2.30 Displacement datatype 138
6.2.31 Duration primitive 139
6.2.32 Emission datatype 139
6.2.33 Float primitive 139
6.2.34 FloatQuantity compound 139
6.2.35 Frequency datatype 139
6.2.36 HeatRate datatype 140
6.2.37 Hours datatype 140
6.2.38 Impedance datatype 140
6.2.39 Inductance datatype 140
6.2.40 InductancePerLength datatype 141
6.2.41 Integer primitive 141
6.2.42 IntegerQuantity compound 141
6.2.43 KiloActivePower datatype 141

IECNORM.COM : Click to view the full PDF of IEC 61970-301:2020+AMD1:2022 CSV

6.2.44 Length datatype 142
6.2.45 Mass datatype 142
6.2.46 Minutes datatype 142
6.2.47 Money datatype 142
6.2.48 MonthDay primitive 143
6.2.49 MonthDayInterval compound 143
6.2.50 PU datatype 143
6.2.51 PerCent datatype 143
6.2.52 Pressure datatype 143
6.2.53 Reactance datatype 144
6.2.54 ReactancePerLength datatype 144
6.2.55 ReactivePower datatype 144
6.2.56 RealEnergy datatype 144
6.2.57 Resistance datatype 145
6.2.58 ResistancePerLength datatype 145
6.2.59 RotationSpeed datatype 145
6.2.60 Seconds datatype 146
6.2.61 Speed datatype 146
6.2.62 String primitive 146
6.2.63 StringQuantity compound 146
6.2.64 Susceptance datatype 146
6.2.65 SusceptancePerLength datatype 147
6.2.66 Temperature datatype 147
6.2.67 Time primitive 147
6.2.68 TimeInterval compound 147
6.2.69 UnitMultiplier enumeration 148
6.2.70 UnitSymbol enumeration 149
6.2.71 Voltage datatype 154
6.2.72 VoltagePerReactivePower datatype 154
6.2.73 Volume datatype 154
6.2.74 VolumeFlowRate datatype 155
6.2.75 WaterLevel datatype 155
6.3 Package Core 155
6.3.1 General 155
6.3.2 ACDCTerminal 160
6.3.3 BaseFrequency 161
6.3.4 BasePower 162
6.3.5 BaseVoltage 162
6.3.6 BasicIntervalSchedule 163
6.3.7 Bay 163
6.3.8 BreakerConfiguration enumeration 164
6.3.9 BusbarConfiguration enumeration 165
6.3.10 ConductingEquipment 165
6.3.11 ConnectivityNode 166
6.3.12 ConnectivityNodeContainer 167
6.3.13 Curve 167
6.3.14 CurveData root class 168
6.3.15 CurveStyle enumeration 169
6.3.16 Equipment 169

IECNORM.COM : Click to view the full PDF of IEC 61970-301:2020+AMD1:2022 CSV

6.3.17 EquipmentContainer 170
6.3.18 Feeder 171
6.3.19 GeographicalRegion 172
6.3.20 IdentifiedObject root class 173
6.3.21 IrregularIntervalSchedule 174
6.3.22 IrregularTimePoint root class 174
6.3.23 Name root class 175
6.3.24 NameType root class 175
6.3.25 NameTypeAuthority root class 176
6.3.26 OperatingParticipant 176
6.3.27 OperatingShare root class 177
6.3.28 PSRType 177
6.3.29 PhaseCode enumeration 178
6.3.30 PowerSystemResource 179
6.3.31 RegularIntervalSchedule 179
6.3.32 RegularTimePoint root class 180
6.3.33 ReportingGroup 181
6.3.34 ReportingSuperGroup 181
6.3.35 SubGeographicalRegion 182
6.3.36 Substation 183
6.3.37 Terminal 184
6.3.38 VoltageLevel 185
6.4 Package Wires 186
6.4.1 General 186
6.4.2 AsynchronousMachineKind enumeration 201
6.4.3 ACLineSegment 202
6.4.4 ACLineSegmentPhase 203
6.4.5 AsynchronousMachine 204
6.4.6 Breaker 206
6.4.7 BusbarSection 208
6.4.8 Clamp 209
6.4.9 CompositeSwitch 210
6.4.10 Conductor 211
6.4.11 Connector 212
6.4.12 CoolantType enumeration 213
6.4.13 Cut 213
6.4.14 Disconnector 215
6.4.15 DisconnectingCircuitBreaker 216
6.4.16 EarthFaultCompensator 217
6.4.17 EnergyConnection 218
6.4.18 EnergyConsumer 219
6.4.19 EnergyConsumerPhase 221
6.4.20 EnergySchedulingType 222
6.4.21 EnergySource 222
6.4.22 EnergySourcePhase 224
6.4.23 ExternalNetworkInjection 225
6.4.24 FrequencyConverter 227
6.4.25 Fuse 228
6.4.26 Ground 229

IECNORM.COM : Click to view the full PDF of IEC 61970-301:2020+AMD1:2022 CSV

6.4.27 GroundingImpedance 230
6.4.28 GroundDisconnector 231
6.4.29 Jumper 232
6.4.30 Junction 234
6.4.31 Line 234
6.4.32 LinearShuntCompensator 235
6.4.33 LinearShuntCompensatorPhase 237
6.4.34 LoadBreakSwitch 237
6.4.35 MutualCoupling 239
6.4.36 NonlinearShuntCompensator 240
6.4.37 NonlinearShuntCompensatorPhase 241
6.4.38 NonlinearShuntCompensatorPhasePoint root class 242
6.4.39 NonlinearShuntCompensatorPoint root class 243
6.4.40 PerLengthImpedance 243
6.4.41 PerLengthLineParameter 244
6.4.42 PerLengthPhaseImpedance 244
6.4.43 PerLengthSequenceImpedance 245
6.4.44 PetersenCoil 246
6.4.45 PetersenCoilModeKind enumeration 247
6.4.46 PhaseImpedanceData root class 247
6.4.47 PhaseShuntConnectionKind enumeration 248
6.4.48 PhaseTapChanger 249
6.4.49 PhaseTapChangerAsymmetrical 250
6.4.50 PhaseTapChangerLinear 251
6.4.51 PhaseTapChangerNonLinear 252
6.4.52 PhaseTapChangerSymmetrical 254
6.4.53 PhaseTapChangerTable 255
6.4.54 PhaseTapChangerTablePoint 255
6.4.55 PhaseTapChangerTabular 256
6.4.56 Plant 257
6.4.57 PowerElectronicsConnection 258
6.4.58 PowerElectronicsConnectionPhase 259
6.4.59 PowerTransformer 260
6.4.60 PowerTransformerEnd 262
6.4.61 ProtectedSwitch 264
6.4.62 RatioTapChanger 266
6.4.63 RatioTapChangerTable 267
6.4.64 RatioTapChangerTablePoint 267
6.4.65 ReactiveCapabilityCurve 268
6.4.66 Recloser 269
6.4.67 RegulatingCondEq 270
6.4.68 RegulatingControl 271
6.4.69 RegulatingControlModeKind enumeration 273
6.4.70 RegulationSchedule 273
6.4.71 RotatingMachine 274
6.4.72 Sectionaliser 276
6.4.73 SeriesCompensator 277
6.4.74 ShortCircuitRotorKind enumeration 278
6.4.75 ShuntCompensator 278

IECNORM.COM : Click to view the full PDF of IEC 61970-301:2020+AMD1:2022 CSV

6.4.76 ShuntCompensatorPhase 280
6.4.77 SinglePhaseKind enumeration 281
6.4.78 StaticVarCompensator 282
6.4.79 SVCControlMode enumeration 283
6.4.80 Switch 283
6.4.81 SwitchPhase 285
6.4.82 SwitchSchedule 286
6.4.83 SynchronousMachine 287
6.4.84 SynchronousMachineOperatingMode enumeration 290
6.4.85 SynchronousMachineKind enumeration 290
6.4.86 TapChanger 290
6.4.87 TapChangerControl 292
6.4.88 TapChangerTablePoint root class 293
6.4.89 TapSchedule 294
6.4.90 TransformerControlMode enumeration 295
6.4.91 TransformerCoreAdmittance 295
6.4.92 TransformerEnd 296
6.4.93 TransformerMeshImpedance 297
6.4.94 TransformerStarImpedance 298
6.4.95 TransformerTank 299
6.4.96 TransformerTankEnd 299
6.4.97 VoltageControlZone 300
6.4.98 WireSegment 301
6.4.99 WireSegmentPhase 302
6.4.100 WindingConnection enumeration 303
6.5 Package LoadModel 303
6.5.1 General 303
6.5.2 ConformLoad 304
6.5.3 ConformLoadGroup 306
6.5.4 ConformLoadSchedule 306
6.5.5 DayType 307
6.5.6 EnergyArea 308
6.5.7 LoadArea 308
6.5.8 LoadGroup 309
6.5.9 LoadResponseCharacteristic 309
6.5.10 NonConformLoad 311
6.5.11 NonConformLoadGroup 312
6.5.12 NonConformLoadSchedule 313
6.5.13 PowerCutZone 314
6.5.14 Season 314
6.5.15 SeasonDayTypeSchedule 315
6.5.16 StationSupply 315
6.5.17 SubLoadArea 317
6.6 Package Generation 317
6.6.1 General 317
6.6.2 Package GenerationTrainingSimulation 318
6.6.3 Package Production 334
6.7 Package DC 386
6.7.1 General 386

IECNORM.COM : Click to view the full PDF of IEC 61970-301:2020+AMD1:2022 CSV

6.7.2 ACDCConverter 390
6.7.3 ACDCConverterDCTerminal 393
6.7.4 CsConverter 394
6.7.5 DCTopologicalNode 396
6.7.6 CsOperatingModeKind enumeration 397
6.7.7 CsPpccControlKind enumeration 397
6.7.8 DCBaseTerminal 397
6.7.9 DCBreaker 398
6.7.10 DCBusbar 399
6.7.11 DCChopper 400
6.7.12 DCConductingEquipment 401
6.7.13 DCConverterOperatingModeKind enumeration 402
6.7.14 DCConverterUnit 402
6.7.15 DCDisconnector 403
6.7.16 DCEquipmentContainer 404
6.7.17 DCGround 405
6.7.18 DCLine 406
6.7.19 DCLineSegment 407
6.7.20 DCNode 408
6.7.21 DCPolarityKind enumeration 409
6.7.22 DCSeriesDevice 409
6.7.23 DCShunt 410
6.7.24 DCSwitch 411
6.7.25 DCTerminal 412
6.7.26 DCTopologicalIsland 413
6.7.27 PerLengthDCLineParameter 413
6.7.28 VsCapabilityCurve 414
6.7.29 VsConverter 414
6.7.30 VsPpccControlKind enumeration 417
6.7.31 VsQpccControlKind enumeration 417
6.8 Package Equivalents 418
6.8.1 General 418
6.8.2 EquivalentBranch 419
6.8.3 EquivalentEquipment 422
6.8.4 EquivalentInjection 423
6.8.5 EquivalentNetwork 425
6.8.6 EquivalentShunt 426
6.9 Package AuxiliaryEquipment 427
6.9.1 General 427
6.9.2 AuxiliaryEquipment 428
6.9.3 CurrentTransformer 429
6.9.4 FaultIndicator 430
6.9.5 PostLineSensor 431
6.9.6 PotentialTransformer 432
6.9.7 PotentialTransformerKind enumeration 433
6.9.8 Sensor 434
6.9.9 SurgeArrester 435
6.9.10 WaveTrap 435
6.10 Package Meas 436

IECNORM.COM : Click to view the full PDF of IEC 61970-301:2020+AMD1:2022 CSV

6.10.1 General 436
6.10.2 Accumulator 440
6.10.3 AccumulatorLimit 441
6.10.4 AccumulatorLimitSet 441
6.10.5 AccumulatorReset 442
6.10.6 AccumulatorValue 443
6.10.7 Analog 444
6.10.8 AnalogControl 444
6.10.9 AnalogLimit 445
6.10.10 AnalogLimitSet 446
6.10.11 AnalogValue 446
6.10.12 Command 447
6.10.13 Control 448
6.10.14 Discrete 449
6.10.15 DiscreteValue 450
6.10.16 IOPoint 451
6.10.17 Limit 452
6.10.18 LimitSet 452
6.10.19 Measurement 453
6.10.20 MeasurementValue 454
6.10.21 MeasurementValueQuality 455
6.10.22 MeasurementValueSource 456
6.10.23 Quality61850 root class 456
6.10.24 RaiseLowerCommand 457
6.10.25 SetPoint 458
6.10.26 StringMeasurement 459
6.10.27 StringMeasurementValue 460
6.10.28 Validity enumeration 460
6.10.29 ValueAliasSet 461
6.10.30 ValueToAlias 462
6.11 Package Topology 462
6.11.1 General 462
6.11.2 BusNameMarker 464
6.11.3 TopologicalIsland 464
6.11.4 TopologicalNode 465
6.12 Package DiagramLayout 466
6.12.1 General 466
6.12.2 Diagram 467
6.12.3 DiagramObject 468
6.12.4 DiagramObjectGluePoint root class 469
6.12.5 DiagramObjectPoint root class 470
6.12.6 DiagramObjectStyle 470
6.12.7 DiagramStyle 471
6.12.8 OrientationKind enumeration 471
6.12.9 TextDiagramObject 472
6.12.10 VisibilityLayer 473
6.13 Package OperationalLimits 473
6.13.1 General 473
6.13.2 ActivePowerLimit 475

IECNORM.COM : Click to view the full PDF of IEC 61970-301:2020+AMD1:2022 CSV

6.13.3 ApparentPowerLimit 476
6.13.4 BranchGroup 476
6.13.5 BranchGroupTerminal root class 477
6.13.6 CurrentLimit 478
6.13.7 OperationalLimit 478
6.13.8 OperationalLimitDirectionKind enumeration 479
6.13.9 OperationalLimitSet 479
6.13.10 OperationalLimitType 480
6.13.11 VoltageLimit 481
6.14 Package ControlArea 481
6.14.1 General 481
6.14.2 AltGeneratingUnitMeas 483
6.14.3 AltTieMeas 484
6.14.4 ControlArea 485
6.14.5 ControlAreaGeneratingUnit 486
6.14.6 ControlAreaTypeKind enumeration 487
6.14.7 TieFlow 487
6.15 Package Contingency 488
6.15.1 General 488
6.15.2 Contingency 488
6.15.3 ContingencyElement 489
6.15.4 ContingencyEquipment 489
6.15.5 ContingencyEquipmentStatusKind enumeration 490
6.16 Package StateVariables 490
6.16.1 General 490
6.16.2 StateVariable root class 491
6.16.3 SvInjection 491
6.16.4 SvPowerFlow 492
6.16.5 SvShuntCompensatorSections 492
6.16.6 SvStatus 493
6.16.7 SvSwitch 493
6.16.8 SvTapStep 494
6.16.9 SvVoltage 494
6.17 Package Protection 495
6.17.1 General 495
6.17.2 CurrentRelay 496
6.17.3 ProtectionEquipment 497
6.17.4 RecloseSequence 498
6.17.5 SynchrocheckRelay 499
6.18 Package Faults 500
6.18.1 General 500
6.18.2 EquipmentFault 501
6.18.3 Fault 501
6.18.4 FaultCauseType 502
6.18.5 FaultImpedance compound 502
6.18.6 LineFault 503
6.18.7 PhaseConnectedFaultKind enumeration 503
6.19 Package SCADA 504
6.19.1 General 504

IECNORM.COM : Click to view the full PDF of IEC 61970-301:2020+AMD1:2022 CSV

6.19.2 CommunicationLink 505
6.19.3 RemoteControl 506
6.19.4 RemotePoint 506
6.19.5 RemoteSource 507
6.19.6 RemoteUnit 508
6.19.7 RemoteUnitType enumeration 508
6.19.8 Source enumeration 509
6.20 Package ICCPConfiguration 509
6.20.1 General 509
6.20.2 ApplicationSecurityKind enumeration 511
6.20.3 BilateralExchangeActor 512
6.20.4 BilateralExchangeAgreement 512
6.20.5 ICCPAccessPrivilegeKind enumeration 513
6.20.6 ICCPInformationMessage 513
6.20.7 ICCPPointKind enumeration 514
6.20.8 ICCPProvidedPoint 514
6.20.9 ICCPQualityKind enumeration 515
6.20.10 ICCPScopeKind enumeration 516
6.20.11 ICCPVCC 516
6.20.12 ICCPVirtualControlCentre 517
6.20.13 IOPointSource 518
6.20.14 IPAccessPoint 519
6.20.15 IPAddressKind enumeration 520
6.20.16 ISOUpperLayer 520
6.20.17 ProvidedBilateralPoint 521
6.20.18 PublicX509Certificate root class 521
6.20.19 TASE2BilateralTable 522
6.20.20 TCPAccessPoint 523
Annex A (normative) Custom extensions 525
A.1 Overview 525
A.2 European extensions 525
A.2.1 General 525
A.2.2 Package ExtEuCore 525
A.2.3 Package ExtEuOperationalLimits 529
A.2.4 Package ExtEuGeneration 531
Annex B (informative) Examples of PST transformer modelling 534
B.1 General 534
B.2 Detailed calculations and examples 534
B.2.1 Symmetrical phase shifters with two cores 534
B.2.2 Quadrature boosters 538
B.2.3 Asymmetrical phase shifter 542
Annex C (informative) Use cases HVDC representation 549
C.1 Overview 549
C.2 Back-to-back installations 549
C.3 Monopole with ground return 550
C.4 Monopole with metallic return 551
C.5 Voltage source converter 552
Bibliography 554

IECNORM.COM : Click to view the full PDF of IEC 61970-301:2020+AMD1:2022 CSV

Figure 1 – Defined dependencies between CIM packages and packages' versions information 42
Figure 2 – CIM IEC 61970-301 package diagram 43
Figure 3 – Example of generalization 45
Figure 4 – Example of simple association 46
Figure 5 – Example of aggregation 46
Figure 6 – Equipment containers 48
Figure 7 – Names 49
Figure 8 – Connectivity model 50
Figure 9 – Simple network example 51
Figure 10 – Simple network connectivity modelled with CIM Topology 52
Figure 11 – Equipment inheritance hierarchy 53
Figure 12 – Transformer and Tank model 54
Figure 13 – Transformer model 56
Figure 14 – Transformer tap model 57
Figure 15 – Phasor diagram and equations 60
Figure 16 – Symmetrical phase shifter impedance variation 61
Figure 17 – Core organization 62
Figure 18 – Phasor diagram and equations 62
Figure 19 – Core organization 63
Figure 20 – Phasor diagram and equations 64
Figure 21 – Core organization 65
Figure 22 – Phasor diagram and equations 65
Figure 23 – Phasor diagrams and equations 67
Figure 24 – Core organization 68
Figure 25 – Phase wire data model 70
Figure 26 – Phase connectivity 71
Figure 27 – Grounding device data model 73
Figure 28 – Station including Petersen coils drawing example 74
Figure 29 – Instance diagram objects with one terminal coil 75
Figure 30 – Cuts, clamps, and jumpers UML model 76
Figure 31 – Example before cuts and jumpers are applied 77
Figure 32 – Example after cuts and jumpers are applied 78
Figure 33 – Example of jumper without cut or clamp 79
Figure 34 – Navigating from PSR to MeasurementValue 81
Figure 35 – Measurement placement 84
Figure 36 – Regulating control models 85
Figure 37 – Simplified example of HVDC model representation 87
Figure 38 – Detailed example of HVDC model representation with fictitious HVDC substations 88
Figure 39 – Detailed example of HVDC model representation with no fictitious HVDC substations 89
Figure 40 – HVDC bi-polar link from IEC 60633 90

IECNORM.COM : Click to view the full PDF of IEC 61970-301:2020+AMD1:2022 CSV

Figure 41 – A point-to-point VSC transmission scheme 90
Figure 42 – HVDC power flow model 91
Figure 43 – Detailed HVDC power flow model 92
Figure 44 – Current Source Converter power flow 92
Figure 45 – Voltage Source Converter power flow 93
Figure 46 – Power flow cases 94
Figure 47 – VSC transmission with a symmetrical monopole illustrated with capacitive earthing on the DC side (IEC 62747) 95
Figure 48 – VSC P-Q capability curve 95
Figure 49 – Bipolar VSC transmission with earth return (IEC 62747) 96
Figure 50 – Object instances for a bi-polar current source HVDC line 97
Figure 51 – Object instances for symmetric monopole VSC HVDC data model 98
Figure 52 – Containment structure for a bipolar HVDC line 99
Figure 53 – Containment structure for a bipolar back-to-back HVDC station 100
Figure 54 – The Basic topology in package Core 101
Figure 55 – DC and AC topology 102
Figure 56 – Equipment model 103
Figure 57 – HVDC line model 104
Figure 58 – Legend 105
Figure 59 – Simple monopole with measurements 105
Figure 60 – Simple bipolar 106
Figure 61 – Monopole one side with detailed model 106
Figure 62 – V-I Characteristic of SVC 107
Figure 63 – ICCP measurements and network models 109
Figure 64 – ICCP configuration and start up 109
Figure 65 – Measurement value provider and consumer example 110
Figure 66 – Generalized bilateral exchange agreement data model 112
Figure 67 – ICCP bilateral exchange agreement data model 114
Figure 68 – Feeder data model 115
Figure 69 – Orientation of the Terminal flow 116
Figure 70 – Several ways to describe control area ties 117
Figure 71 – CIM top level packages 121
Figure 72 – Class diagram Domain::CombinedElectricalDatatypes 123
Figure 73 – Class diagram Domain::BasicDatatypes 123
Figure 74 – Class diagram Domain::ElectricityDatatypes 124
Figure 75 – Class diagram Domain::EnumeratedUnitDatatypes 125
Figure 76 – Class diagram Domain::GeneralDatatypes 126
Figure 77 – Class diagram Domain::MonetaryDatatypes 127
Figure 78 – Class diagram Domain::TimeDatatypes 128
Figure 79 – Class diagram Core::Main 156
Figure 80 – Class diagram Core::Names 157
Figure 81 – Class diagram Core::CurveSchedule 157
Figure 82 – Class diagram Core::Datatypes 158
IECNORM.COM : Click to view the full PDF of IEC 61970-301:2020+AMD1:2022 CSV

Figure 83 – Class diagram Core::FeederContainment 159
Figure 84 – Class diagram Core::Reporting 159
Figure 85 – Class diagram Core::OperatingShare 160
Figure 86 – Class diagram Wires::CutsAndJumpers 187
Figure 87 – Class diagram Wires::Datatypes 188
Figure 88 – Class diagram Wires::EarthFaultCompensator 189
Figure 89 – Class diagram Wires::InheritanceHierarchy 190
Figure 90 – Class diagram Wires::LineModel 191
Figure 91 – Class diagram Wires::MutualCoupling 192
Figure 92 – Class diagram Wires::NamingHierarchyPart1 193
Figure 93 – Class diagram Wires::NamingHierarchyPart2 194
Figure 94 – Class diagram Wires::RegulatingEquipment 195
Figure 95 – Class diagram Wires::Schedules 196
Figure 96 – Class diagram Wires::ShuntCompensator 196
Figure 97 – Class diagram Wires::SwitchingEquipment 197
Figure 98 – Class diagram Wires::TapChanger 198
Figure 99 – Class diagram Wires::VoltageControl 199
Figure 100 – Class diagram Wires::WiresPhaseModel 200
Figure 101 – Class diagram Wires::Transformer 201
Figure 102 – Class diagram LoadModel::Main 304
Figure 103 – Class diagram Generation::Main 318
Figure 104 – Class diagram GenerationTrainingSimulation::Main 318
Figure 105 – Class diagram GenerationTrainingSimulation::Datatypes 319
Figure 106 – Class diagram Production::PowerElectronics 334
Figure 107 – Class diagram Production::Nuclear 335
Figure 108 – Class diagram Production::Main 336
Figure 109 – Class diagram Production::Datatypes 337
Figure 110 – Class diagram Production::Hydro 338
Figure 111 – Class diagram Production::Thermal 339
Figure 112 – Class diagram DC::DCContainment 386
Figure 113 – Class diagram DC::DCEquipment 387
Figure 114 – Class diagram DC::DCLineModel 388
Figure 115 – Class diagram DC::ACDCConverter 389
Figure 116 – Class diagram DC::ACDCConnectivityModel 390
Figure 117 – Class diagram Equivalents::Main 419
Figure 118 – Class diagram AuxiliaryEquipment::AuxiliaryEquipment 428
Figure 119 – Class diagram Meas::Control 437
Figure 120 – Class diagram Meas::Datatypes 437
Figure 121 – Class diagram Meas::Measurement 438
Figure 122 – Class diagram Meas::MeasurementInheritance 439
Figure 123 – Class diagram Meas::Quality 440
Figure 124 – Class diagram Topology::Main 463
Figure 125 – Class diagram Topology::TopologyReporting 463
IECNORM.COM : Click to view the full PDF of IEC 61970-301:2020+AMD1:2022 CSV

Figure 126 – Class diagram DiagramLayout::DiagramLayout 467
Figure 127 – Class diagram OperationalLimits::OperationalLimits 474
Figure 128 – Class diagram OperationalLimits::BranchGroup 475
Figure 129 – Class diagram ControlArea::ControlArea 482
Figure 130 – Class diagram ControlArea::ControlAreaInheritance 483
Figure 131 – Class diagram ControlArea::Datatypes 483
Figure 132 – Class diagram Contingency::Contingency 488
Figure 133 – Class diagram StateVariables::StateVariables 491
Figure 134 – Class diagram Protection::Main 495
Figure 135 – Class diagram Faults::Faults 500
Figure 136 – Class diagram SCADA::Datatypes 504
Figure 137 – Class diagram SCADA::Main 505
Figure 138 – Class diagram ICCPConfiguration::GenericBilateralExchange 510
Figure 139 – Class diagram ICCPConfiguration::ICCP 511
Figure A.1 – Class diagram ExtEuBase::ExtEuBase 525
Figure A.2 – Class diagram ExtEuCore::ExtEuCore 526
Figure A.3 – Class diagram ExtEuOperationalLimits::ExtEuOperationalLimits 529
Figure A.4 – Class diagram ExtEuProduction::ExtEuProduction 531
Figure B.1 – Symmetrical phase shifters with two cores 534
Figure B.2 – Detailed three phase diagram 535
Figure B.3 – Detailed three phase diagram 538
Figure B.4 – Single phase diagram 539
Figure B.5 – Phasor diagram 540
Figure B.6 – Detailed three phase diagram 541
Figure B.7 – Phasor diagram 542
Figure B.8 – Asymmetrical phase shifter with two cores 542
Figure B.9 – Detailed three phase diagram 543
Figure B.10 – Phasor diagram 544
Figure B.11 – Asymmetrical phase shifter with a single core 545
Figure B.12 – Phasor diagram 546
Figure B.13 – Example of detailed three-phase diagram of voltage regulating auto-transformer and quadrature booster 547
Figure B.14 – Example of detailed winding diagram of voltage regulating auto-transformer and quadrature booster 548
Figure C.1 – Representation of a 12-p back-to-back installation 550
Figure C.2 – Representation of a 12-p monopole installation with ground return 551
Figure C.3 – Representation of a 12-p monopole installation with metallic return 552
Figure C.4 – Representation of a voltage source converter 553

Table 1 – Mapping of phase shift transformers to CIM classes 58
Table 2 – Mapping of symbols used in formulas to CIM attributes 59
Table 3 – Impedance variations in a phase shift transformer 59
Table 4 – Description of variables 60
Table 5 – Tap changer control options 69
IECNORM.COM : Click to view the full PDF of IEC 61970-301:2020+AMD1:2022 CSV

Table 6 – measurementType naming conventions 82
Table 7 – MeasurementValueSource naming conventions 83
Table 8 – Attributes of Package1::Class1 121
Table 9 – Association ends of Package1::Class1 with other classes 122
Table 10 – Literals of Package1::Enumeration1 122
Table 11 – Attributes of Domain::ActivePower 128
Table 12 – Attributes of Domain::ActivePowerChangeRate 129
Table 13 – Attributes of Domain::ActivePowerPerCurrentFlow 129
Table 14 – Attributes of Domain::ActivePowerPerFrequency 129
Table 15 – Attributes of Domain::Admittance 129
Table 16 – Attributes of Domain::AngleDegrees 130
Table 17 – Attributes of Domain::AngleRadians 130
Table 18 – Attributes of Domain::ApparentPower 130
Table 19 – Attributes of Domain::Area 130
Table 20 – Attributes of Domain::Capacitance 131
Table 21 – Attributes of Domain::CapacitancePerLength 131
Table 22 – Attributes of Domain::Classification 131
Table 23 – Attributes of Domain::Conductance 132
Table 24 – Attributes of Domain::ConductancePerLength 132
Table 25 – Attributes of Domain::CostPerEnergyUnit 132
Table 26 – Attributes of Domain::CostPerHeatUnit 132
Table 27 – Attributes of Domain::CostPerVolume 133
Table 28 – Attributes of Domain::CostRate 133
Table 29 – Literals of Domain::Currency 133
Table 30 – Attributes of Domain::CurrentFlow 137
Table 31 – Attributes of Domain::Damping 137
Table 32 – Attributes of Domain::DateInterval 138
Table 33 – Attributes of Domain::DateTimeInterval 138
Table 34 – Attributes of Domain::DecimalQuantity 138
Table 35 – Attributes of Domain::Displacement 139
Table 36 – Attributes of Domain::Emission 139
Table 37 – Attributes of Domain::FloatQuantity 139
Table 38 – Attributes of Domain::Frequency 140
Table 39 – Attributes of Domain::HeatRate 140
Table 40 – Attributes of Domain::Hours 140
Table 41 – Attributes of Domain::Impedance 140
Table 42 – Attributes of Domain::Inductance 141
Table 43 – Attributes of Domain::InductancePerLength 141
Table 44 – Attributes of Domain::IntegerQuantity 141
Table 45 – Attributes of Domain::KiloActivePower 141
Table 46 – Attributes of Domain::Length 142
Table 47 – Attributes of Domain::Mass 142
Table 48 – Attributes of Domain::Minutes 142

IECNORM.COM : Click to view the full PDF of IEC 61970-301:2020+AMD1:2022 CSV

Table 49 – Attributes of Domain::Money 142
Table 50 – Attributes of Domain::MonthDayInterval 143
Table 51 – Attributes of Domain::PU 143
Table 52 – Attributes of Domain::PerCent 143
Table 53 – Attributes of Domain::Pressure 144
Table 54 – Attributes of Domain::Reactance 144
Table 55 – Attributes of Domain::ReactancePerLength 144
Table 56 – Attributes of Domain::ReactivePower 144
Table 57 – Attributes of Domain::RealEnergy 145
Table 58 – Attributes of Domain::Resistance 145
Table 59 – Attributes of Domain::ResistancePerLength 145
Table 60 – Attributes of Domain::RotationSpeed 145
Table 61 – Attributes of Domain::Seconds 146
Table 62 – Attributes of Domain::Speed 146
Table 63 – Attributes of Domain::StringQuantity 146
Table 64 – Attributes of Domain::Susceptance 147
Table 65 – Attributes of Domain::SusceptancePerLength 147
Table 66 – Attributes of Domain::Temperature 147
Table 67 – Attributes of Domain::TimeInterval 147
Table 68 – Literals of Domain::UnitMultiplier 148
Table 69 – Literals of Domain::UnitSymbol 149
Table 70 – Attributes of Domain::Voltage 154
Table 71 – Attributes of Domain::VoltagePerReactivePower 154
Table 72 – Attributes of Domain::Volume 154
Table 73 – Attributes of Domain::VolumeFlowRate 155
Table 74 – Attributes of Domain::WaterLevel 155
Table 75 – Attributes of Core::ACDCTerminal 160
Table 76 – Association ends of Core::ACDCTerminal with other classes 161
Table 77 – Attributes of Core::BaseFrequency 161
Table 78 – Association ends of Core::BaseFrequency with other classes 162
Table 79 – Attributes of Core::BasePower 162
Table 80 – Association ends of Core::BasePower with other classes 162
Table 81 – Attributes of Core::BaseVoltage 162
Table 82 – Association ends of Core::BaseVoltage with other classes 163
Table 83 – Attributes of Core::BasicIntervalSchedule 163
Table 84 – Association ends of Core::BasicIntervalSchedule with other classes 163
Table 85 – Attributes of Core::Bay 164
Table 86 – Association ends of Core::Bay with other classes 164
Table 87 – Literals of Core::BreakerConfiguration 165
Table 88 – Literals of Core::BusbarConfiguration 165
Table 89 – Attributes of Core::ConductingEquipment 165
Table 90 – Association ends of Core::ConductingEquipment with other classes 166
Table 91 – Attributes of Core::ConnectivityNode 166
IECNORM.COM : Click to view the full PDF of IEC 61970-301:2020+AMD1:2022 CSV

Table 92 – Association ends of Core::ConnectivityNode with other classes 167
Table 93 – Attributes of Core::ConnectivityNodeContainer 167
Table 94 – Association ends of Core::ConnectivityNodeContainer with other classes 167
Table 95 – Attributes of Core::Curve 168
Table 96 – Association ends of Core::Curve with other classes 168
Table 97 – Attributes of Core::CurveData 168
Table 98 – Association ends of Core::CurveData with other classes 169
Table 99 – Literals of Core::CurveStyle 169
Table 100 – Attributes of Core::Equipment 169
Table 101 – Association ends of Core::Equipment with other classes 170
Table 102 – Attributes of Core::EquipmentContainer 170
Table 103 – Association ends of Core::EquipmentContainer with other classes 171
Table 104 – Attributes of Core::Feeder 171
Table 105 – Association ends of Core::Feeder with other classes 172
Table 106 – Attributes of Core::GeographicalRegion 172
Table 107 – Association ends of Core::GeographicalRegion with other classes 173
Table 108 – Attributes of Core::IdentifiedObject 173
Table 109 – Association ends of Core::IdentifiedObject with other classes 173
Table 110 – Attributes of Core::IrregularIntervalSchedule 174
Table 111 – Association ends of Core::IrregularIntervalSchedule with other classes 174
Table 112 – Attributes of Core::IrregularTimePoint 174
Table 113 – Association ends of Core::IrregularTimePoint with other classes 175
Table 114 – Attributes of Core::Name 175
Table 115 – Association ends of Core::Name with other classes 175
Table 116 – Attributes of Core::NameType 175
Table 117 – Association ends of Core::NameType with other classes 176
Table 118 – Attributes of Core::NameTypeAuthority 176
Table 119 – Association ends of Core::NameTypeAuthority with other classes 176
Table 120 – Attributes of Core::OperatingParticipant 176
Table 121 – Association ends of Core::OperatingParticipant with other classes 177
Table 122 – Attributes of Core::OperatingShare 177
Table 123 – Association ends of Core::OperatingShare with other classes 177
Table 124 – Attributes of Core::PSRType 177
Table 125 – Association ends of Core::PSRType with other classes 178
Table 126 – Literals of Core::PhaseCode 178
Table 127 – Attributes of Core::PowerSystemResource 179
Table 128 – Association ends of Core::PowerSystemResource with other classes 179
Table 129 – Attributes of Core::RegularIntervalSchedule 180
Table 130 – Association ends of Core::RegularIntervalSchedule with other classes 180
Table 131 – Attributes of Core::RegularTimePoint 180
Table 132 – Association ends of Core::RegularTimePoint with other classes 181
Table 133 – Attributes of Core::ReportingGroup 181
Table 134 – Association ends of Core::ReportingGroup with other classes 181
IECNORM.COM : Click to view the full PDF of IEC 61970-301:2020+AMD1:2022 CSV

Table 135 – Attributes of Core::ReportingSuperGroup 182
Table 136 – Association ends of Core::ReportingSuperGroup with other classes 182
Table 137 – Attributes of Core::SubGeographicalRegion 182
Table 138 – Association ends of Core::SubGeographicalRegion with other classes 182
Table 139 – Attributes of Core::Substation 183
Table 140 – Association ends of Core::Substation with other classes 183
Table 141 – Attributes of Core::Terminal 184
Table 142 – Association ends of Core::Terminal with other classes 184
Table 143 – Attributes of Core::VoltageLevel 185
Table 144 – Association ends of Core::VoltageLevel with other classes 186
Table 145 – Literals of Wires::AsynchronousMachineKind 202
Table 146 – Attributes of Wires::ACLineSegment 202
Table 147 – Association ends of Wires::ACLineSegment with other classes 203
Table 148 – Attributes of Wires::ACLineSegmentPhase 204
Table 149 – Association ends of Wires::ACLineSegmentPhase with other classes 204
Table 150 – Attributes of Wires::AsynchronousMachine 205
Table 151 – Association ends of Wires::AsynchronousMachine with other classes 206
Table 152 – Attributes of Wires::Breaker 207
Table 153 – Association ends of Wires::Breaker with other classes 207
Table 154 – Attributes of Wires::BusbarSection 208
Table 155 – Association ends of Wires::BusbarSection with other classes 208
Table 156 – Attributes of Wires::Clamp 209
Table 157 – Association ends of Wires::Clamp with other classes 210
Table 158 – Attributes of Wires::CompositeSwitch 210
Table 159 – Association ends of Wires::CompositeSwitch with other classes 211
Table 160 – Attributes of Wires::Conductor 211
Table 161 – Association ends of Wires::Conductor with other classes 212
Table 162 – Attributes of Wires::Connector 212
Table 163 – Association ends of Wires::Connector with other classes 213
Table 164 – Literals of Wires::CoolantType 213
Table 165 – Attributes of Wires::Cut 214
Table 166 – Association ends of Wires::Cut with other classes 214
Table 167 – Attributes of Wires::Disconnector 215
Table 168 – Association ends of Wires::Disconnector with other classes 215
Table 169 – Attributes of Wires::DisconnectingCircuitBreaker 216
Table 170 – Association ends of Wires::DisconnectingCircuitBreaker with other classes 217
Table 171 – Attributes of Wires::EarthFaultCompensator 217
Table 172 – Association ends of Wires::EarthFaultCompensator with other classes 218
Table 173 – Attributes of Wires::EnergyConnection 218
Table 174 – Association ends of Wires::EnergyConnection with other classes 219
Table 175 – Attributes of Wires::EnergyConsumer 219
Table 176 – Association ends of Wires::EnergyConsumer with other classes 220
Table 177 – Attributes of Wires::EnergyConsumerPhase 221
IECNORM.COM : Click to view the full PDF of IEC 61970-301:2020+AMD1:2022 CSV

Table 178 – Association ends of Wires::EnergyConsumerPhase with other classes 222
Table 179 – Attributes of Wires::EnergySchedulingType 222
Table 180 – Association ends of Wires::EnergySchedulingType with other classes 222
Table 181 – Attributes of Wires::EnergySource 223
Table 182 – Association ends of Wires::EnergySource with other classes 224
Table 183 – Attributes of Wires::EnergySourcePhase 224
Table 184 – Association ends of Wires::EnergySourcePhase with other classes 225
Table 185 – Attributes of Wires::ExternalNetworkInjection 225
Table 186 – Association ends of Wires::ExternalNetworkInjection with other classes 226
Table 187 – Attributes of Wires::FrequencyConverter 227
Table 188 – Association ends of Wires::FrequencyConverter with other classes 228
Table 189 – Attributes of Wires::Fuse 228
Table 190 – Association ends of Wires::Fuse with other classes 229
Table 191 – Attributes of Wires::Ground 229
Table 192 – Association ends of Wires::Ground with other classes 230
Table 193 – Attributes of Wires::GroundingImpedance 230
Table 194 – Association ends of Wires::GroundingImpedance with other classes 231
Table 195 – Attributes of Wires::GroundDisconnector 231
Table 196 – Association ends of Wires::GroundDisconnector with other classes 232
Table 197 – Attributes of Wires::Jumper 233
Table 198 – Association ends of Wires::Jumper with other classes 233
Table 199 – Attributes of Wires::Junction 234
Table 200 – Association ends of Wires::Junction with other classes 234
Table 201 – Attributes of Wires::Line 235
Table 202 – Association ends of Wires::Line with other classes 235
Table 203 – Attributes of Wires::LinearShuntCompensator 235
Table 204 – Association ends of Wires::LinearShuntCompensator with other classes 236
Table 205 – Attributes of Wires::LinearShuntCompensatorPhase 237
Table 206 – Association ends of Wires::LinearShuntCompensatorPhase with other classes 237
Table 207 – Attributes of Wires::LoadBreakSwitch 238
Table 208 – Association ends of Wires::LoadBreakSwitch with other classes 238
Table 209 – Attributes of Wires::MutualCoupling 239
Table 210 – Association ends of Wires::MutualCoupling with other classes 240
Table 211 – Attributes of Wires::NonlinearShuntCompensator 240
Table 212 – Association ends of Wires::NonlinearShuntCompensator with other classes 241
Table 213 – Attributes of Wires::NonlinearShuntCompensatorPhase 241
Table 214 – Association ends of Wires::NonlinearShuntCompensatorPhase with other classes 242
Table 215 – Attributes of Wires::NonlinearShuntCompensatorPhasePoint 242
Table 216 – Association ends of Wires::NonlinearShuntCompensatorPhasePoint with other classes 242
Table 217 – Attributes of Wires::NonlinearShuntCompensatorPoint 243
IECNORM.COM : Click to view the full PDF of IEC 61970-301:2020+AMD1:2022 CSV

Table 218 – Association ends of Wires::NonlinearShuntCompensatorPoint with other classes 243
Table 219 – Attributes of Wires::PerLengthImpedance 243
Table 220 – Association ends of Wires::PerLengthImpedance with other classes 244
Table 221 – Attributes of Wires::PerLengthLineParameter 244
Table 222 – Association ends of Wires::PerLengthLineParameter with other classes 244
Table 223 – Attributes of Wires::PerLengthPhaseImpedance 244
Table 224 – Association ends of Wires::PerLengthPhaseImpedance with other classes 245
Table 225 – Attributes of Wires::PerLengthSequenceImpedance 245
Table 226 – Association ends of Wires::PerLengthSequenceImpedance with other classes 246
Table 227 – Attributes of Wires::PetersenCoil 246
Table 228 – Association ends of Wires::PetersenCoil with other classes 247
Table 229 – Literals of Wires::PetersenCoilModeKind 247
Table 230 – Attributes of Wires::PhaseImpedanceData 248
Table 231 – Association ends of Wires::PhaseImpedanceData with other classes 248
Table 232 – Literals of Wires::PhaseShuntConnectionKind 248
Table 233 – Attributes of Wires::PhaseTapChanger 249
Table 234 – Association ends of Wires::PhaseTapChanger with other classes 249
Table 235 – Attributes of Wires::PhaseTapChangerAsymmetrical 250
Table 236 – Association ends of Wires::PhaseTapChangerAsymmetrical with other classes 251
Table 237 – Attributes of Wires::PhaseTapChangerLinear 251
Table 238 – Association ends of Wires::PhaseTapChangerLinear with other classes 252
Table 239 – Attributes of Wires::PhaseTapChangerNonLinear 253
Table 240 – Association ends of Wires::PhaseTapChangerNonLinear with other classes 253
Table 241 – Attributes of Wires::PhaseTapChangerSymmetrical 254
Table 242 – Association ends of Wires::PhaseTapChangerSymmetrical with other classes 255
Table 243 – Attributes of Wires::PhaseTapChangerTable 255
Table 244 – Association ends of Wires::PhaseTapChangerTable with other classes 255
Table 245 – Attributes of Wires::PhaseTapChangerTablePoint 256
Table 246 – Association ends of Wires::PhaseTapChangerTablePoint with other classes 256
Table 247 – Attributes of Wires::PhaseTapChangerTabular 256
Table 248 – Association ends of Wires::PhaseTapChangerTabular with other classes 257
Table 249 – Attributes of Wires::Plant 257
Table 250 – Association ends of Wires::Plant with other classes 257
Table 251 – Attributes of Wires::PowerElectronicsConnection 258
Table 252 – Association ends of Wires::PowerElectronicsConnection with other classes 259
Table 253 – Attributes of Wires::PowerElectronicsConnectionPhase 260
Table 254 – Association ends of Wires::PowerElectronicsConnectionPhase with other classes 260
Table 255 – Attributes of Wires::PowerTransformer 261
IECNORM.COM : Click to view the full PDF of IEC 61970-301:2020+AMD1:2022 CSV

Table 256 – Association ends of Wires::PowerTransformer with other classes 262
Table 257 – Attributes of Wires::PowerTransformerEnd 263
Table 258 – Association ends of Wires::PowerTransformerEnd with other classes 264
Table 259 – Attributes of Wires::ProtectedSwitch 265
Table 260 – Association ends of Wires::ProtectedSwitch with other classes 265
Table 261 – Attributes of Wires::RatioTapChanger 266
Table 262 – Association ends of Wires::RatioTapChanger with other classes 267
Table 263 – Attributes of Wires::RatioTapChangerTable 267
Table 264 – Association ends of Wires::RatioTapChangerTable with other classes 267
Table 265 – Attributes of Wires::RatioTapChangerTablePoint 268
Table 266 – Association ends of Wires::RatioTapChangerTablePoint with other classes 268
Table 267 – Attributes of Wires::ReactiveCapabilityCurve 268
Table 268 – Association ends of Wires::ReactiveCapabilityCurve with other classes 269
Table 269 – Attributes of Wires::Recloser 269
Table 270 – Association ends of Wires::Recloser with other classes 270
Table 271 – Attributes of Wires::RegulatingCondEq 270
Table 272 – Association ends of Wires::RegulatingCondEq with other classes 271
Table 273 – Attributes of Wires::RegulatingControl 272
Table 274 – Association ends of Wires::RegulatingControl with other classes 273
Table 275 – Literals of Wires::RegulatingControlModeKind 273
Table 276 – Attributes of Wires::RegulationSchedule 274
Table 277 – Association ends of Wires::RegulationSchedule with other classes 274
Table 278 – Attributes of Wires::RotatingMachine 274
Table 279 – Association ends of Wires::RotatingMachine with other classes 275
Table 280 – Attributes of Wires::Sectionaliser 276
Table 281 – Association ends of Wires::Sectionaliser with other classes 276
Table 282 – Attributes of Wires::SeriesCompensator 277
Table 283 – Association ends of Wires::SeriesCompensator with other classes 278
Table 284 – Literals of Wires::ShortCircuitRotorKind 278
Table 285 – Attributes of Wires::ShuntCompensator 279
Table 286 – Association ends of Wires::ShuntCompensator with other classes 280
Table 287 – Attributes of Wires::ShuntCompensatorPhase 280
Table 288 – Association ends of Wires::ShuntCompensatorPhase with other classes 281
Table 289 – Literals of Wires::SinglePhaseKind 282
Table 290 – Attributes of Wires::StaticVarCompensator 282
Table 291 – Association ends of Wires::StaticVarCompensator with other classes 283
Table 292 – Literals of Wires::SVCControlMode 283
Table 293 – Attributes of Wires::Switch 284
Table 294 – Association ends of Wires::Switch with other classes 285
Table 295 – Attributes of Wires::SwitchPhase 285
Table 296 – Association ends of Wires::SwitchPhase with other classes 286
Table 297 – Attributes of Wires::SwitchSchedule 286
Table 298 – Association ends of Wires::SwitchSchedule with other classes 287

IECNORM.COM : Click to view the full PDF of IEC 61970-301:2020+AMD1:2022 CSV

Table 299 – Attributes of Wires::SynchronousMachine 287
Table 300 – Association ends of Wires::SynchronousMachine with other classes 289
Table 301 – Literals of Wires::SynchronousMachineOperatingMode 290
Table 302 – Literals of Wires::SynchronousMachineKind 290
Table 303 – Attributes of Wires::TapChanger 291
Table 304 – Association ends of Wires::TapChanger with other classes 292
Table 305 – Attributes of Wires::TapChangerControl 292
Table 306 – Association ends of Wires::TapChangerControl with other classes 293
Table 307 – Attributes of Wires::TapChangerTablePoint 293
Table 308 – Attributes of Wires::TapSchedule 294
Table 309 – Association ends of Wires::TapSchedule with other classes 295
Table 310 – Literals of Wires::TransformerControlMode 295
Table 311 – Attributes of Wires::TransformerCoreAdmittance 295
Table 312 – Association ends of Wires::TransformerCoreAdmittance with other classes 296
Table 313 – Attributes of Wires::TransformerEnd 296
Table 314 – Association ends of Wires::TransformerEnd with other classes 297
Table 315 – Attributes of Wires::TransformerMeshImpedance 297
Table 316 – Association ends of Wires::TransformerMeshImpedance with other classes 298
Table 317 – Attributes of Wires::TransformerStarImpedance 298
Table 318 – Association ends of Wires::TransformerStarImpedance with other classes 298
Table 319 – Attributes of Wires::TransformerTank 299
Table 320 – Association ends of Wires::TransformerTank with other classes 299
Table 321 – Attributes of Wires::TransformerTankEnd 300
Table 322 – Association ends of Wires::TransformerTankEnd with other classes 300
Table 323 – Attributes of Wires::VoltageControlZone 301
Table 324 – Association ends of Wires::VoltageControlZone with other classes 301
Table 325 – Attributes of Wires::WireSegment 301
Table 326 – Association ends of Wires::WireSegment with other classes 302
Table 327 – Attributes of Wires::WireSegmentPhase 302
Table 328 – Association ends of Wires::WireSegmentPhase with other classes 303
Table 329 – Literals of Wires::WindingConnection 303
Table 330 – Attributes of LoadModel::ConformLoad 305
Table 331 – Association ends of LoadModel::ConformLoad with other classes 305
Table 332 – Attributes of LoadModel::ConformLoadGroup 306
Table 333 – Association ends of LoadModel::ConformLoadGroup with other classes 306
Table 334 – Attributes of LoadModel::ConformLoadSchedule 307
Table 335 – Association ends of LoadModel::ConformLoadSchedule with other classes 307
Table 336 – Attributes of LoadModel::DayType 307
Table 337 – Association ends of LoadModel::DayType with other classes 308
Table 338 – Attributes of LoadModel::EnergyArea 308
Table 339 – Association ends of LoadModel::EnergyArea with other classes 308
Table 340 – Attributes of LoadModel::LoadArea 308
Table 341 – Association ends of LoadModel::LoadArea with other classes 309
IECNORM.COM : Click to view the full PDF of IEC 61970-301:2020+AMD1:2022 CSV

Table 342 – Attributes of LoadModel::LoadGroup 309
Table 343 – Association ends of LoadModel::LoadGroup with other classes 309
Table 344 – Attributes of LoadModel::LoadResponseCharacteristic 310
Table 345 – Association ends of LoadModel::LoadResponseCharacteristic with other classes 311
Table 346 – Attributes of LoadModel::NonConformLoad 311
Table 347 – Association ends of LoadModel::NonConformLoad with other classes 312
Table 348 – Attributes of LoadModel::NonConformLoadGroup 312
Table 349 – Association ends of LoadModel::NonConformLoadGroup with other classes 313
Table 350 – Attributes of LoadModel::NonConformLoadSchedule 313
Table 351 – Association ends of LoadModel::NonConformLoadSchedule with other classes 313
Table 352 – Attributes of LoadModel::PowerCutZone 314
Table 353 – Association ends of LoadModel::PowerCutZone with other classes 314
Table 354 – Attributes of LoadModel::Season 314
Table 355 – Association ends of LoadModel::Season with other classes 315
Table 356 – Attributes of LoadModel::SeasonDayTypeSchedule 315
Table 357 – Association ends of LoadModel::SeasonDayTypeSchedule with other classes 315
Table 358 – Attributes of LoadModel::StationSupply 316
Table 359 – Association ends of LoadModel::StationSupply with other classes 316
Table 360 – Attributes of LoadModel::SubLoadArea 317
Table 361 – Association ends of LoadModel::SubLoadArea with other classes 317
Table 362 – Attributes of GenerationTrainingSimulation::BWRSteamSupply 319
Table 363 – Association ends of GenerationTrainingSimulation::BWRSteamSupply with other classes 320
Table 364 – Literals of GenerationTrainingSimulation::BoilerControlMode 320
Table 365 – Attributes of GenerationTrainingSimulation::CTTempActivePowerCurve 321
Table 366 – Association ends of GenerationTrainingSimulation::CTTempActivePowerCurve with other classes 321
Table 367 – Attributes of GenerationTrainingSimulation::CombustionTurbine 321
Table 368 – Association ends of GenerationTrainingSimulation::CombustionTurbine with other classes 322
Table 369 – Attributes of GenerationTrainingSimulation::DrumBoiler 323
Table 370 – Association ends of GenerationTrainingSimulation::DrumBoiler with other classes 324
Table 371 – Attributes of GenerationTrainingSimulation::FossilSteamSupply 324
Table 372 – Association ends of GenerationTrainingSimulation::FossilSteamSupply with other classes 325
Table 373 – Attributes of GenerationTrainingSimulation::HeatRecoveryBoiler 325
Table 374 – Association ends of GenerationTrainingSimulation::HeatRecoveryBoiler with other classes 326
Table 375 – Attributes of GenerationTrainingSimulation::HydroTurbine 327
Table 376 – Association ends of GenerationTrainingSimulation::HydroTurbine with other classes 327

IECNORM.COM : Click to view the full PDF of IEC 61970-301:2020+AMD1:2022 CSV

Table 377 – Attributes of GenerationTrainingSimulation::PWRSteamSupply 328
Table 378 – Association ends of GenerationTrainingSimulation::PWRSteamSupply with other classes 328
Table 379 – Attributes of GenerationTrainingSimulation::PrimeMover 329
Table 380 – Association ends of GenerationTrainingSimulation::PrimeMover with other classes 329
Table 381 – Attributes of GenerationTrainingSimulation::SteamSupply 329
Table 382 – Association ends of GenerationTrainingSimulation::SteamSupply with other classes 330
Table 383 – Attributes of GenerationTrainingSimulation::SteamTurbine 330
Table 384 – Association ends of GenerationTrainingSimulation::SteamTurbine with other classes 331
Table 385 – Attributes of GenerationTrainingSimulation::Subcritical 331
Table 386 – Association ends of GenerationTrainingSimulation::Subcritical with other classes 332
Table 387 – Attributes of GenerationTrainingSimulation::Supercritical 332
Table 388 – Association ends of GenerationTrainingSimulation::Supercritical with other classes 333
Table 389 – Literals of GenerationTrainingSimulation::HydroTurbineKind 334
Table 390 – Attributes of Production::AirCompressor 339
Table 391 – Association ends of Production::AirCompressor with other classes 340
Table 392 – Literals of Production::BatteryStateKind 340
Table 393 – Attributes of Production::BatteryUnit 340
Table 394 – Association ends of Production::BatteryUnit with other classes 341
Table 395 – Attributes of Production::CAESPlant 341
Table 396 – Association ends of Production::CAESPlant with other classes 342
Table 397 – Attributes of Production::CogenerationPlant 342
Table 398 – Association ends of Production::CogenerationPlant with other classes 343
Table 399 – Attributes of Production::CombinedCyclePlant 343
Table 400 – Association ends of Production::CombinedCyclePlant with other classes 343
Table 401 – Attributes of Production::EmissionAccount 344
Table 402 – Association ends of Production::EmissionAccount with other classes 344
Table 403 – Attributes of Production::EmissionCurve 345
Table 404 – Association ends of Production::EmissionCurve with other classes 345
Table 405 – Literals of Production::EmissionType 346
Table 406 – Literals of Production::WindGenUnitKind 346
Table 407 – Literals of Production::EmissionValueSource 346
Table 408 – Attributes of Production::FossilFuel 347
Table 409 – Association ends of Production::FossilFuel with other classes 347
Table 410 – Attributes of Production::FuelAllocationSchedule 348
Table 411 – Association ends of Production::FuelAllocationSchedule with other classes 348
Table 412 – Literals of Production::FuelType 349
Table 413 – Attributes of Production::GenUnitOpCostCurve 349
Table 414 – Association ends of Production::GenUnitOpCostCurve with other classes 350
Table 415 – Attributes of Production::GenUnitOpSchedule 350
IECNORM.COM : Click to view the full PDF of IEC 61970-301:2020+AMD1:2022 CSV

Table 416 – Association ends of Production::GenUnitOpSchedule with other classes 350
Table 417 – Attributes of Production::GeneratingUnit 351
Table 418 – Association ends of Production::GeneratingUnit with other classes 353
Table 419 – Literals of Production::GeneratorControlMode 354
Table 420 – Literals of Production::GeneratorControlSource 354
Table 421 – Attributes of Production::GrossToNetActivePowerCurve 354
Table 422 – Association ends of Production::GrossToNetActivePowerCurve with other classes 355
Table 423 – Attributes of Production::HeatInputCurve 355
Table 424 – Association ends of Production::HeatInputCurve with other classes 356
Table 425 – Attributes of Production::HeatRateCurve 356
Table 426 – Association ends of Production::HeatRateCurve with other classes 356
Table 427 – Literals of Production::HydroEnergyConversionKind 357
Table 428 – Attributes of Production::HydroGeneratingEfficiencyCurve 357
Table 429 – Association ends of Production::HydroGeneratingEfficiencyCurve with other classes 358
Table 430 – Attributes of Production::HydroGeneratingUnit 358
Table 431 – Association ends of Production::HydroGeneratingUnit with other classes 359
Table 432 – Literals of Production::HydroPlantStorageKind 360
Table 433 – Attributes of Production::HydroPowerPlant 360
Table 434 – Association ends of Production::HydroPowerPlant with other classes 361
Table 435 – Attributes of Production::HydroPump 362
Table 436 – Association ends of Production::HydroPump with other classes 362
Table 437 – Attributes of Production::HydroPumpOpSchedule 363
Table 438 – Association ends of Production::HydroPumpOpSchedule with other classes 363
Table 439 – Attributes of Production::IncrementalHeatRateCurve 364
Table 440 – Association ends of Production::IncrementalHeatRateCurve with other classes 364
Table 441 – Attributes of Production::InflowForecast 364
Table 442 – Association ends of Production::InflowForecast with other classes 365
Table 443 – Attributes of Production::LevelVsVolumeCurve 365
Table 444 – Association ends of Production::LevelVsVolumeCurve with other classes 366
Table 445 – Attributes of Production::NuclearGeneratingUnit 366
Table 446 – Association ends of Production::NuclearGeneratingUnit with other classes 367
Table 447 – Attributes of Production::PenstockLossCurve 368
Table 448 – Association ends of Production::PenstockLossCurve with other classes 368
Table 449 – Attributes of Production::PhotoVoltaicUnit 369
Table 450 – Association ends of Production::PhotoVoltaicUnit with other classes 369
Table 451 – Attributes of Production::PowerElectronicsUnit 370
Table 452 – Association ends of Production::PowerElectronicsUnit with other classes 370
Table 453 – Attributes of Production::PowerElectronicsWindUnit 371
Table 454 – Association ends of Production::PowerElectronicsWindUnit with other classes 371
Table 455 – Attributes of Production::Reservoir 372
IECNORM.COM : Click to view the full PDF of IEC 61970-301:2020+AMD1:2022 CSV

Table 456 – Association ends of Production::Reservoir with other classes 372
Table 457 – Attributes of Production::ShutdownCurve 373
Table 458 – Association ends of Production::ShutdownCurve with other classes 373
Table 459 – Attributes of Production::SolarGeneratingUnit 374
Table 460 – Association ends of Production::SolarGeneratingUnit with other classes 375
Table 461 – Attributes of Production::StartIgnFuelCurve 376
Table 462 – Association ends of Production::StartIgnFuelCurve with other classes 376
Table 463 – Attributes of Production::StartMainFuelCurve 376
Table 464 – Association ends of Production::StartMainFuelCurve with other classes 377
Table 465 – Attributes of Production::StartRampCurve 377
Table 466 – Association ends of Production::StartRampCurve with other classes 378
Table 467 – Attributes of Production::StartupModel 378
Table 468 – Association ends of Production::StartupModel with other classes 379
Table 469 – Attributes of Production::SteamSendoutSchedule 379
Table 470 – Association ends of Production::SteamSendoutSchedule with other classes 379
Table 471 – Attributes of Production::TailbayLossCurve 380
Table 472 – Association ends of Production::TailbayLossCurve with other classes 380
Table 473 – Attributes of Production::TargetLevelSchedule 381
Table 474 – Association ends of Production::TargetLevelSchedule with other classes 381
Table 475 – Attributes of Production::ThermalGeneratingUnit 382
Table 476 – Association ends of Production::ThermalGeneratingUnit with other classes 383
Table 477 – Attributes of Production::WindGeneratingUnit 384
Table 478 – Association ends of Production::WindGeneratingUnit with other classes 385
Table 479 – Attributes of DC::ACDCConverter 391
Table 480 – Association ends of DC::ACDCConverter with other classes 392
Table 481 – Attributes of DC::ACDCConverterDCTerminal 393
Table 482 – Association ends of DC::ACDCConverterDCTerminal with other classes 393
Table 483 – Attributes of DC::CsConverter 394
Table 484 – Association ends of DC::CsConverter with other classes 396
Table 485 – Attributes of DC::DCTopologicalNode 396
Table 486 – Association ends of DC::DCTopologicalNode with other classes 397
Table 487 – Literals of DC::CsOperatingModeKind 397
Table 488 – Literals of DC::CsPpccControlKind 397
Table 489 – Attributes of DC::DCBaseTerminal 398
Table 490 – Association ends of DC::DCBaseTerminal with other classes 398
Table 491 – Attributes of DC::DCBreaker 398
Table 492 – Association ends of DC::DCBreaker with other classes 399
Table 493 – Attributes of DC::DCBusbar 399
Table 494 – Association ends of DC::DCBusbar with other classes 400
Table 495 – Attributes of DC::DCChopper 400
Table 496 – Association ends of DC::DCChopper with other classes 401
Table 497 – Attributes of DC::DCConductingEquipment 401
IECNORM.COM : Click to view the full PDF of IEC 61970-301:2020+AMD1:2022 CSV

Table 498 – Association ends of DC::DCConductingEquipment with other classes 402
Table 499 – Literals of DC::DCConverterOperatingModeKind 402
Table 500 – Attributes of DC::DCConverterUnit 402
Table 501 – Association ends of DC::DCConverterUnit with other classes 403
Table 502 – Attributes of DC::DCDisconnector 403
Table 503 – Association ends of DC::DCDisconnector with other classes 404
Table 504 – Attributes of DC::DCEquipmentContainer 404
Table 505 – Association ends of DC::DCEquipmentContainer with other classes 405
Table 506 – Attributes of DC::DCGround 405
Table 507 – Association ends of DC::DCGround with other classes 406
Table 508 – Attributes of DC::DCLine 406
Table 509 – Association ends of DC::DCLine with other classes 406
Table 510 – Attributes of DC::DCLineSegment 407
Table 511 – Association ends of DC::DCLineSegment with other classes 408
Table 512 – Attributes of DC::DCNode 408
Table 513 – Association ends of DC::DCNode with other classes 409
Table 514 – Literals of DC::DCPolarityKind 409
Table 515 – Attributes of DC::DCSeriesDevice 409
Table 516 – Association ends of DC::DCSeriesDevice with other classes 410
Table 517 – Attributes of DC::DCShunt 410
Table 518 – Association ends of DC::DCShunt with other classes 411
Table 519 – Attributes of DC::DCSwitch 411
Table 520 – Association ends of DC::DCSwitch with other classes 412
Table 521 – Attributes of DC::DCTerminal 412
Table 522 – Association ends of DC::DCTerminal with other classes 412
Table 523 – Attributes of DC::DCTopologicalIsland 413
Table 524 – Association ends of DC::DCTopologicalIsland with other classes 413
Table 525 – Attributes of DC::PerLengthDCLineParameter 413
Table 526 – Association ends of DC::PerLengthDCLineParameter with other classes 414
Table 527 – Attributes of DC::VsCapabilityCurve 414
Table 528 – Association ends of DC::VsCapabilityCurve with other classes 414
Table 529 – Attributes of DC::VsConverter 415
Table 530 – Association ends of DC::VsConverter with other classes 416
Table 531 – Literals of DC::VsPpccControlKind 417
Table 532 – Literals of DC::VsQpccControlKind 418
Table 533 – Attributes of Equivalents::EquivalentBranch 420
Table 534 – Association ends of Equivalents::EquivalentBranch with other classes 422
Table 535 – Attributes of Equivalents::EquivalentEquipment 422
Table 536 – Association ends of Equivalents::EquivalentEquipment with other classes 423
Table 537 – Attributes of Equivalents::EquivalentInjection 423
Table 538 – Association ends of Equivalents::EquivalentInjection with other classes 425
Table 539 – Attributes of Equivalents::EquivalentNetwork 425
Table 540 – Association ends of Equivalents::EquivalentNetwork with other classes 426
IECNORM.COM : Click to view the full PDF of IEC 61970-301:2020+AMD1:2022 CSV

Table 541 – Attributes of Equivalents::EquivalentShunt 426
Table 542 – Association ends of Equivalents::EquivalentShunt with other classes 427
Table 543 – Attributes of AuxiliaryEquipment::AuxiliaryEquipment 429
Table 544 – Association ends of AuxiliaryEquipment::AuxiliaryEquipment with other classes 429
Table 545 – Attributes of AuxiliaryEquipment::CurrentTransformer 430
Table 546 – Association ends of AuxiliaryEquipment::CurrentTransformer with other classes 430
Table 547 – Attributes of AuxiliaryEquipment::FaultIndicator 431
Table 548 – Association ends of AuxiliaryEquipment::FaultIndicator with other classes 431
Table 549 – Attributes of AuxiliaryEquipment::PostLineSensor 432
Table 550 – Association ends of AuxiliaryEquipment::PostLineSensor with other classes 432
Table 551 – Attributes of AuxiliaryEquipment::PotentialTransformer 433
Table 552 – Association ends of AuxiliaryEquipment::PotentialTransformer with other classes 433
Table 553 – Literals of AuxiliaryEquipment::PotentialTransformerKind 434
Table 554 – Attributes of AuxiliaryEquipment::Sensor 434
Table 555 – Association ends of AuxiliaryEquipment::Sensor with other classes 434
Table 556 – Attributes of AuxiliaryEquipment::SurgeArrester 435
Table 557 – Association ends of AuxiliaryEquipment::SurgeArrester with other classes 435
Table 558 – Attributes of AuxiliaryEquipment::WaveTrap 436
Table 559 – Association ends of AuxiliaryEquipment::WaveTrap with other classes 436
Table 560 – Attributes of Meas::Accumulator 440
Table 561 – Association ends of Meas::Accumulator with other classes 441
Table 562 – Attributes of Meas::AccumulatorLimit 441
Table 563 – Association ends of Meas::AccumulatorLimit with other classes 441
Table 564 – Attributes of Meas::AccumulatorLimitSet 442
Table 565 – Association ends of Meas::AccumulatorLimitSet with other classes 442
Table 566 – Attributes of Meas::AccumulatorReset 442
Table 567 – Association ends of Meas::AccumulatorReset with other classes 443
Table 568 – Attributes of Meas::AccumulatorValue 443
Table 569 – Association ends of Meas::AccumulatorValue with other classes 443
Table 570 – Attributes of Meas::Analog 444
Table 571 – Association ends of Meas::Analog with other classes 444
Table 572 – Attributes of Meas::AnalogControl 445
Table 573 – Association ends of Meas::AnalogControl with other classes 445
Table 574 – Attributes of Meas::AnalogLimit 445
Table 575 – Association ends of Meas::AnalogLimit with other classes 446
Table 576 – Attributes of Meas::AnalogLimitSet 446
Table 577 – Association ends of Meas::AnalogLimitSet with other classes 446
Table 578 – Attributes of Meas::AnalogValue 447
Table 579 – Association ends of Meas::AnalogValue with other classes 447
Table 580 – Attributes of Meas::Command 448
IECNORM.COM : Click to view the full PDF of IEC 61970-301:2020+AMD1:2022 CSV

Table 581 – Association ends of Meas::Command with other classes 448
Table 582 – Attributes of Meas::Control 449
Table 583 – Association ends of Meas::Control with other classes 449
Table 584 – Attributes of Meas::Discrete 450
Table 585 – Association ends of Meas::Discrete with other classes 450
Table 586 – Attributes of Meas::DiscreteValue 450
Table 587 – Association ends of Meas::DiscreteValue with other classes 451
Table 588 – Attributes of Meas::IOPoint 451
Table 589 – Association ends of Meas::IOPoint with other classes 451
Table 590 – Attributes of Meas::Limit 452
Table 591 – Association ends of Meas::Limit with other classes 452
Table 592 – Attributes of Meas::LimitSet 452
Table 593 – Association ends of Meas::LimitSet with other classes 453
Table 594 – Attributes of Meas::Measurement 453
Table 595 – Association ends of Meas::Measurement with other classes 454
Table 596 – Attributes of Meas::MeasurementValue 454
Table 597 – Association ends of Meas::MeasurementValue with other classes 455
Table 598 – Attributes of Meas::MeasurementValueQuality 455
Table 599 – Association ends of Meas::MeasurementValueQuality with other classes 456
Table 600 – Attributes of Meas::MeasurementValueSource 456
Table 601 – Association ends of Meas::MeasurementValueSource with other classes 456
Table 602 – Attributes of Meas::Quality61850 457
Table 603 – Attributes of Meas::RaiseLowerCommand 458
Table 604 – Association ends of Meas::RaiseLowerCommand with other classes 458
Table 605 – Attributes of Meas::SetPoint 458
Table 606 – Association ends of Meas::SetPoint with other classes 459
Table 607 – Attributes of Meas::StringMeasurement 459
Table 608 – Association ends of Meas::StringMeasurement with other classes 460
Table 609 – Attributes of Meas::StringMeasurementValue 460
Table 610 – Association ends of Meas::StringMeasurementValue with other classes 460
Table 611 – Literals of Meas::Validity 461
Table 612 – Attributes of Meas::ValueAliasSet 461
Table 613 – Association ends of Meas::ValueAliasSet with other classes 461
Table 614 – Attributes of Meas::ValueToAlias 462
Table 615 – Association ends of Meas::ValueToAlias with other classes 462
Table 616 – Attributes of Topology::BusNameMarker 464
Table 617 – Association ends of Topology::BusNameMarker with other classes 464
Table 618 – Attributes of Topology::TopologicalIsland 465
Table 619 – Association ends of Topology::TopologicalIsland with other classes 465
Table 620 – Attributes of Topology::TopologicalNode 465
Table 621 – Association ends of Topology::TopologicalNode with other classes 466
Table 622 – Attributes of DiagramLayout::Diagram 467
Table 623 – Association ends of DiagramLayout::Diagram with other classes 468
IECNORM.COM : Click to view the full PDF of IEC 61970-301:2020+AMD1:2022 CSV

Table 624 – Attributes of DiagramLayout::DiagramObject 468
Table 625 – Association ends of DiagramLayout::DiagramObject with other classes 469
Table 626 – Association ends of DiagramLayout::DiagramObjectGluePoint with other classes 470
Table 627 – Attributes of DiagramLayout::DiagramObjectPoint 470
Table 628 – Association ends of DiagramLayout::DiagramObjectPoint with other classes 470
Table 629 – Attributes of DiagramLayout::DiagramObjectStyle 471
Table 630 – Association ends of DiagramLayout::DiagramObjectStyle with other classes 471
Table 631 – Attributes of DiagramLayout::DiagramStyle 471
Table 632 – Association ends of DiagramLayout::DiagramStyle with other classes 471
Table 633 – Literals of DiagramLayout::OrientationKind 472
Table 634 – Attributes of DiagramLayout::TextDiagramObject 472
Table 635 – Association ends of DiagramLayout::TextDiagramObject with other classes 472
Table 636 – Attributes of DiagramLayout::VisibilityLayer 473
Table 637 – Association ends of DiagramLayout::VisibilityLayer with other classes 473
Table 638 – Attributes of OperationalLimits::ActivePowerLimit 475
Table 639 – Association ends of OperationalLimits::ActivePowerLimit with other classes 476
Table 640 – Attributes of OperationalLimits::ApparentPowerLimit 476
Table 641 – Association ends of OperationalLimits::ApparentPowerLimit with other classes 476
Table 642 – Attributes of OperationalLimits::BranchGroup 477
Table 643 – Association ends of OperationalLimits::BranchGroup with other classes 477
Table 644 – Attributes of OperationalLimits::BranchGroupTerminal 477
Table 645 – Association ends of OperationalLimits::BranchGroupTerminal with other classes 477
Table 646 – Attributes of OperationalLimits::CurrentLimit 478
Table 647 – Association ends of OperationalLimits::CurrentLimit with other classes 478
Table 648 – Attributes of OperationalLimits::OperationalLimit 478
Table 649 – Association ends of OperationalLimits::OperationalLimit with other classes 479
Table 650 – Literals of OperationalLimits::OperationalLimitDirectionKind 479
Table 651 – Attributes of OperationalLimits::OperationalLimitSet 479
Table 652 – Association ends of OperationalLimits::OperationalLimitSet with other classes 480
Table 653 – Attributes of OperationalLimits::OperationalLimitType 480
Table 654 – Association ends of OperationalLimits::OperationalLimitType with other classes 480
Table 655 – Attributes of OperationalLimits::VoltageLimit 481
Table 656 – Association ends of OperationalLimits::VoltageLimit with other classes 481
Table 657 – Attributes of ControlArea::AltGeneratingUnitMeas 484
Table 658 – Association ends of ControlArea::AltGeneratingUnitMeas with other classes 484
Table 659 – Attributes of ControlArea::AltTieMeas 484
IECNORM.COM : Click to view the full PDF of IEC 61970-301:2020+AMD1:2022 CSV

Table 660 – Association ends of ControlArea::AltTieMeas with other classes 485
Table 661 – Attributes of ControlArea::ControlArea 485
Table 662 – Association ends of ControlArea::ControlArea with other classes 486
Table 663 – Attributes of ControlArea::ControlAreaGeneratingUnit 486
Table 664 – Association ends of ControlArea::ControlAreaGeneratingUnit with other classes 487
Table 665 – Literals of ControlArea::ControlAreaTypeKind 487
Table 666 – Attributes of ControlArea::TieFlow 487
Table 667 – Association ends of ControlArea::TieFlow with other classes 488
Table 668 – Attributes of Contingency::Contingency 489
Table 669 – Association ends of Contingency::Contingency with other classes 489
Table 670 – Attributes of Contingency::ContingencyElement 489
Table 671 – Association ends of Contingency::ContingencyElement with other classes 489
Table 672 – Attributes of Contingency::ContingencyEquipment 490
Table 673 – Association ends of Contingency::ContingencyEquipment with other classes 490
Table 674 – Literals of Contingency::ContingencyEquipmentStatusKind 490
Table 675 – Attributes of StateVariables::SvInjection 492
Table 676 – Association ends of StateVariables::SvInjection with other classes 492
Table 677 – Attributes of StateVariables::SvPowerFlow 492
Table 678 – Association ends of StateVariables::SvPowerFlow with other classes 492
Table 679 – Attributes of StateVariables::SvShuntCompensatorSections 493
Table 680 – Association ends of StateVariables::SvShuntCompensatorSections with other classes 493
Table 681 – Attributes of StateVariables::SvStatus 493
Table 682 – Association ends of StateVariables::SvStatus with other classes 493
Table 683 – Attributes of StateVariables::SvSwitch 494
Table 684 – Association ends of StateVariables::SvSwitch with other classes 494
Table 685 – Attributes of StateVariables::SvTapStep 494
Table 686 – Association ends of StateVariables::SvTapStep with other classes 494
Table 687 – Attributes of StateVariables::SvVoltage 495
Table 688 – Association ends of StateVariables::SvVoltage with other classes 495
Table 689 – Attributes of Protection::CurrentRelay 496
Table 690 – Association ends of Protection::CurrentRelay with other classes 497
Table 691 – Attributes of Protection::ProtectionEquipment 497
Table 692 – Association ends of Protection::ProtectionEquipment with other classes 498
Table 693 – Attributes of Protection::RecloseSequence 498
Table 694 – Association ends of Protection::RecloseSequence with other classes 499
Table 695 – Attributes of Protection::SynchrocheckRelay 499
Table 696 – Association ends of Protection::SynchrocheckRelay with other classes 500
Table 697 – Attributes of Faults::EquipmentFault 501
Table 698 – Association ends of Faults::EquipmentFault with other classes 501
Table 699 – Attributes of Faults::Fault 501
Table 700 – Association ends of Faults::Fault with other classes 502

IECNORM.COM : Click to view the full PDF of IEC 61970-301:2020+AMD1:2022 CSV

Table 701 – Attributes of Faults::FaultCauseType 502
Table 702 – Association ends of Faults::FaultCauseType with other classes 502
Table 703 – Attributes of Faults::FaultImpedance 503
Table 704 – Attributes of Faults::LineFault 503
Table 705 – Association ends of Faults::LineFault with other classes 503
Table 706 – Literals of Faults::PhaseConnectedFaultKind 504
Table 707 – Attributes of SCADA::CommunicationLink 505
Table 708 – Association ends of SCADA::CommunicationLink with other classes 506
Table 709 – Attributes of SCADA::RemoteControl 506
Table 710 – Association ends of SCADA::RemoteControl with other classes 506
Table 711 – Attributes of SCADA::RemotePoint 507
Table 712 – Association ends of SCADA::RemotePoint with other classes 507
Table 713 – Attributes of SCADA::RemoteSource 507
Table 714 – Association ends of SCADA::RemoteSource with other classes 508
Table 715 – Attributes of SCADA::RemoteUnit 508
Table 716 – Association ends of SCADA::RemoteUnit with other classes 508
Table 717 – Literals of SCADA::RemoteUnitType 509
Table 718 – Literals of SCADA::Source 509
Table 719 – Literals of ICCPConfiguration::ApplicationSecurityKind 512
Table 720 – Attributes of ICCPConfiguration::BilateralExchangeActor 512
Table 721 – Association ends of ICCPConfiguration::BilateralExchangeActor with other classes 512
Table 722 – Attributes of ICCPConfiguration::BilateralExchangeAgreement 513
Table 723 – Association ends of ICCPConfiguration::BilateralExchangeAgreement with other classes 513
Table 724 – Literals of ICCPConfiguration::ICCPAccessPrivilegeKind 513
Table 725 – Attributes of ICCPConfiguration::ICCPInformationMessage 514
Table 726 – Association ends of ICCPConfiguration::ICCPInformationMessage with other classes 514
Table 727 – Literals of ICCPConfiguration::ICCPPointKind 514
Table 728 – Attributes of ICCPConfiguration::ICCPProvidedPoint 515
Table 729 – Association ends of ICCPConfiguration::ICCPProvidedPoint with other classes 515
Table 730 – Literals of ICCPConfiguration::ICCPQualityKind 516
Table 731 – Literals of ICCPConfiguration::ICCPScopeKind 516
Table 732 – Attributes of ICCPConfiguration::ICCPVCC 516
Table 733 – Association ends of ICCPConfiguration::ICCPVCC with other classes 517
Table 734 – Attributes of ICCPConfiguration::ICCPVirtualControlCentre 517
Table 735 – Association ends of ICCPConfiguration::ICCPVirtualControlCentre with other classes 518
Table 736 – Attributes of ICCPConfiguration::IOPointSource 518
Table 737 – Association ends of ICCPConfiguration::IOPointSource with other classes 519
Table 738 – Attributes of ICCPConfiguration::IPAccessPoint 519
Table 739 – Association ends of ICCPConfiguration::IPAccessPoint with other classes 519
Table 740 – Literals of ICCPConfiguration::IPAddressKind 520
IECNORM.COM : Click to view the full PDF of IEC 61970-301:2020+AMD1:2022 CSV

Table 741 – Attributes of ICCPConfiguration::ISOUpperLayer 520
Table 742 – Association ends of ICCPConfiguration::ISOUpperLayer with other classes 521
Table 743 – Attributes of ICCPConfiguration::ProvidedBilateralPoint 521
Table 744 – Association ends of ICCPConfiguration::ProvidedBilateralPoint with other classes 521
Table 745 – Attributes of ICCPConfiguration::PublicX509Certificate 522
Table 746 – Association ends of ICCPConfiguration::PublicX509Certificate with other classes 522
Table 747 – Attributes of ICCPConfiguration::TASE2BilateralTable 522
Table 748 – Association ends of ICCPConfiguration::TASE2BilateralTable with other classes 523
Table 749 – Attributes of ICCPConfiguration::TCPAccessPoint 523
Table 750 – Association ends of ICCPConfiguration::TCPAccessPoint with other classes 524
Table A.1 – Attributes of ExtEuCore::BoundaryPoint 527
Table A.2 – Association ends of ExtEuCore::BoundaryPoint with other classes 528
Table A.3 – Attributes of ExtEuCore::ExtEuIdentifiedObject 528
Table A.4 – Attributes of ExtEuOperationalLimits::ExtEuOperationalLimitType 529
Table A.5 – Literals of ExtEuOperationalLimits::LimitKind 530
Table A.6 – Attributes of ExtEuProduction::SolarPowerPlant 532
Table A.7 – Association ends of ExtEuProduction::SolarPowerPlant with other classes 532
Table A.8 – Attributes of ExtEuProduction::WindPowerPlant 533
Table A.9 – Association ends of ExtEuProduction::WindPowerPlant with other classes 533

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ENERGY MANAGEMENT SYSTEM APPLICATION PROGRAM INTERFACE (EMS-API) –

Part 301: Common information model (CIM) base

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This consolidated version of the official IEC Standard and its amendment has been prepared for user convenience.

IEC 61970-301 edition 7.1 contains the seventh edition (2020-06) [documents 57/2210/FDIS and 57/2224/RVD] and its amendment 1 (2022-02) [documents 57/2439/FDIS and 57/2450/RVD].

This Final version does not show where the technical content is modified by amendment 1. A separate Redline version with all changes highlighted is available in this publication.

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International Standard IEC 61970-301 has been prepared by IEC technical committee 57: Power systems management and associated information exchange.

This seventh constitutes a technical revision.

This edition reflects the model content version ‘IEC61970CIM17v38’, dated ‘2020-01-21’, and includes the following significant technical changes with respect to the previous edition:

a) Added Feeder modelling;
b) Added ICCP configuration modelling;
c) Correction of issues found in interoperability testing or use of the standard;
d) Improved documentation;
e) Updated Annex A with custom extensions;
f) Added Annex B Examples of PST transformer modelling;
g) Added Annex C HVDC use cases.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

A list of all parts of the IEC 61970 series, under the general title: *Energy management system application program interface (EMS-API)*, can be found on the IEC website.

The committee has decided that the contents of the base publication and its amendment will remain unchanged until the stability date indicated on the IEC web site under webstore.iec.ch in the data related to the specific publication. At this date, the publication will be

- reconfirmed,
- withdrawn,
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INTRODUCTION

This document is part of the IEC 61970 series which define an application program interface (API) for an energy management system (EMS). IEC 61970 was originally based upon the work of the EPRI Control Center API (CCAPI) research project (RP-3654-1). The principle objectives of the EPRI CCAPI project were to:

- reduce the cost and time needed to add new applications to an EMS;
- protect the investment of existing applications or systems that are working effectively with an EMS.

The principal objective of the IEC 61970 series is to produce documents which facilitate the integration of EMS applications developed independently by different vendors, between entire EMS systems developed independently, or between an EMS system and other systems concerned with different aspects of power system operations, such as generation or distribution management systems (DMS). This is accomplished by defining application program interfaces to enable these applications or systems access to public data and exchange information independent of how such information is represented internally.

The Common Information Model (CIM) specifies the semantics for this API. The Component Interface Specifications (CIS), which are contained in other parts of the IEC 61970 series, specify the content of the messages exchanged.

The CIM is an abstract model that represents all the major objects in an electric utility enterprise typically needed to model the operational aspects of a utility. This model includes public classes and attributes for these objects, as well as the relationships between them.

This document defines the CIM Base set of packages which provide a logical view of the functional aspects of an Energy Management System including Supervisory Control and Data Acquisition (SCADA). Other functional areas are standardized in separate IEC documents that augment and reference this document. For example, IEC 61968-11 addresses distribution models and references this document. While there are multiple IEC standards dealing with different parts of the CIM, there is a single, unified information model comprising the CIM behind all these individual standards documents.

The International Electrotechnical Commission (IEC) draws attention to the fact that it is claimed that compliance with this document may involve the use of a patent concerning a computer-based implementation of an object-oriented power system model in a relational database. As such, it does not conflict with the development of any logical power system model including the Common Information Model (CIM), where implementation of the model is not defined.

The IEC takes no position concerning the evidence, validity and scope of this patent right.

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ENERGY MANAGEMENT SYSTEM APPLICATION PROGRAM INTERFACE (EMS-API) –

Part 301: Common information model (CIM) base

1 Scope

The common information model (CIM) is an abstract model that represents all the major objects in an electric utility enterprise typically involved in utility operations. By providing a standard way of representing power system resources as object classes and attributes, along with their relationships, the CIM facilitates the integration and interoperability of network applications developed independently by different vendors, between entire systems running network applications developed independently, or between a system running network applications and other systems concerned with different aspects of power system operations, such as generation or distribution management. SCADA is modelled to the extent necessary to support power system simulation and inter-control centre communication. The CIM facilitates integration by defining a common language (i.e. semantics) based on the CIM to enable these applications or systems to access public data and exchange information independent of how such information is represented internally.

The object classes represented in the CIM are abstract in nature and can be used in a wide variety of applications. The use of the CIM goes far beyond its application in an EMS. This document should be understood as a tool to enable integration in any domain where a common power system model is needed to facilitate interoperability and plug compatibility between applications and systems independent of any particular implementation.

Due to the size of the complete CIM, the object classes contained in the CIM are grouped into several logical Packages, each of which represents a certain part of the overall power system being modelled. Collections of these Packages are progressed as separate International Standards. This document specifies a Base set of packages which provide a logical view of the functional aspects of Energy Management System (EMS) and power system modelling information within the electric utility enterprise that is shared between all applications. Other standards specify more specific parts of the model that are needed by only certain applications. Subclause 4.3 of this document provides the current grouping of packages into standards documents.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 61850 (all parts), *Communication networks and systems for power utility automation*

IEC 61850-7-4:2010, *Communication networks and systems for power utility automation – Part 7-4: Basic communication structure – Compatible logical node classes and data object classes*

IEC 61968 (all parts), *Application integration at electric utilities – System interfaces for distribution management*

IEC TS 61970-2, *Energy management system application program interface (EMS-API) – Part 2: Glossary*

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Object Management Group: *UML 2.0 Specification* – http://www.omg.org

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC TS 61970-2 and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at http://www.electropedia.org/
- ISO Online browsing platform: available at http://www.iso.org/obp

3.1
energy management system
EMS
computer system comprising a software platform providing basic support services and a set of applications providing the functionality needed for the effective operation of electrical generation and transmission facilities so as to assure adequate security of energy supply at minimum cost

3.2
application program interface
API
set of public functions provided by an executable application component for use by other executable application components

3.3
unified modelling language
UML
formal and comprehensive descriptive language with diagramming techniques used to represent software systems, from requirements analysis, through design and implementation, to documentation

Note 1 to entry: UML has evolved from a collection of methods contributed by different practitioners into an International Standard (ISO/IEC 19505, published in 2012). The CIM relies on UML for defining the model, and automated tools generate the documentation, schemas, and other artefacts directly from the UML. A basic understanding of UML is necessary to understand the CIM.

3.4
profile
subset of CIM classes, associations and attributes needed to accomplish a specific type of interface

Note 1 to entry: This may be expressed in XSD, RDF, and/or OWL files. A profile can be tested between applications. A profile is necessary in order to “use” the CIM. Several profiles are defined in other parts of the IEC 61968 and IEC 62325 series.

4 CIM specification

4.1 Overview

The CIM model is described in the Unified Modelling Language (UML) which is maintained as a UML file managed by a UML editing tool. The UML file exists in two different formats:

- a tool proprietary format,
- a standardized xmi format.

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The CIM model is described in Clause 6, which is a report generated from the UML file. The name of the UML file use to generate Clause 6 is:

- iec61970cim17v40_iec61968cim13v13a_iec62325cim03v17a.eap

This file can be obtained from CIM users group.

4.2 CIM modelling notation

The CIM is defined using object-oriented modelling techniques. Specifically, the CIM specification uses the UML notation, which defines the CIM as a group of packages.

Each package in the CIM contains one or more class diagrams showing graphically all the classes in that package and their relationships. Each class is then defined in text in terms of its attributes and relationships to other classes.

The UML notation is described in Object Management Group (OMG) documents and several published textbooks.

4.3 CIM packages

A package is a general purpose means of grouping related model elements. The packages have been chosen to make the model easier to design, understand and review. Entities may have associations that cross many package boundaries. Each application will use information represented in several packages.

Different groups of packages are assigned to different working groups within the IEC for convenience in managing and maintaining them.

WG13 packages are included in this document and contained under the IEC61970 package. The IEC61970 packages do not depend upon other outside packages. As shown in Figure 1, the IEC61970 package and its subpackages are used as a core or base model for other CIM packages. The dashed lines indicate dependency relationships, with the arrowhead pointing from the dependent package to the package on which it has a dependency. WG14 packages in the IEC 61968 series describe additional parts of the CIM that deal with other logical views of utility operations including assets, locations, activities, consumers, documentation, work management, and metering. WG16 packages in the IEC 62325 series describe electric energy markets.

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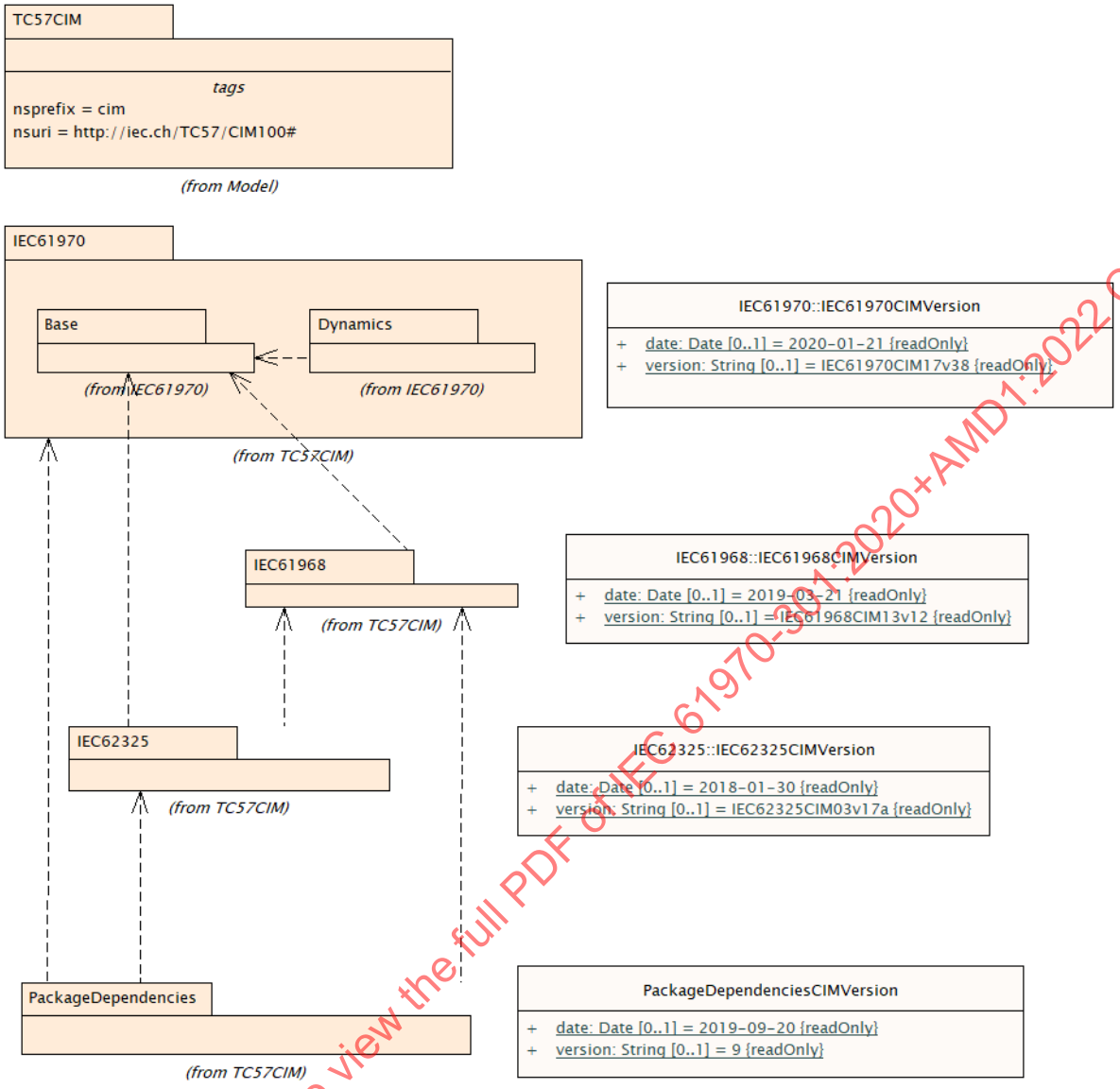


Figure 1 – Defined dependencies between CIM packages and packages' versions information

Note that the package boundaries do not imply application boundaries. An application may use CIM entities from several packages. It is also anticipated that CIM packages outside of this document will have dependencies upon some of the packages described in this document, and particularly the Domain and Core packages, though other dependencies will also exist.

Figure 2 shows the packages defined for IEC 61970-301 CIM Base and their dependency relationships.

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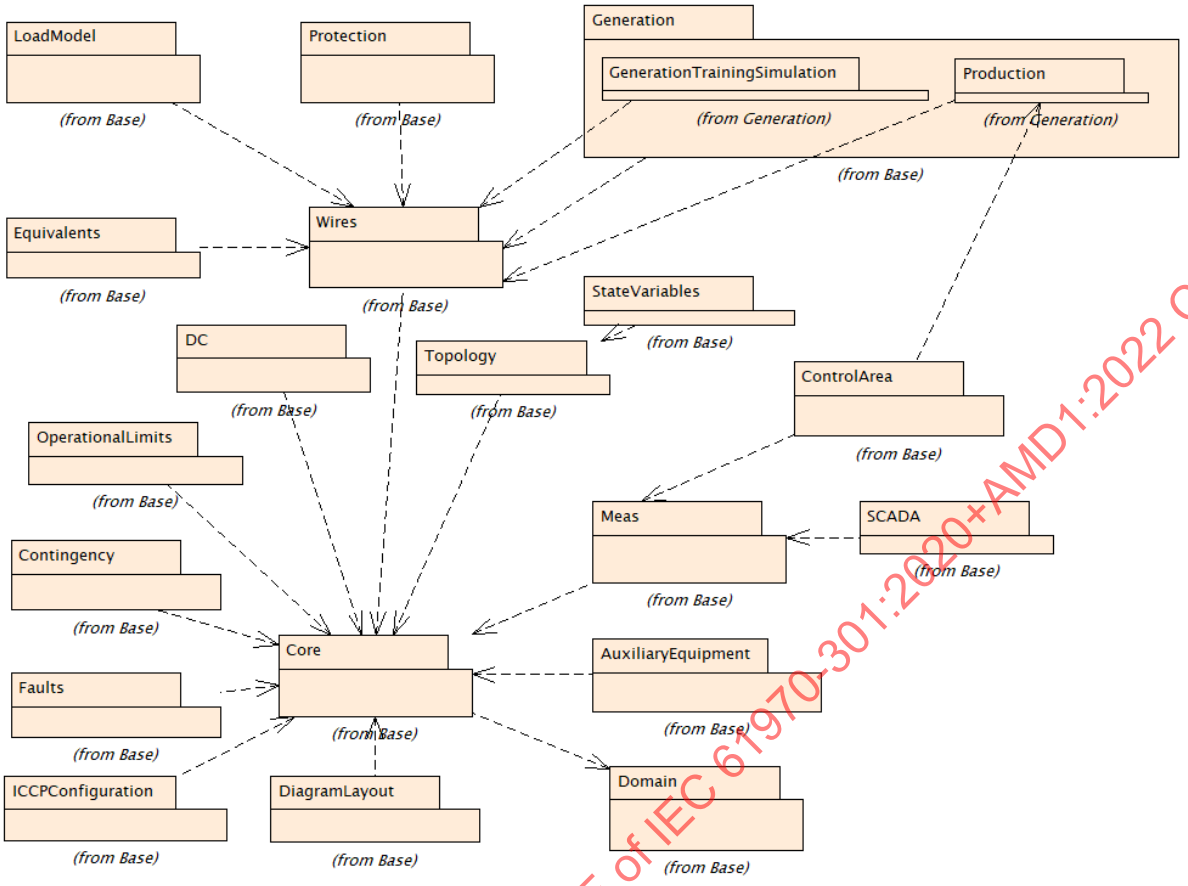


Figure 2 – CIM IEC 61970-301 package diagram

4.4 CIM classes and relationships

4.4.1 Classes

The class diagram(s) for each CIM package shows all the classes in the package and their relationships. Where relationships exist with classes in other packages, those classes may also be shown.

Classes and objects model what is in a power system that needs to be represented in a common way to power system applications. A class is a description of an object found in the real world, such as a power transformer, generator, or load that needs to be represented as part of the overall power system model in, for example, an EMS. Other types of objects include things such as schedules and measurements that EMS applications also need to process, analyse, and store. Such objects need a common representation to achieve the purposes of the EMS-API standard for plug-compatibility and interoperability. A particular object in a power system with a unique identity is modelled as an instance of the class to which it belongs.

It should also be noted that the CIM is defined to facilitate data exchange. As defined in this document, the properties of CIM entities are modelled, but not their behaviour. For a specific interface, a profile is defined consisting of subsets of CIM classes, attributes, and associations. A profile defines the message payload for an interface.

Classes have attributes that describe the characteristics of the objects. Each class in the CIM contains the attributes that describe and identify a specific instance of the class. Only the attributes that are important for the integration and interoperability of power system applications are included in the class descriptions.

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Each attribute has a type, which identifies what kind of attribute it is. Typical attributes are of type Integer, Float, Boolean, String, Date, and Decimal, which are called primitive types. However, many additional types are defined as part of the CIM specification. For example, ShuntCompensator has a "maxU" attribute of type Voltage. The definition of many shared types is contained in the Domain package. The UML stereotypes of Primitive, enumeration, CIMDatatype, and Compound are added to classes used as types. The CIMDatatype stereotype is used with a specific CIM semantics for a simple value with additional attributes describing the unit and multiplier of the value, e.g. unit, multiplier. This implies custom mapping to serialization artefacts such as RDFS, OWL, and XSD. Classes with these stereotypes do not participate in generalization or association relationships and are simply used as types for attributes. The enumeration stereotype is used to describe an attribute with an enumerated list of choices. The Compound stereotype is used to describe sets of related attributes that are commonly reused. Compound classes may consist of Primitive, enumeration, CIMDatatype or other Compound classes as long as the Compound classes do not recurse.

All CIM attributes are optional in the sense that profiles using the CIM may eliminate any attributes.

Relationships between classes reveal how they are structured in terms of each other. CIM classes are related in a variety of ways, as described in 4.4.2 to 4.4.4.

4.4.2 Generalization

A generalization is a relationship between a more general and a more specific class. The more specific class can contain only additional information. Generalization provides for the specific class to inherit attributes and relationships from all the more general classes above it.

Figure 3 is an example of generalization. In this example taken from the Wires package, a Breaker is a more specific type of ProtectedSwitch, which in turn is a more specific type of Switch, which is a more specific type of ConductingEquipment, etc. A PowerTransformer is another more specific type of ConductingEquipment. Note that PowerSystemResource inherits from class IdentifiedObject which is not on the diagram. Therefore, IdentifiedObject is shown in italic type in the upper right corner of class PowerSystemResource.

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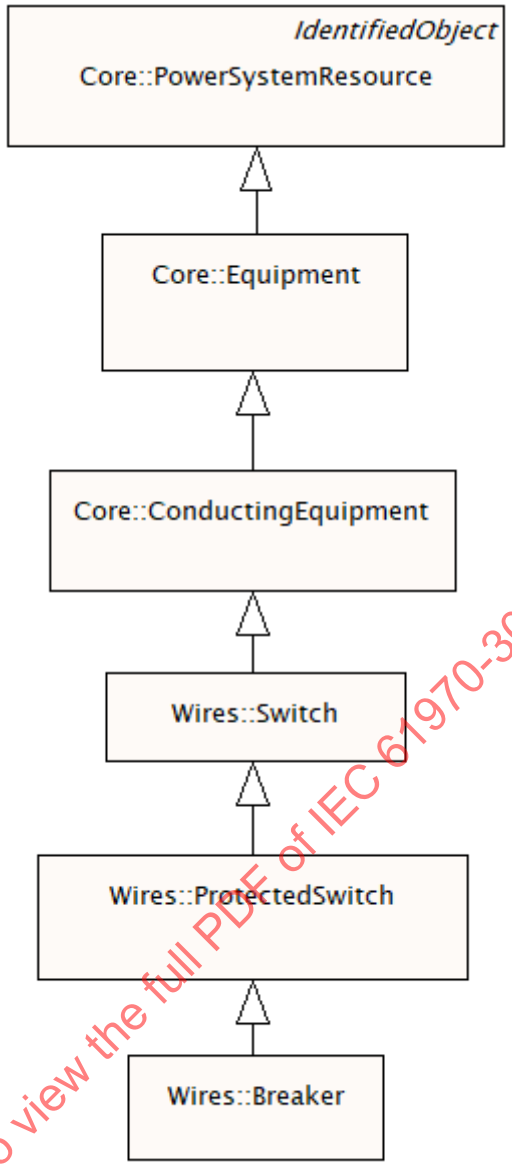


Figure 3 – Example of generalization

4.4.3 Simple association

An association is a conceptual connection between classes. Each association has two "association ends". The "association ends" were called "roles" prior to the UML 2.0 specification. Each association end describes the role the target class (i.e. the class the association end goes *to*) has in relation to the source class (i.e. the class the association end goes *from*). Association ends are usually given the name of the target class with or without a verb phrase. Each association end also has multiplicity/cardinality, which is an indication of how many objects may participate in the given relationship. In the CIM, associations are not named, only association ends are named. For example, as shown by Figure 4, in the CIM there is an association between a BaseVoltage and a VoltageLevel. Multiplicity is shown at both ends of the association. In this example, a VoltageLevel object may reference 1 BaseVoltage, and a BaseVoltage may be referenced by 0 or more VoltageLevel objects.

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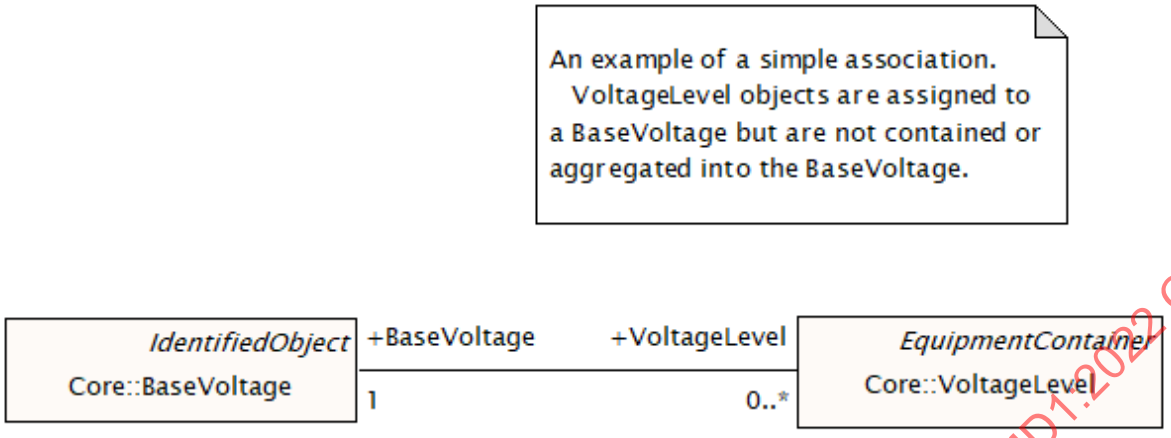


Figure 4 – Example of simple association

4.4.4 Aggregation

Aggregation is a special case of association. Aggregation indicates that the relationship between the classes is some sort of whole-part relationship, where the whole class "consists of" or "contains" the part class, and the part class is "part of" the whole class. The part class does not inherit from the whole class as in generalization. Figure 5 illustrates an aggregation between the EquipmentContainer class and the Equipment class, which is taken from the Core package. As shown, an Equipment can be a member of zero or one EquipmentContainer objects, but an EquipmentContainer object can contain any number of Equipment objects. In the context of using CIM as an information model, aggregation does not have a precise or formal interpretation beyond a simple association and is intended to visually assist in representing normal usage.

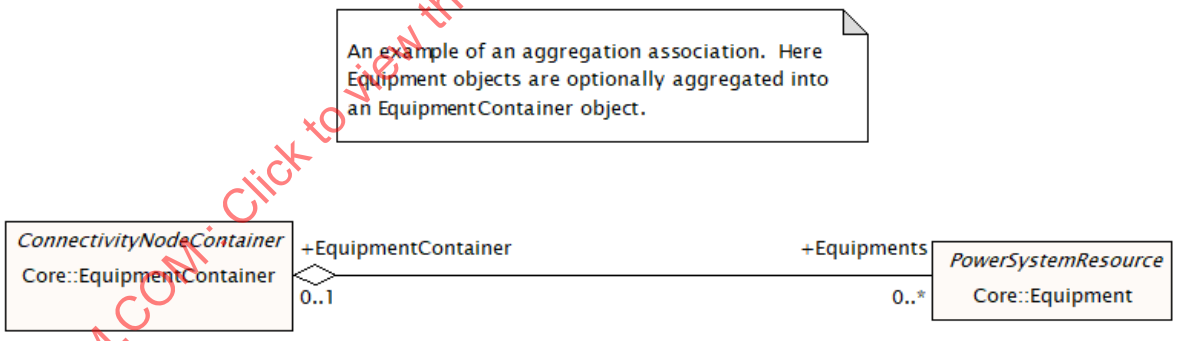


Figure 5 – Example of aggregation

4.5 CIM model concepts and examples

4.5.1 Concepts

To help understand how to interpret the CIM, some key model concepts used in the CIM are introduced and described in 4.5.2 to 4.5.16.

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4.5.2 Containment, equipment hierarchies and naming

4.5.2.1 Containment structure

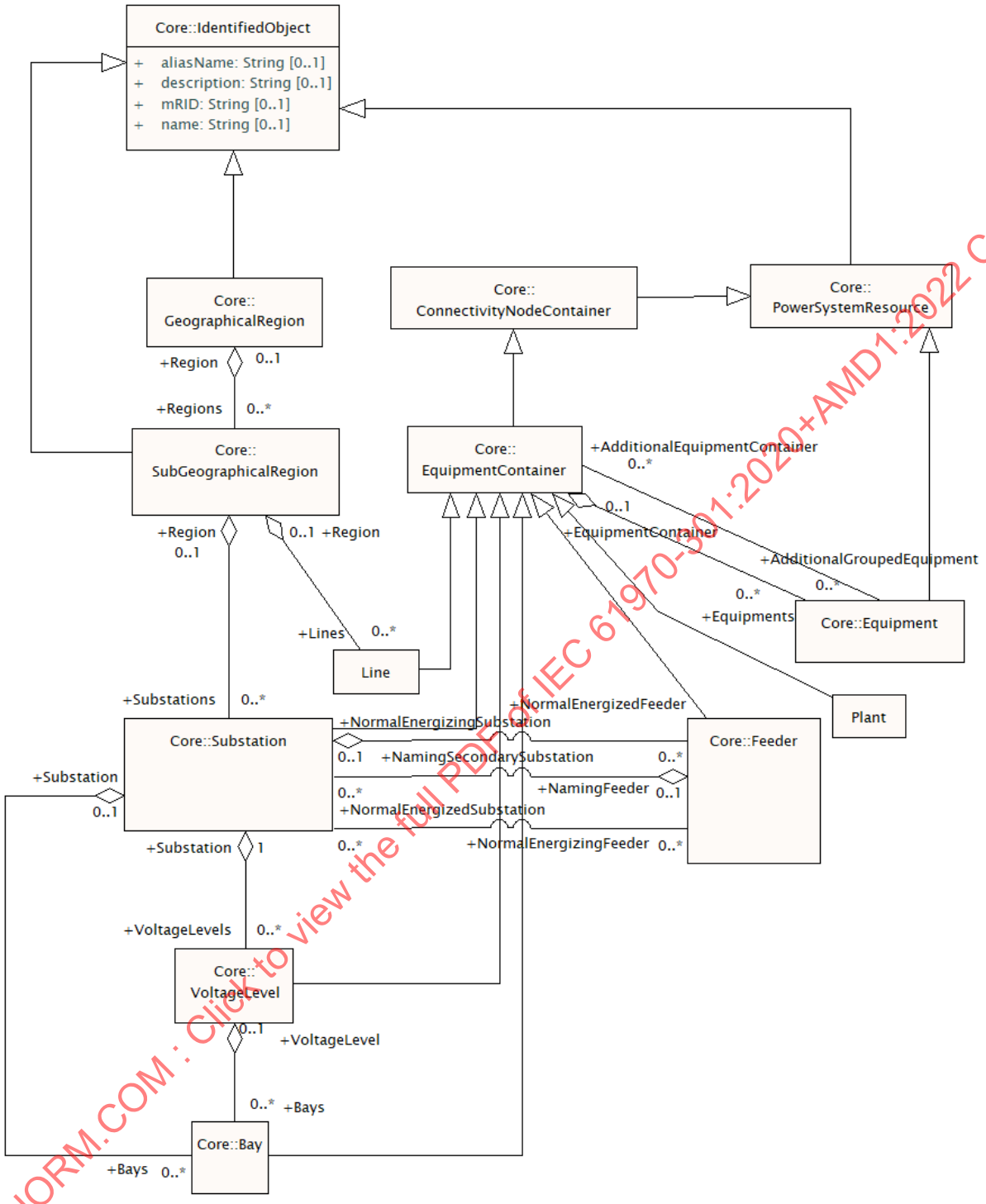
Figure 6 shows the concept of equipment containers to form hierarchies in the CIM. Equipment containers represent ways of organizing and naming equipment typically found within a substation. As may be seen, there is some flexibility provided in which containers are used in a specific application of the CIM in order to accommodate different international practices as well as differences typically found between transmission and distribution substations. Bay, VoltageLevel, Substation, Line, and Plant are all types of EquipmentContainer(s). In general, a Bay is contained within a specific VoltageLevel, which in turn is contained within a Substation. Substation(s) and Line(s) may be contained within SubGeographicalRegion(s) and GeographicalRegion(s).

One containment hierarchy is used with the IdentifiedObject class to create human readable hierarchical naming. This hierarchy is specifically used to name equipment according to its function in the power system. This is the functional naming hierarchy. Other common identifications beside functional names are asset serial numbers. The functional name is different from a serial number in that it relates to the function of a particular equipment position or location in the power system. Regardless of what specific piece of physical equipment is placed at a location, the functional name is the same but the serial number varies depending on the physical equipment currently used.

4.5.2.2 IdentifiedObject class

The IdentifiedObject class contained in the Core package is inherited by all PowerSystemResource and many other classes. This class has attributes and associations to be used for naming all CIM objects. Additional names can be defined by using name classes of 4.5.3 or by defining extensions. The mRID attribute of the IdentifiedObject class provides a straight forward and rigorous means of identity for CIM objects.

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Figure 6 – Equipment containers

The diagrams NamingHierarchyPart1 and NamingHierarchyPart2 in the Wires package show the functional naming hierarchy.

4.5.3 Names model

A flexible and extensible naming model is provided to specify alternate names for objects. A use cases where the names model is useful is when multiple applications or systems have different names for the same object. The names model then enables exchange of these names.

Figure 7 shows the class diagram for alternate names and how they can be associated to a specific user defined name type. This model allows for specific definition of names within a particular domain and enforces no specific naming rules. The concepts of alias names, path names, and local names can all be accommodated by this model. The CIM models do not enforce or promote specific naming conventions but allow for such naming conventions to be exchanged in a clear context.

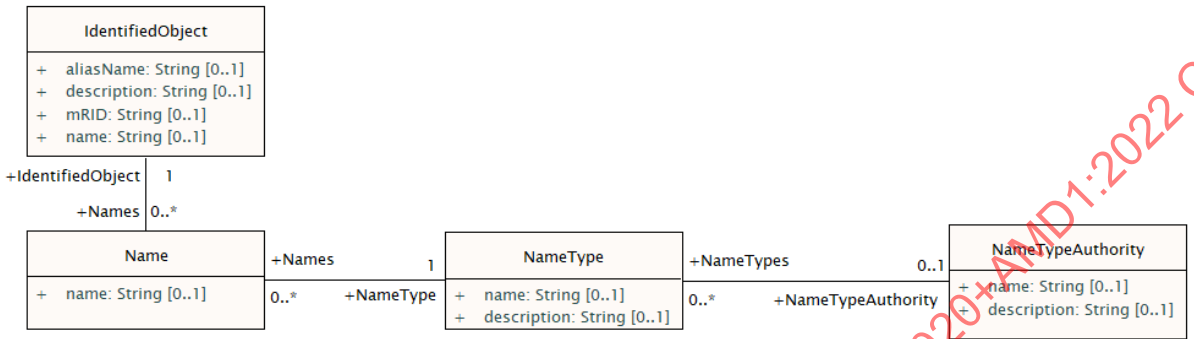


Figure 7 – Names

4.5.4 Connectivity model

4.5.4.1 Connectivity description

Figure 8 shows the Topology class diagram which models connectivity between different types of ConductingEquipment. Also included is a part of the Meas package class diagram dealing with measurements to illustrate how measurements are associated with conducting equipment.

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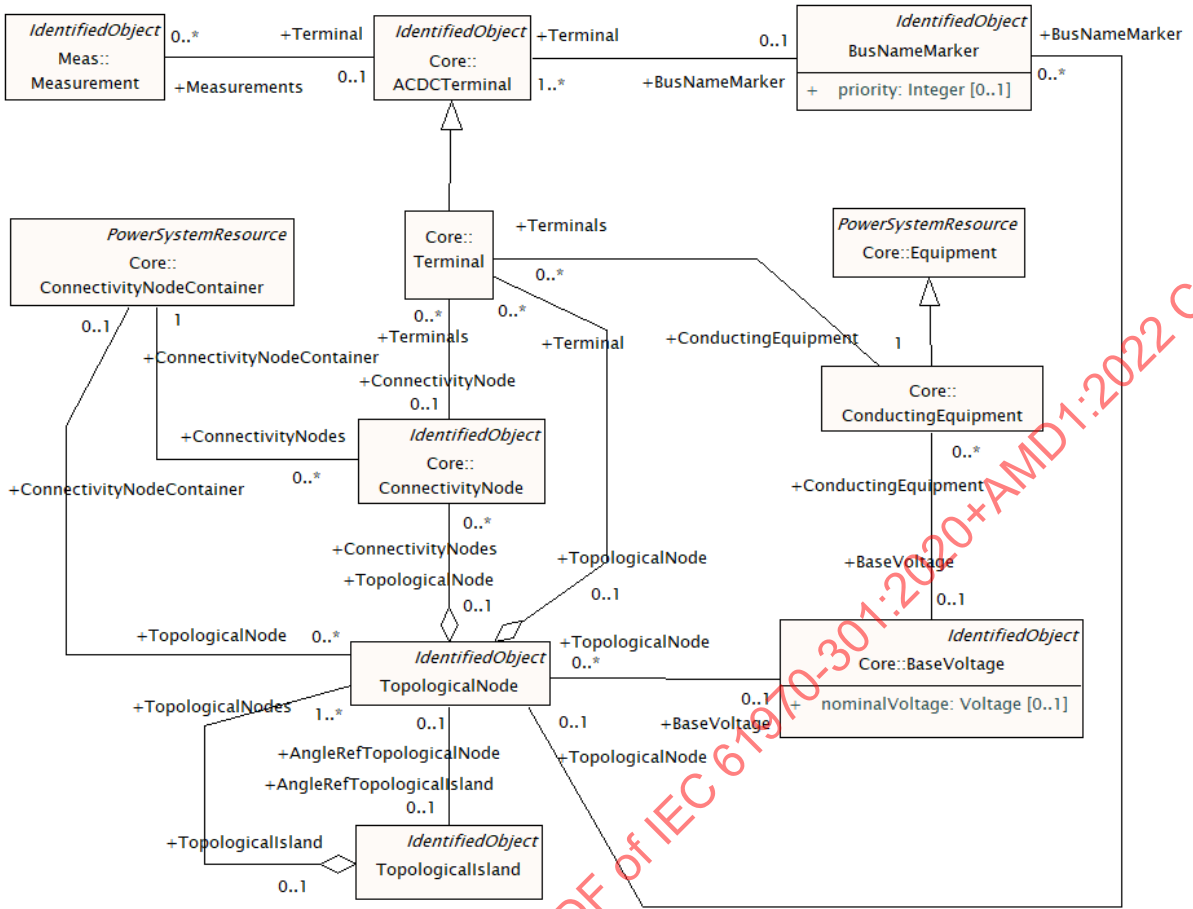


Figure 8 – Connectivity model

To model connectivity, Terminal and ConnectivityNode classes are defined. A Terminal belongs to one ConductingEquipment, although ConductingEquipment may have any number of Terminals. Each Terminal may be connected to a ConnectivityNode, which is a point where terminals of conducting equipment are connected together with zero impedance. A ConnectivityNode may have any number of terminals connected and may be a member of a TopologicalNode (i.e. a bus), which is in turn a member of a TopologicalIsland. TopologicalNode-s and TopologicalIsland-s are created as a result of a topology processor evaluating the “as built” connectivity and the actual Switch positions.

It is possible to exchange documents directly involving TopologicalNode and bypassing the ConnectivityNode details by using the TopologicalNode to Terminal association. This is often useful for exchanges involving models which do not contain switch detail. When the TopologicalNode model is exchanged it is useful to also exchange the “connected” attribute on the Terminal class. This allows for the topological structure of the model to be retained, yet indicate a terminal is not completely connected. Normally this disconnection is the result of one or more switches opening in the detailed model which is not represented in a model exchange without switch detail.

EquipmentContainer-s, which are a specialization of a ConnectivityNodeContainer, may contain zero or more ConnectivityNode-s. The associations, ConductingEquipment–Terminal and Terminal–ConnectivityNode, capture the as-built connectivity of an actual power system network. For each Terminal connected to a ConnectivityNode, the associations of the other Terminal(s) connected to the same ConnectivityNode identify the ConductingEqupment object(s) that are electrically connected. Similar connectivity at the “bus/branch” level of detail can be expressed using the TopologicalNode instead of the ConnectivityNode. The BusNameMarker class, which has an association to ConnectivityNode, is used to carry user bus names to be applied to TopologicalNode-s. TopologicalNode-s are created from

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ConnectivityNode-s as a result of topology processing and various names might be applied depending upon which ConnectivityNode instances are present.

To model the analog values such as voltage and power, each Terminal has an association with a Measurement class from the Meas package. Although not shown in Figure 8, a Measurement object is associated with at least one MeasurementValue object. Each MeasurementValue object is an instance of a measurement from a specific source, for example, a telemetered measurement.

4.5.4.2 Connectivity and containment example

To illustrate how the connectivity model and containment model would appear as objects, a small example is presented in Figure 9. The example shows a transmission line with a T-junction spanning two substations and a substation having two voltage levels with a transformer between them. The transmission line consists of two different cables. One of the voltage levels is shown with a busbar section having a single busbar and two very simple switchgear bays connecting to the busbar.

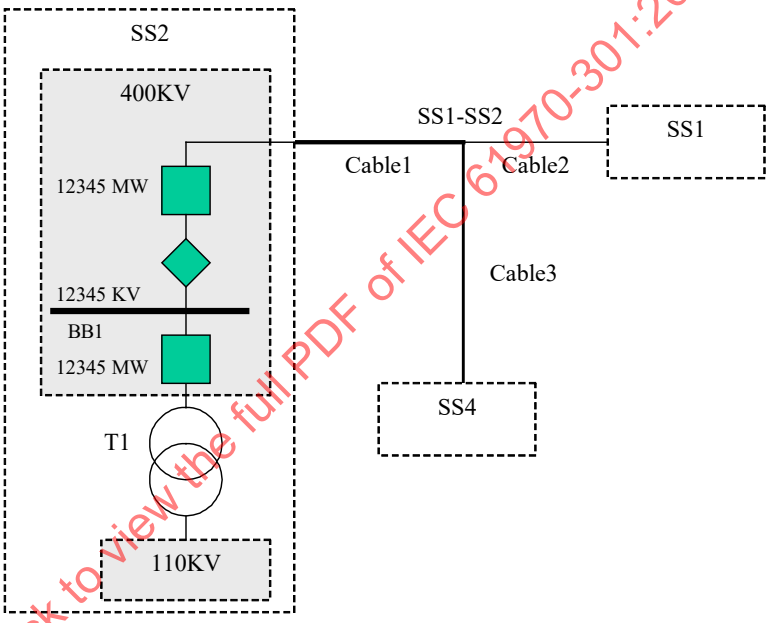


Figure 9 – Simple network example

Figure 10 shows how connectivity is modelled in the CIM as well as one way (but not necessarily the only way) containment is modelled for the diagram in Figure 9. The shaded square boxes represent EquipmentContainer-s, and the white square boxes represent ConductingEquipment. Darker shading indicates the EquipmentContainer is higher up in the containment hierarchy (i.e. Substation is highest, VoltageLevel next, etc.). White circles represent ConnectivityNode-s, and black small circles represent Terminals. A Terminal belongs to a ConductingEquipment, and a ConnectivityNode belongs to an EquipmentContainer. This means that the borders (or contact points) between ConductingEquipment are their Terminals interconnected via ConnectivityNode-s.

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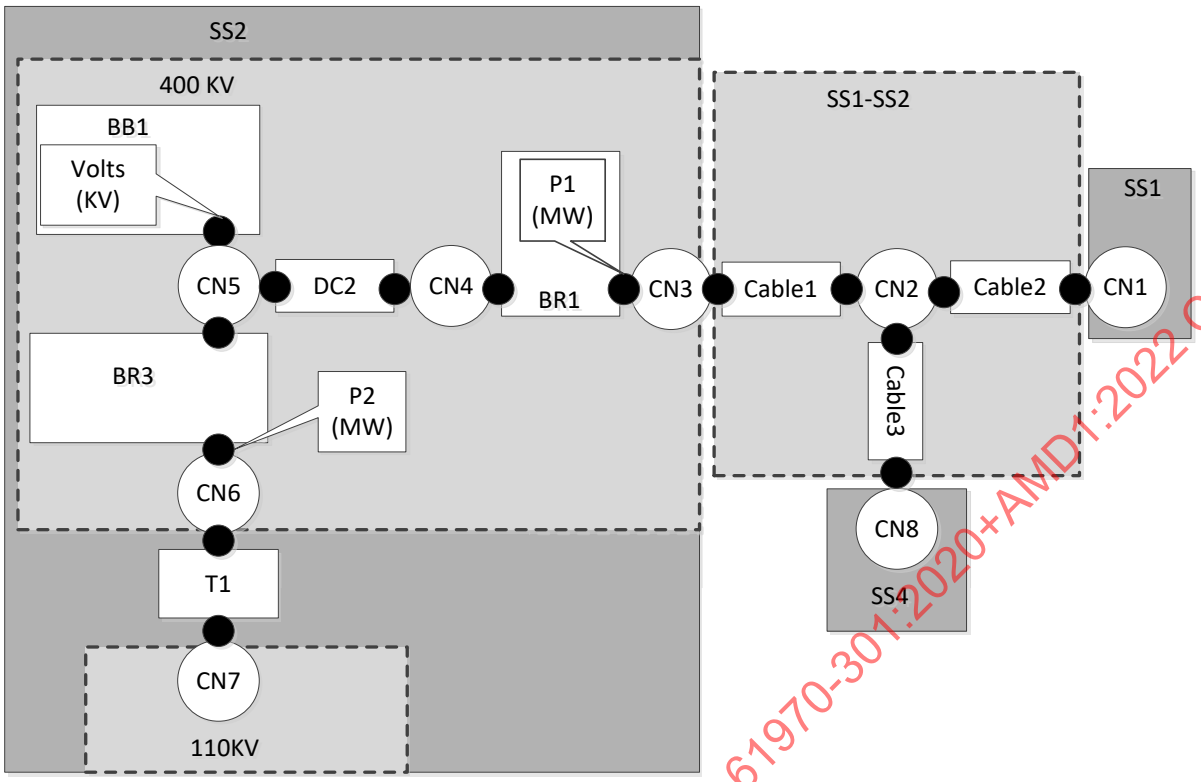


Figure 10 – Simple network connectivity modelled with CIM Topology

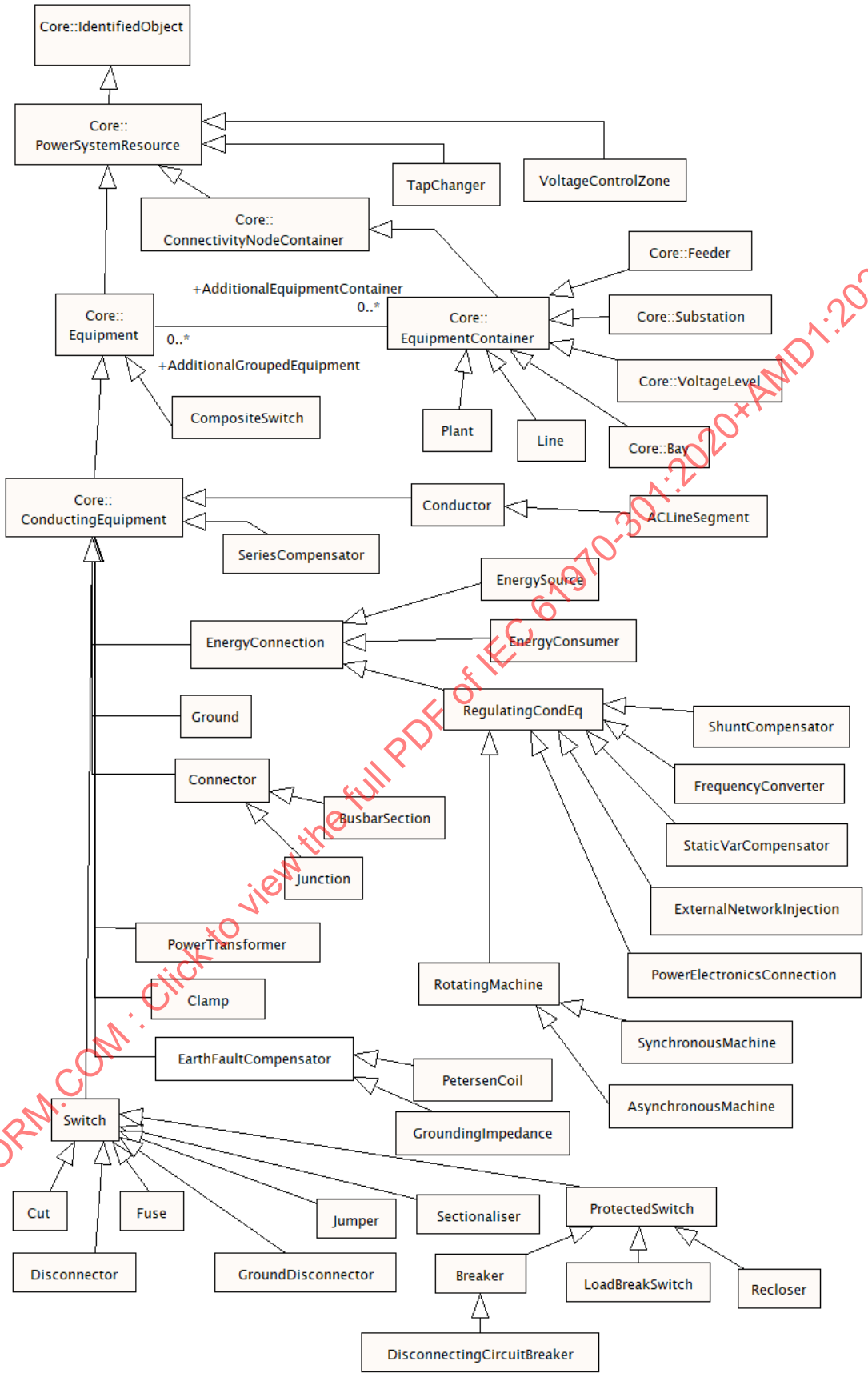
The Line SS1-SS2 contains three ACLineSegment-s (Cable1, Cable2, and Cable3) and associated ConnectivityNode (CN2) to model a T-junction, which provides a connection to SS4. This represents just one way that this configuration could be modelled. Each ACLineSegment has two Terminals. Cable1 is connected to CN3 and CN2 via these Terminals. CN3 is contained by the VoltageLevel 400KV. The breaker BR1 has two terminals one of which is connected to CN3.

Measurements are represented by square callouts where the arrow points to a Terminal. P1 is connected to the right Terminal belonging to Breaker BR1. Note that P1 is drawn inside the box representing BR1. This is because a Measurement may belong to a PowerSystemResource (PSR), as is the case with BR1. P2 is drawn inside the VoltageLevel 400 KV, which means it belongs to the 400 KV VoltageLevel instead of BR3.

4.5.5 Inheritance hierarchy

Figure 11 shows an overview of the inheritance hierarchy modelled in the CIM. This overview, which is included as one of the Wires package diagrams, spans several of the CIM packages.

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Figure 11 – Equipment inheritance hierarchy

4.5.6 Transformer model

Figure 13 shows a part of the Wires package in a class diagram which models a PowerTransformer device.

The transformer model is applicable for both balanced and unbalanced models. Additionally the PowerTransformer itself is now a ConductingEquipment with potentially multiple terminals to more directly model transformers with one, two, three, or more terminals.

As shown in Figure 12, the PowerTransformer is also able to optionally model tank details, which can be used to describe in detail the transformer internal winding phase connections and imbalances. In all cases a PowerTransformer models a group of physical devices acting together to transform power among terminals and in one physical location. For transmission systems, three physical single phase devices are often represented by one PowerTransformer instance. If detail of the individual single phase devices were required, the TransformerTank objects should additionally be modelled.

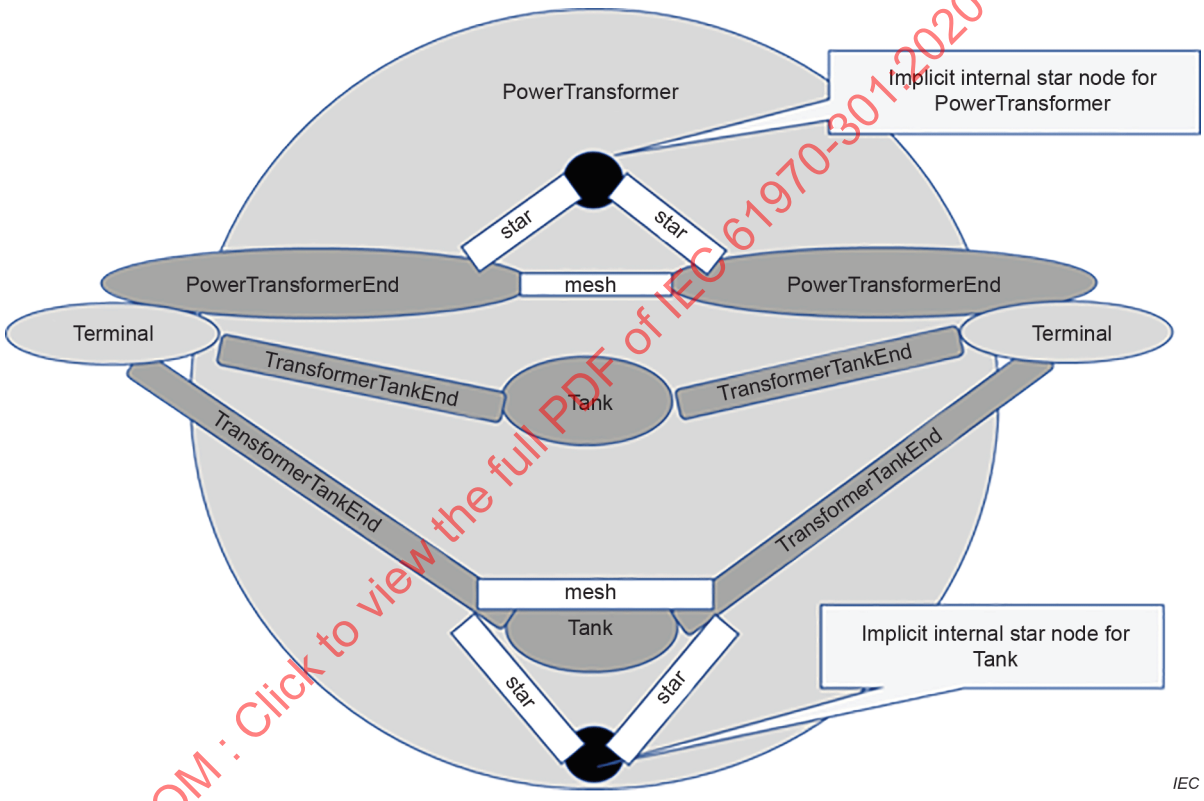


Figure 12 – Transformer and Tank model

Both a PowerTransformer and a TransformerTank can have impedance described in either an assumed star connection with implied centre connection or with mesh impedance form by using the optional TransformerMeshImpedance class. The mesh form of impedance is required to accurately model transformers with more than three terminals. If using the mesh impedance form, you would specify a TransformerMeshImpedance class for each possible terminal to terminal connection, thus one instance for two terminals, three for three terminals, and six for four terminals and so on. If using the star connection, the impedance parameters can be specified directly on the PowerTransformerEnd class, or alternatively shared among transformers using the TransformerStarImpedance class.

As shown in Figure 11, a PowerTransformer is a specialized class of ConductingEquipment, which is a specialized class of Equipment. This is shown by the use of the generalization-type of relationship, which uses an arrow to point to the general class. The inheritance permits the

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PowerTransformer to inherit attributes from ConductingEquipment, Equipment, and all generalizations of Equipment that are not shown in Figure 11.

A PowerTransformer also has relationships to PowerTransformerEnd and TransformerTank which are modelled with association type relationships. As shown, a PowerTransformer may associate zero or more PowerTransformerEnd-s, but a PowerTransformerEnd may associate to only zero or one PowerTransformer. Similarly, the PowerTransformer may associate to zero or more TransformerTank objects, but a TransformerTank may associate to only zero or one PowerTransformer object.

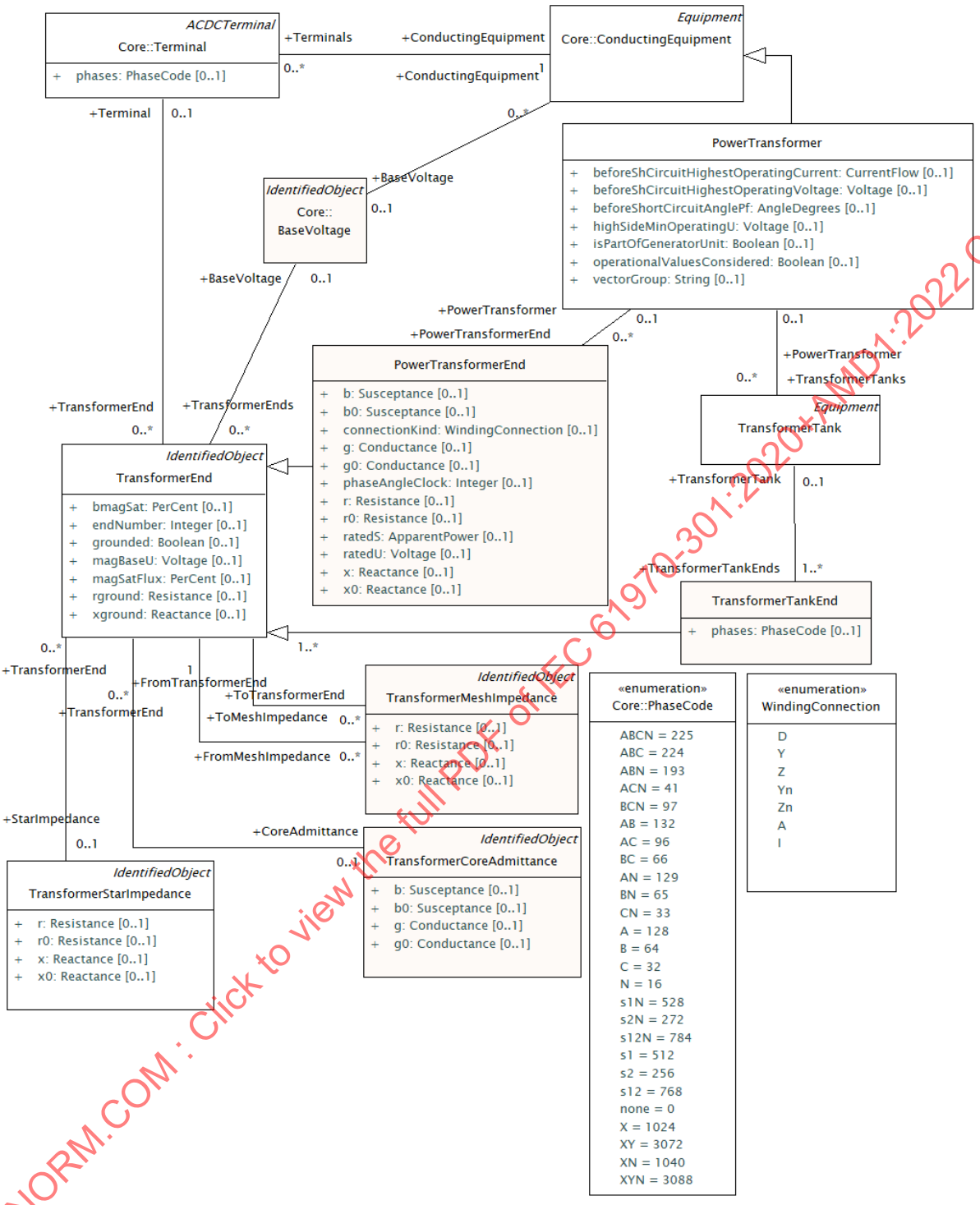
The PowerTransformerEnd specializes the TransformerEnd class which has other relationships as well:

- a generalization relationship with IdentifiedObject;
- two association relationships with the TransformerMeshImpedance class, such that a TransformerEnd object may be “From” 0, 1, or more TransformerMeshImpedance objects and “To” 0, 1, or more TransformerMeshImpedance objects;
- aggregation relationships with the PhaseTapChanger and RatioTapChanger classes, such that a TransformerWinding object may have 0 or 1 PhaseTapChanger objects and 0 or 1 RatioTapChanger objects associated with it.

For a transmission network PowerTransfomer that has two or three ends, the equivalent pi-model impedances appear in the PowerTransformerEnd r, r0, x, x0, g, g0, b and b0 attributes. The PowerTransformerEnd and its connected Terminal both have sequence numbers TransformerEnd.endNumber and ACDCTerminal.sequenceNumber. Those numbers may or may not be in synch.

Figure 13 shows UML for the transformer model.

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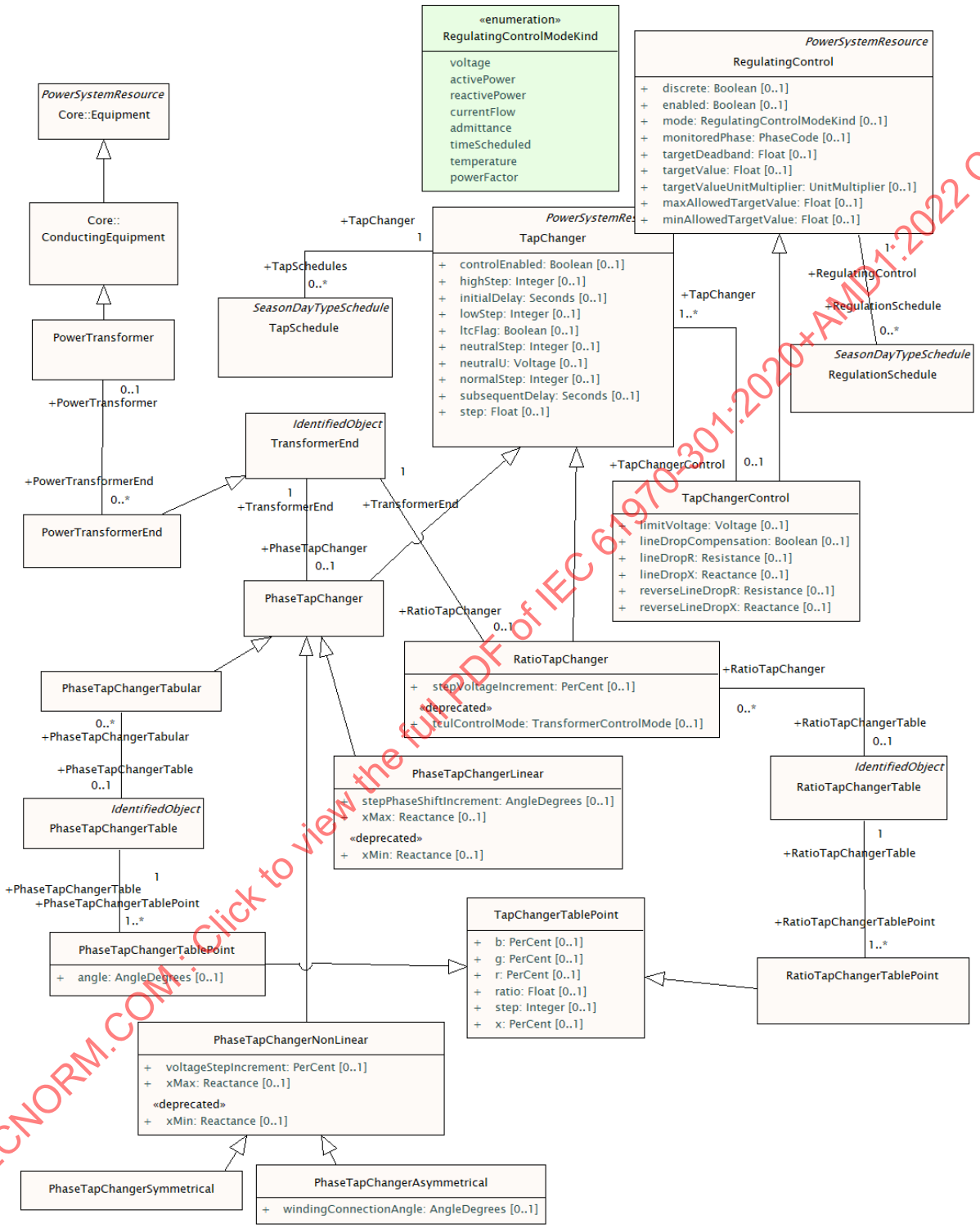
Figure 13 – Transformer model

4.5.7 Transformer tap modelling

4.5.7.1 Generalized tap modelling

Multiple types of transformer tap models are supported by the CIM model. Depending on the physical construction, the effects of tap movement shall be defined using either the RatioTapChanger class or the PhaseTapChanger class and its various specializations. The PhaseTapChanger can be specialized into several different types representing the physical

construction and hence behaviour. The attributes of TapChanger are applicable for all the RatioTapChanger specializations. Figure 14 shows the UML model for the transformer taps.



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Figure 14 – Transformer tap model

Multiple tap changers can be combined within one power transformer, but to avoid interpretation issues only one phase shifting and one ratio changing tap changer shall be modelled on any given terminal. The ratio or phase shift change is documented relative to the other terminal(s) assuming those terminals are at the nominal (1 PU) ratio and nominal (zero) phase angle shift. Tabular representation is required in cases where it is necessary to combine both phase shifting and ratio tap changer on one terminal, as it conveys the explicit values of the resulting phases and angles.

Tabular representations for both ratio and phase shifting transformers can be used where the available CIM models do not appropriately reflect the physical behaviour. The tabular models are optional to the other CIM tap models. Tabular models may be used to describe the change in impedance through the tap range.

In 4.5.7.2 to 4.5.7.7 the various tap changer models are described in more detail.

4.5.7.2 Voltage ratio transformer modelling

The RatioTapChanger class is used to define a transformer tap that changes the voltage magnitude ratio without changing the phase angle across the transformer. A RatioTapChanger may be used in cases where the transformer inherently introduces a fixed phase shift, such as from a wye-delta winding connection.

4.5.7.3 Voltage ratio transformer tabular modelling

A RatioTapChangerTabular may be optionally associated to any RatioTapChanger and may represent a non-linear relationship between tap number, tap ratio, and impedances. If associated, the tabular ratio model takes precedence.

4.5.7.4 Linear phase shifter transformer modelling

A phase shifting transformer is linear if the phase shift increment per tap step is uniform and the voltage magnitude is constant over the full range of the tap changer. A linear phase shifter is modelled using the PhaseTapChangerLinear class.

4.5.7.5 Symmetrical and asymmetrical phase shifter modelling

4.5.7.5.1 Common information

Subclause 4.5.7.5 describes Phase-Shifting Transformer (PST) modelling according to the type and technology of the equipment; and more specifically, equivalent series reactance of phase shifters in the positive sequence as a function of the phase shift angle. In these specific models, the resistances and the magnetizing currents are always neglected.

The phase shift transformers within 4.5.7.5 are mapped to CIM classes as described in Table 1.

Table 1 – Mapping of phase shift transformers to CIM classes

Phase shifter type	CIM class
General Case	cim:PhaseTapChangerTabular
Symmetrical phase shifters	cim:PhaseTapChangerSymmetrical or cim:PhaseTapChangerLinear
Asymmetrical phase shifter	cim:PhaseTapChangerAsymmetrical
In-phase transformer and symmetrical phase shifter	cim:PhaseTapChangerSymmetrical and cim:RatioTapChanger
In-phase transformer and asymmetrical phase shifter	cim:PhaseTapChangerAsymmetrical and cim:RatioTapChanger

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It is highly recommended to use tabular data to exchange PST parameters (cim:PhaseTapChangerTabular) instead of having to recalculate the parameters per tap according to each model type.

The symbols used in formulas within 4.5.7.5 are mapped to CIM classes as described in Table 2.

Table 2 – Mapping of symbols used in formulas to CIM attributes

Power Shifter Transformer attribute	CIM attribute
n	cim:PhaseTapChangerTablePoint.step
n_0	cim:TapChanger.neutralStep
δu	cim:PhaseTapChangerNonLinear.voltageStepIncrement
r	cim:TapChangerTablePoint.ratio
α	cim:PhaseTapChangerTablePoint.angle
$\delta\alpha$	cim:PhaseTapChangerLinear.stepPhaseShiftIncrement
$X(\alpha)$	cim:TapChangerTablePoint.x
$X(0)$	cim:PhaseTapChangerLinear.xMin or cim:PhaseTapChangerNonLinear.xMin or PowerTransformerEnd.x as .xMin is a deprecated attribute
$X(\alpha_{max})$	cim:PhaseTapChangerLinear.xMax or cim:PhaseTapChangerNonLinear.xMax or PowerTransformerEnd.x as .xMin is a deprecated attribute
θ	cim:PhaseTapChangerAsymmetrical.windingConnectionAngle

The impedance variation depending on tap position on a phase shift transformer is described in Table 3 and variables in Table 4.

Table 3 – Impedance variations in a phase shift transformer

Equipment type	Equivalent series reactance as a function of the phase shift angle
Symmetrical Phase shifters	$X(\alpha) = X(0) + \left(X(\alpha_{max}) - X(0)\right)\left(\frac{\sin(\alpha/2)}{\sin(\alpha_{max}/2)}\right)^2$
Asymmetrical Phase Shifter	$X(\alpha) = X(0) + \left(X(\alpha_{max}) - X(0)\right)\left(\frac{\tan\alpha}{\tan\alpha_{max}}\frac{\sin\theta - \tan\alpha_{max}\cos\theta}{\sin\theta - \tan\alpha\cos\theta}\right)^2$
In-phase transformer and symmetrical phase shifter	$X(r,\alpha) = X_r(r_{nom})\left(\frac{r}{r_{nom}}\right)^2 + X_\alpha(0) + \left(X_\alpha(\alpha_{max}) - X_\alpha(0)\right)\left(\frac{\sin(\alpha/2)}{\sin(\alpha_{max}/2)}\right)^2$
In-phase transformer and asymmetrical phase shifter	$X(r,\alpha) = X_r(r_{nom})\left(\frac{r}{r_{nom}}\right)^2 + X_\alpha(0)$ $+ \left(X_\alpha(\alpha^0_{max}) - X_\alpha(0)\right)\left(\frac{\tan\alpha}{\tan\alpha_{max}(r)}\frac{\sin\theta - \tan\alpha_{max}(r)\cos\theta}{\sin\theta - \tan\alpha\cos\theta}\right)^2$

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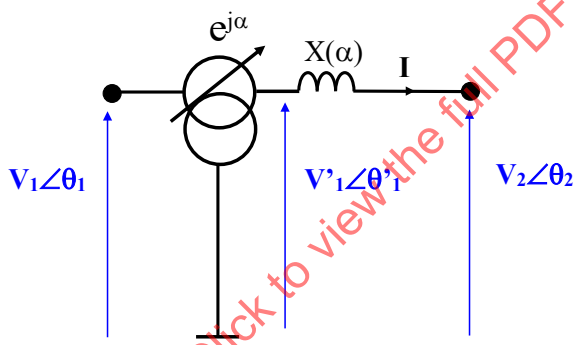
Equipment type	Equivalent series reactance as a function of the phase shift angle
	with $\alpha_{max}(r) = A\tan\left(\frac{\sin\theta}{\frac{r}{r_{nom}\tan\alpha^0_{max}}\left(\sin\theta - \tan\alpha^0_{max}\cos\theta\right)+\cos\theta}\right)$ and $\alpha^0_{max} = \alpha_{max}(r_{nom})$

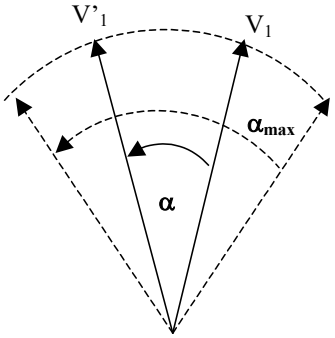
Table 4 – Description of variables

Variable	Meaning
α_{max}	Maximum phase shift: the maximum angle value of the phase shifter angles table
r_{nom}	Nominal ratio of the in-phase transformer
α^0_{max}	Maximum phase shift when the in-phase transformer ratio is nominal

4.5.7.5.2 Symmetrical Phase shifters

Phasor diagram and equations are shown in Figure 15.





$$V_2 = V_1 e^{j\alpha} - jX(\alpha)I \qquad V'_1 = V_1\left(1 + 2j\sin\frac{\alpha}{2}e^{j\frac{\alpha}{2}}\right) = e^{j\alpha}V_1$$

Figure 15 – Phasor diagram and equations

Expression of the angle and ratio per tap

Based on Figure 15:

$$\alpha = (n - n_0)\cdot\delta\alpha \qquad \text{or} \qquad \alpha = 2A\tan\left(\frac{(n - n_0)\cdot\delta u}{2}\right)$$

$r = 1$

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Expression of the equivalent series reactance given the angle

Assuming the reactance of the regulating winding varies as the square of the number of turns, the equivalent reactance for non-delta-hexagonal technologies can be written as follows:

$$X(\alpha) = X(0) + \left(X(\alpha_{max}) - X(0)\right)\left(\frac{\sin(\alpha/2)}{\sin(\alpha_{max}/2)}\right)^2$$

Parameters:

α_{max} maximum phase shift

$X(0)$ equivalent series reactance at zero phase shift $\alpha = 0$

$X(\alpha_{max})$ equivalent series reactance at maximum phase shift $\alpha = \alpha_{max}$

Variable:

α current phase shift

The formula above is valid for single or double core symmetrical phase shifters except for the hexagonal technology.

For single core symmetrical phase shifters: $X(0) = 0$. An example of impedance variation is shown in Figure 16.

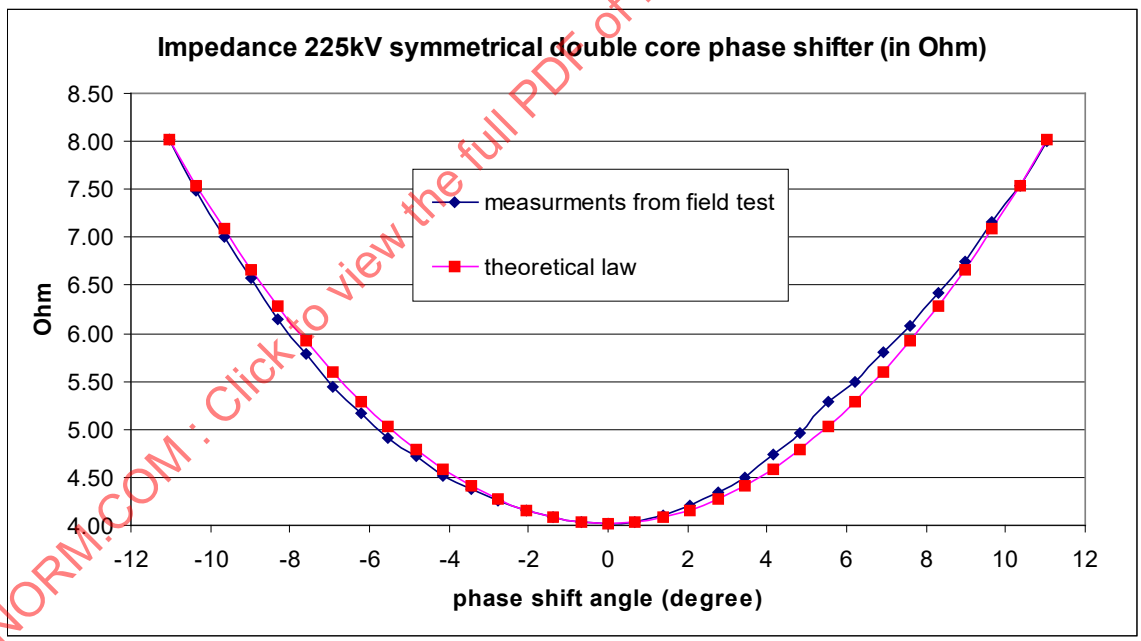


Figure 16 – Symmetrical phase shifter impedance variation

Three-phase core organization is shown in Figure 17.

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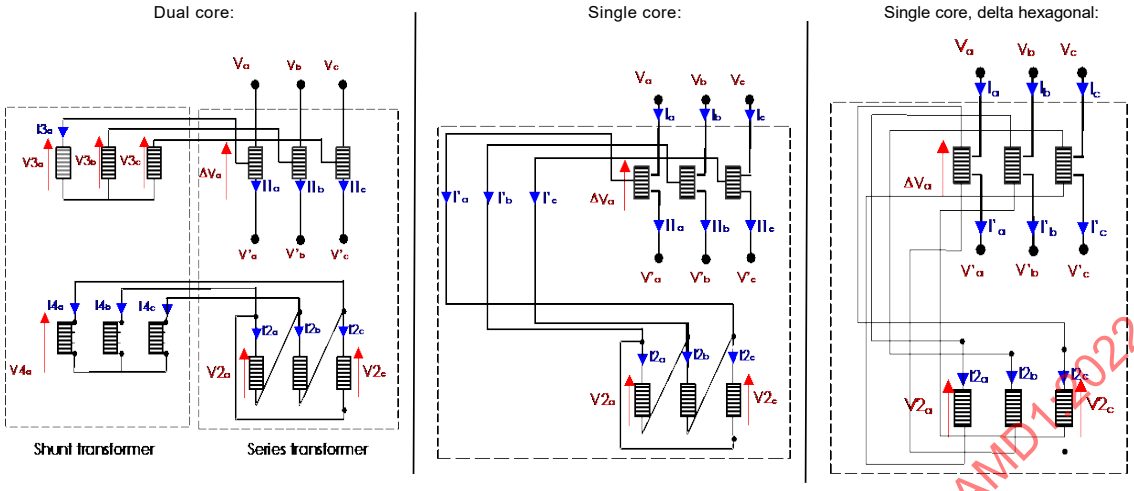
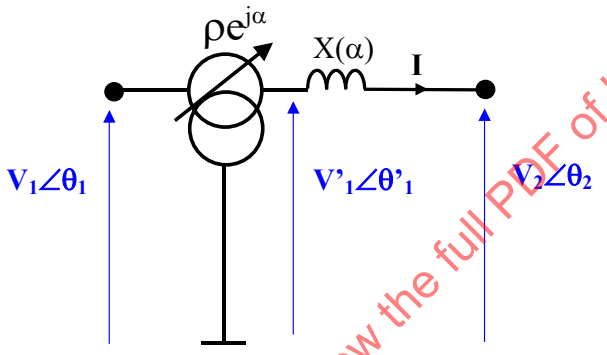
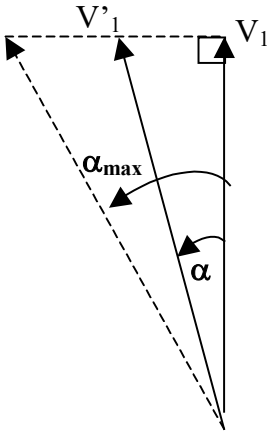


Figure 17 – Core organization

4.5.7.5.3 Quadrature booster

Phasor diagram and equations are shown in Figure 18.





$$V'_1 = V_1(1 + j\tan\alpha) = \rho e^{j\alpha} V_1$$

$$V_2 = V_1 \rho e^{j\alpha} - jX(\alpha)I$$

ρ and α vary with ρ.cos α = constant.

Figure 18 – Phasor diagram and equations

Expression of the angle and ratio per tap

Based on Figure 18:

$$\alpha = A\tan((n - n_0)\cdot\delta u)$$

$$r = \frac{1}{\sqrt{((n - n_0)\cdot\delta u)^2 + 1}}$$

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Expression of the equivalent series reactance given the angle

Assuming the reactance of the regulating winding varies as the square of the number of turns, the equivalent reactance of the quadrature booster can be written as follows.

$$X(\alpha) = X(0) + \left(X(\alpha_{max}) - X(0)\right)\left(\frac{\tan(\alpha)}{\tan(\alpha_{max})}\right)^2$$

Parameters:

α_{max} maximum phase shift

$X(0)$ equivalent series reactance at zero phase shift

$X(\alpha_{max})$ equivalent series reactance at maximum phase shift

Variable:

α current phase shift

For quadrature boosters with a single core: $X(0) = 0$

Three-phase core organization is shown in Figure 19.

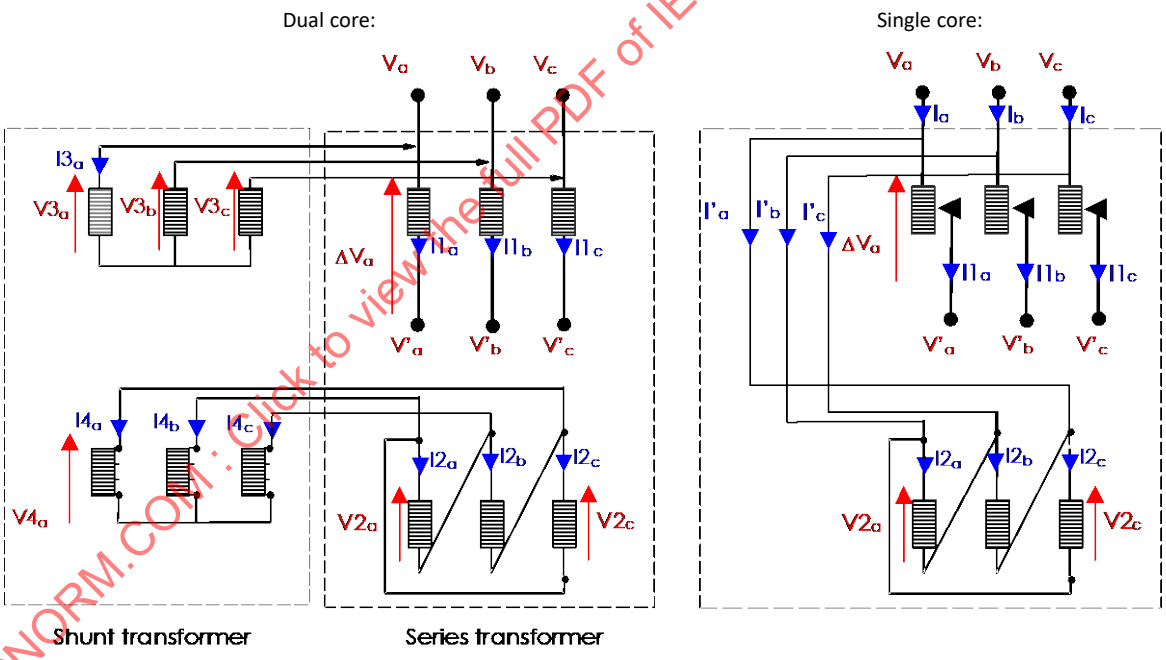
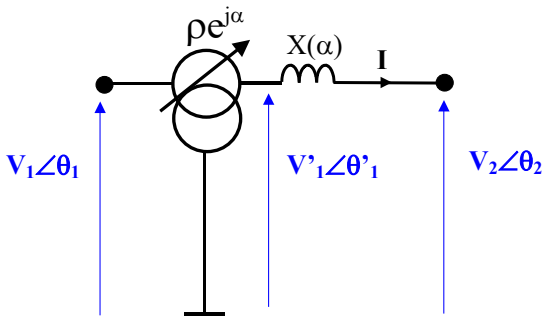


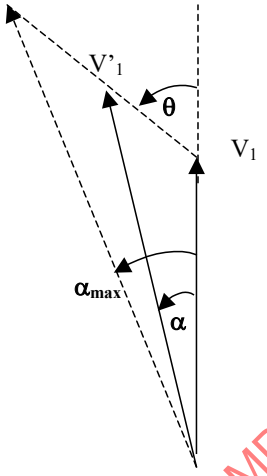
Figure 19 – Core organization

4.5.7.5.4 Asymmetrical phase shifter modelling

Phasor diagram and equations are shown in Figure 20.

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$$V'_1 = V_1\left(1 + e^{j\theta}.\frac{\tan\alpha}{\sin\theta - \tan\alpha\cos\theta}\right) = \rho e^{j\alpha}V_1$$

$$V_2 = V_1.\rho e^{j\alpha} - jX(\alpha)I$$

θ is fixed, only α and ρ vary.

Figure 20 – Phasor diagram and equations

Expression of the angle and ratio per tap

Based on Figure 20:

$$\alpha = A\tan\left(\frac{(n-n_0)\cdot\delta u\cdot\sin\theta}{1+(n-n_0)\cdot\delta u\cdot\cos\theta}\right)$$

$$r = \frac{1}{\sqrt{((n-n_0)\cdot\delta u\cdot\sin\theta)^2 + (1+(n-n_0)\cdot\delta u\cdot\sin\theta)^2}}$$

Expression of the equivalent series reactance given the angle

Assuming the reactance of the regulating winding varies as the square of the number of turns, the equivalent reactance can be written as follows

$$X(\alpha) = X(0) + (X(\alpha_{max}) - X(0))\left(\frac{\tan\alpha}{\tan\alpha_{max}}\frac{\sin\theta - \tan\alpha_{max}\cos\theta}{\sin\theta - \tan\alpha\cos\theta}\right)^2$$

Parameters:

α_{max}	maximum phase shift
$X(0)$	equivalent series reactance at zero phase shift
$X(\alpha_{max})$	equivalent series reactance at maximum phase shift
θ	boost voltage angle

Variable:

α	current phase shift

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Three-phase organizations are shown in Figure 21.

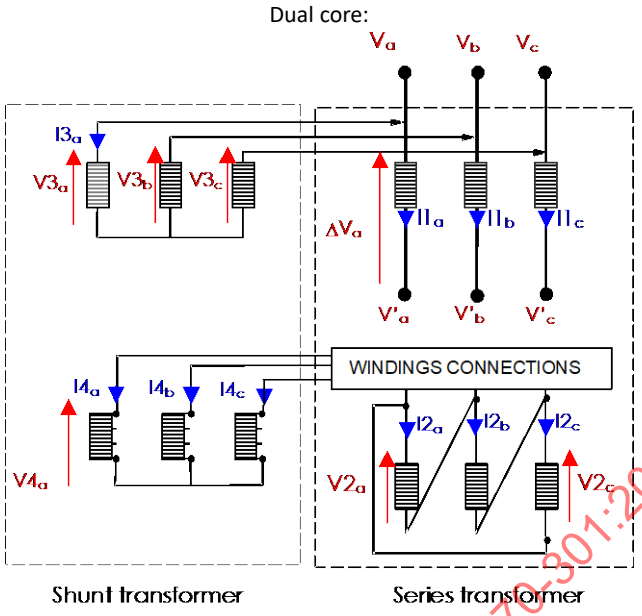
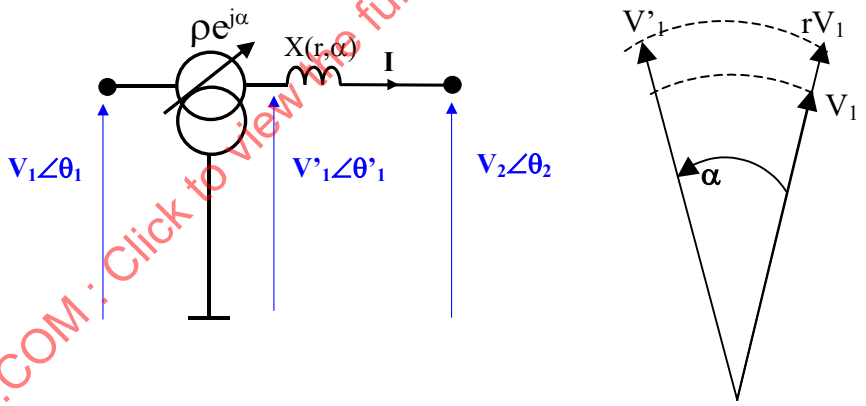


Figure 21 – Core organization

4.5.7.5.5 In-phase transformer and symmetrical phase shifter

Phasor diagram and equations are shown in Figure 22.



$$V_2 = \rho V_1 e^{j\alpha} - jX(\alpha)I. \qquad V'_1 = r.V_1\left(1 + 2j\sin\frac{\alpha}{2}e^{j\frac{\alpha}{2}}\right) = \rho e^{j\alpha}V_1$$

r and α vary, and ρ=r.

r and α vary, and ρ=r.

Figure 22 – Phasor diagram and equations

Expression of the angle and ratio per tap

Same as 4.5.7.5.2 with the addition of the in-phase transformer ratio r.

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Equivalent series reactance given the angle and the in-phase transformer ratio;

Assumptions:

- the reactance of the regulating winding varies as the square of the number of turns,
- the equivalent reactance is the sum of the reactance of the in-phase transformer X_r and the reactance of the phase shifter part X_α,
- the phase shifting angle α does not depend on the in-phase ratio r.

The equivalent reactance can be written as follows:

$$X(r,\alpha) = X_r(r_{nom})\left(\frac{r}{r_{nom}}\right)^2 + X_\alpha(0) + \left(X_\alpha(\alpha_{max}) - X_\alpha(0)\right)\left(\frac{\sin(\alpha/2)}{\sin(\alpha_{max}/2)}\right)^2$$

Parameters:

r_{nom} nominal ratio of the in-phase transformer

$X_r(r_{nom})$ equivalent series reactance of the in-phase transformer at nominal in-phase ratio

α_{max} maximum phase shift

$X_\alpha(0)$ equivalent series reactance of the phase shifter part at zero phase shift

$X_\alpha(\alpha_{max})$ equivalent series reactance of the phase shifter part at maximum phase shift at nominal in-phase ratio (r_{nom})

Variables:

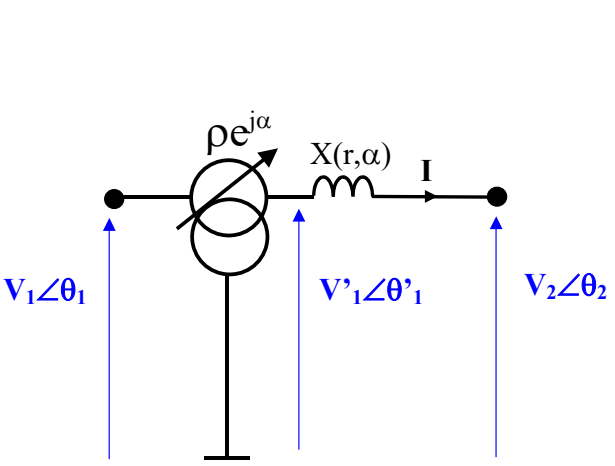
r current ratio of the in-phase transformer

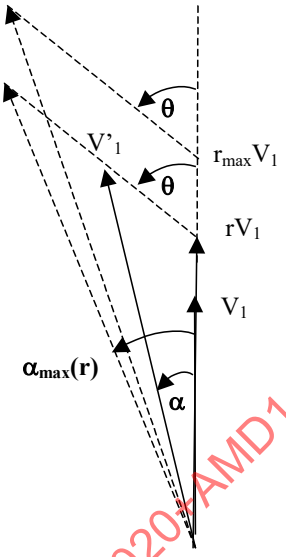
α current phase shift

4.5.7.5.6 In-phase transformer and asymmetrical phase shifter

Phasor diagram and equations are shown in Figure 23.

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$$V'_1 = rV_1\left(1 + e^{j\theta}.\frac{\tan\alpha}{\sin\theta - \tan\alpha\cos\theta}\right) = \rho e^{j\alpha}V_1 \qquad V_2 = (V1 - jX(\alpha)I).\rho e^{j\alpha}$$

θ is fixed, only r and α are variables, ρ varies as a consequence.

θ is fixed, only r and α are variables, ρ varies as a consequence.

Figure 23 – Phasor diagrams and equations

Equivalent series reactance given the angle and the in-phase transformer ratio

Assumptions:

- the reactance of the regulating winding varies as the square of the number of turns.
- the equivalent reactance is the sum of the reactance of the in-phase transformer X_r and the reactance of the phase shifter part X_α.

The equivalent series reactance can be written as follows:

$$X(r,\alpha) = X_r(r_{nom})\left(\frac{r}{r_{nom}}\right)^2 + X_\alpha(0) + \left(X_\alpha(\alpha^0_{\max}) - X_\alpha(0)\right)\left(\frac{\tan\alpha}{\tan\alpha_{\max}(r)}\frac{\sin\theta - \tan\alpha_{\max}(r)\cos\theta}{\sin\theta - \tan\alpha\cos\theta}\right)^2$$

$$\text{with } \alpha_{\max}(r) = A\tan\left(\frac{\sin\theta}{\frac{r}{r_{nom}\tan\alpha^0_{\max}}\left(\sin\theta - \tan\alpha^0_{\max}\cos\theta\right) + \cos\theta}\right) \text{ with } \alpha^0_{\max} = \alpha_{\max}(r_{nom})$$

Parameters:

r_{nom}	nominal ratio of the in-phase transformer
$X_r(r_{nom})$	equivalent series reactance of the in-phase transformer at nominal in-phase ratio r_{nom}
θ	fixed boost voltage angle

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$\alpha^0_{\max} = \alpha_{\max}(r_{nom})$ maximum phase shift for nominal in-phase ratio (r_{nom})

X_α (0) equivalent series reactance of the phase shifter part at zero phase shift

X_α ($\alpha^0_{\max}$) equivalent series reactance of the phase shifter part at maximum phase shift at nominal in-phase ratio (r_{nom})

Variables:

r current ratio of the in-phase transformer

α current phase shift

For $\theta = \pi/2$ (quadrature booster): $\alpha_{\max}(r) = A\tan\left(\frac{r_{nom}}{r}\tan\alpha^0_{\max}\right)$

Three-phase organizations shown in Figure 24.

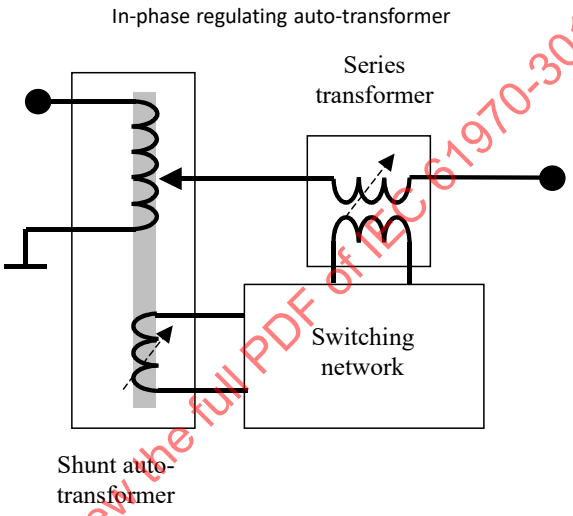


Figure 24 – Core organization

The phase shift regulation may be on the shunt or on the series transformer.

4.5.7.6 Phase shifter transformer tabular modelling

A PhaseTapChangerTabular is an explicit tabular representation of the phase shift, ratio and impedance change over the range of the tap changer. The PhaseTapChangerTabular may be associated with PhaseTapChangerTable representing a non-linear relationship between tap number, phase shift, ratios and impedances.

4.5.7.7 Tap changer control

Control of tap changers in a power flow type of application is made using the TapChangerControl class and the TapChanger.ltcFlag. If a TapChanger has a TapChangerControl (referenced TapChanger.TapChangerControl), power flow application may control the tap changer. The TapChanger.ltcFlag provides information that the TapChanger has physical capability to move the tap under load. The attribute is also used in the IEC 60909 calculations.

The meaning of the combinations for TapChanger.TapChangerControl and TapChanger.ltcFlag are described in Table 5.

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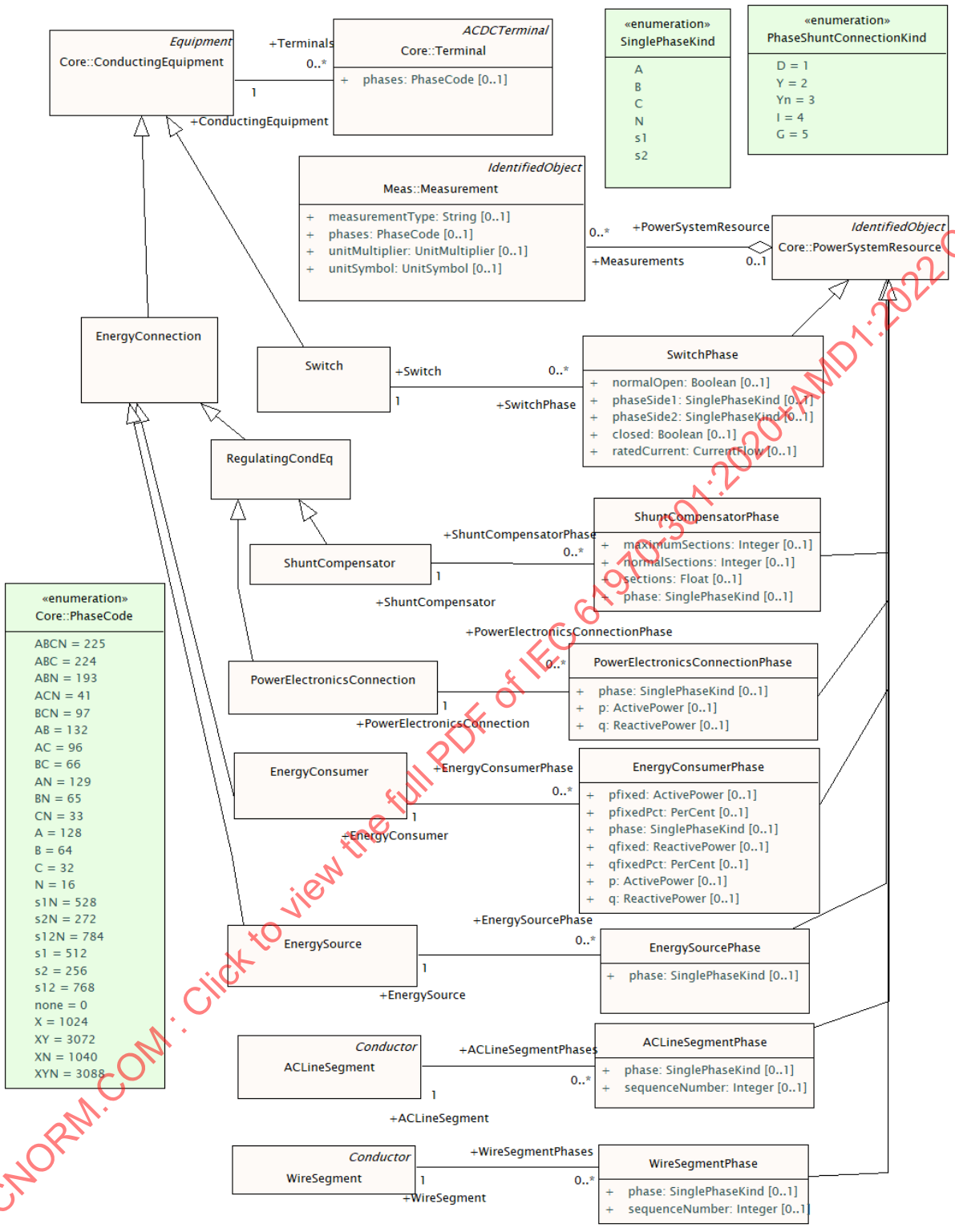
Table 5 – Tap changer control options

TapChanger. ltcFlag	TapChanger. TapChangerControl	Description
False	Not present	A real and fixed tap that is not controlled and cannot be moved on load (manual tap change). Power flow cannot be set to change the tap for voltage control during the calculation.
True	Not present	A real and fixed tap that is not controlled but can be moved under load, e.g. manually. Power flow cannot be set to change the tap for voltage control during the calculation. Optimal power flow might have access to these taps and change in order to optimize. Also State Estimator may estimate the tap position to find a better solution for the system state.
True	Present	A real tap with a possibility to change taps automatically for voltage control/active power (load flow) enabled. Depending on the RegulatingControl.enabled and TapChanger.controlEnabled in SSH, the power flow shall or shall not participate in the regulation. In cases where the RegulatingControl is associated with more than one tap changer or other devices, the attribute TapChanger.controlEnabled can be set to false in order to set which of the taps are not enabled.
False	Present	An artificial tap changer can be used to simulate control behaviour in power flow.

4.5.8 Phase wire modelling

The CIM models provide a means to specify equivalent single-line representation of balanced three phase networks or to additionally and optionally specify individual phase detail. In single phase networks there is a direct correspondence between Terminal objects and physical wire connections. In the single-line representation of balanced three phase networks we use one Terminal to represent the group of coordinating phase connections. Thus one Terminal can be used to specify one or more coordinated phase connections using the Terminal.phases attribute which is of enumeration type PhaseCode. PhaseCode has the possible phase connection combinations of ABC, ABCN, AB, BC, CA, A, B, C and so forth. The specification of phases at each terminal allows for modelling jumpers or switches that connect the same or different phases. This phase connectivity specification is intended as a nominal or normal phase specification. The result of energization source is not reflected in this specification. This phase specification provides a means to locally connect the same phases. Figure 25 shows the phase wire data model.

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Figure 25 – Phase wire data model

Figure 26 provides an example for specifying phase connections. This example shows a ConnectivityNode instance on the left with A, B, and C phases implied. Note that ConnectivityNode does not specify its phase content but rather implicitly connects the same phases of terminals associated to the ConnectivityNode. The example shows a two phase jumper connecting on the left (Terminal.sequenceNumber=1) phases A and C and on the right (Terminal.sequenceNumber=2) phases A and B, with the internals of the jumper model SwitchPhase objects which specify in detail how the phase connections route. The

Terminal.phases attribute only specifies the external connection of a device. Continuing to the right, two line segments are connected. The upper line segment is a two phase line on phases A and B. The lower line segment is single phase on phase B. The dark lines indicate CIM associations while the lighter arrows indicate the represented electrical connections at the phase level.

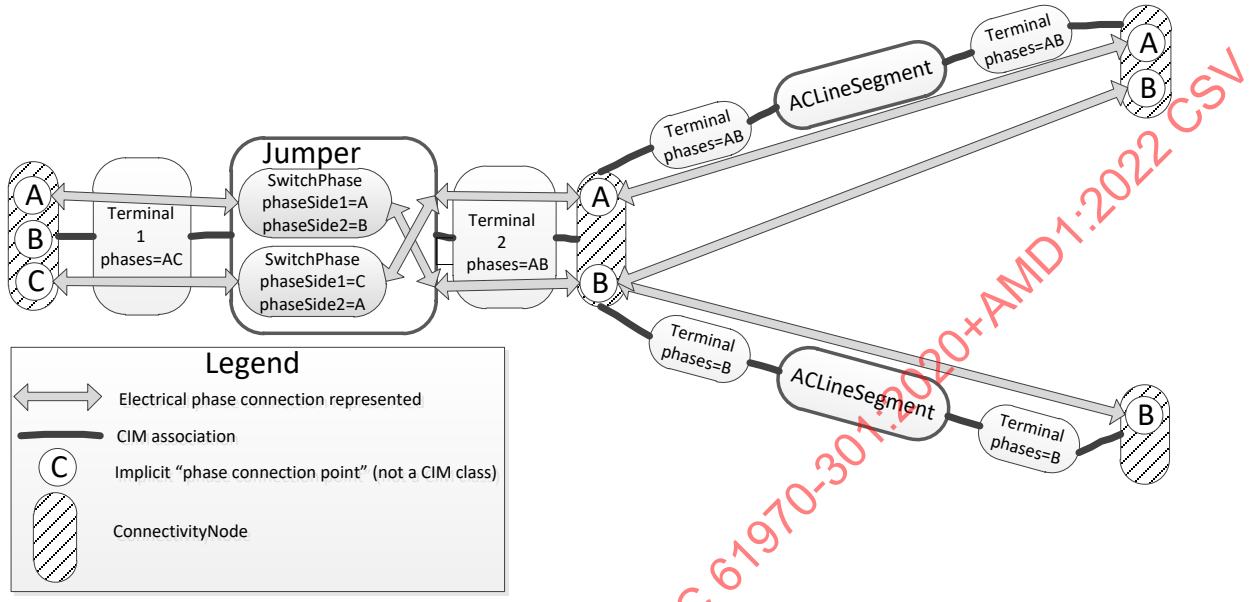


Figure 26 – Phase connectivity

As a clarification, the SwitchPhase attribute named phaseSide1 specifies any single phase (such as A, B, C, or N) and refers to the Terminal with sequenceNumber equal to 1. The SwitchPhase attribute named phaseSide2 refers to the Terminal with sequenceNumber equal to 2.

The switch model allows for cross phase connections to be modelled in general within the device. The transformer model also has explicit internal device modelling of phase connectivity. At this time all other ConductingEquipment branch specializations such as ACLineSegment assume the same phases connect at both terminals. The CIM model is open for future extensions to introduce internal device phase connectivity.

4.5.9 Grounding devices modelling

4.5.9.1 Use case for modelling grounding devices.

These devices have significant impact on short circuit currents for unbalanced faults. The devices are switched around in operation with switches when transformer to line switching is reconfigured. A Petersen Coil is a grounding reactor, used in alternating-current power transmission systems, designed to limit the current flowing to ground at the location of a fault by setting up a reactive current to ground that balances the capacitive current to ground flowing from the lines. Additionally Petersen coils are "tuned" to match the charging current expected from unbalanced faults. The impedance of Petersen coils can be "tuned" by adjusting a step position like a tap. This step position is telemetered sometimes. Sometimes a linear model is sufficient for relating step position to impedance value and sometimes a table is needed to reflect the non-linear relationship between step position and impedance.

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4.5.9.2 Model

The EarthFaultCompensator is a type of abstract conducting equipment intended to model grounding equipment. The EarthFaultCompensator is a specialization of ConductingEquipment because a short circuit requires proper connections and various switches may open or close to change the topology configuration. This is not the same thing as a branch like ACLineSegment, ShuntCompensator, or PowerTransformer; it does not regulate voltage and is never connected to Y or delta. A zig-zag grounding transformer is still a PowerTransformer, because of all the other complexities of the transformer. Two specializations handle fixed impedance devices (GroundingImpedance) and adjustable (variable) Petersen coil devices (PetersenCoil).

The GroundingImpedance and PetersenCoil connect the same way as other devices using Terminal. The phases attribute on Terminal indicates the connection is at the neutral phase. The EarthFaultCompensator can have either one or two terminals modelled. If the second terminal of an EarthFaultCompensator is omitted, it is assumed the terminal solidly connects to ground. If there is some kind of topology or local earth resistivity that is important to model on the ground side of the device, then a second terminal is added.

If a PowerTransformer has a Y connection on one Terminal (secondary) and a PetersenCoil is connected to that Terminal, then the PowerTransformer's secondary Terminal should be specified with phases attribute equal to ABCN and the PetersenCoil's Terminal should be specified with phase N. This allows the ACLineSegment to connect with phases ABC (the default) and the PetersenCoil to connect to the same TransformerTerminal but only on the N phase. It is expected all PetersenCoil terminals to have only phase N.

If a normal modelling of a non-neutral network is done, then the Petersen coil model is added, which includes:

1) Adding the phasing of ABCN to the transformer secondary terminal so you have a place to connect neutral.
2) Adding the PetersenCoil object with its associated Terminal which is phase N, since only one Terminal is modelled the PetersenCoil is assumed solidly grounded.
3) Associating the PetersenCoil's single Terminal to the ConnectivityNode at transformer secondary.

A separate class for ground disconnector (GroundDisconnector) is included since these are typically physically very different from most other switches and often excluded from normal power flow analysis. Similar to PetersenCoils, it is expected that all GroundDisconnector terminals will have only phase N. For the data model refer to Figure 27.

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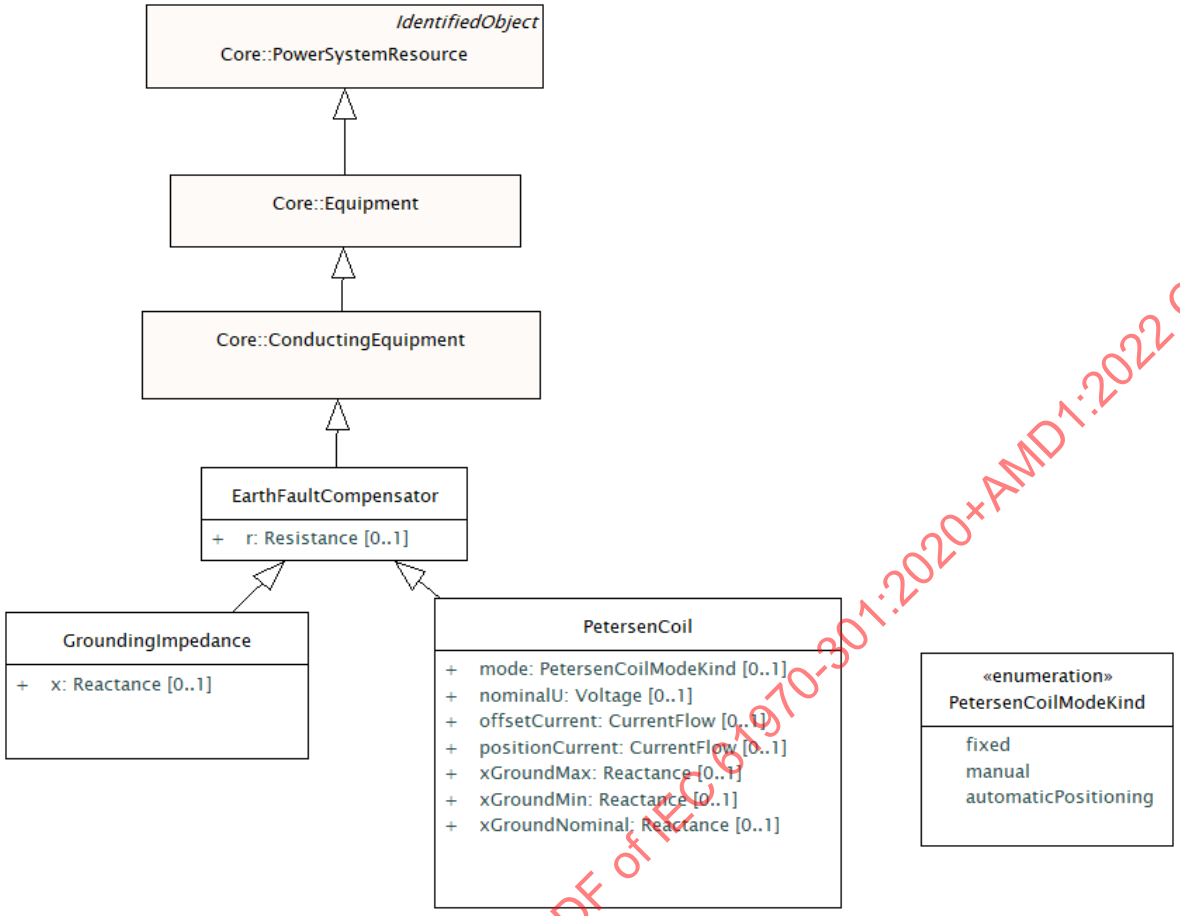


Figure 27 – Grounding device data model

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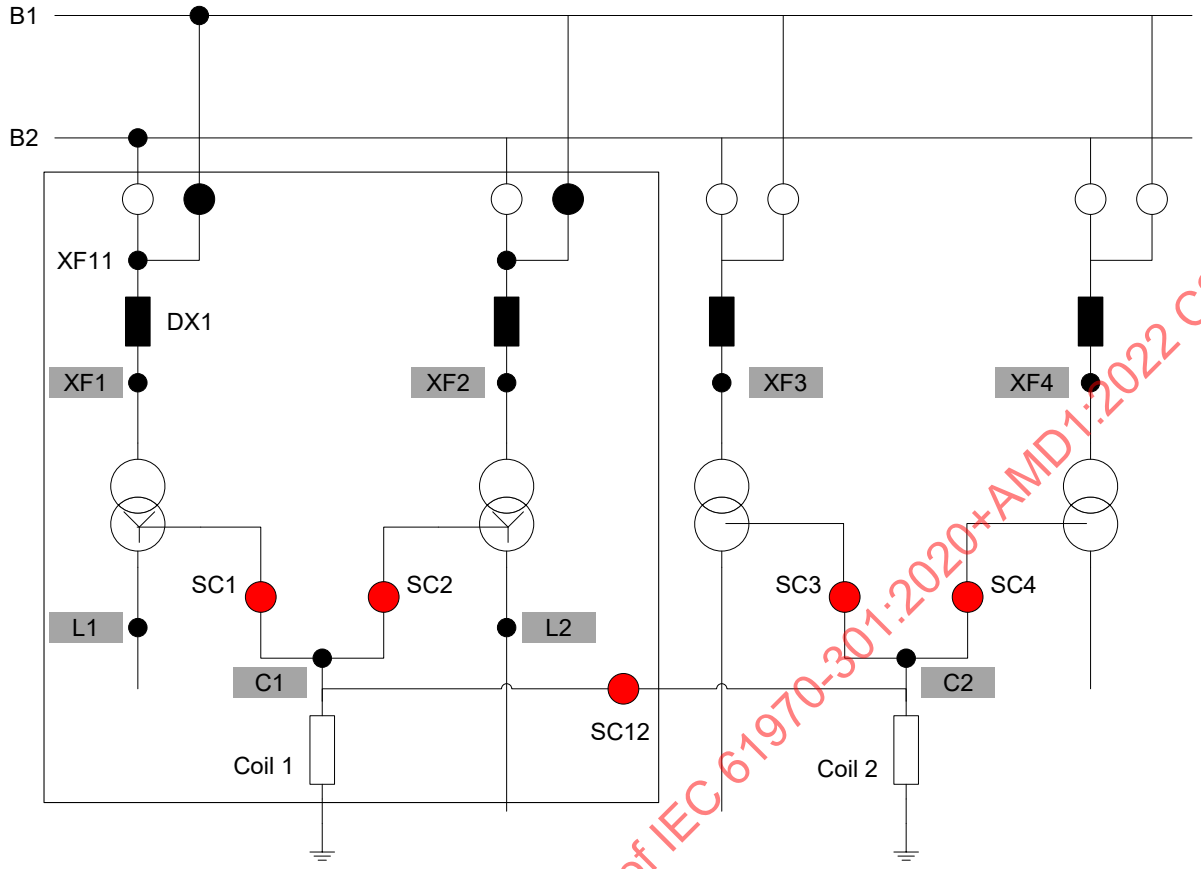


Figure 28 – Station including Petersen coils drawing example

In the example above, SC1, SC2, SC3, SC4 and SC12 are the ground circuit disconnectors. B1 and B2 are bus bar sections. XF1, XF2, XF3, XF4, C1, C2, L1 and L2 are connectivity nodes.

The grounding point in a transformer is the midpoint of the Y-connected windings and the ground circuit disconnectors are connected to these midpoints. In CIM the midpoint is described by the phasing attribute of the Terminal at the Y-connected windings. This means that ground circuit switches are connected to the connectivity node at the Terminal with the Y-connected windings. In Figure 28 this means SC1 is connected to L1 and SC2 is connected to L2 and that L1/L2 has the phases ABC as well as the N phase for the midpoint.

4.5.9.3 CIM instance model example

The PetersenCoil that was depicted previously in Figure 28 is shown in Figure 29 modelled with only one terminal and implicit grounding.

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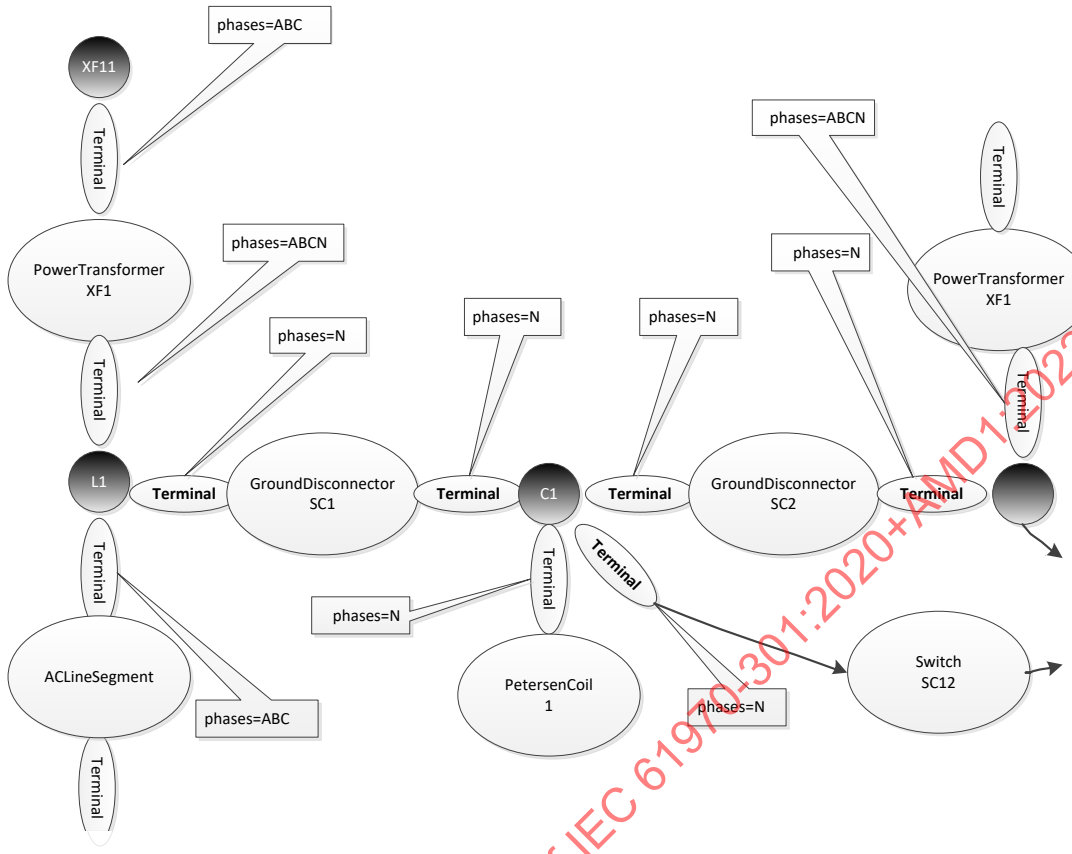


Figure 29 – Instance diagram objects with one terminal coil

Figure 29 shows how the ground disconnector SC1 has a Terminal with N phase and the transformer Terminal connected to L1 has the phases ABCN.

4.5.10 Cuts, clamps and jumpers model

The UML model for cuts and jumpers on a line segment and the additional connections are described in Figure 30. The Jumper class is a specialization of the more general Switch class and provides for phase crossings and phase connectivity as was illustrated in Figure 26. The jumpers therefore can connect terminals in the normal manner. The CIM classes Cut and Clamp provide a means to effectively add Terminals to an ACLineSegment at a specified distance down the line by associating new CIM objects to an ACLineSegment object, without other modification of ACLineSegment as-built model. Each Clamp instance introduces one new terminal connected at the specified distance down the line and without interruption of the line. Each Cut instance introduces two new terminals which are effectively the ends of the cut. By convention, each terminal of a cut is oriented toward the ACLineSegment terminal with the same sequenceNumber. If the cut is open, no flow passes through the ACLineSegment across the point of the cut, but flow can pass through either side of the ACLineSegment and through the appropriate cut terminal. Commonly, jumpers are connected to the ends of cuts, but they can also be connected to any type of conducting equipment in the normal manner using ConnectivityNode or TopologicalNode.

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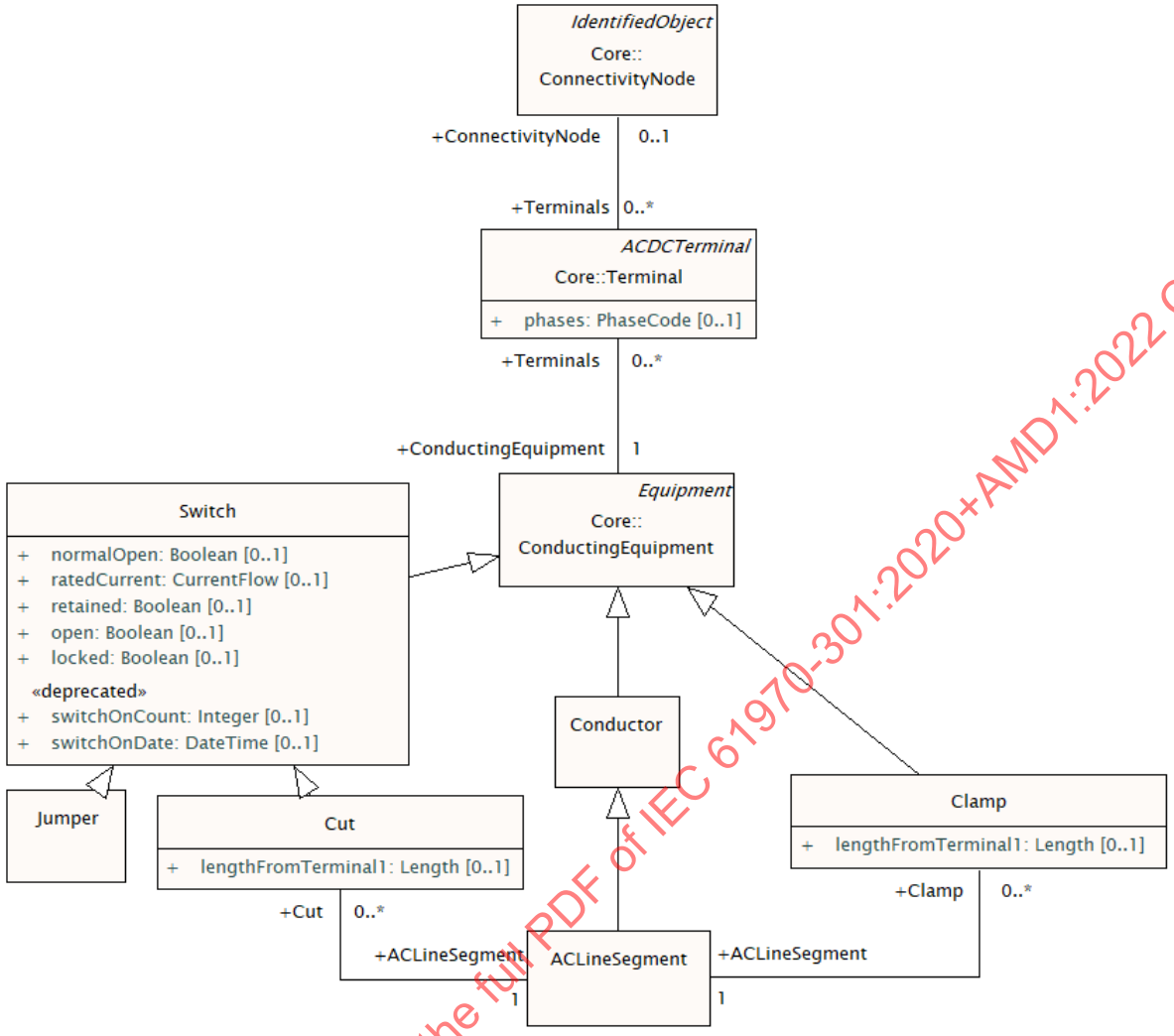


Figure 30 – Cuts, clamps, and jumpers UML model

An example of the addition of cuts and clamps to an existing CIM model is illustrated in Figure 31 and Figure 32. Figure 31 shows two physically parallel line segments named “FRED” and “LEROY”. In this example the system is energized from the right, the switch on the left is closed, and the loads named “ONE” and “TWO” are being supplied. Then the three faults are applied at the specified distances from Terminal 1 of the respective line segments. In this example the phase detail is not specified for simplicity, but phase detail can follow the same approach outlined in 4.5.8.

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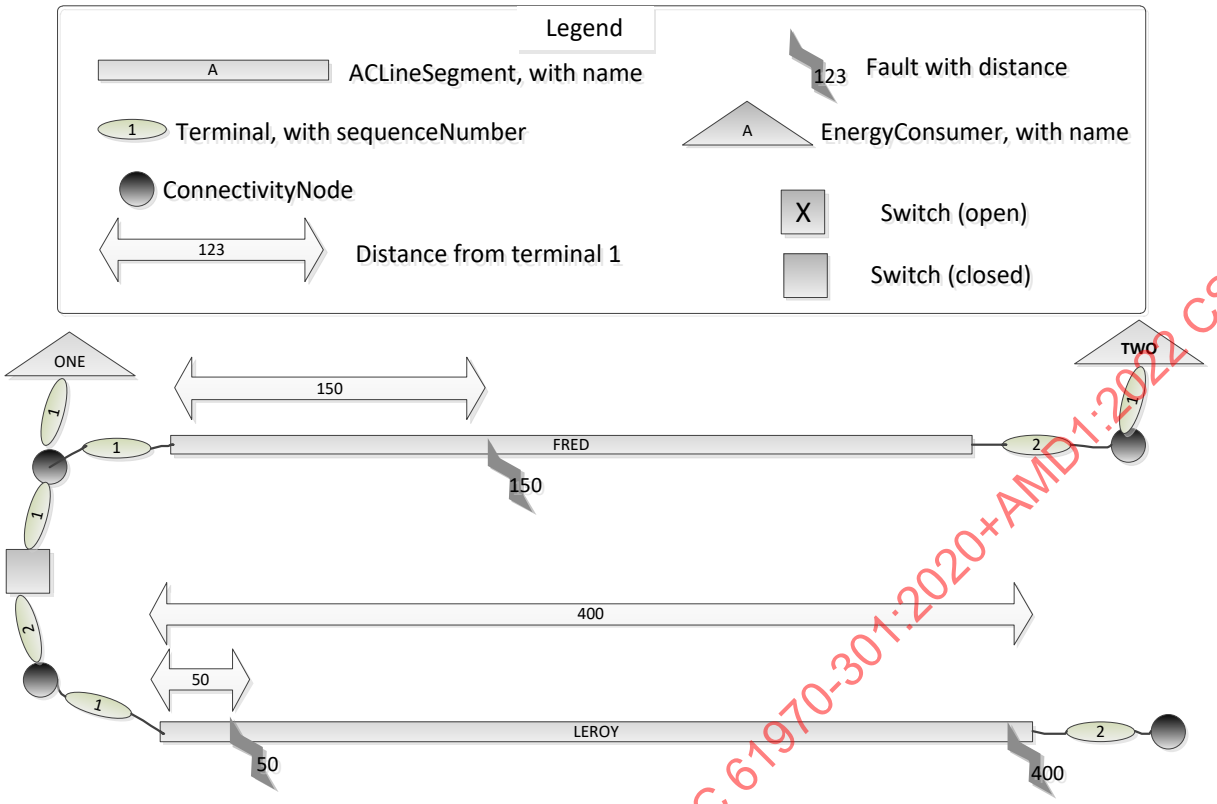


Figure 31 – Example before cuts and jumpers are applied

Figure 32 shows how the pure addition of Cut, ConnectivityNode, Jumper, Clamp and potentially other Conducting Equipment can represent model changes reflecting typical temporary work. These same models can also be used for permanent model changes. The example shows how cuts applied at the specified distances can isolate the faults, leaving the faulted ends of cuts dangling, while the remaining network is connected to supply the loads. This example also demonstrates how multiple cuts can be applied to one line segment. This example shows open cuts, but if a cut were closed, flow could continue through the ACLineSegment with part of the flow potentially redirected to the terminals of the cut, much like the case for a clamp.

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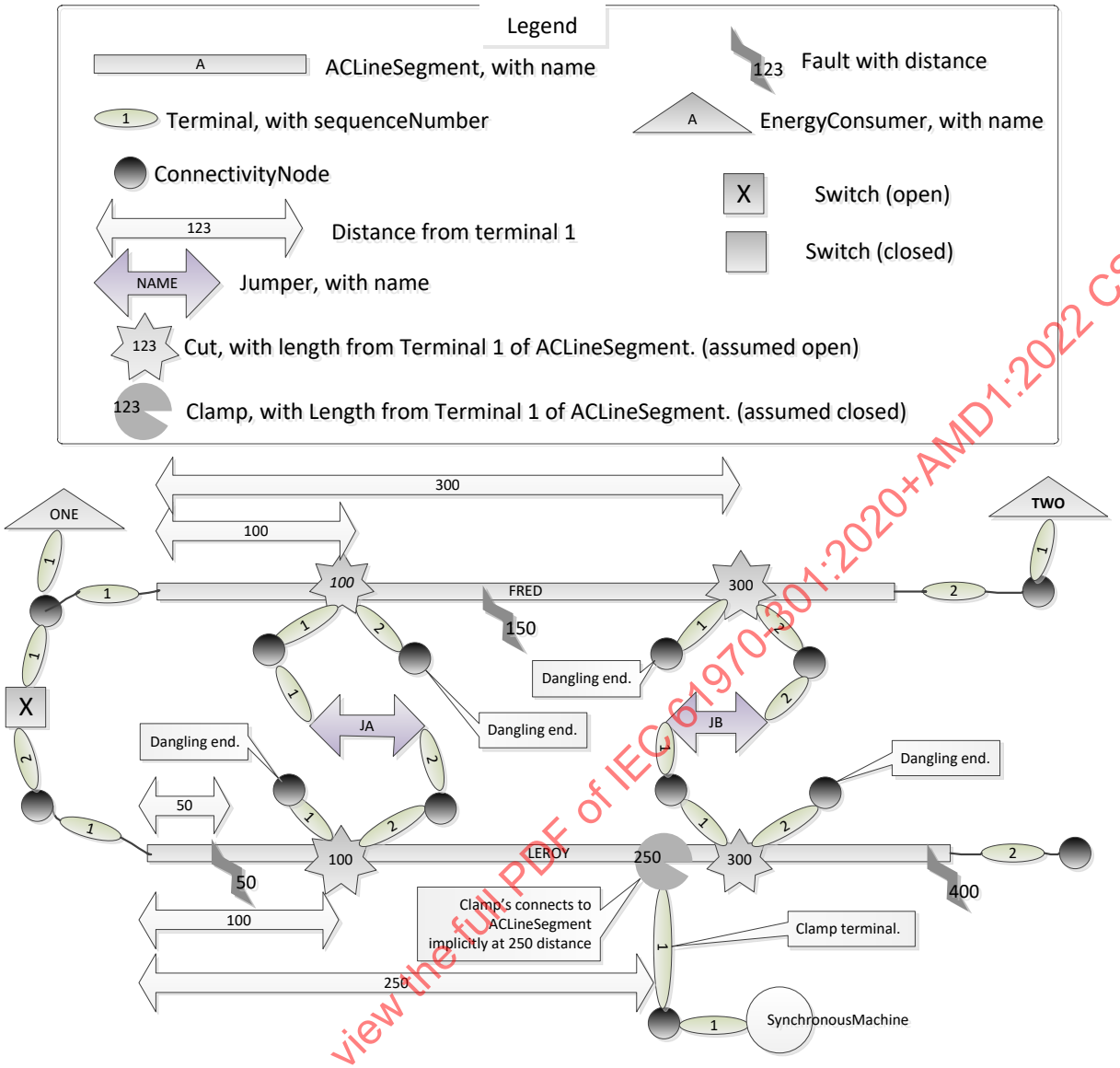


Figure 32 – Example after cuts and jumpers are applied

A cut provides two terminals, and although not shown in the example above, connections could be made to either or both terminals of the cut. An example case might involve introducing a cut and connecting both cut terminals with a jumper that crosses phases.

A jumper may be used without clamps or cuts in a situation where existing terminals are to be connected. Figure 33 shows an example of using a jumper without a cut or clamp. In this case a temporary jumper might be used to bypass a switch under maintenance.

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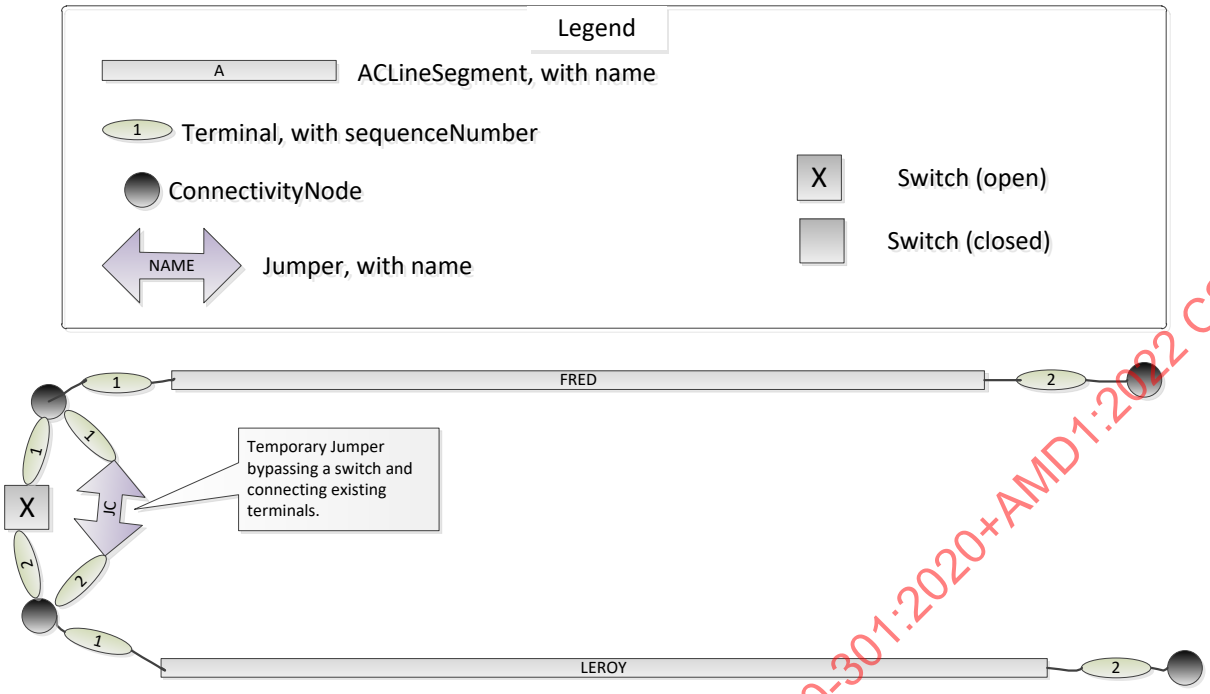


Figure 33 – Example of jumper without cut or clamp

4.5.11 Measurements and controls

4.5.11.1 Measurement overview

Measurements are used to represent the state variables that can be found in industrial processes. Each industrial process has its specific types of measurements. A power system typically has power flows, voltages, positions (e.g. breakers, isolators), fault indications (air pressure, oil pressure over temperature, etc.), counters (e.g. energy), etc.

The name "Measurement" would seem to indicate that all the state variables are measured. This is not always strictly the case as many measurements are calculated by SCADA or EMS/DMS functions, such as state estimator or power flow calculations. As a consequence, a measurement may have several alternate values (e.g. manually supplied, telemetered, state estimated, optimized etc.). This is supported by the Measurement and MeasurementValue models in the Meas package. The classes in the StateVariables package have been added to the CIM model specifically for the purpose of supporting exchange of values calculated by functions such as state estimator and power flow.

The measurement model now allows for optionally specifying the specific phases of a measurement.

4.5.11.2 Control overview

Controls are used to represent control variables. Power system control variables typically are set points, raise/lower commands, select before execute commands and on/off commands. The Meas package supports control variables with the Control model.

4.5.11.3 Use of measurement-related classes

A PowerSystemResource (PSR) may have zero to many measurements associated with it by containing one or more measurements. Each measurement may have one or more measurement values. Observing the following guidelines will enable applications to navigate and find the required measurement values in a consistent way (see Figure 34):

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a) Measurements of a PowerSystemResource are classified by the attribute measurementType. The values to be used for Measurement.measurementType are specified in Table 6.

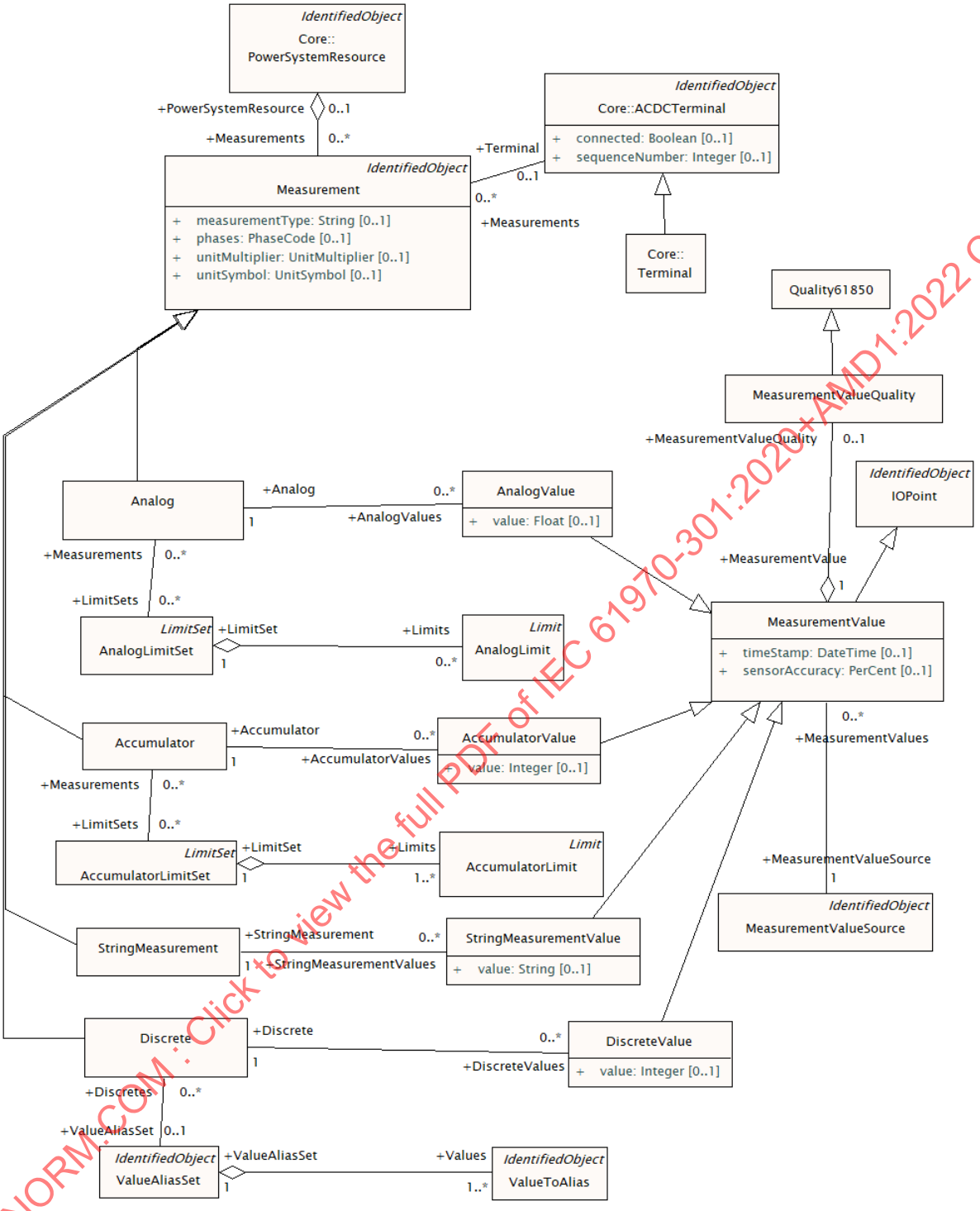
b) MeasurementValues of a Measurement are classified by MeasurementValueSource.

c) MeasurementValueSource inherits from IdentifiedObject. The values to be used for MeasurementValueSource.name are given in Table 7. This table provides several source names to be used where possible. However, the exact names to be used for specific applications are defined in related IEC 61970 Component Interface Specifications (CIS).

d) The tables may be extended for proprietary needs. The names added shall start with a unique name (e.g. the company name) and an underscore. Example: xyz_AverageTemperature.

e) The ValueAliasSet is used for discrete measurements and describes mappings from values to symbolic names, such as enumeration literals having specific integer values. Different communication protocols (e.g. for RTUs and for control centres such as ICCP or ELCOM) use different data encodings. A system may have a system wide mapping for all Discrete values or group the Discrete values and make a mapping per group. Creation of a single system wide mapping that covers existing communication protocols is outside the scope of this document.

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Figure 34 – Navigating from PSR to MeasurementValue

Table 6 – measurementType naming conventions

measurementType	61850 Name	description
Current	Amp	Current (rms) of a non-three phase circuit
ThreePhaseCurrent	AvAmps	Total current (rms) in a three phase circuit
PhaseCurrent	A	Measured phase current.
Frequency	Hz	Frequency
PowerFactor	PwrFact	Power factor not allocated to a phase
ThreePhasePowerFactor	TotPF	Average power factor in a three phase circuit
ThreePhaseApparentPower	TotVA	Total apparent power in a three phase circuit
ThreePhaseReactivePower	TotVAr	Total reactive power in a three phase circuit
ThreePhaseActivePower	TotW	Total real power in a three phase circuit.
ApparentPower	VolAmp	Apparent power in a non-three phase circuit
ReactivePower	VolAmpr	Reactive power in a non-three phase circuit
Voltage	Vol	Voltage (rms) not allocated to a phase
ActivePower	Watt	Real power in a non-three phase circuit
Pressure	Pres	Pressure
Temperature	Tmp	Temperature
Angle	Ang	Angle between voltage and current
ApparentEnergy	TotVAh	Apparent energy
ReactiveEnergy	TotVArh	Reactive energy
ActiveEnergy	TotWh	Real energy
Automatic	Auto	Automatic operation (not manual)
LocalOperation	Loc	Local operation (not remote)
SwitchPosition	Pos	Switch position [2bits= intermediate,open,closed,ignore]
TapPosition	TapPos	Tap position of power transformer or phaseshifter
Operation Count	OperCnt	Operation count – typically for switches
LineToNeutralVoltage		Line to neutral voltage.
LineToGroundVoltage		Line to ground voltage.
Specialization		Used when a specialization of the Analog class defines the type of measurement rather than the Measurement.measurementType attribute.

Table 6 describes various types of measurements also defined in IEC 61850. The meanings of the columns in Table 6 are as follows:

- measurementType (Measurement.measurementType) is the IEC 61970 measurement type name.
- 61850 Name is the name assigned to the data object in IEC 61850. IEC 61850-7-4:2010, data object name semantics).
- description is the description of the data.

It shall be noted that Table 6 is not an exhaustive list and that the mapping between measurements as defined in a control centre and a substation is non-trivial.

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Table 7 – MeasurementValueSource naming conventions

Name	description
SCADA	Telemetered values received from a local SCADA system
CCLink	Value received from a remote control centre via TASE.2 or other control centre protocol
Operator	Operator entered value (always manually maintained, PSR is not connected to an RTU)
Estimated	Value updated by a state estimator
PowerFlow	Value updated as result of a Powerflow
Forecasted	Value that is planned or forecasted.
Calculated	Calculated from other measurement values (e.g. a sum)
Allocated	Calculated by a load allocator

Following these conventions:

- each Measurement instance represents a technological quantity of a PowerSystemResource;
- each MeasurementValue of a Measurement represents a value for the technological quantity, as supplied from a single source;
- the source attribute in MeasurementValueQuality then indicates whether the source actually provided the current value, or whether it had been substituted or defaulted.

Note that a new MeasurementValue identity is not normally created for each exchange of a measured value. It is expected that the same MeasurementValue instance could exchange new values in subsequent messages. Therefore the identity of a MeasurementValue instance can be established apriori to exchange of measured values. The modelling of a time series of values is not explicitly expressed in the CIM model, though the model allows for systems to internally build such time series models through a series of measurement value exchanges.

4.5.11.4 Attachment of measurements

As mentioned in 4.5.11.3 and as shown in Figure 34, Measurements are contained by a PowerSystemResource. This is sufficient for Measurements that are not related to connectivity, e.g. temperature, weight, size.

To specify the location of a Measurement in the network, an association to Terminal is used. Examples include power flows, voltages, and currents. Voltages have no direction and can be attached wherever appropriate in relation to the sensor placement. Flows have direction and shall be attached such that the flow direction is evident from the placement.

Figure 35 shows two examples of the placement of Measurements.

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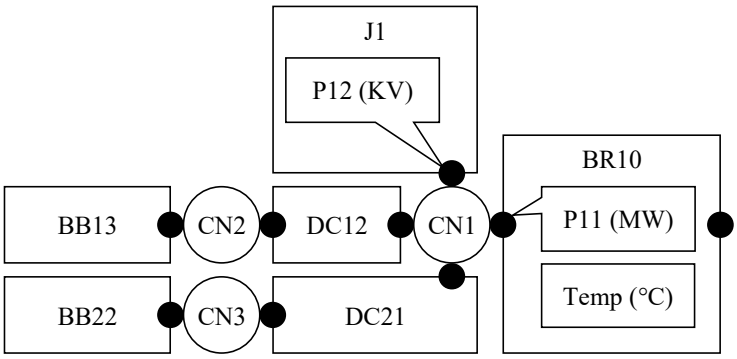


Figure 35 – Measurement placement

P12 is a voltage Measurement that measures the voltage at the Junction J1. P12 is topologically related to the ConnectivityNode CN1 via the Terminal in Junction J1. P11 is a Measurement that measures the flow through Breaker BR10 at the side connected to the ConnectivityNode CN1. P11 is topologically related to the ConnectivityNode CN1 via the left Terminal in Breaker BR10. Temp is a Measurement that measures the Breaker temperature. As a temperature is not related to connectivity, it has no relation to a Terminal – it just belongs to the Breaker BR10.

4.5.12 Regulating control models

Regulation control, such as automatic voltage control at generators or voltage tap control at transformers is modelled using the RegulatingControl class which provides the capability to model multiple instances of equipment participating in a regulation scheme. These regulation schemes may be physical or manually implemented in actual power system operation but are reflected in the models used for power system analysis purposes. Figure 36 shows how RegulatingCondEq and TapChanger classes can participate in regulation.

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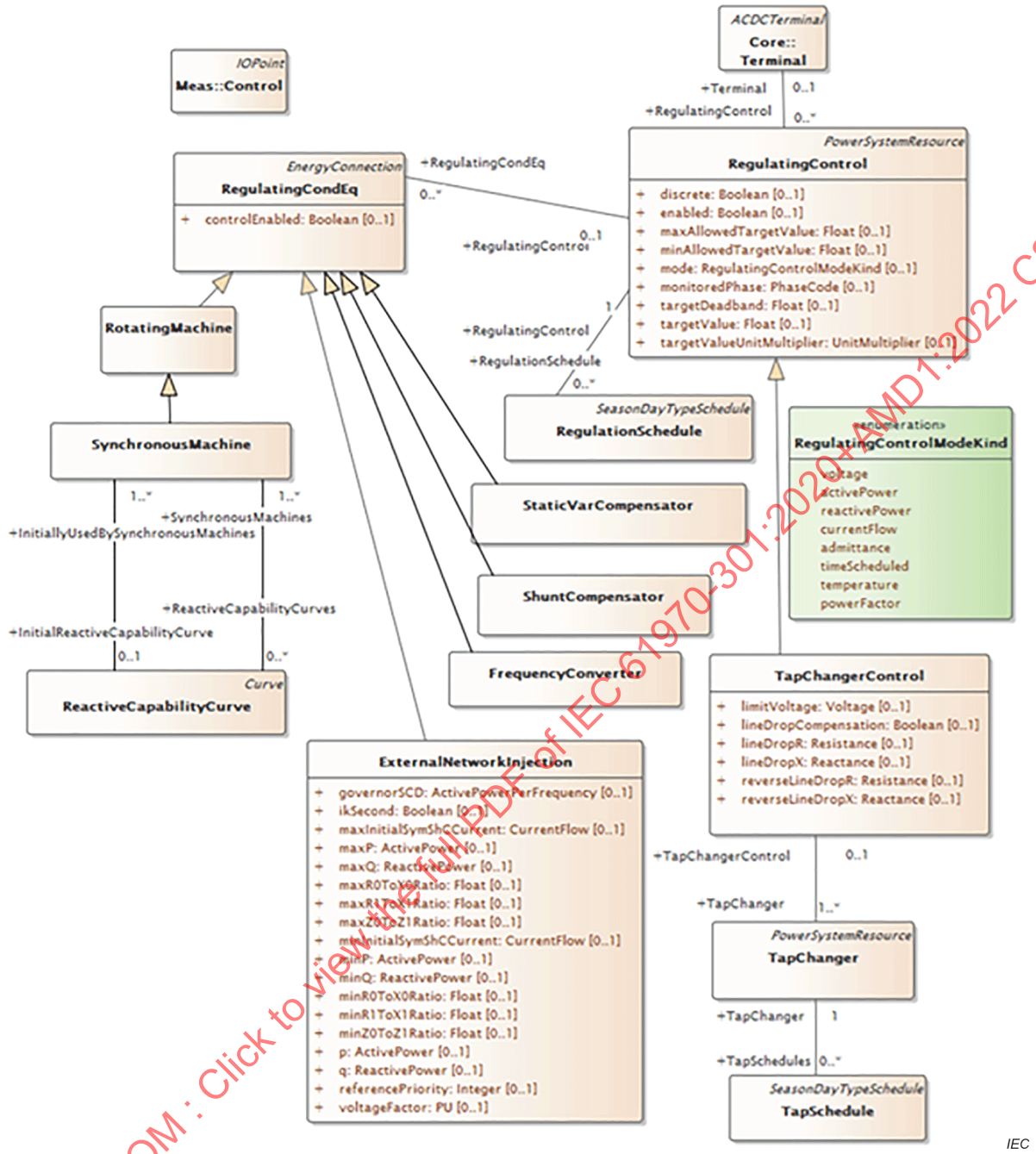


Figure 36 – Regulating control models

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4.5.13 DC model for CIM

4.5.13.1 Introduction

4.5.13.1.1 General

Control systems modelling HVDC interconnection typically have three levels of detail in terms of modelling:

- Simplified injection model not using the CIM DC package.
- Detailed HVDC model using the CIM DC package and fictitious HVDC substations.
- Detailed HVDC model using the CIM DC package and no fictitious HVDC substations.

The purpose of this document is to outline the most minimal HVDC model possible for use in SCADA/EMS/planning power flow, short circuit calculations and dynamic studies. Transient studies are not covered.

The following general rules are defined:

- The flow through a DC pole relate to the Point of Common Coupling (PCC) at the ends of a pole. This means that PCC is always on the AC side.
- Detailed HVDC model using the CIM DC package and no fictitious HVDC substations is the preferred modelling as it corresponds to how substations are built, and equipment named
- Rules for switching of AC filters for LCCs are not supported by the standard.
- The converter transformer typically connects to switches located in a VoltageLevel where the AC network connects.
- The filters are typically located in the VoltageLevel where converter transformer connects.
- No TapChangerControl is used for the converter transformer, the control function is described in the ACDCConverter-s.
- The terminal at the HV side of the converter transformer, closest to the AC network, shall be associated with the Boundary Point/Connection point with the other MAS.
- The converter transformer and every ACDCConverter instance, belonging to the same substation pole, as well as all converter control equipment, essential protective and switching devices and auxiliaries, if any, used for conversion, shall be contained in the same cim:DCConverterUnit container instance. This also applies to shunts and series compensators at the LV side of the converter transformer and the DC smoothing reactors.
- In case of back-to-back installations two separate DCConverterUnit instances are used, each associated with one converter transformer.
- All HVDC overhead lines and cables, connecting two or more substations, shall be contained in the same DCLine container for every HVDC system pole.

4.5.13.1.2 Simplified Injection Model

The simplified injection model illustrated in Figure 37 connects the real substations at each ends of the DC pole with a Line that has two boundary ConnectivityNodes (CNs) or TopologicalNodes in case of bus-branch model representation, one for each DC pole end. The CNs are also the Point of Common Coupling (PCC) for each side. The real substations connect to the boundary CN/PCC with a ACLineSegment (ACLS) and an EquivalentInjection (EI).

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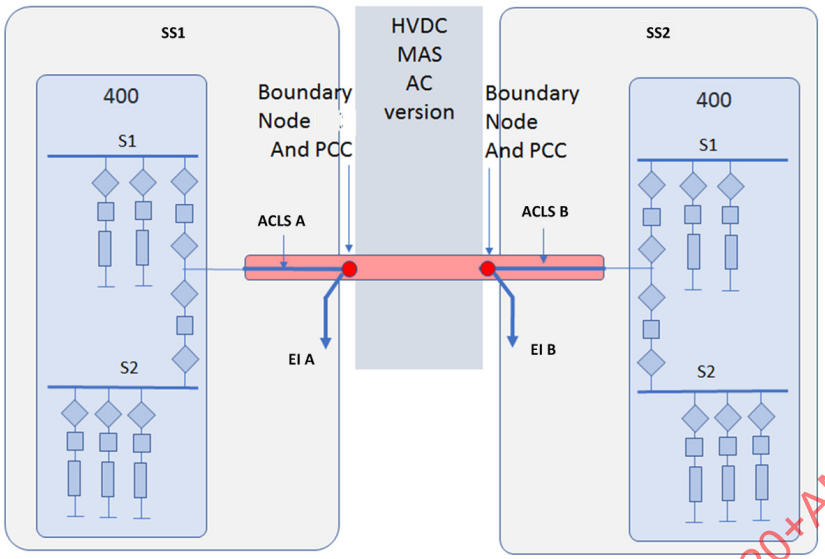


Figure 37 – Simplified example of HVDC model representation

Blue colours in Figure 37 represent objects in a regular MAS and red objects in a boundary MAS.

The ACLS "A", EI "A", ACLS "B" and EI "B" are at the PCCs at each side of the DC pole. The PCCs are the boundary nodes or connection points agreed between the parties responsible for the MAS of SS1 and SS2.

For a current source converter the reactive power is set to zero assuming that the AC filters keep the reactive consumption around zero. If the AC substation models the AC filters, then the reactive power consumption of the LCC shall be considered. The reactive consumption can normally be approximated by a reactive power demand equal to approx. 0.45-0.55 of the absolute value of the active power transfer. When substituting the HVDC poles by an internal representation featuring two "simplified HVDC injection models", and the power transfer is changed the reactive power may stay at the same value. This will ease power flow solution and not requiring switching of AC filters.

For voltage source converters reactive power control capabilities can be described by setting the attributes EquivalentInjection.regulationCapability and regulatingStatus to true. The limits minQ and maxQ or associated ReactiveCapabilityCurve shall reflect the reactive capability range if regulatingStatus is true.

4.5.13.1.3 Detailed HVDC model using the CIM DC package and fictitious HVDC substations

A detailed model contains the following parts:

- The real substations at each side of the connection.
- The same boundary as in the simplified model as in all cases the HVDC links have two boundary/connection points, see 4.5.13.1.2.
- For each real substation a fictitious substation that represents the HVDC part and connects to the boundary PCCs at each DC pole end.

Figure 38 shows a HVDC connection as a detailed model.

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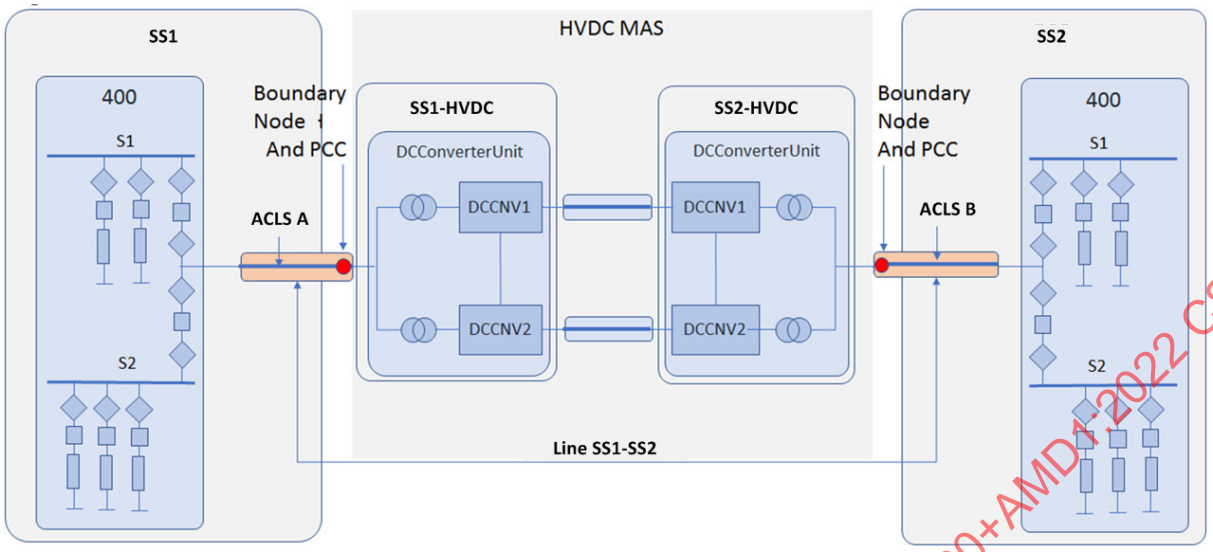


Figure 38 – Detailed example of HVDC model representation with fictitious HVDC substations

Blue colours in Figure 38 represent objects in a regular MAS and red objects in the boundary.

The SS1 and SS2 substations are the real ones, SS1-HVDC and SS2-HVDC are the fictitious with the HVDC equipment. “SS1-SS2” is the boundary Line with the two boundary CNs/PCCs that connect with the DC poles.

To convert a detailed model to simplified model the fictitious HVDC substations are removed and the EIs at the PCCs are inserted.

4.5.13.1.4 Detailed HVDC model using the CIM DC package and no fictitious HVDC substations

The preferred HVDC model is with all components in the real substation without fictitious substations or boundary Lines as shown in Figure 39.

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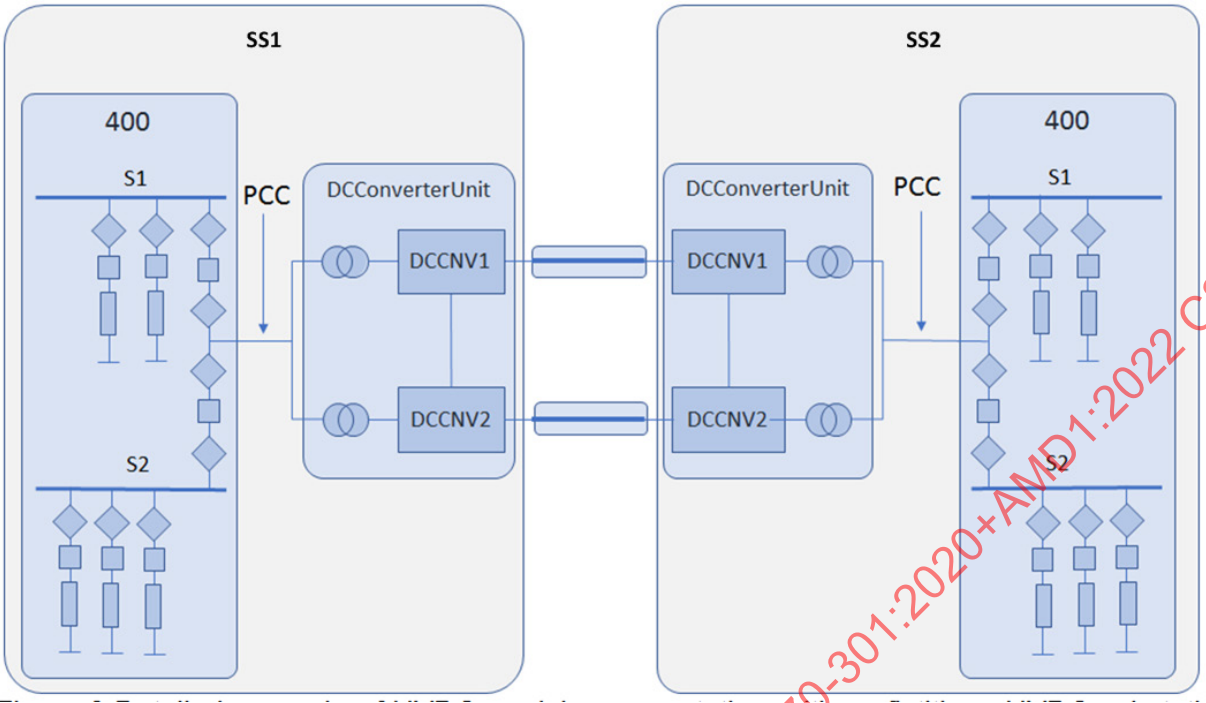


Figure 39 – Detailed example of HVDC model representation with no fictitious HVDC substations

A boundary point within a substation is defined at the PCC arrows in Figure 39.

A detailed HVDC model using the CIM DC package and no fictitious HVDC substations cannot easily be converted to a simplified model and must first be changed to a detailed HVDC model using the CIM DC package and fictitious HVDC substations model before it can be converted.

4.5.13.2 HVDC basic design

4.5.13.2.1 General

The proposed model is based on the following documents:

- IEC 60633:1998+AMD1:2009, *Terminology for high-voltage direct current (HVDC) transmission.*
- ”VSC Transmission”, CIGRÉ B4-37 April 2005
- IEC 62747, *Terminology for voltage-sourced converters (VSC) for high-voltage direct current (HVDC) systems*
- HVDC Transmission by Dennis A. Woodford, Manitoba HVDC Research Centre.
- “ABB technical description of HVDC light technology”
- Flexible Power Transmission. Jos Arrillaga, Y. H. Liu, Neville R. Watson, 2007
- ”Power System Stability Benefits with VSC DC-Transmission Systems”, CIGRÉ B4-204, 2004

4.5.13.2.2 CSC Topology

A current source HVDC link is modelled as shown in Figure 40.

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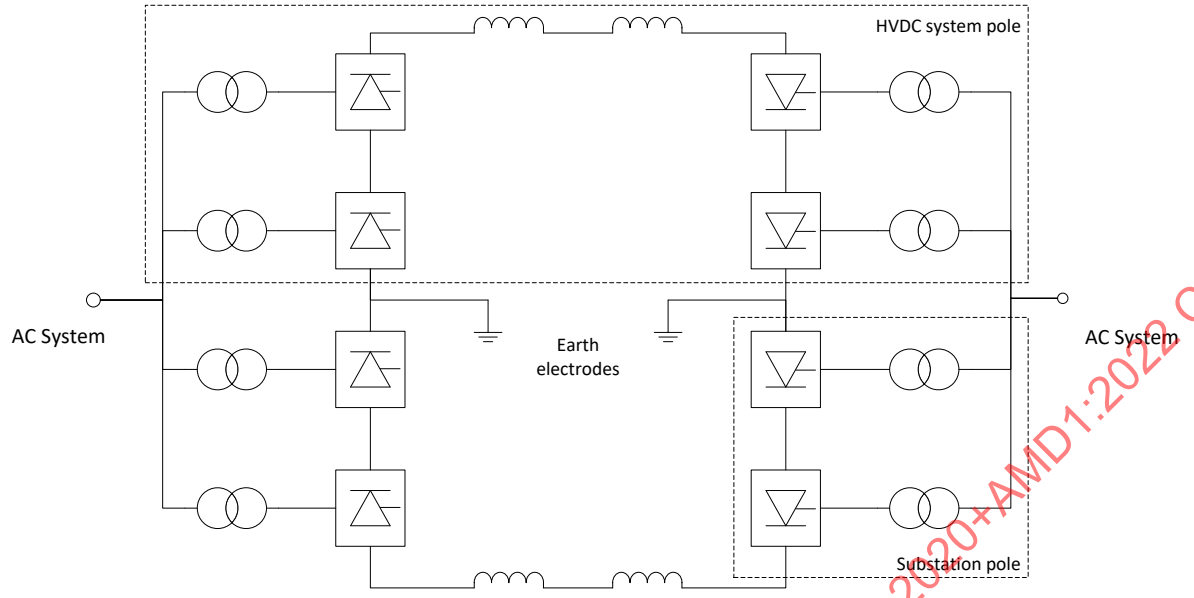


Figure 40 – HVDC bi-polar link from IEC 60633

HVDC Bipolar link consists of two poles, one with positive polarity and another with negative polarity having both their natural points grounded. No current flows in the ground return because the current flowing in the poles is the same. For a CSC HVDC, the transformer shall be modelled explicitly.

4.5.13.2.3 VSC Topology

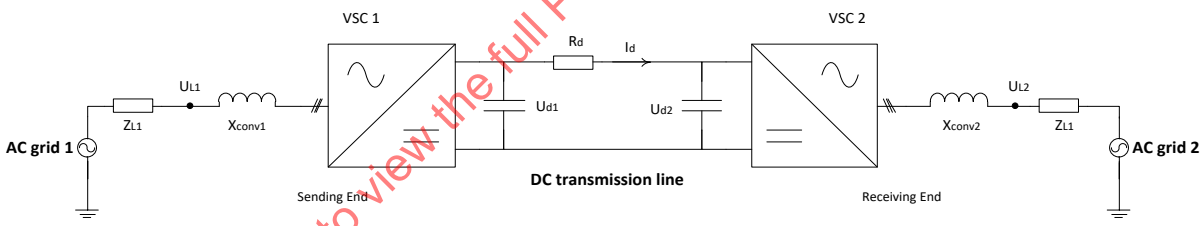


Figure 41 – A point-to-point VSC transmission scheme

The point-to-point VSC transmission scheme shown in Figure 41 consists of two VSCs interconnected on the DC side via a DC transmission line and connected to two different AC systems on the AC side. One of VSC characteristics is that the DC voltage polarity is always the same. Therefore, the direction of the power flow on the DC line is determined by the direction of the DC current.

The direction of a DC current is always from a higher DC voltage level to a lower DC voltage level. The DC voltage at the sending end of the DC line shall therefore be higher than DC voltage at the receiving end.

In line-commutated converter (LCC) HVDC, the DC line power flow can be controlled by holding the DC voltage at the receiving end converter (the inverter) at a constant value, and by letting the sending end converter (the rectifier) control the DC current. The same approach can be used in VSC transmission. However, one main difference is that in LCC HVDC the current direction is always the same; therefore, the power direction is changed by changing the DC voltage polarity.

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4.5.13.3 HVDC power flow modelling

4.5.13.3.1 General

A power flow model derived from Figure 41 is shown in Figure 42.

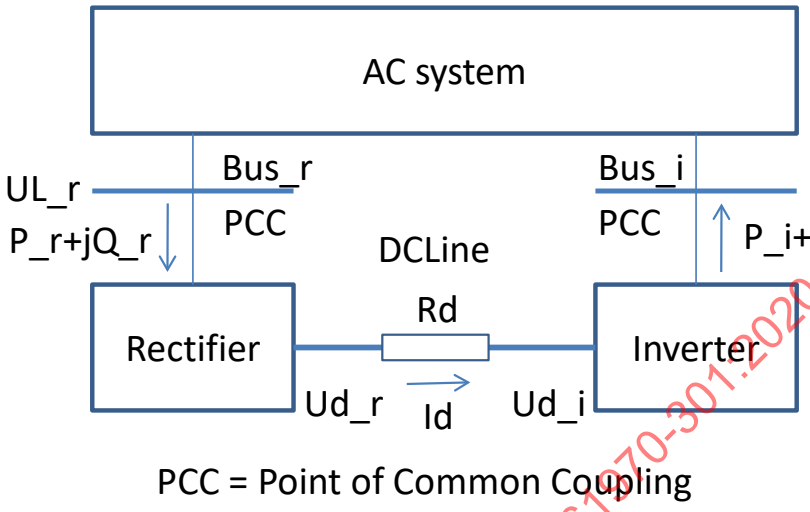


Figure 42 – HVDC power flow model

The AC side variables are as follows:

- P is the AC side active power injection at the rectifier (index r) and inverter (index i).
- Q is the AC side reactive power injection at the rectifier (index r) and inverter (index i).
- U_{L} is the AC side voltage at the rectifier (index r) and inverter (index i).

The DC side variables are as follows:

- U_{d} is the DC voltage at the rectifier (index r) and inverter (index i).
- U_{dN} is the rated DC voltage
- I_{d} is the DC line current
- I_{dN} is rated DC line current
- R_{d} is the DC line resistance

The interface between the HVDC system and the AC system are the two busses Bus_r and Bus_i. The voltage at Bus_r is $U_{\mathrm{L_r}}$ and the voltage at Bus_i is $U_{\mathrm{L_i}}$. Power injected into the Rectifier from the AC system is $P_{\mathrm{r}} + jQ_{\mathrm{r}}$ and power injected into the Inverter is $P_i + jQ_{\mathrm{i}}$. The busses Bus_r and Bus_i are from the AC system seen as PQ nodes for current source HVDC and PV nodes for voltage source HVDC. For PQ nodes the injections $P_{\mathrm{r}} + jQ_{\mathrm{r}}$ and $P_{\mathrm{i}} + jQ_{\mathrm{i}}$ and for PV nodes the active power injection and voltage $P_{\mathrm{r}}, UL_{\mathrm{r}}$ and $P_{\mathrm{i}}, UL_{\mathrm{i}}$ are computed from the HVDC link. Initial conditions for the HVDC link are given in two ways:

- P_{r} or P_{i}
- $U_{\mathrm{d_r}}$ or $U_{\mathrm{d_i}}$

The relation between the variables are $I_{\mathrm{d}} = P_{\mathrm{r}}/U_{\mathrm{d_r}} = P_{\mathrm{i}}/U_{\mathrm{d}_i}$.

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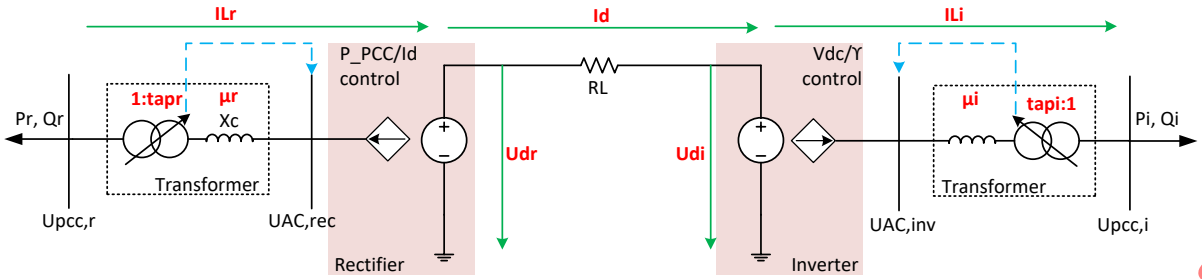


Figure 43 – Detailed HVDC power flow model

The active power and the reactive power at PCCs are derived, for lossless converters, via the following equations:

- $P_{\mathrm{r}} = U_{\mathrm{dr}} * I_{\mathrm{d}}$
- $Q_{\mathrm{r}} = U_{\mathrm{d0r}} * I_{\mathrm{d}} * \frac{\sin 2\alpha - \sin 2(\alpha - \mu_r) + 2\mu_r}{4 * (\cos\alpha - \cos(\alpha + \mu_r))}$
- $P_i = -U_{\mathrm{di}} * I_{\mathrm{d}}$
- $Q_i = U_{\mathrm{d0}i} * I_{\mathrm{d}} * \frac{\sin 2\gamma - \sin 2(\gamma - \mu_r) + 2\mu_r}{4 * (\cos\gamma - \cos(\gamma + \mu_r))}$

The power flow is illustrated in Figure 44 and Figure 45.

4.5.13.3.2 Current Source Converter (CSC)

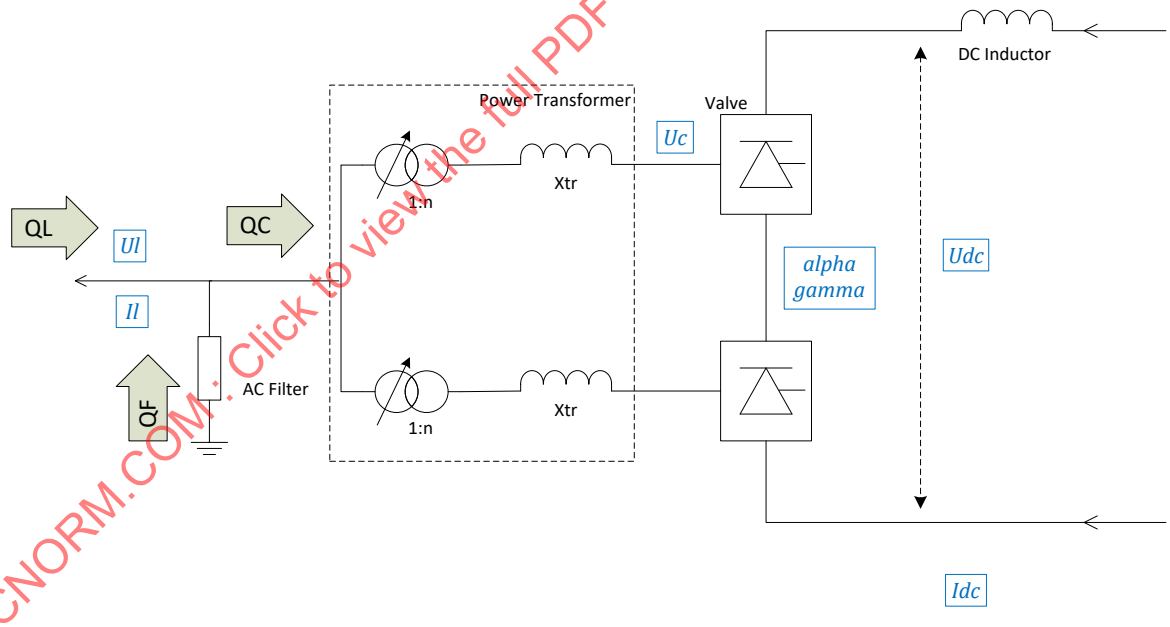


Figure 44 – Current Source Converter power flow

In a current source converter the reactive power is not controlled. Instead it is determined by the bridge firing angle that impacts the power factor. CSC equations require commutation reactance, tap changer and firing angle cascaded control. The commutation reactance for the CsConverters is based on the PowerTransformer which belongs to the DcConverterUnit, i.e. the impedance from converter transformer is used as Xc. The tap changer control for firing angle adjustment used also the tap changer data from the converter transformer. In case of shared tap changer in 2x6-pulse bridge configurations (3-winding converter transformer) the 6-pulse bridges shall be controlled in master/slave.

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The following equations shall be considered:

- $U_{\mathrm{d}} = U_{\mathrm{d0}} * \cos\alpha - \left(\frac{3}{\pi}\right) * X_{\mathrm{tr}} * I_{\mathrm{d}} * B$ or $U_{\mathrm{d}} = U_{\mathrm{d0}} * \cos\gamma - \left(\frac{3}{\pi}\right) * X_{\mathrm{tr}} * I_{\mathrm{d}} * B$
- $\varphi \approx cos^{-1}\left(\frac{V_d}{V_{d0}}\right)$
- $P = V_{\mathrm{d}} * I_{\mathrm{d}} = P_{\mathrm{ac}}$
- $Q = P * tan\varphi$
- the rated direct voltage: $U_{\mathrm{d0}} = ((3 * \sqrt{2})/\pi) * U_{\mathrm{C}} * B * T$
- $U_{\mathrm{t}} = U_{\mathrm{L}} * tapratio$

The approximation of reactive power injection could be presented in the following way:

- $Q_{\mathrm{L}} = Q_{\mathrm{C}} - Q_{\mathrm{F}} = \left(\frac{P}{2}\right) - Q_{\mathrm{F}} \approx \frac{P}{2}$

where:

- α – firing angle
- B – number of bridges in series
- T – transformer turns ratio
- I_{d}, V_{d} – direct current and voltage per pole

4.5.13.3.3 Voltage Source Converter

The electrical components and their interconnections within a converter are shown in Figure 45. Figure 45 is the reference for the formulas in 4.5.13.3.

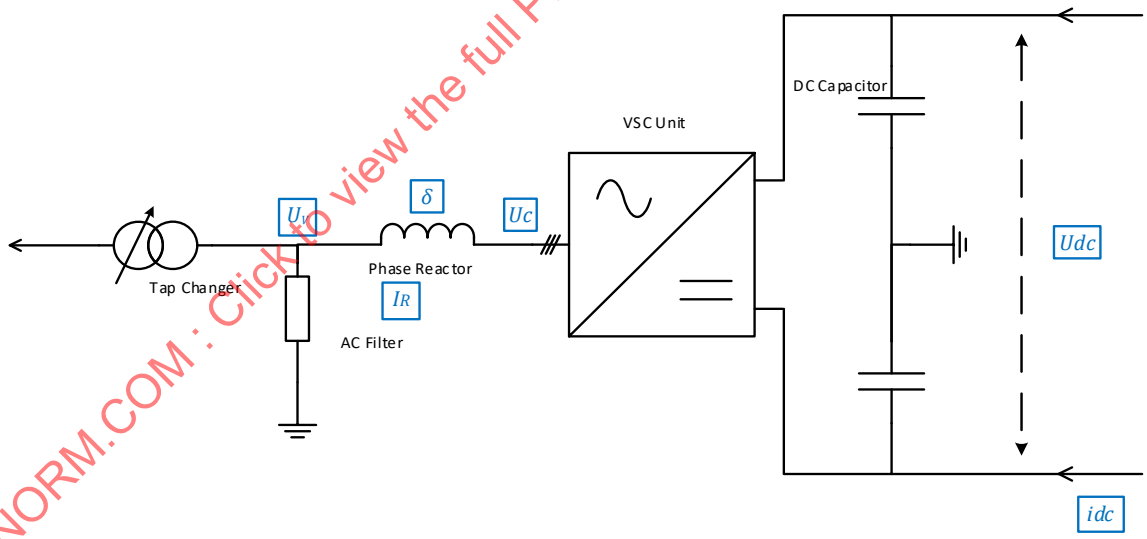


Figure 45 – Voltage Source Converter power flow

Additional parameters to those previously listed are as follows:

- U_{dc} is the voltage at the DC side of the VSC Unit.
- I_{dc} is the current at the DC side of the VSC Unit.
- U_{C} is the voltage at the AC side of the VSC Unit, also called converter voltage
- U_{V} is the voltage at the filter bus.
- modulation index is the ratio between U_{dc} and U_{C}, this is a VSC parameter and has typical values between 0 and 1.

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- I_R is the current through the phase reactor.
- X_C is the phase reactor reactance.
- δ is the angle between the U_V and U_C voltages.

The diagrams in Figure 46 show the voltage vectors and the resulting power flow cases.

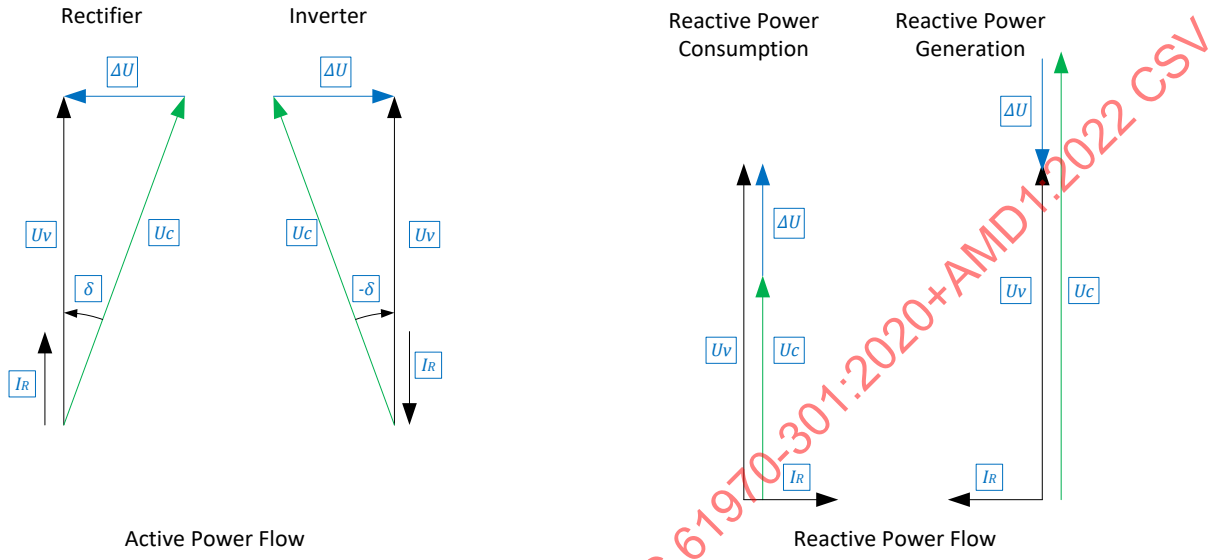


Figure 46 – Power flow cases

The behaviour of the Rectifier and Inverter can be described by a set of formulas having the following parameters, some of which are shown in Figure 42 and Figure 45.

- U_{rated} is the converter rated AC voltage (one each for rectifier and inverter).
- S_{rated} is the converter rated AC power.
- R_C is the phase reactor resistance
- number of converter bridges (one each for rectifier and inverter)
- I_{dmax} and I_{dmin} are the DC flow upper and lower limits.
- R_d is the DC line resistance.
- The active and reactive components (refer to Figure 46) are computed as $P = U_V * U_C * (\sin(\delta)/X_C)$
- $Q = U_V * (U_V - U_C) * (\cos(\delta)/X_C)$

The losses at a pole are described by the equation:

- $P(poleLoss) = idleLossFactor + switchLossFactor * I_{dc} + resistiveLossFactor * I_{dc} + resistiveLossFactor * I_{dc}^2$

Where:

- $P_{dc} = P_{ac}$ for lossless operation
- $P_{dc} = P_{ac} - P_{loss}$ for rectifier operation with losses
- $P_{dc} = P_{ac} + P_{loss}$ for inverter operation with losses

Figure 47 shows a diagram for a symmetric monopole Voltage Source Converter.

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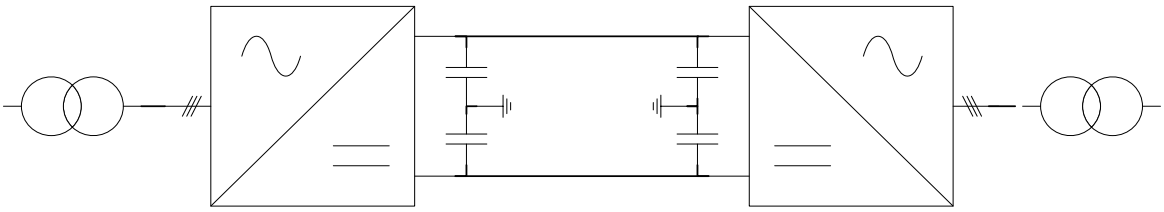


Figure 47 – VSC transmission with a symmetrical monopole illustrated with capacitive earthing on the DC side (IEC 62747)

By controlling the angle δ between the voltages U_V/U_C and voltage difference $U_V - U_C$ independent active and reactive power control is achieved.

Limitations of the VSC results in a P-Q curve. An example P-Q curve is shown in Figure 48.

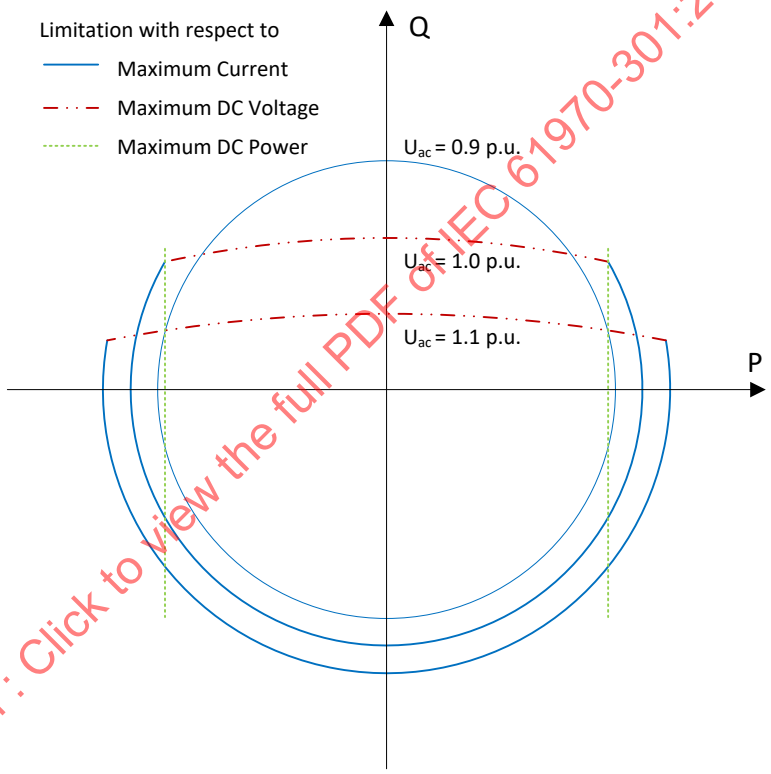


Figure 48 – VSC P-Q capability curve

It is also possible to use VSC in bipolar configurations as shown in Figure 49.

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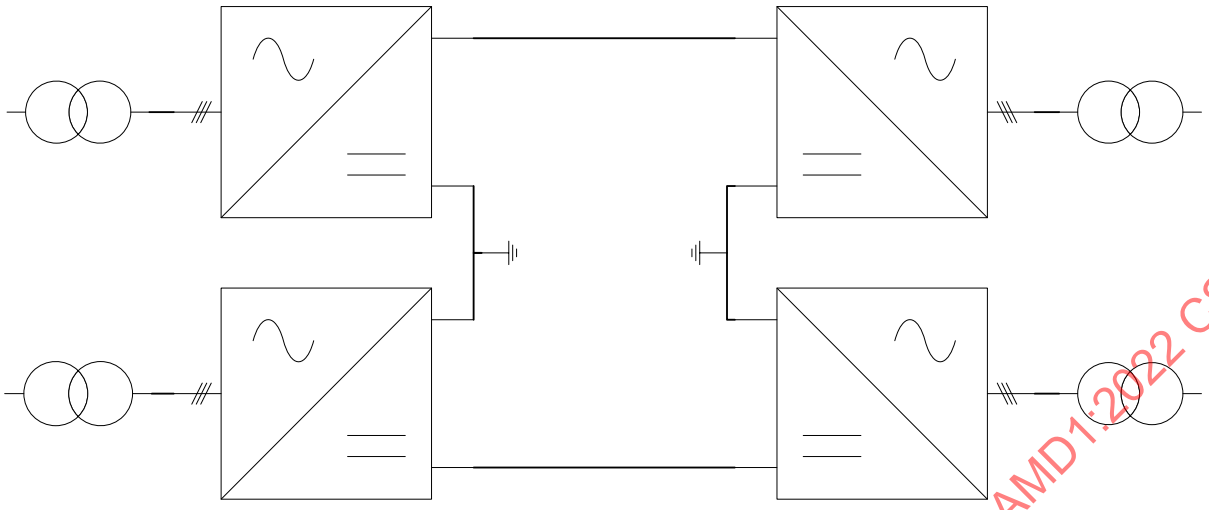


Figure 49 – Bipolar VSC transmission with earth return (IEC 62747)

In this configuration two high voltage DC cables are used for the positive (+DC) and negative (-DC) voltages. A medium voltage cable is used for the neutral.

4.5.13.4 Data model

4.5.13.4.1 General

A data model is created using the following assumptions

- The DCConverterUnit in CIM is identical with IEC 60633 Substation Pole that is a container.
- The IEC 60633 System Pole is not modelled in CIM. The reason is that the IEC 60633 System Pole is not relevant in DC grids. The bridges, filters and bridge units are not modelled explicitly in CIM and are considered part of the Converter.
- Using ConnectivityNode and Terminal for the connectivity also in DC grids enables DC and AC components to be connected together, which is an error. Attributes will also have different meanings in AC and DC grids, e.g. DCNode does not have phase angle or reactive power injection. Hence different artefacts are used to describe AC and DC grids.

Figure 50 shows an example with the modelled objects of a bi-polar current source HVDC line.

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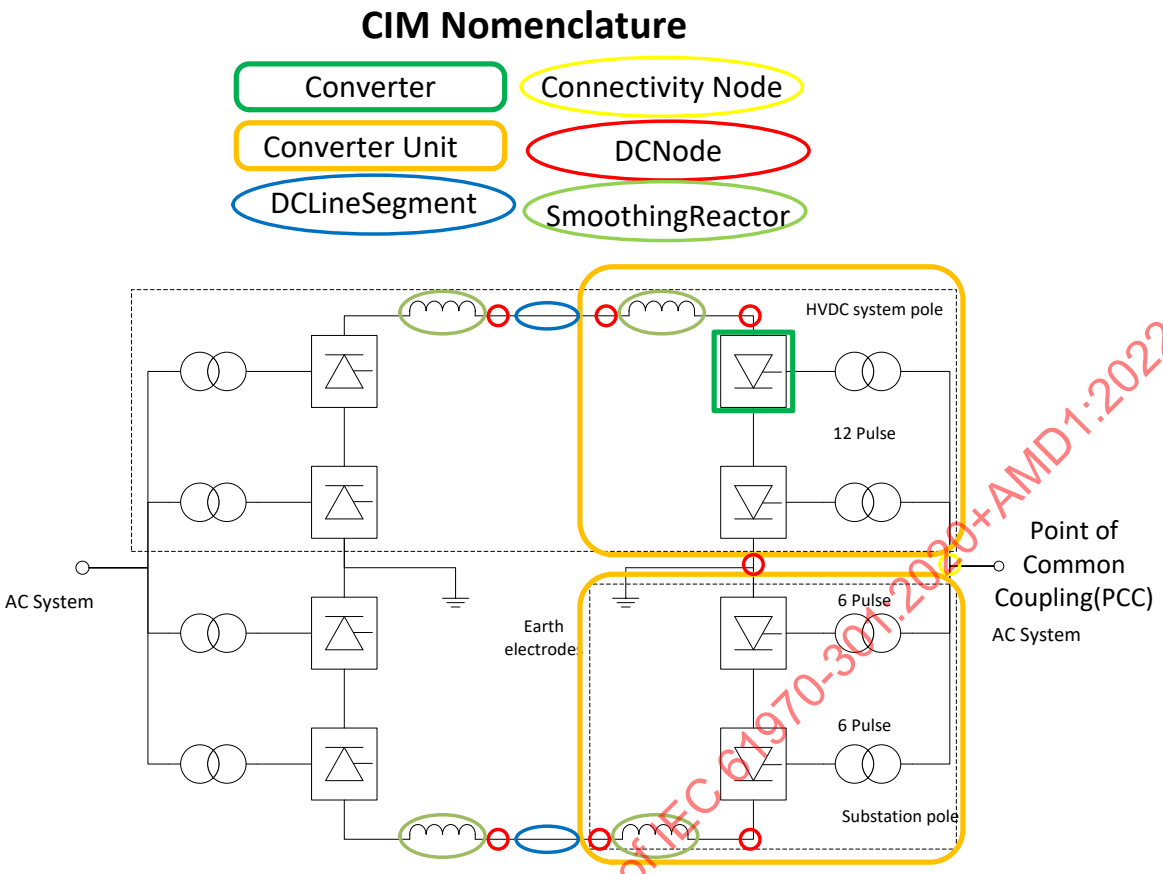


Figure 50 – Object instances for a bi-polar current source HVDC line

The Converter Unit is the object bridging the AC and DC networks.

The corresponding diagram for VSC is shown in Figure 51.

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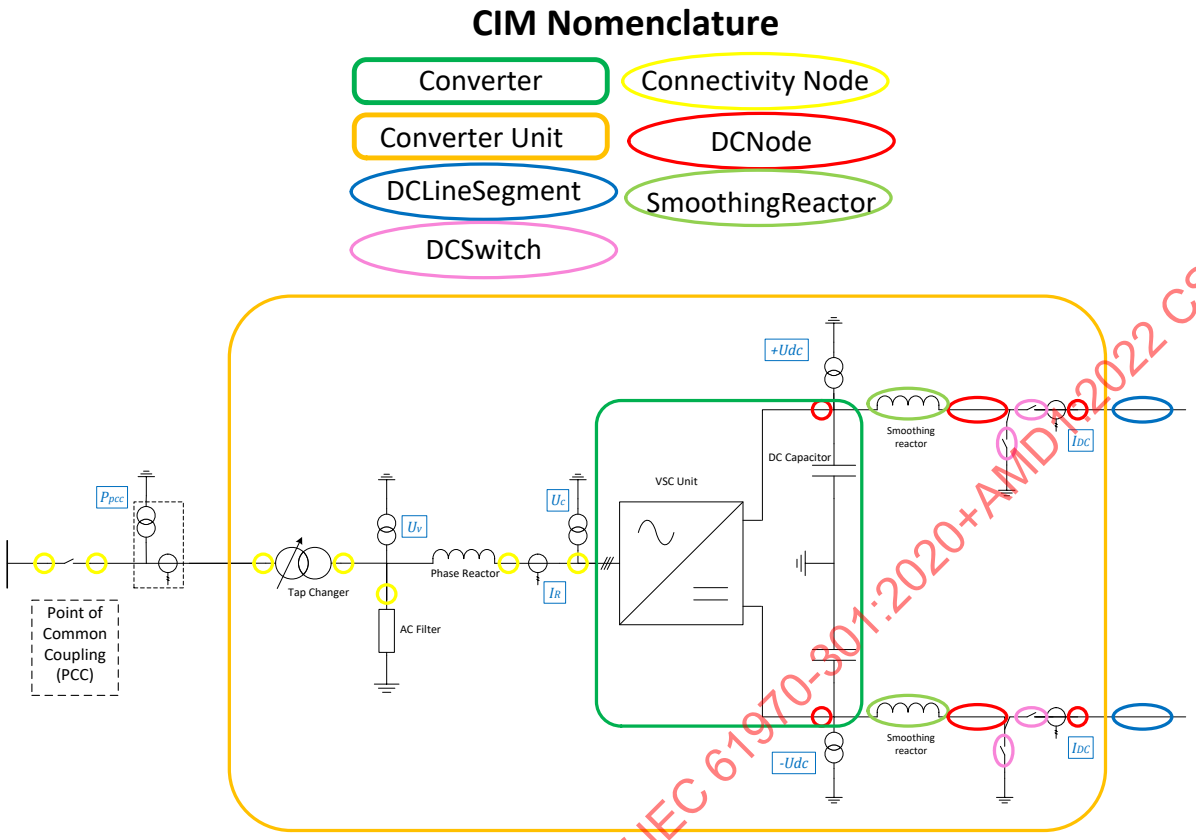


Figure 51 – Object instances for symmetric monopole VSC HVDC data model

As indicated in Figure 50 and Figure 51 an HVDC substation consists of

- one or more Converters;
- SmoothingReactors;
- DC switches for reconfiguration of the DC-lines;
- a Point of Common Coupling (PCC) that is the interface with the AC system.

A Converter consists of one or more sets of

- bridges;
- a PowerTransformer;
- an AC filter;
- a converter or phase reactor for VSC, in multi-level HVDC several Bridges exists in the converter arms. The Converter reactor is then part of the arms rather than a single reactor as shown in Figure 51;
- breakers and disconnectors.

HVDC link can be operated in several ways:

- Bipolar, refer to Figure 49;
- Symmetrical monopole with capacitive earthing on the DC side – refer to Figure 47;
- Asymmetrical monopole with ground return – this lower active power capacity and sustained operation is not allowed;
- Asymmetrical monopole with metallic return – this lower active power capacity and sustained operation is allowed.

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A Converter with several Bridges may have the capability to reconfigure how Bridges are connected. A reconfiguration normally results in down rating of limits.

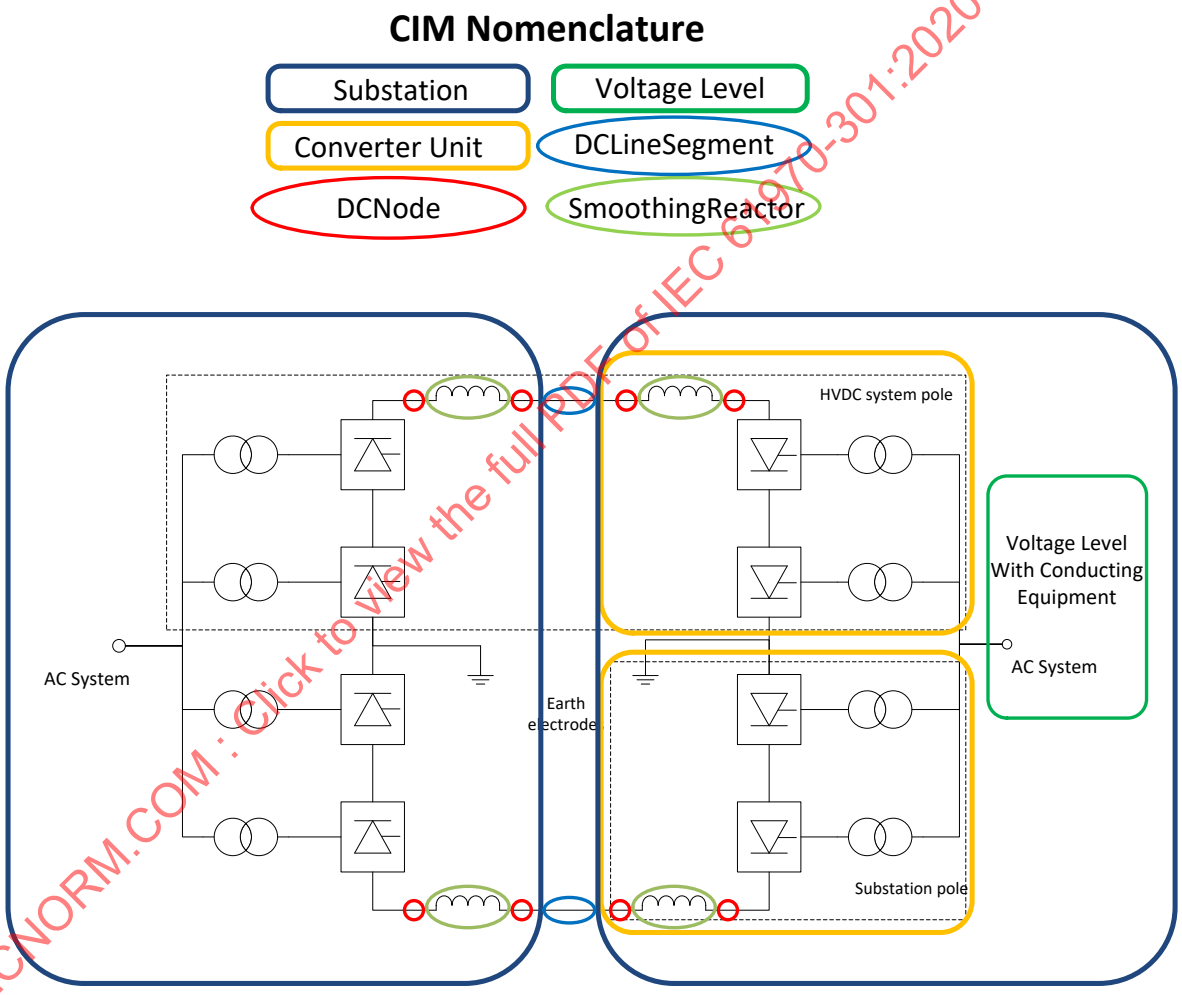
An HVDC substation sends operational status as SCADA signals to a superior SCADA. In bi-polar operation mode down rated Converter limits are typically sent to the superior SCADA.

The containment structures for two cases are shown in Figure 52 and Figure 53.

For the transformers note that

- they are not in a Substation but a DCConverterUnit;
- no VoltageLevels exist at the low and high voltage sides of a transformer.

Hence the containment rules for transformers in the AC network are replaced by rules specific to the DCConverterUnit.



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Figure 52 – Containment structure for a bipolar HVDC line

The two DCLineSegments are part of a Line. The reason is that the DCLineSegments typically are at the same tower or in the same cable channel.

The two substations are regular Substations mixing DC and AC equipment. The DCConverterUnit and Converters are at Substation level and connect to AC equipment in a VoltageLevel.

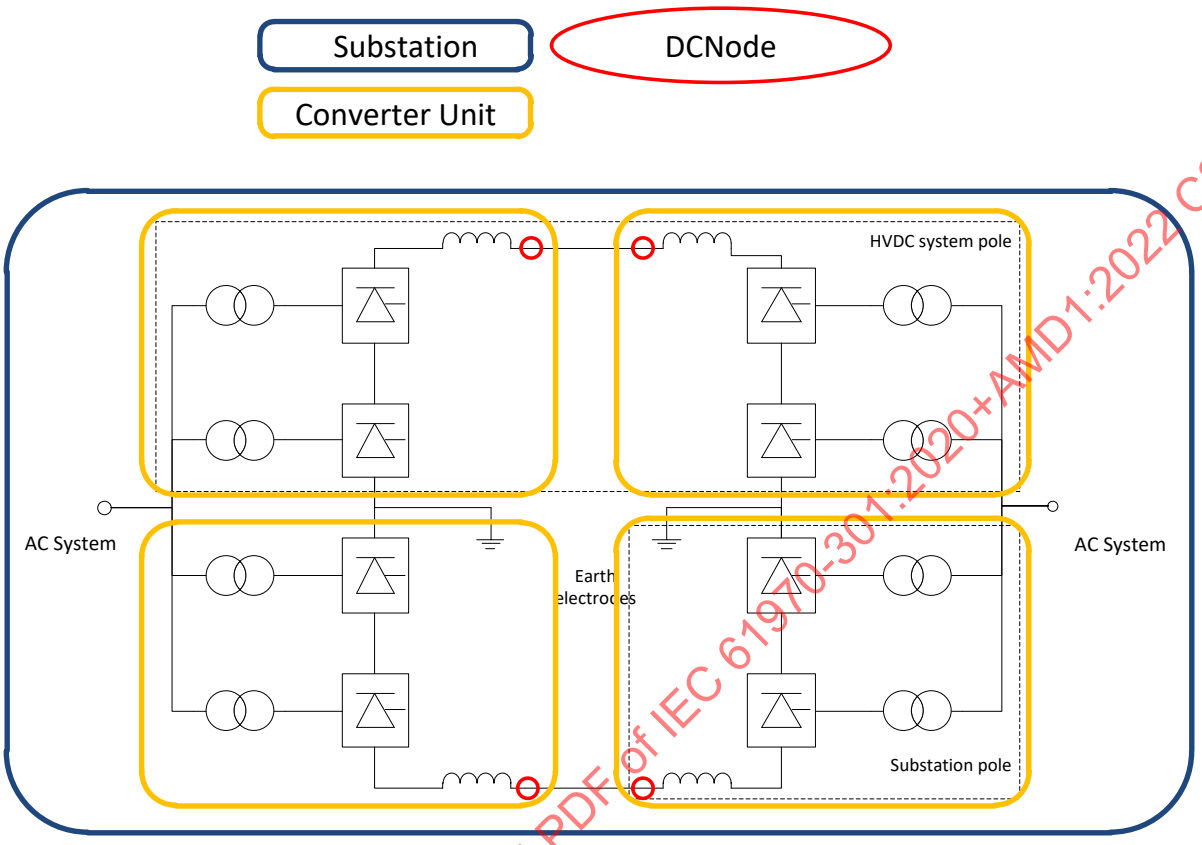


Figure 53 – Containment structure for a bipolar back-to-back HVDC station

4.5.13.4.2 DC Grids

DC grids will have switches that are used to reconfigure the DCLine-s in the grid. To do this it is important that the switches are included in the model and are placed at the appropriate locations in the grid. Figure 51 shows a DCLine connected at a Converter with a simple switch arrangement. As the smoothing reactor belongs to the Substation rather than the DCLine it cannot be included in the DCLine inductance. For DC grid the incoming DCLine connections with the Converters will have more switches and the information model needs to support this. DC grid topology processing will be required in the same way as AC grid topology processing is currently done.

4.5.13.4.3 Topology

The basic AC system connectivity is shown in Figure 54.

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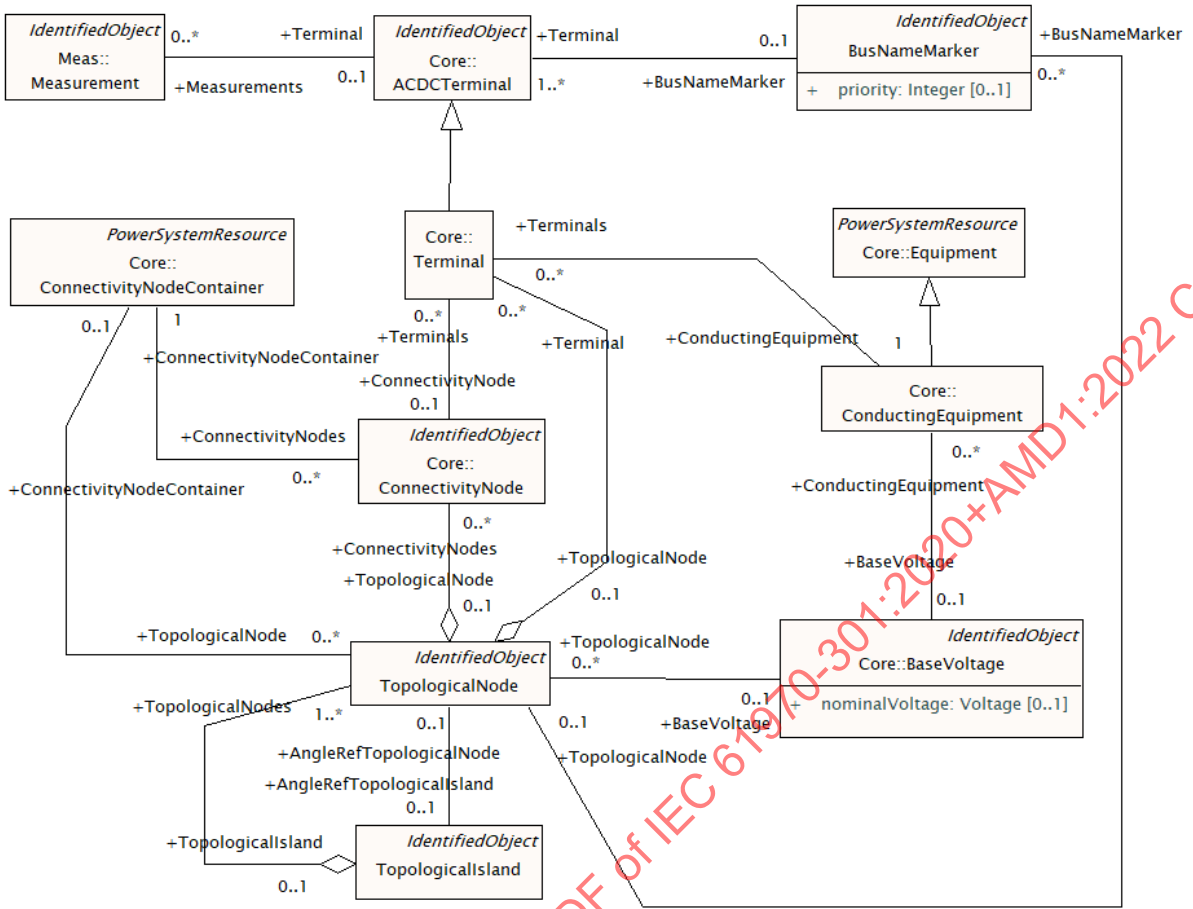


Figure 54 – The Basic topology in package Core

As shown in Figure 54, Terminal is used only for AC ConductingEquipment. A new class ACDCTerminal has been introduced to hold characteristics common between AC and DC.

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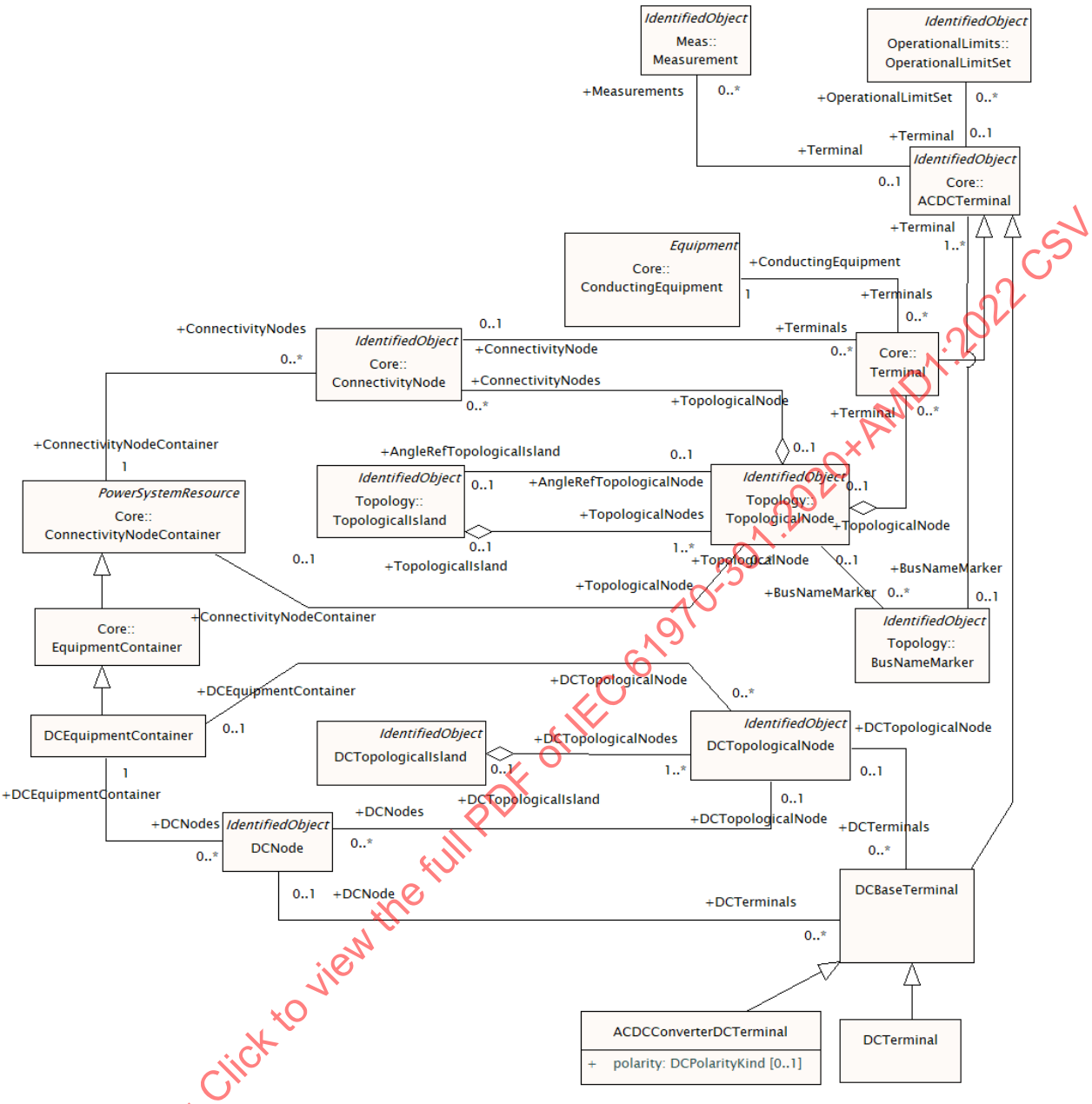


Figure 55 – DC and AC topology

As shown in Figure 55, the ConductingEquipment-Terminal-ConnectivityNode pattern from the AC network is repeated for the DC network with the classes DCConductingEquipment-DCTerminal-DCNode.

4.5.13.4.4 Equipment

The DC equipment model is shown in Figure 56.

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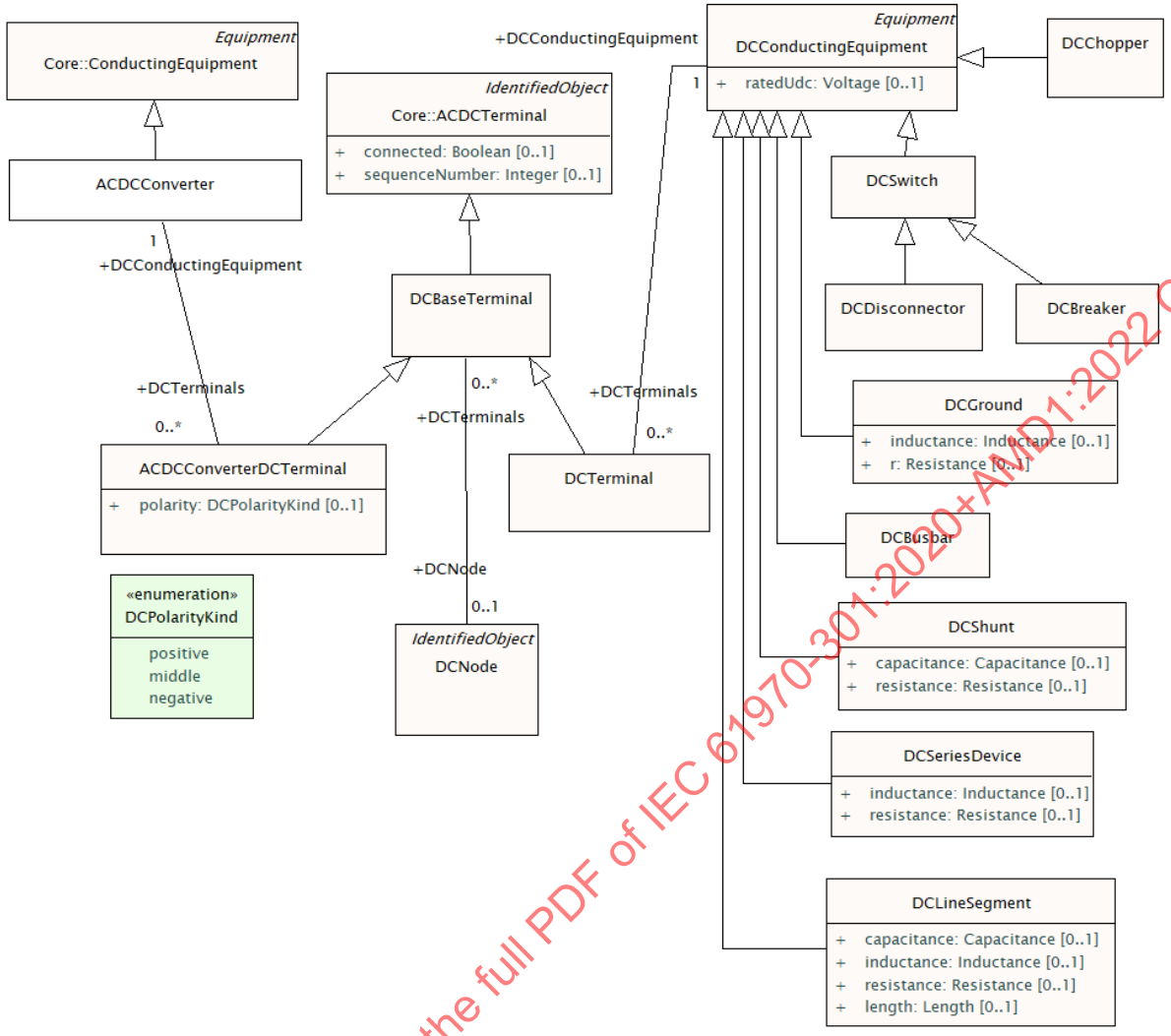


Figure 56 – Equipment model

In order for the ACDCTerminal to feature both ACDCConverter and DCConductingEquipment, two types of DC terminals have been implemented as shown in Figure 56: ACDCConverterDCTerminal and DCTerminal. ACDCConverterDCTerminal is associated with ACDCConverter. The DCTerminal is in association with DCConductingEquipment. In order to associate DCNode with DCTerminal and ACDCConverterDCTerminal, DCBaseTerminal is introduced which is inherited from ACDCTerminal.

As DCConductingEquipment in many cases will have different parameters compared with corresponding AC equipment, specific DC classes are needed anyway, e.g. the DCBreaker and DCBusbar.

The SvPowerFlow-s at the PCCTerminal-s hold the AC injections into the converter.

The DC line model is shown in Figure 57.

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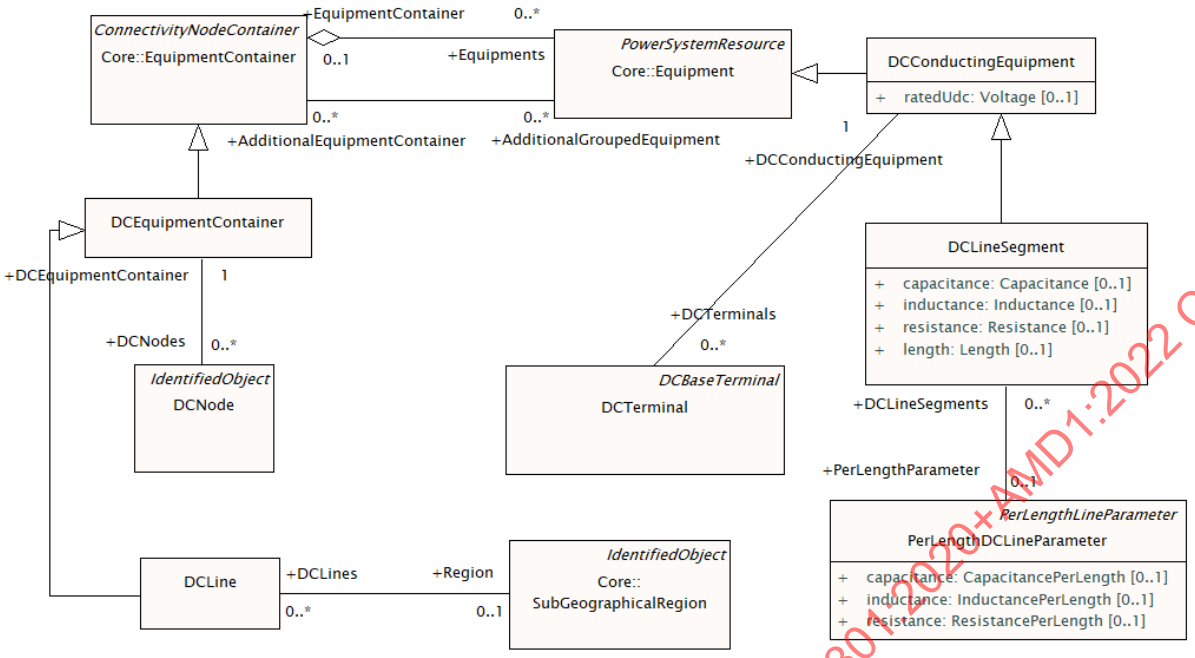


Figure 57 – HVDC line model

As shown in Figure 57 DCLineSegment is no longer a Conductor but DCConductingEquipment and does not connect to the AC network. It has its own attributes and per length class PerLengthDCLineParameter.

Every type of equipment in an HVDC grid will need its DC…class. Possible equipment types are

- DCSwitch
- DCGround

The method of specific DC… classes may result in duplication of attributes with the corresponding AC… classes.

4.5.13.5 Instance diagrams

Figure 58 is the legend for examples of DC equipment: a simple monopole, a simple bipolar and a detailed side of a monopole, shown in Figure 59, Figure 60 and Figure 61, respectively.

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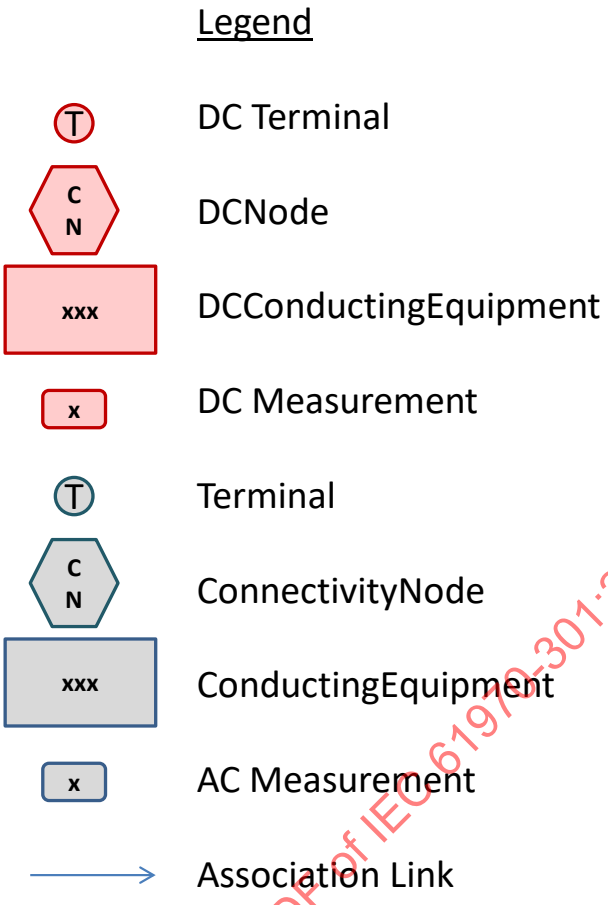


Figure 58 – Legend

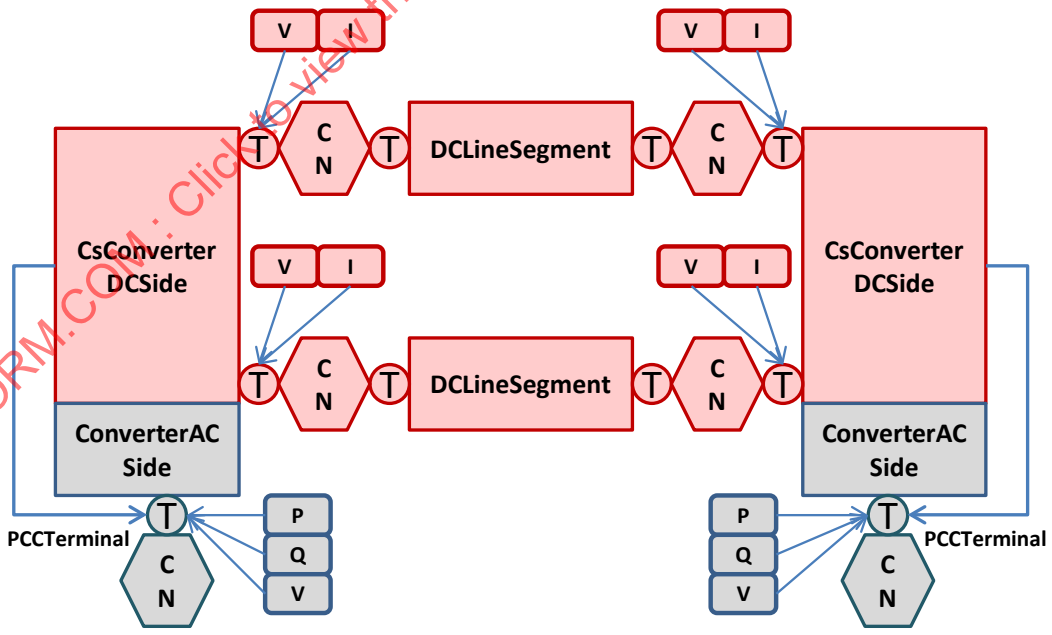


Figure 59 – Simple monopole with measurements

Refer to Figure 58 for an explanation of the symbols in Figure 59.

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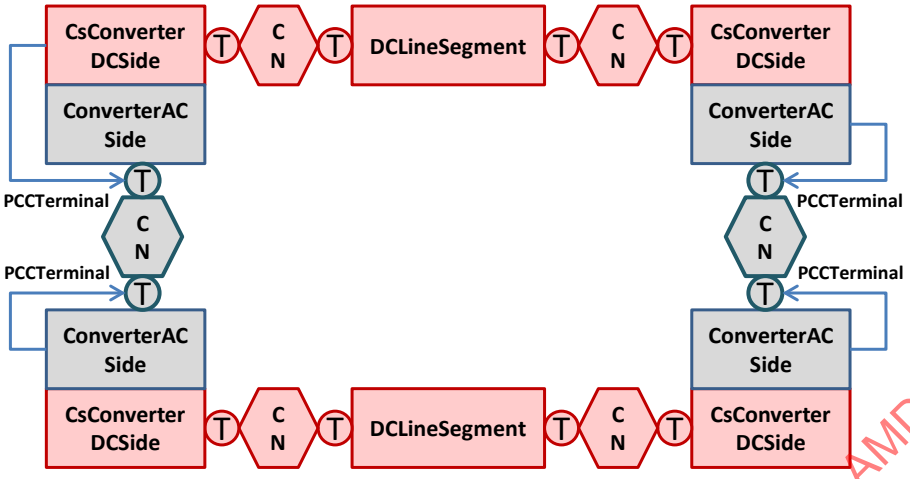


Figure 60 – Simple bipolar

Refer to Figure 58 for an explanation of the symbols in Figure 60.

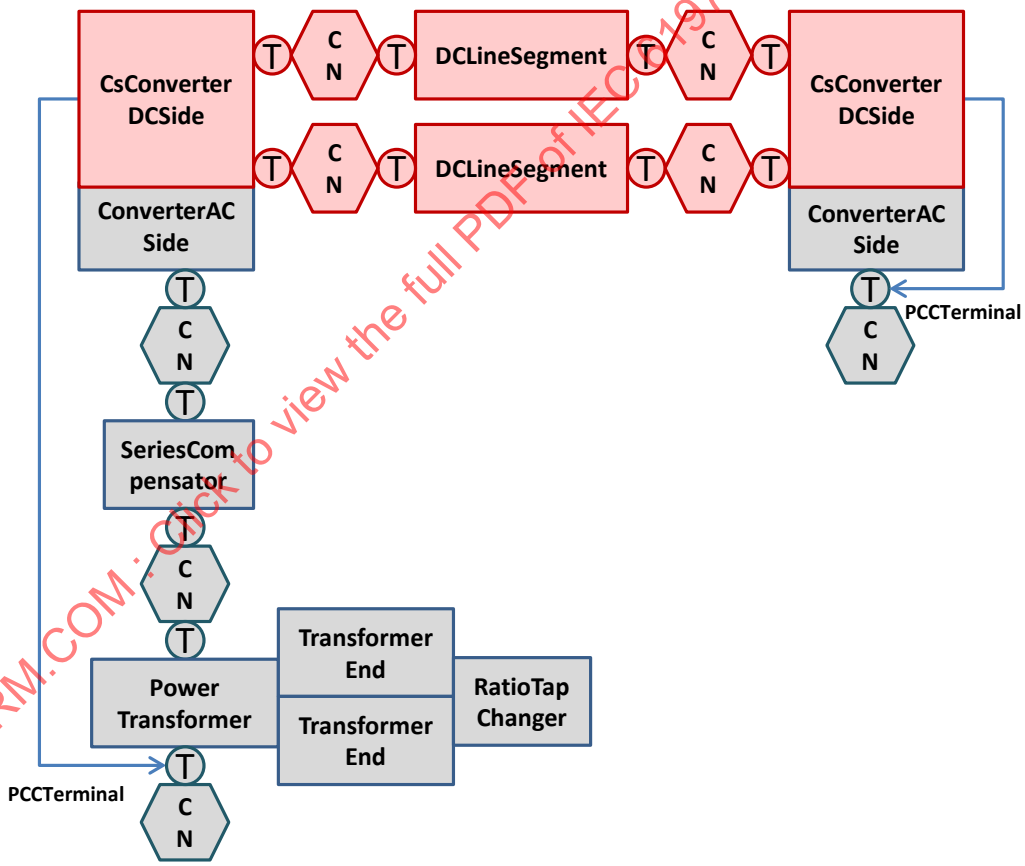


Figure 61 – Monopole one side with detailed model

Refer to Figure 58 for an explanation of the symbols in Figure 61.

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4.5.14 Static Var Compensator Voltage Regulation

4.5.14.1 Background

The Static VAR Compensator (SVC) is a shunt device of the Flexible AC Transmission Systems (FACTS) family using power electronics to control power flow and improve transient stability on power grids. The SVC can be operated in two different modes:

- Voltage regulation mode (the voltage is regulated within limits as explained below)
- Var control mode (the SVC susceptance is kept constant).

When the SVC is operated in voltage regulation mode, it implements the V-I characteristic shown in Figure 62.

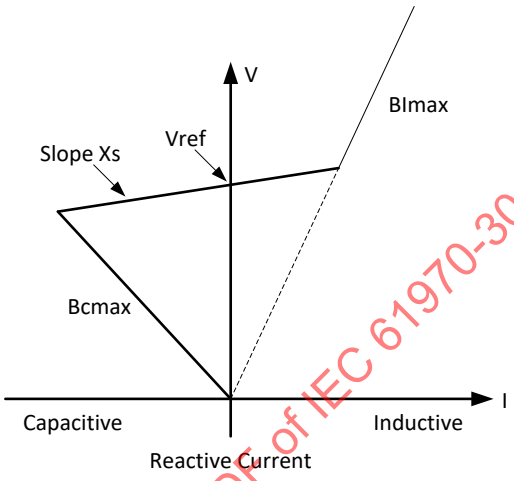


Figure 62 – V-I Characteristic of SVC

As long as the SVC susceptance B stays within the maximum and minimum susceptance values imposed by the total reactive power of capacitor banks (Bcmax) and reactor banks (BI_{max}), the voltage is regulated at the reference voltage V_{ref} (also referred to as voltage set point). The voltage at which the SVC neither absorbs nor generates reactive power is the reference voltage (V_{ref}).

A voltage droop is normally used (usually between 1 % and 4 % at maximum reactive power output), and the V-I characteristic has the slope indicated in the figure. The V-I characteristic is described by the following three equations:

$$V = \begin{cases} V_{ref} + X_S * I & if\ SVC\ is\ in\ regulation\ mode \quad (-Bc_{max} < B < BI_{max}) \\ -\dfrac{I}{Bc_{max}} & if\ SVC\ is\ fully\ capacitive \quad (B = Bc_{max}) \\ \dfrac{I}{BI_{max}} & if\ SVC\ is\ fully\ inductive \quad (B = BI_{max}) \end{cases}$$

Where:

V is the positive sequence voltage (pu) at regulated bus;

I is the reactive current ($I > 0$ indicates an inductive current);

X_S is the slope or droop reactance;

V_{ref} is the voltage reference (voltage set point);

Bc_{max} is the maximum capacitive susceptance;

BI_{max} is the maximum inductive susceptance.

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The voltage set point is typically chosen such that under normal operating conditions the SVC delivers close to zero reactive power so that the full control range of the SVC is available.

The voltage set point of an SVC is fundamentally different from a target voltage. The reactive output of an SVC is proportional to the square of the difference between the regulated bus voltage and the voltage set point. If the SVC is generating or absorbing reactive power, then there will by definition be a difference between the regulated bus voltage and the voltage set point.

4.5.14.2 CIM Model

StaticVarCompensator inherits the following attributes from RegulatingCondEq:

controlEnabled – Specifies the regulation status of the equipment. True is regulating, false is not regulating.

StaticVarCompensator gets its regulated Terminal through the association to RegulatingControl inherited from RegulatingCondEq.

4.5.15 ICCP Configuration Model

4.5.15.1 Configuration use case

An ICCP configuration can be created in two ways:

1) The IO points (measurement values and controls) that will be exchanged over ICCP are known from an exchange of the equipment profile IEC 61970-452/EQ and the ICCP configuration relate directly to these IO points.
2) The IO points that will be exchanged over ICCP are not known from an exchange of the equipment profile and the ICCP configuration instead use an intermediate and commonly agreed name, the ICCP provided point name for the IO points to be exchanged over ICCP. This corresponds to the traditional ICCP configuration case.

The following example is for use case 1 above.

Two utilities, Utility A and B, may have overlapping network models see Figure 63 and exchange CIMXML EQ files with the connectivity node as border. Both Utility A and B want measurement values from each other. The description of the IO points in the network model are included in the exchanged CIMXML IEC 61970-452/EQ files. Both Utility A and B have a subset of the measurements in the CIMXML IEC 61970-452/EQ files available for ICCP exchange.

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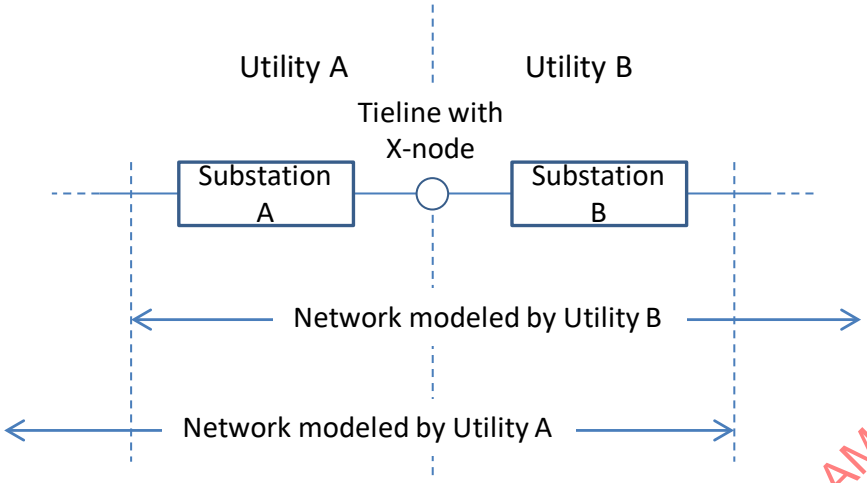


Figure 63 – ICCP measurements and network models

According to use case 2 above traditional way to configure ICCP is for the parties to agree on a common set of names for the exchanged measurements, the ICCP provided points. It is assumed that the two parties use different names for the same measurement and hence a third commonly agreed name is needed, the ICCP provided point names.

Based on this assumption Figure 64 shows a simplified sequence of configuring and starting ICCP.

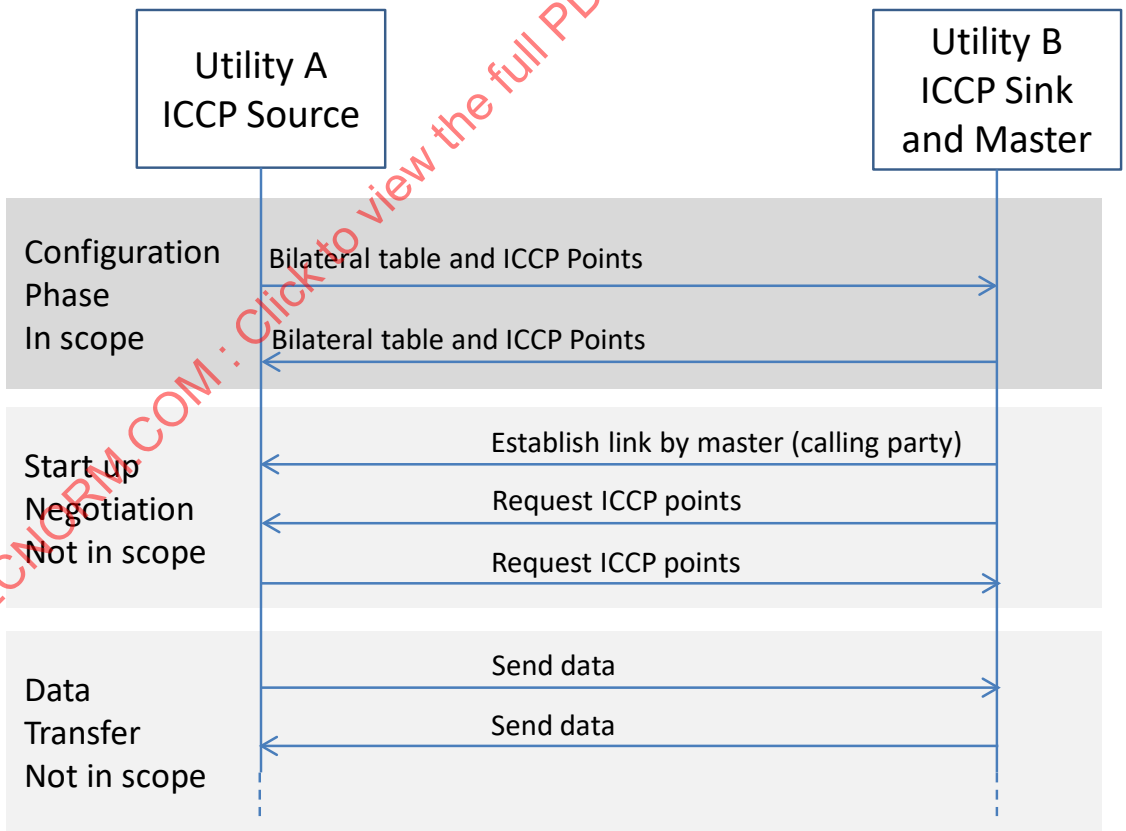


Figure 64 – ICCP configuration and start up

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In the configuration phase files describing the bilateral tables and ICCP point lists are exchanged, the dark grey shaded are in Figure 64. Configuring this exchange is in the scope of this document.

Setting up ICCP configuration means creating a cross reference for each measurement value between the parties. Creating the cross reference is tedious manual work.

When network models are exchanged as CIMXML data both the IEC 61970-452/EQ data and ICCP configuration data described in this document are exchanged. Given this the IO point identifiers and names are known by both parties. Hence the ICCP point mapping is already known and the manual cross referencing that is replaced by automatic linking.

Not all IO points defined in an IEC 61970-452/EQ file may be available over ICCP. Hence availability of a IO points over ICCP need to be described per IO point.

The ICCP protocol support providers of ICCP data to give different ICCP consumers different access rights, e.g. for the example in Figure 63 Utility A may want to allow access for the measurements in Substation A to Utility B but not to other utilities. Hence it must be possible for an ICCP provider to describe ICCP point availability per ICCP consumer. ICCP also support IO points that are globally available to all ICCP consumers.

Figure 65 shows an example ICCP configuration for one measurement value between different parties.

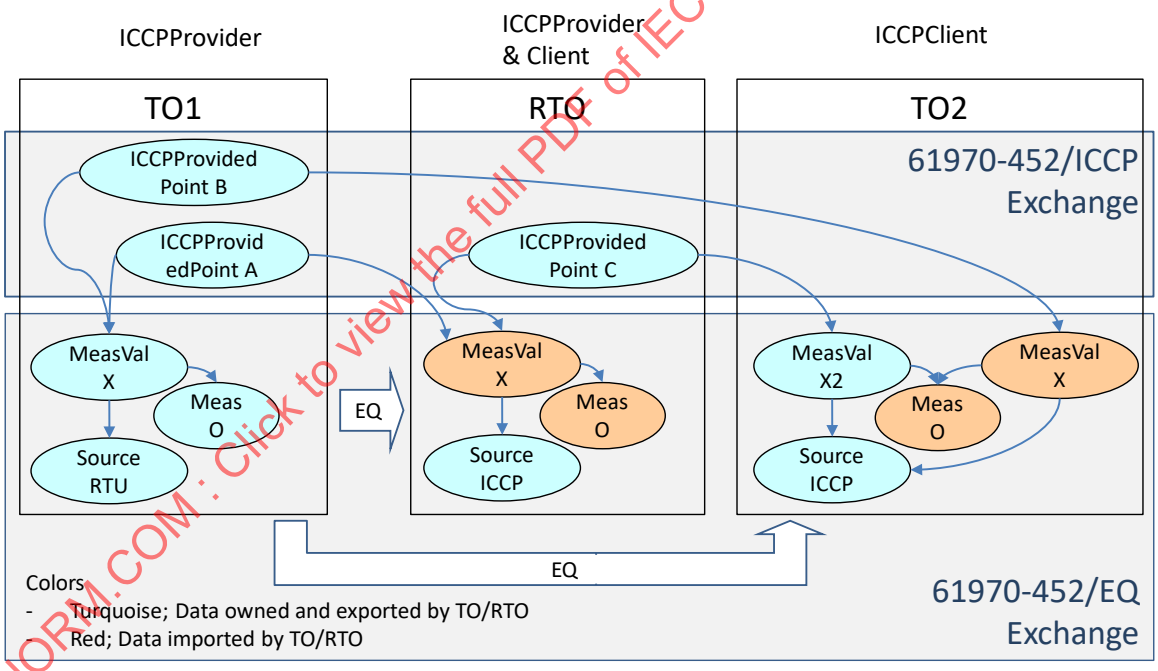


Figure 65 – Measurement value provider and consumer example

TO1 and RTO are control centres where TO1 provide the measurement value MeasVal X to an RTO and TO2. TO2 may get the measurement value MeasVal X directly from TO1 or indirectly from the RTO. Indirect exchange as between the RTO and TO2 may not be allowed even though it is technically possible.

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4.5.15.2 Information Model

ICCP (known officially as IEC 61870-6 TASE.2) data is exchanged using the Measurement classes (Analog, Discrete, and Accumulator), the MeasurementValue classes (AnalogValue, DiscreteValue, and AccumulatorValue), and the MeasurementValueSource class. The MeasurementValueSource class is used to define the control centre supplying the ICCP data. The MeasurementValueSource must be associated with an instance of Name where the attribute Name.name holds the name of the supplying control centre. The instance of NameType associated with the control centre Name must have the NameType.name attribute set to “ICCP Provider ID”.

The MeasurementValue classes are used to specify the ICCP ID. The MeasurementValue must be associated with an instance of Name where the attribute Name.name holds the ICCP ID. The instance of NameType associated with the ICCP ID Name must have the NameType.name attribute set to “ICCP ID”. The MeasurementValue.name attribute holds the SCADA point name. Each MeasurementValue will be associated with one Measurement.

Each MeasurementValue being supplied via ICCP must also have an association to a MeasurementValueSource.

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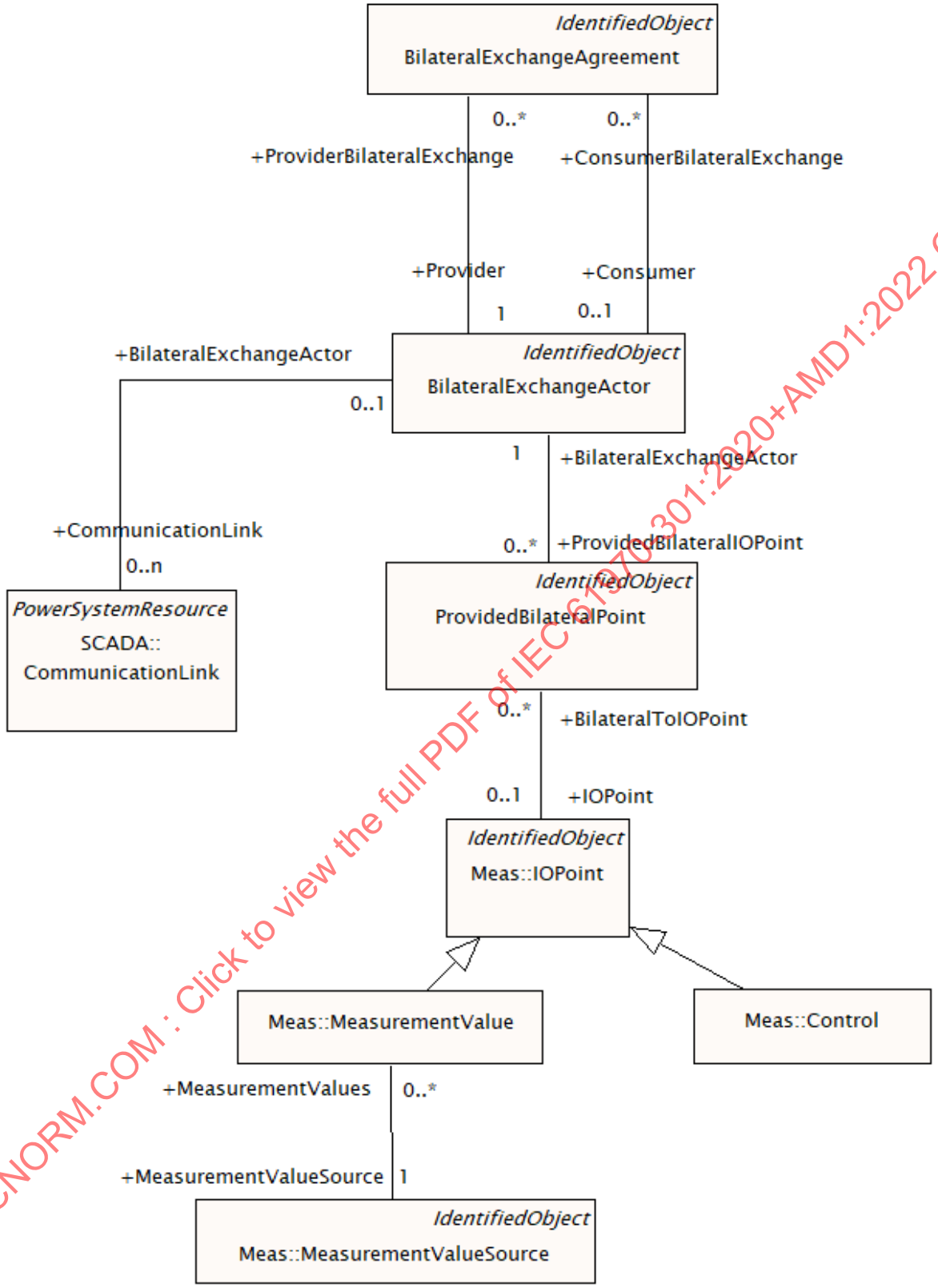


Figure 66 – Generalized bilateral exchange agreement data model

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The data model in Figure 66 is generalized to any bilateral exchange. It describes the actors in such an exchange with BilateralExchangeActor. Two types of actors exist:

- Providers that may also be consumers
- Consumers only

Providers offer IOPoint-s that are available for exchange, currently MeasurementValue-s and Controls. The availability of data is described by BilateralExchangeAgreement. A BilateralExchangeAgreement has two BilateralExchangeActor-s referenced by BilateralExchangeAgreement.Provider and BilateralExchangeAgreement.Consumer. The actor referenced by BilateralExchangeAgreement.Provider is always a provider but may also be a consumer. The actor referenced by BilateralExchangeAgreement.Consumer is always a consumer but may also be a provider. In the case that the actor referenced by BilateralExchangeAgreement.Consumer is also a provider means that the actor referenced by BilateralExchangeAgreement.Provider is also a consumer such that the data exchange is bidirectional for this BilateralExchangeAgreement. A bidirectional exchange between two actors can also be achieved with two one way BilateralExchangeAgreement-s where one of the BilateralExchangeAgreement-s have one actor as provider only and the other as consumer only, this is reversed in the other BilateralExchangeAgreement.

Data provided by a BilateralExchangeActor is described by ProvidedBilateralPoint that represents a many to many relation between the BilateralExchangeActor and IOPoint. IOPoint is a base class for MeasurementValue and Control and provides the association between measurements and ICCP points described by the class ProvidedBilateralPoint.

In the case where network models are exchanged as IEC 61970-452/EQ CIMXML files the ProvidedBilateralPoint.IOPont reference gives the IOPoint such that IOPoint identifiers (mRIDs) and names are known by a consumer. Based on this a consumer can select the whole or a subset of the provided IOPoint-s for exchange over ICCP. This is an internal decision on the consumer side and need not be exchanged as configuration data.

In the case where network models are not exchanged as IEC 61970-452/EQ CIMXML files the ProvidedBilateralPoint.IOPont reference is unspecified and the IOPoint identifiers (mRIDs) and names are unknown by a consumer. The ProvidedBilateralPoint name is then used as the commonly agreed ICCP name. The power industry has established rules for ICCP names that should be followed when used.

UML for ICCP bilateral exchange agreement is shown in Figure 67.

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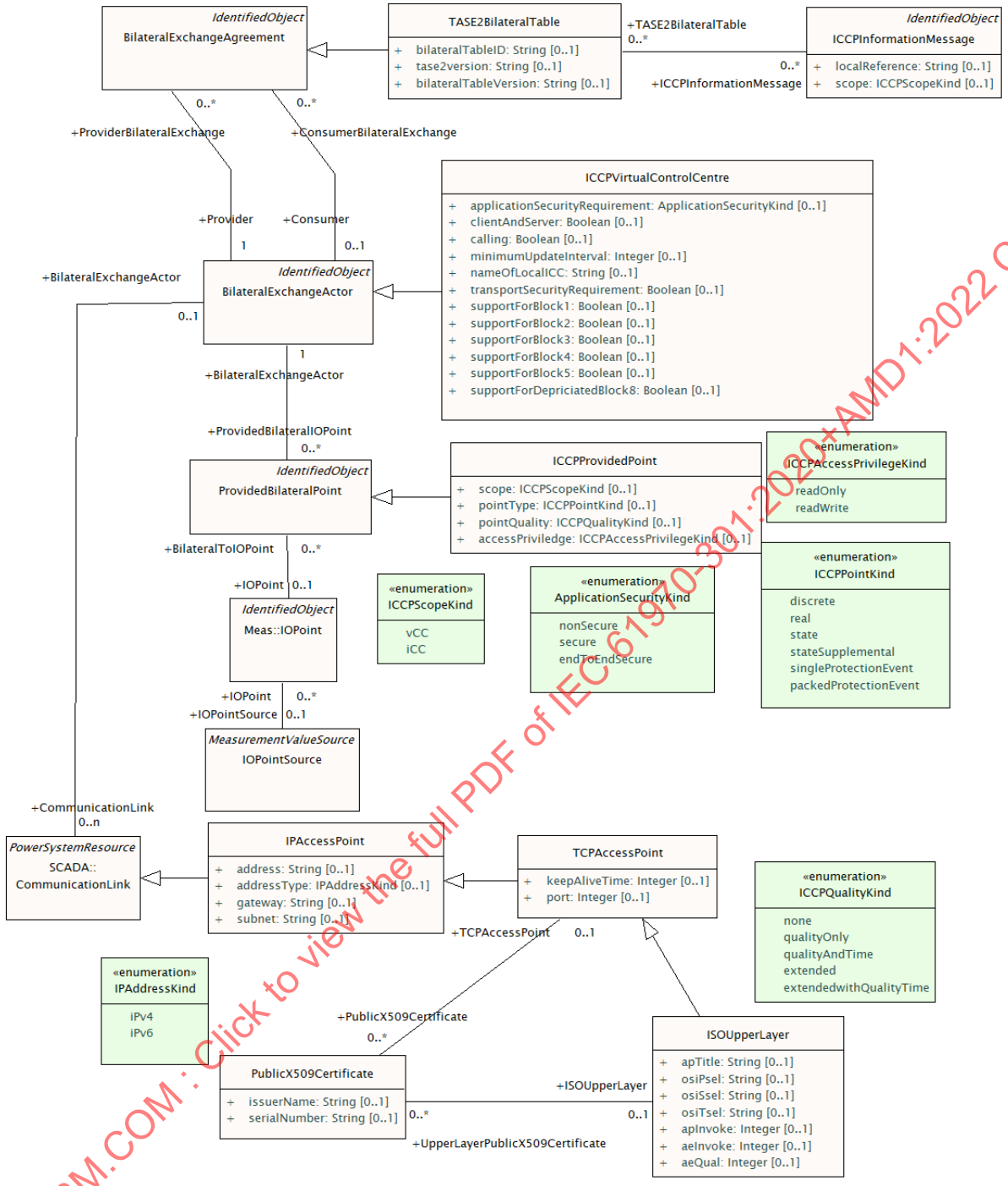


Figure 67 – ICCP bilateral exchange agreement data model

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The following subtypes from the generic data model are defined

- BilateralExchangeAgreement to TASE2BilateralTable.
- BilateralExchangeActor to ICCPVirtualControlCenter.
- ProvidedBilateralPoint to ICCPProvidedPoint.
- CommunicationLink to IPAccessPoint.

4.5.16 Feeder Model

The feeder model is used to represent “as built” feeders. Because Feeder is a type of ConnectivityNodeContainer, a Feeder can contain Equipment just as a Substation or VoltageLevel does. In addition to the containment association between EquipmentContainer and Equipment used for hierarchical naming purposes, there is a second association between these two classes to allow a piece of Equipment to be grouped with an additional EquipmentContainer. This modelling allows Equipment to be associated with more than one Feeder.

A Feeder can be contained by the Substation that nominally energized the feeder. One or more Terminals can also be associated with a Feeder to define the specific normal head feeding it. A Feeder can also contain a secondary distribution Substation. A secondary Substation can be associated with more than one Feeder to represent the Feeders that are normally energizing the Substation.

UML for the Feeder model is shown in Figure 68.

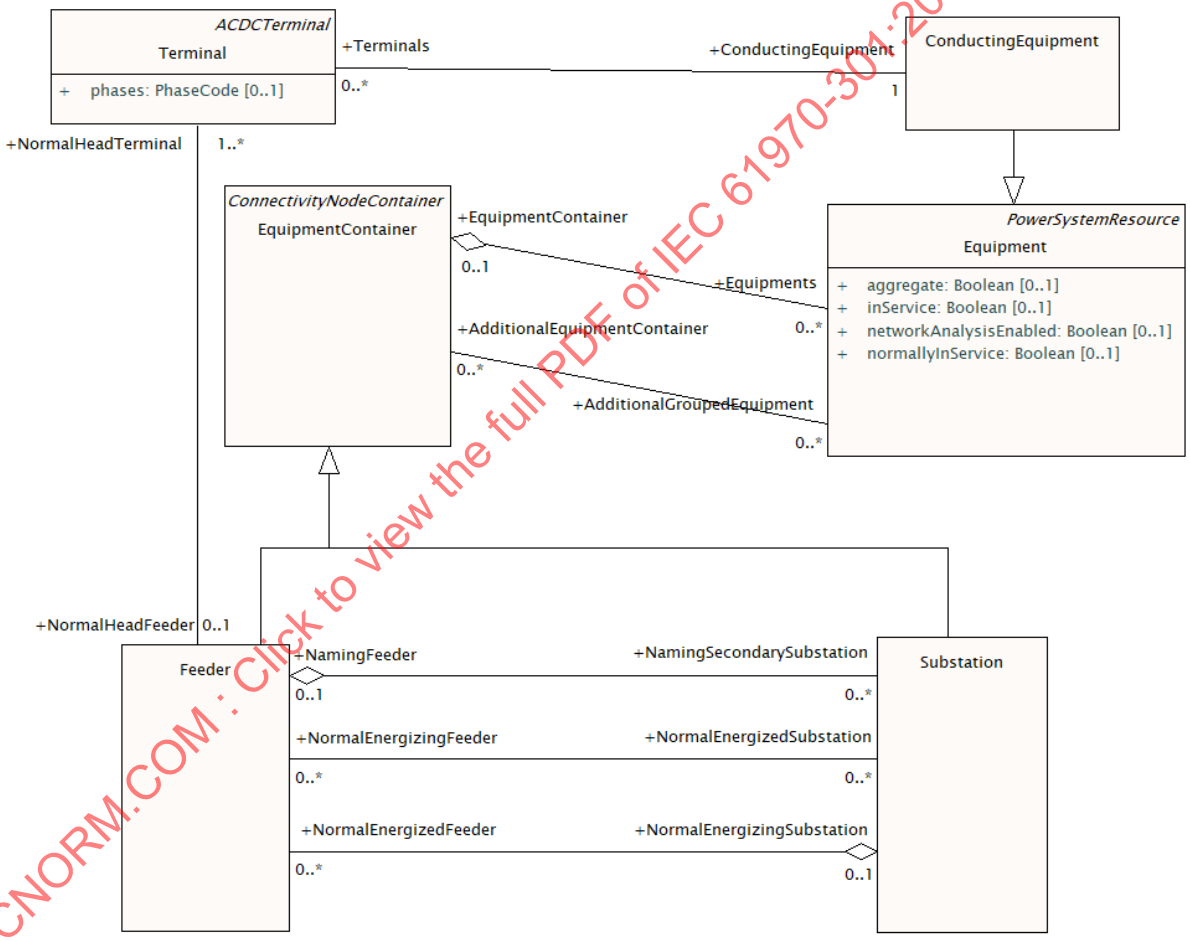


Figure 68 – Feeder data model

4.5.17 Control area modelling

Control area net interchange constraints are important for network analysis because when power flow cases are constructed, the situation to be studied almost always starts with a specification of the net load and net interchange for each control area. Control area constraints must be properly defined to correspond to the definitions for balancing authorities in the grid.Control area constraints in power flow are represented as a set of area control equality constraints of the form:

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Control Area Net Interchange = SUM (control area flow into the area on each tie)

Ties define control areas and ties must be defined such that every conducting element of the network is inside exactly one control area – in other words, control areas cover the network and do not overlap. This is also what happens in the real network, so it is natural and tie locations are usually well known. The control area net interchange is determined by summing flows in Terminals. The Terminals are identified by creating a set of TieFlow objects associated with a ControlArea object. Each TieFlow object is associated with one Terminal. An attribute of the ControlArea object specifies the net interchange (ControlArea.netInterchange).The control area orientation for net interchange is positive for an import, negative for an export. A tie between two control areas will appear in both control area specifications. It must be modelled in each such that the two representations of the tie flow sum to zero. The normal orientation of Terminal flow is positive for flow into the conducting equipment of the Terminal. (i.e. Flow from a bus into a device is positive.) However, the orientation of each flow in the control area specification must align with the control area convention, i.e. import is positive. If the orientation of the Terminal flow referenced by a TieFlow is positive into the control area, then this is confirmed by setting TieFlow.positiveFlowIn flag TRUE; if not, the orientation must be reversed by setting the TieFlow.positiveFlowIn flag FALSE.Figure 69 illustrates a simple tie, where the green arrows indicate the orientation of the Terminal flow (not the actual flow, but the direction of flow that will carry a plus sign):

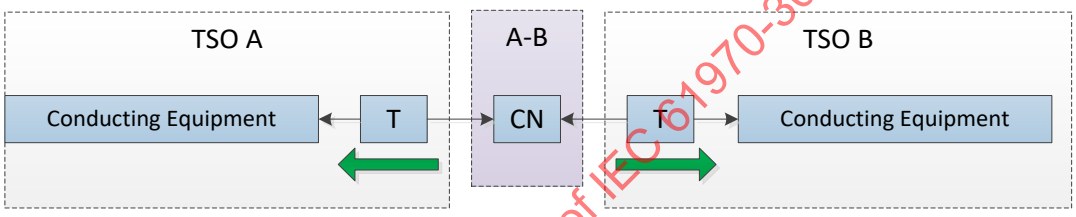


Figure 69 – Orientation of the Terminal flow

Figure 70 illustrates several ways that one can correctly describe the corresponding control area ties. The first two examples below agree on one single Terminal where both parties will measure flow. The third example chooses Terminals that are in the TSO network model so that the area control is always referencing its own network model.

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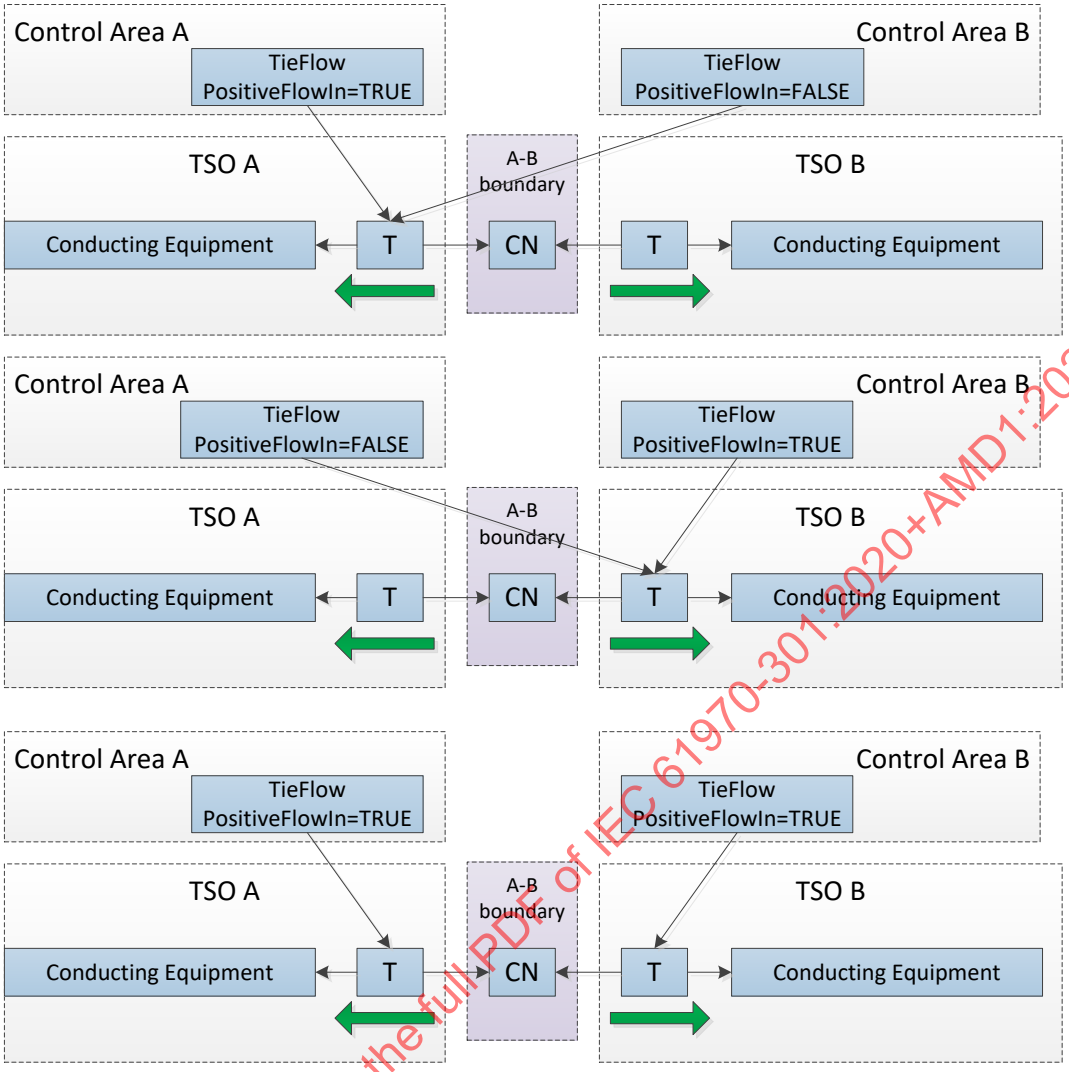


Figure 70 – Several ways to describe control area ties

4.6 Modelling guidelines

4.6.1 Modelling for change

Subclauses 4.6.2 to 4.6.5 provide guidelines on how to maintain and extend the CIM.

The CIM is meant to contain classes and attributes that will be exchanged over public interfaces between major applications. The goal is to keep, as much as possible, only the generic features from which a detailed implementation may be derived. In general, it is easier to change the value or domain of an attribute than to change a class definition. This makes the model more robust because it is able to support a broader class of requirements, and more stable because new requirements may be able to be handled without requiring changes to the model.

4.6.2 Process for amendments to the CIM

It may be desirable to amend the CIM to either revise the existing model or to extend the CIM to model additional elements of an electric utility power system. The recommended process for such amendments is as follows.

1) Prepare use case(s) and a request for change to describe the desired changes. This should include proposed changes to the appropriate class diagrams showing new/revised classes, attributes, and associations.

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2) The use case(s) and request for change are then reviewed by the appropriate IEC Working Group to decide if the requested changes should be treated as revisions to the current CIM standard, or if they should be treated as private amendments, not requiring a change to the standard itself.

3) Proposed amendments accepted by the working group will be added to a list of outstanding issues, and at the appropriate time, a new version of the CIM model will be prepared and an update made to the appropriate IEC CIM specification.

4.6.3 Changes to the CIM UML model

From a modelling perspective, when the CIM is extended, the approach is to start with the existing CIM UML model. The extensions may be added in any of several ways that are available in UML, but in all cases the approach is to inspect the current model and determine the best way to start from the existing class diagrams. The extensions may take the form of any of the following, starting from the simplest to the most complex:

- adding additional attributes to existing classes;
- adding new classes that are specializations of existing classes;
- adding new classes via associations with existing classes.

For the purpose of extending this standard, the main objective is to reuse the existing CIM to the maximum extent possible. From a packaging point of view, extensions should be made to existing packages where possible. If the extensions comprise a new domain of application, then consideration should be given to creating a new package for the additions, but still creating the necessary associations to the existing package, keeping in mind that even though a new package is being created, the CIM is still a single model.

For the purpose of creating non-standard changes to the information model, the standard CIM should be extended without modifying the standard CIM. Preferably, such extensions should be placed in new packages to both identify the changes as non-standard and to facilitate transferring changes to an updated version of the standard.

4.6.4 Changes to the CIM standards documents

From a documentation perspective, when the CIM is extended, a decision shall be made whether the changes constitute updates to existing CIM standards documents, or new IEC 61970-3x is required. In either case, the extensions will then become part of the IEC standard CIM.

4.6.5 Deprecations

The CIM model may at times contain packages, classes, attributes, or associations that have been identified as deprecated. These items will be noted in the documentation or with a UML stereotype of “deprecated”. A deprecated item is retained in the present version of the model but is expected to be removed from future versions. An item that has not been deprecated is not guaranteed to be retained in future versions, but using an item marked as deprecated should be avoided if possible.

4.6.6 CIM profiles

An implementation of the CIM need not include all classes, attributes, or associations in the standard CIM specification to be compliant with the CIM standard. Profiles may be defined to specify which elements shall be included (i.e. mandatory elements) in a particular use of the CIM, as well as which are optional. These profiles are defined in the profile documents of IEC 61970 series, as well as in other IEC series of standards that use and extend the base CIM specified in this document.

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An example is IEC 61970-452, CIM static transmission network model profiles. This profile specifies how the CIM is to be used for exchanging power system models in XML, and also specifies the mandatory and optional classes, attributes, and associations to be supported for this use of the CIM. Profiles can be maintained using a variety of tools such as the open source CIMTool[1].

4.7 Modelling tools

This CIM release was constructed using Enterprise Architect[2]. The entire CIM UML model exists as an Enterprise Architect project file and is viewable with that tool, including the class diagrams and descriptions of classes, attributes, types, and relationships. Viewing the CIM in this fashion provides a graphical navigation interface that permits all CIM specification data to be viewed via point-and-click from the class diagram in each package. A free viewer is available through Sparx Systems.

Ideally, the CIM information model is independent of any specific UML tool, though experience has shown that exchanges between different tools are often less than perfect. Until tool interoperability is proven effective, future changes to the CIM specification, resulting in new versions of this standard, will be incorporated first into the Enterprise Architect project description to ensure a single source for the CIM model data.

Clause 6 of this document was auto-generated using the open source tool jCleanCim[3], which uses the automation interfaces of Microsoft® Word[4] and Enterprise Architect and the standard IEC format and styles.

4.8 User implementation conventions

4.8.1 Conventions beyond UML

Subclause 4.8 provides recommended user conventions when using the CIM in actual system implementations.

4.8.2 Number of terminals for ConductingEquipment objects

The following ConductingEquipment classes have two terminals: ACLineSegment, DCLineSegment, DCSeriesDevice, DCSwitch (and its specializations), DCChopper, Switch and all its specializations (including Jumper, Fuse, Breaker, Disconnector, LoadBreakSwitch, and Cut), SeriesCompensator, and EquivalentBranch. The PowerTransformer class typically has two terminals but may also have one or more terminals. For example, a zig-zag connected grounding transformer may have one terminal. Three terminal transformers are commonly used in transmission systems and in special cases transformers may have four, five, or more terminals. All other ConductingEquipment leaf classes (notably also including Clamp and BusbarSection) and DCConductingEquipment have a single terminal.

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1 Available at <https://cimug-org.github.io/CIMTool/>. CIMTool is the trade name of a product supplied by the Free Software Foundation. This information is given for the convenience of users of this document and does not constitute an endorsement by IEC of the product named. Equivalent products may be used if they can be shown to lead to the same results.

2 Enterprise Architect is the trade name of a product supplied by Sparx Systems. This information is given for the convenience of users of this document and does not constitute an endorsement by IEC of the product named. Equivalent products may be used if they can be shown to lead to the same results.

3 Available at <http://tanjakostic.org/jcleancim>. JCleanCim is the trade name of a product supplied by the Free Software Foundation. This information is given for the convenience of users of this document and does not constitute an endorsement by IEC of the product named. Equivalent products may be used if they can be shown to lead to the same results.

4 Word is the trade name of a product supplied by Microsoft. This information is given for the convenience of users of this document and does not constitute an endorsement by IEC of the product named. Equivalent products may be used if they can be shown to lead to the same results.

4.8.3 Nominal quantities

Many network model equipment attributes express nominal quantities. The following principles apply to those attributes.

- Nominal quantities are not related to the equipment but to the system nominal voltage in the grid.
- Rated quantities such as ratedU are related to the nameplate data.

4.8.4 Datatypes

W3C XML Schema Definition Language (XSD) 1.1 Part 2: Datatypes allows use of the following special values: INF, NaN to express quantities such as positive infinity, negative infinity, and not a number. CIM data types in general and the primitive Float are restricted not to use INF and NaN, if not explicitly allowed in a description of an attribute.

4.9 CIM modelling examples

Power system models have been created from the CIM UML model in various ways. The first example is an RDF (Resource Description Framework) Schema version of the CIM, which uses XML (eXtensible Markup Language) to describe a power system network model. IEC 61970-501 and other profile standards in development are used to specify the model exchange format. RDF Schema versions of the CIM have been used to create XML model files of actual networks for purposes of interoperability testing. An RDF Schema version of the CIM is generated from the CIM UML model file using software tools based on the RDF Schema specification of the CIM.

It should be noted that an RDF schema version of the CIM is still metadata rather than an instantiation of an actual network. However, complete network model files with descriptions of all network elements and their electrical connectivity can be generated by system suppliers using proprietary export tools, and then imported by other systems via a similar import tool, which is used to populate a local network engineering tool database.

5 Detailed model

5.1 Overview

The part of the common information model (CIM) covered by IEC 61970-301 represents a comprehensive logical view of information exchanged between various systems in electrical utilities. This definition includes the public classes and attributes, as well as the relationships between them.

5.2 Context

The CIM is partitioned into subpackages. Classes within the packages are listed in the order they are defined in the UML model. Native class attributes are listed first, followed by inherited attributes in order of depth of inheritance. Native associations are listed first for each class, followed by inherited associations in order of depth of inheritance, then alphabetically by association end name. The associations are described according to the role of each class participating in the association. The association ends are listed under the class at each end of an association.

Figure 71 shows the top level packages included in this document.

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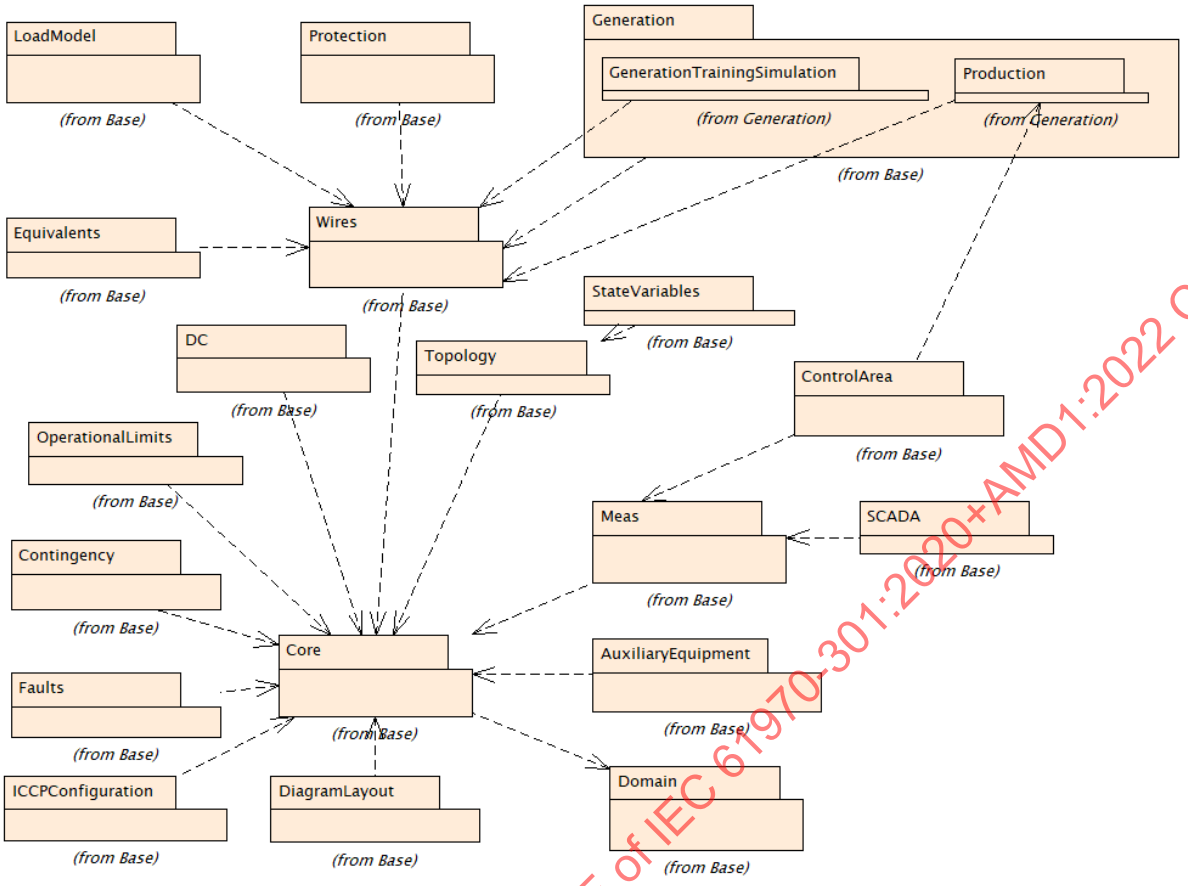


Figure 71 – CIM top level packages

For each package, the model information for each class is fully described. Attribute and association end information for native and inherited attributes is listed as in Table 8 and Table 9 for an example class named “Class1” in example package “Package1”. For any inherited attributes or association ends the “description” column will contain text indicating the attributes is inherited from a specific class. In this example we assume Class1 inherits from class IdentifiedObject. The description column for native attributes and association ends contains the actual description. For inherited attributes, the base class is noted in the description and the full attribute documentation is available in that base class as a native attribute.

Table 8 – Attributes of Package1::Class1

name	type	description
native1	Float	A floating point native attribute of the class is described here.
native2	ActivePower	Documentation for another native attribute of type ActivePower.
name	String	Inherited from: IdentifiedObject

For cases where an attribute is a constant, Table 8 will add the phrase “(const)” to the name column. In such cases, the attribute normally has an initial value also which is preceded by an equal sign and appended to the attribute name.

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Table 9 – Association ends of Package1::Class1 with other classes

[mult from]	[mult to] name	type	description
[0..*]	[0..1] Class2	Class2	The description of the association end to another class named “Class1”. Note it is typical, but not required, that the association end is the same as the referenced type. This association end may reference zero or one objects. The other end of the association may reference any number of Class1 instances.
[0..1]	[0..*] SecondClass2	Class2	The description of references to class named “Class2”. In this case any number of references may be made. The reverse reference may reference zero or one Class1 instances.
[1..1]	[0..*] Class3	Class3	References any number of Class3 instances. The reverse reference shall reference only one instance of Class1.
[0..*]	[0..*] Class4	Class4	A many to many association.
[0..1]	[0..*] DiagramObjects	DiagramObject	inherited from: IdentifiedObject
[1..1]	[0..*] Names	Name	inherited from: IdentifiedObject

In Table 9, the first column describes the multiplicity at this end of the association (i.e. how this class participates in association). Second column describes the other association end. Its multiplicity is included in brackets. The association end name is listed in plain text. The class at the other end of the association is in the third column. A multiplicity of zero indicates an optional association. A multiplicity of “*” indicates any number is allowed. For example, a multiplicity of [1..*] indicates a range from 1 to any larger number is allowed.

In the case that a class is an enumeration named “Enumeration1”, the attributes table is replaced by the literals documentation as shown in Table 10 since enumeration literals have no type. There are no inherited enumeration literals for an enumeration class.

Table 10 – Literals of Package1::Enumeration1

literal	description
native1	This is the first native enumeration value.
native2	This is the second native enumeration value.
native3	There are typically no inherited attributes for enumerations.

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6 Package Base

6.1 General

[nsuri = http://iec.ch/TC57/CIM100#, nsprefix = cim]

Content of the base CIM published as IEC 61970-301.

6.2 Package Domain

6.2.1 General

The domain package defines primitive datatypes that are used by classes in other packages. Stereotypes are used to describe the datatypes. The following stereotypes are defined:

- <<enumeration>> A list of permissible constant values.
- <<Primitive>> The most basic data types used to compose all other data types.
- <<CIMDatatype>> A datatype that contains a value attribute, an optional unit of measure and a unit multiplier. The unit and multiplier may be specified as a static variable initialized to the allowed value.
- <<Compound>> A composite of Primitive, enumeration, CIMDatatype or other Compound classes, as long as the Compound classes do not recurse.

For all datatypes both positive and negative values are allowed unless stated otherwise for a particular datatype.

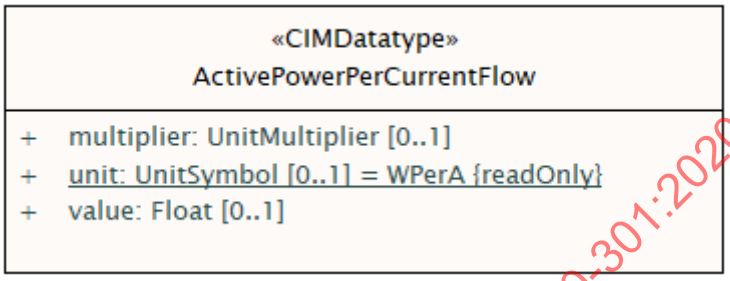


Figure 72 – Class diagram Domain::CombinedElectricalDatatypes

Figure 72: This diagram shows electrical datatypes that are combinations of other electrical datatypes.

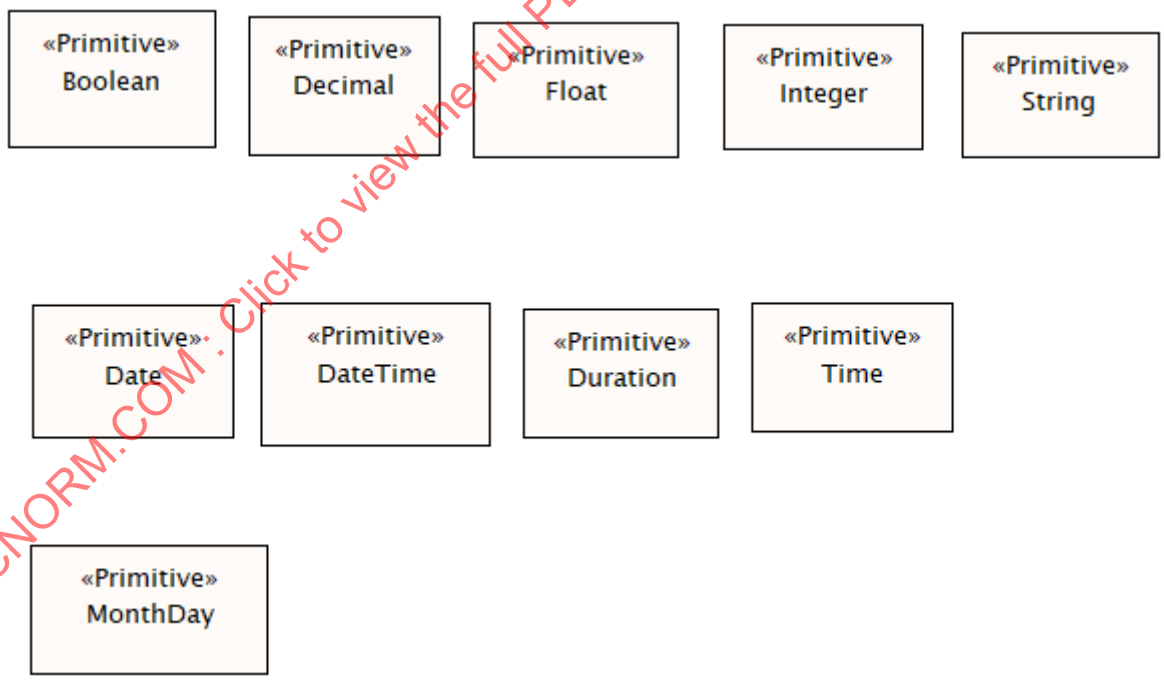
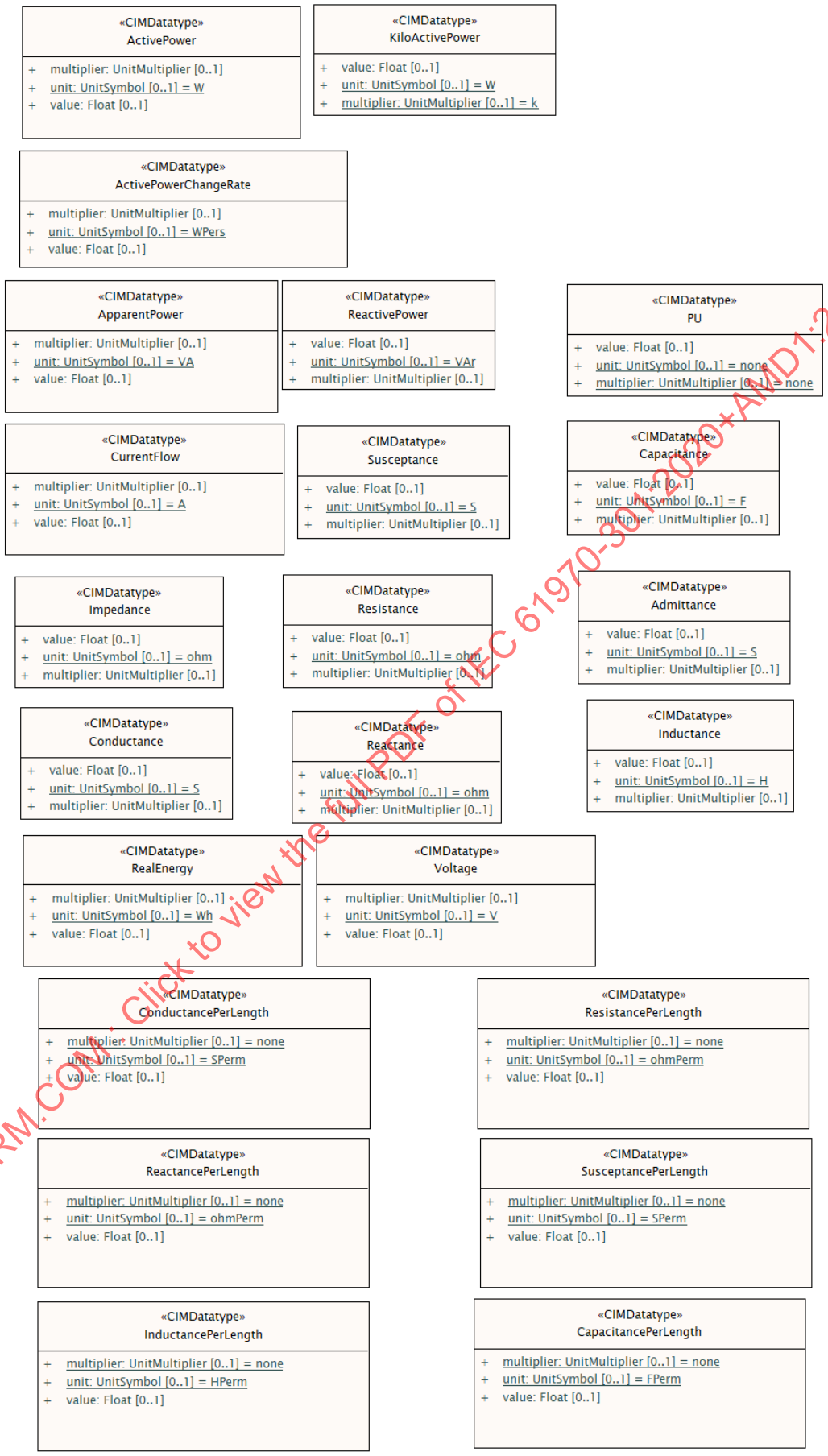


Figure 73 – Class diagram Domain::BasicDatatypes

Figure 73: This diagram shows basic datatypes that are the basis for all other datatypes.

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Figure 74 – Class diagram Domain::ElectricityDatatypes

Figure 74: This diagram shows electricity related data types.

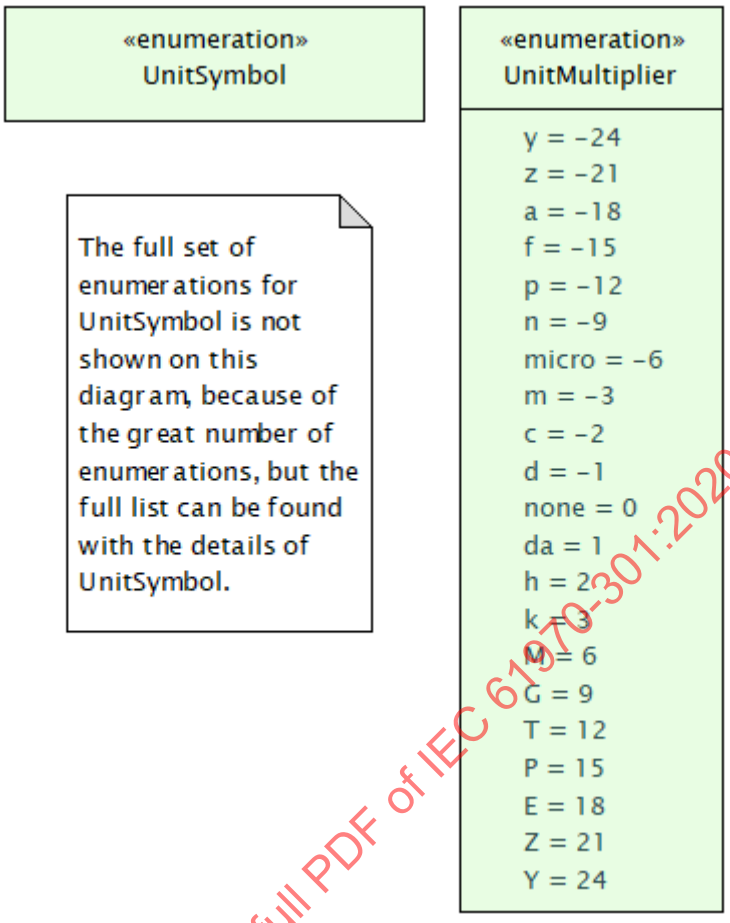
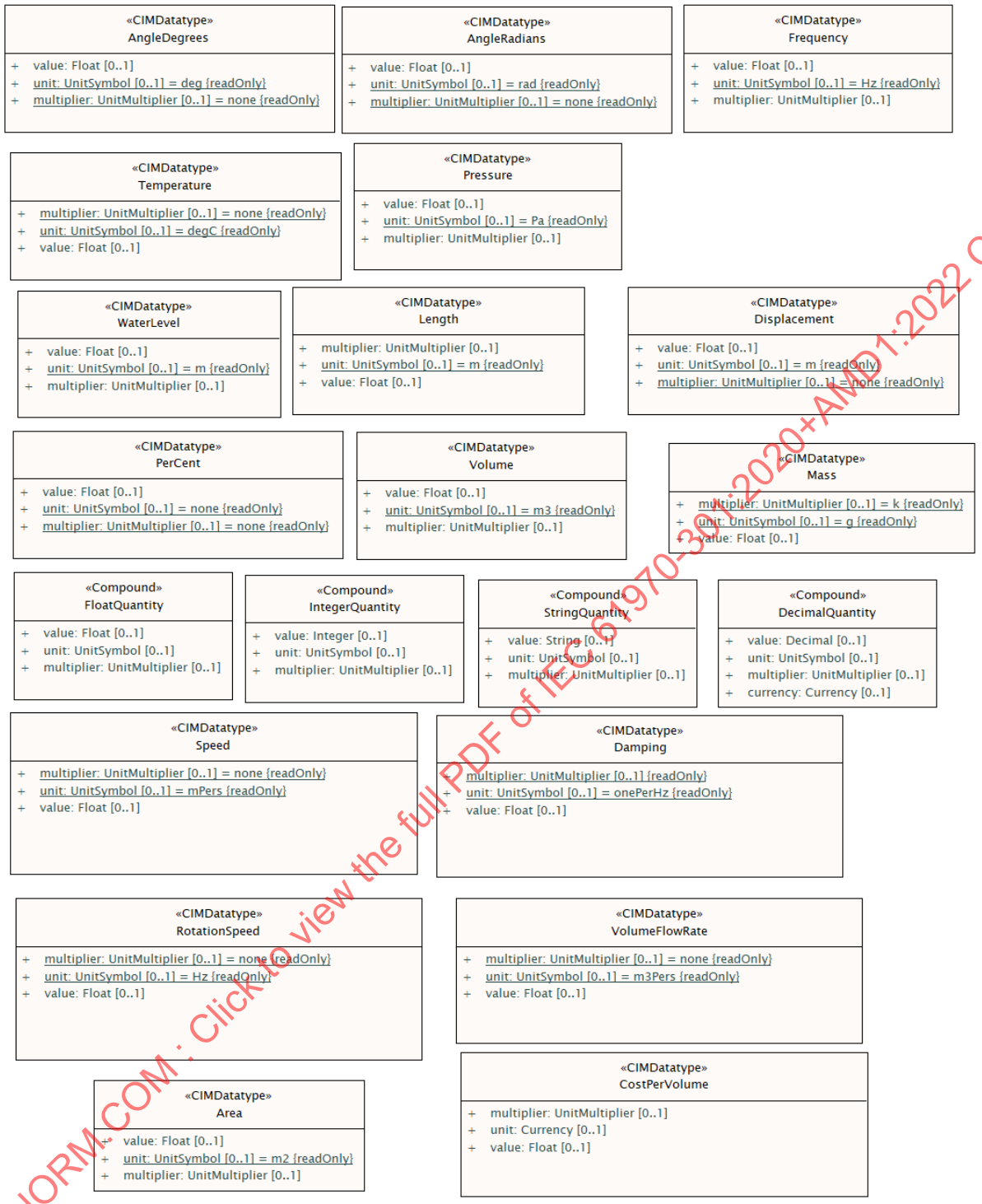


Figure 75 – Class diagram Domain::EnumeratedUnitDatatypes

Figure 75: This diagram shows enumerated data types related to the SI unit system.

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Figure 76 – Class diagram Domain::GeneralDatatypes

Figure 76: This diagram shows general data types.

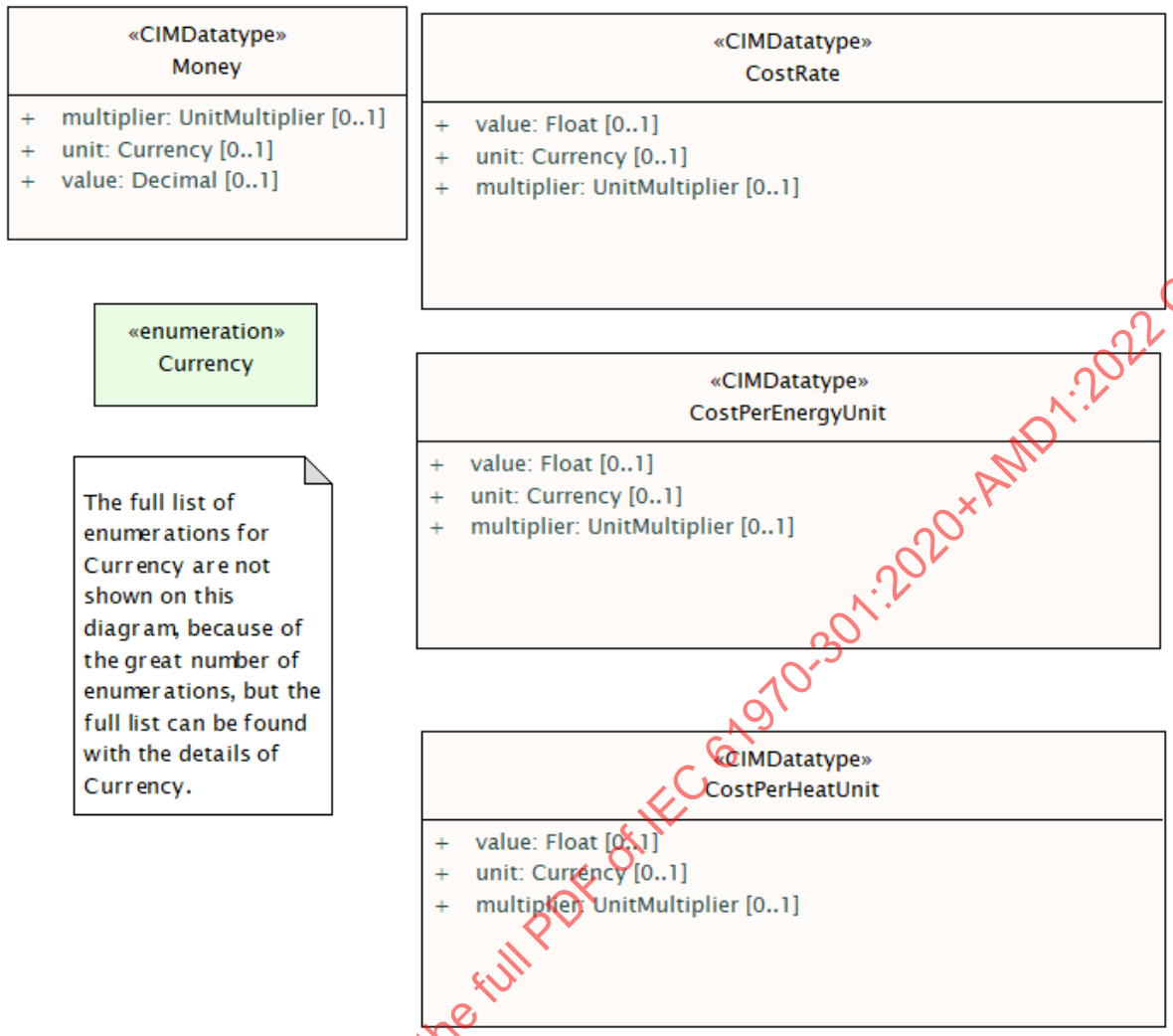


Figure 77 – Class diagram Domain::MonetaryDatatypes

Figure 77: This diagram shows monetary related data types.

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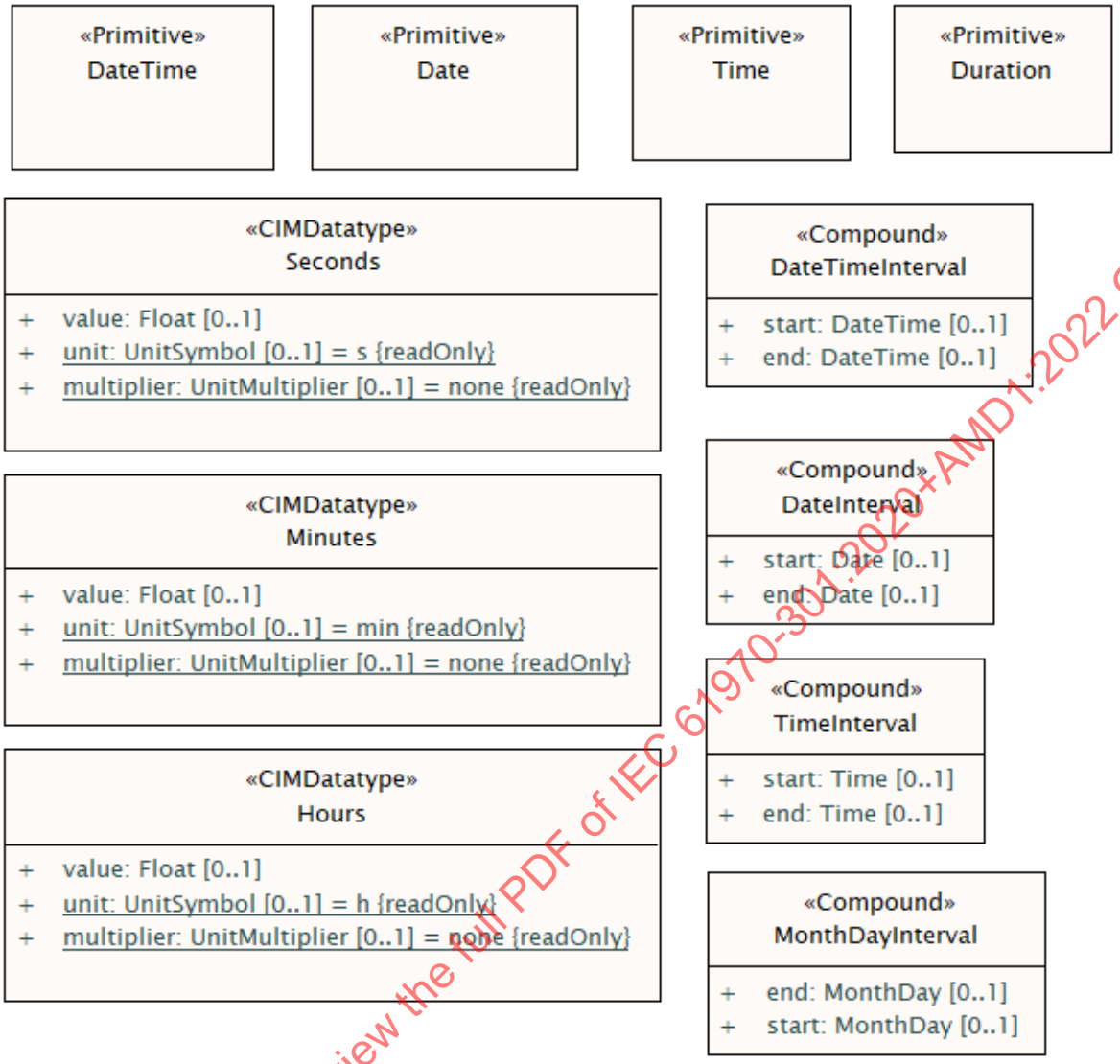


Figure 78 – Class diagram Domain::TimeDatatypes

Figure 78: This diagram shows time related data types.

6.2.2 ActivePower datatype

Product of RMS value of the voltage and the RMS value of the in-phase component of the current.

Table 11 shows all attributes of ActivePower.

Table 11 – Attributes of Domain::ActivePower

name	mult	type	description
multiplier	0..1	UnitMultiplier	
unit	0..1	UnitSymbol	(const=W)
value	0..1	Float	

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6.2.3 ActivePowerChangeRate datatype

Rate of change of active power per time.

Table 12 shows all attributes of ActivePowerChangeRate.

Table 12 – Attributes of Domain::ActivePowerChangeRate

name	mult	type	description
multiplier	0..1	UnitMultiplier	
unit	0..1	UnitSymbol	(const=WPers)
value	0..1	Float	

6.2.4 ActivePowerPerCurrentFlow datatype

Active power variation with current flow.

Table 13 shows all attributes of ActivePowerPerCurrentFlow.

Table 13 – Attributes of Domain::ActivePowerPerCurrentFlow

name	mult	type	description
multiplier	0..1	UnitMultiplier	
unit	0..1	UnitSymbol	(const=WPerA)
value	0..1	Float	

6.2.5 ActivePowerPerFrequency datatype

Active power variation with frequency.

Table 14 shows all attributes of ActivePowerPerFrequency.

Table 14 – Attributes of Domain::ActivePowerPerFrequency

name	mult	type	description
multiplier	0..1	UnitMultiplier	
unit	0..1	UnitSymbol	(const=WPers)
value	0..1	Float	

6.2.6 Admittance datatype

Ratio of current to voltage.

Table 15 shows all attributes of Admittance.

Table 15 – Attributes of Domain::Admittance

name	mult	type	description
value	0..1	Float	
unit	0..1	UnitSymbol	(const=S)
multiplier	0..1	UnitMultiplier	

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6.2.7 AngleDegrees datatype

Measurement of angle in degrees.

Table 16 shows all attributes of AngleDegrees.

Table 16 – Attributes of Domain::AngleDegrees

name	mult	type	description
value	0..1	Float	
unit	0..1	UnitSymbol	(const=deg)
multiplier	0..1	UnitMultiplier	(const=none)

6.2.8 AngleRadians datatype

Phase angle in radians.

Table 17 shows all attributes of AngleRadians.

Table 17 – Attributes of Domain::AngleRadians

name	mult	type	description
value	0..1	Float	
unit	0..1	UnitSymbol	(const=rad)
multiplier	0..1	UnitMultiplier	(const=none)

6.2.9 ApparentPower datatype

Product of the RMS value of the voltage and the RMS value of the current.

Table 18 shows all attributes of ApparentPower.

Table 18 – Attributes of Domain::ApparentPower

name	mult	type	description
multiplier	0..1	UnitMultiplier	
unit	0..1	UnitSymbol	(const=VA)
value	0..1	Float	

6.2.10 Area datatype

Area.

Table 19 shows all attributes of Area.

Table 19 – Attributes of Domain::Area

name	mult	type	description
value	0..1	Float	
unit	0..1	UnitSymbol	(const=m2)
multiplier	0..1	UnitMultiplier	

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6.2.11 Boolean primitive

A type with the value space "true" and "false".

6.2.12 Capacitance datatype

Capacitive part of reactance (imaginary part of impedance), at rated frequency.

Table 20 shows all attributes of Capacitance.

Table 20 – Attributes of Domain::Capacitance

name	mult	type	description
value	0..1	Float	
unit	0..1	UnitSymbol	(const=F)
multiplier	0..1	UnitMultiplier	

6.2.13 CapacitancePerLength datatype

Capacitance per unit of length.

Table 21 shows all attributes of CapacitancePerLength.

Table 21 – Attributes of Domain::CapacitancePerLength

name	mult	type	description
multiplier	0..1	UnitMultiplier	(const=none)
unit	0..1	UnitSymbol	(const=FPerm)
value	0..1	Float	

6.2.14 Classification datatype

Classification of level. Specify as 1..n, with 1 being the most detailed, highest priority, etc as described on the attribute using this data type.

Table 22 shows all attributes of Classification.

Table 22 – Attributes of Domain::Classification

name	mult	type	description
value	0..1	Integer	
unit	0..1	UnitSymbol	(const=none)
multiplier	0..1	UnitMultiplier	(const=none)

6.2.15 Conductance datatype

Factor by which voltage must be multiplied to give corresponding power lost from a circuit. Real part of admittance.

Table 23 shows all attributes of Conductance.

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Table 23 – Attributes of Domain::Conductance

name	mult	type	description
value	0..1	Float	
unit	0..1	UnitSymbol	(const=S)
multiplier	0..1	UnitMultiplier	

6.2.16 ConductancePerLength datatype

Real part of admittance per unit of length.

Table 24 shows all attributes of ConductancePerLength.

Table 24 – Attributes of Domain::ConductancePerLength

name	mult	type	description
multiplier	0..1	UnitMultiplier	(const=none)
unit	0..1	UnitSymbol	(const=SPerm)
value	0..1	Float	

6.2.17 CostPerEnergyUnit datatype

Cost, in units of currency, per quantity of electrical energy generated.

Table 25 shows all attributes of CostPerEnergyUnit.

Table 25 – Attributes of Domain::CostPerEnergyUnit

name	mult	type	description
value	0..1	Float	
unit	0..1	Currency	
multiplier	0..1	UnitMultiplier	

6.2.18 CostPerHeatUnit datatype

Cost, in units of currency, per quantity of heat generated.

Table 26 shows all attributes of CostPerHeatUnit.

Table 26 – Attributes of Domain::CostPerHeatUnit

name	mult	type	description
value	0..1	Float	
unit	0..1	Currency	
multiplier	0..1	UnitMultiplier	

6.2.19 CostPerVolume datatype

Cost per unit volume.

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Table 27 shows all attributes of CostPerVolume.

Table 27 – Attributes of Domain::CostPerVolume

name	mult	type	description
multiplier	0..1	UnitMultiplier	
unit	0..1	Currency	
value	0..1	Float	

6.2.20 CostRate datatype

Cost, in units of currency, per elapsed time.

Table 28 shows all attributes of CostRate.

Table 28 – Attributes of Domain::CostRate

name	mult	type	description
value	0..1	Float	
unit	0..1	Currency	
multiplier	0..1	UnitMultiplier	

6.2.21 Currency enumeration

Monetary currencies. ISO 4217 standard including 3-character currency code.

Table 29 shows all literals of Currency.

Table 29 – Literals of Domain::Currency

literal	value	description
AED	784	United Arab Emirates dirham.
AFN	971	Afghan afghani.
ALL	008	Albanian lek.
AMD	051	Armenian dram.
ANG	532	Netherlands Antillean guilder.
AOA	973	Angolan kwanza.
ARS	032	Argentine peso.
AUD	036	Australian dollar.
AWG	533	Aruban florin.
AZN	944	Azerbaijani manat.
BAM	977	Bosnia and Herzegovina convertible mark.
BBD	052	Barbados dollar.
BDT	050	Bangladeshi taka.
BGN	975	Bulgarian lev.
BHD	048	Bahraini dinar.
BIF	108	Burundian franc.
BMD	060	Bermudian dollar (customarily known as Bermuda dollar).

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literal	value	description
BND	096	Brunei dollar.
BOB	068	Boliviano.
BOV	984	Bolivian Mvdol (funds code).
BRL	986	Brazilian real.
BSD	044	Bahamian dollar.
BTN	064	Bhutanese ngultrum.
BWP	072	Botswana pula.
BYR	974	Belarusian ruble.
BZD	084	Belize dollar.
CAD	124	Canadian dollar.
CDF	976	Congolese franc.
CHF	756	Swiss franc.
CLF	990	Unidad de Fomento (funds code), Chile.
CLP	152	Chilean peso.
CNY	156	Chinese yuan.
COP	170	Colombian peso.
COU	970	Unidad de Valor Real.
CRC	188	Costa Rican colon.
CUC	931	Cuban convertible peso.
CUP	192	Cuban peso.
CVE	132	Cape Verde escudo.
CZK	203	Czech koruna.
DJF	262	Djiboutian franc.
DKK	208	Danish krone.
DOP	214	Dominican peso.
DZD	012	Algerian dinar.
EEK	233	Estonian kroon.
EGP	818	Egyptian pound.
ERN	232	Eritrean nakfa.
ETB	230	Ethiopian birr.
EUR	978	Euro.
FJD	242	Fiji dollar.
FKP	238	Falkland Islands pound.
GBP	826	Pound sterling.
GEL	981	Georgian lari.
GHS	936	Ghanaian cedi.
GIP	929	Gibraltar pound.
GMD	270	Gambian dalasi.
GNF	324	Guinean franc.
GTQ	320	Guatemalan quetzal.
GYD	328	Guyanese dollar.
HKD	344	Hong Kong dollar.
HNL	340	Honduran lempira.
HRK	191	Croatian kuna.

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literal	value	description
HTG	332	Haitian gourde.
HUF	348	Hungarian forint.
IDR	360	Indonesian rupiah.
ILS	376	Israeli new sheqel.
INR	356	Indian rupee.
IQD	368	Iraqi dinar.
IRR	364	Iranian rial.
ISK	352	Icelandic króna.
JMD	388	Jamaican dollar.
JOD	400	Jordanian dinar.
JPY	392	Japanese yen.
KES	404	Kenyan shilling.
KGS	417	Kyrgyzstani som.
KHR	116	Cambodian riel.
KMF	174	Comoro franc.
KPW	408	North Korean won.
KRW	410	South Korean won.
KWD	414	Kuwaiti dinar.
KYD	136	Cayman Islands dollar.
KZT	398	Kazakhstani tenge.
LAK	418	Lao kip.
LBP	422	Lebanese pound.
LKR	144	Sri Lanka rupee.
LRD	430	Liberian dollar.
LSL	426	Lesotho loti.
LTL	440	Lithuanian litas.
LVL	428	Latvian lats.
LYD	434	Libyan dinar.
MAD	504	Moroccan dirham.
MDL	498	Moldovan leu.
MGA	969	Malagasy ariary.
MKD	807	Macedonian denar.
MMK	104	Myanma kyat.
MNT	496	Mongolian tugrik.
MOP	446	Macanese pataca.
MRO	478	Mauritanian ouguiya.
MUR	480	Mauritian rupee.
MVR	462	Maldivian rufiyaa.
MWK	454	Malawian kwacha.
MXN	484	Mexican peso.
MYR	458	Malaysian ringgit.
MZN	943	Mozambican metical.
NAD	516	Namibian dollar.
NGN	566	Nigerian naira.

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literal	value	description
NIO	558	Cordoba oro.
NOK	578	Norwegian krone.
NPR	524	Nepalese rupee.
NZD	554	New Zealand dollar.
OMR	512	Omani rial.
PAB	590	Panamanian balboa.
PEN	604	Peruvian nuevo sol.
PGK	598	Papua New Guinean kina.
PHP	608	Philippine peso.
PKR	586	Pakistani rupee.
PLN	985	Polish zloty.
PYG	600	Paraguayan guaraní.
QAR	634	Qatari rial.
RON	946	Romanian new leu.
RSD	941	Serbian dinar.
RUB	643	Russian rouble.
RWF	646	Rwandan franc.
SAR	682	Saudi riyal.
SBD	090	Solomon Islands dollar.
SCR	690	Seychelles rupee.
SDG	938	Sudanese pound.
SEK	752	Swedish krona/kronor.
SGD	702	Singapore dollar.
SHP	654	Saint Helena pound.
SLL	694	Sierra Leonean leone.
SOS	706	Somali shilling.
SRD	968	Surinamese dollar.
STD	678	São Tomé and Príncipe dobra.
SYP	760	Syrian pound.
SZL	748	Lilangeni.
THB	764	Thai baht.
TJS	972	Tajikistani somoni.
TMT	934	Turkmenistani manat.
TND	788	Tunisian dinar.
TOP	776	Tongan pa'anga.
TRY	949	Turkish lira.
TTD	780	Trinidad and Tobago dollar.
TWD	901	New Taiwan dollar.
TZS	834	Tanzanian shilling.
UAH	980	Ukrainian hryvnia.
UGX	800	Ugandan shilling.
USD	840	United States dollar.
UYU	858	Uruguayan peso.
UZS	860	Uzbekistan som.

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literal	value	description
VEF	937	Venezuelan bolívar fuerte.
VND	704	Vietnamese Dong.
VUV	548	Vanuatu vatu.
WST	882	Samoan tala.
XAF	950	CFA franc BEAC.
XCD	951	East Caribbean dollar.
XOF	952	CFA Franc BCEAO.
XPF	953	CFP franc.
YER	886	Yemeni rial.
ZAR	710	South African rand.
ZMK	894	Zambian kwacha.
ZWL	932	Zimbabwe dollar.

6.2.22 CurrentFlow datatype

Electrical current with sign convention: positive flow is out of the conducting equipment into the connectivity node. Can be both AC and DC.

Table 30 shows all attributes of CurrentFlow.

Table 30 – Attributes of Domain::CurrentFlow

name	mult	type	description
multiplier	0..1	UnitMultiplier	
unit	0..1	UnitSymbol	(const=A)
value	0..1	Float	

6.2.23 Damping datatype

Per-unit active power variation with frequency referenced on the system apparent power base. Typical values are in the range 1,0 – 2,0.

Table 31 shows all attributes of Damping.

Table 31 – Attributes of Domain::Damping

name	mult	type	description
multiplier	0..1	UnitMultiplier	
unit	0..1	UnitSymbol	(const=onePerHz)
value	0..1	Float	

6.2.24 Date primitive

Date as "yyyy-mm-dd", which conforms with ISO 8601. UTC time zone is specified as "yyyy-mm-ddZ". A local timezone relative UTC is specified as "yyyy-mm-dd(+/-)hh:mm".

6.2.25 DateInterval compound

Interval between two dates.

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Table 32 shows all attributes of DateInterval.

Table 32 – Attributes of Domain::DateInterval

name	mult	type	description
start	0..1	Date	Start date of this interval.
end	0..1	Date	End date of this interval.

6.2.26 DateTime primitive

Date and time as "yyyy-mm-ddThh:mm:ss.sss", which conforms with ISO 8601. UTC time zone is specified as "yyyy-mm-ddThh:mm:ss.sssZ". A local timezone relative UTC is specified as "yyyy-mm-ddThh:mm:ss.sss-hh:mm". The second component (shown here as "ss.sss") could have any number of digits in its fractional part to allow any kind of precision beyond seconds.

6.2.27 DateTimeInterval compound

Interval between two date and time points, where the interval includes the start time but excludes end time.

Table 33 shows all attributes of DateTimeInterval.

Table 33 – Attributes of Domain::DateTimeInterval

name	mult	type	description
start	0..1	DateTime	Start date and time of this interval. The start date and time is included in the defined interval.
end	0..1	DateTime	End date and time of this interval. The end date and time where the interval is defined up to, but excluded.

6.2.28 Decimal primitive

Decimal is the base-10 notational system for representing real numbers.

6.2.29 DecimalQuantity compound

Quantity with decimal value and associated unit or currency information.

Table 34 shows all attributes of DecimalQuantity.

Table 34 – Attributes of Domain::DecimalQuantity

name	mult	type	description
value	0..1	Decimal	Value of this quantity.
unit	0..1	UnitSymbol	Unit of this quantity.
multiplier	0..1	UnitMultiplier	Unit multiplier of this quantity.
currency	0..1	Currency	Currency of this quantity.

6.2.30 Displacement datatype

Unit of displacement relative to a reference position, hence can be negative.

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Table 35 shows all attributes of Displacement.

Table 35 – Attributes of Domain::Displacement

name	mult	type	description
value	0..1	Float	
unit	0..1	UnitSymbol	(const=m)
multiplier	0..1	UnitMultiplier	(const=none)

6.2.31 Duration primitive

Duration as "PnYnMnDTnHnMnS" which conforms to ISO 8601, where nY expresses a number of years, nM a number of months, nD a number of days. The letter T separates the date expression from the time expression and, after it, nH identifies a number of hours, nM a number of minutes and nS a number of seconds. The number of seconds could be expressed as a decimal number, but all other numbers are integers.

6.2.32 Emission datatype

Quantity of emission per fuel heat content.

Table 36 shows all attributes of Emission.

Table 36 – Attributes of Domain::Emission

name	mult	type	description
multiplier	0..1	UnitMultiplier	(const=none)
unit	0..1	UnitSymbol	(const=kgPerJ)
value	0..1	Float	

6.2.33 Float primitive

A floating point number. The range is unspecified and not limited.

6.2.34 FloatQuantity compound

Quantity with float value and associated unit information.

Table 37 shows all attributes of FloatQuantity.

Table 37 – Attributes of Domain::FloatQuantity

name	mult	type	description
value	0..1	Float	Value of this quantity.
unit	0..1	UnitSymbol	Unit of this quantity.
multiplier	0..1	UnitMultiplier	Unit multiplier of this quantity.

6.2.35 Frequency datatype

Cycles per second.

Table 38 shows all attributes of Frequency.

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Table 38 – Attributes of Domain::Frequency

name	mult	type	description
value	0..1	Float	
unit	0..1	UnitSymbol	(const=Hz)
multiplier	0..1	UnitMultiplier	

6.2.36 HeatRate datatype

Heat generated, in energy per time unit of elapsed time.

Table 39 shows all attributes of HeatRate.

Table 39 – Attributes of Domain::HeatRate

name	mult	type	description
unit	0..1	UnitSymbol	(const=J)
value	0..1	Float	
multiplier	0..1	UnitMultiplier	

6.2.37 Hours datatype

Time specified in hours.

Table 40 shows all attributes of Hours.

Table 40 – Attributes of Domain::Hours

name	mult	type	description
value	0..1	Float	
unit	0..1	UnitSymbol	(const=h)
multiplier	0..1	UnitMultiplier	(const=none)

6.2.38 Impedance datatype

Ratio of voltage to current.

Table 41 shows all attributes of Impedance.

Table 41 – Attributes of Domain::Impedance

name	mult	type	description
value	0..1	Float	
unit	0..1	UnitSymbol	(const=ohm)
multiplier	0..1	UnitMultiplier	

6.2.39 Inductance datatype

Inductive part of reactance (imaginary part of impedance), at rated frequency.

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Table 42 shows all attributes of Inductance.

Table 42 – Attributes of Domain::Inductance

name	mult	type	description
value	0..1	Float	
unit	0..1	UnitSymbol	(const=H)
multiplier	0..1	UnitMultiplier	

6.2.40 InductancePerLength datatype

Inductance per unit of length.

Table 43 shows all attributes of InductancePerLength.

Table 43 – Attributes of Domain::InductancePerLength

name	mult	type	description
multiplier	0..1	UnitMultiplier	(const=none)
unit	0..1	UnitSymbol	(const=HPerm)
value	0..1	Float	

6.2.41 Integer primitive

An integer number. The range is unspecified and not limited.

6.2.42 IntegerQuantity compound

Quantity with integer value and associated unit information.

Table 44 shows all attributes of IntegerQuantity.

Table 44 – Attributes of Domain::IntegerQuantity

name	mult	type	description
value	0..1	Integer	Value of this quantity.
unit	0..1	UnitSymbol	Unit of this quantity.
multiplier	0..1	UnitMultiplier	Unit multiplier of this quantity.

6.2.43 KiloActivePower datatype

Active power in kilowatts.

Table 45 shows all attributes of KiloActivePower.

Table 45 – Attributes of Domain::KiloActivePower

name	mult	type	description
value	0..1	Float	
unit	0..1	UnitSymbol	(const=W)
multiplier	0..1	UnitMultiplier	(const=k)

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6.2.44 Length datatype

Unit of length. It shall be a positive value or zero.

Table 46 shows all attributes of Length.

Table 46 – Attributes of Domain::Length

name	mult	type	description
multiplier	0..1	UnitMultiplier	
unit	0..1	UnitSymbol	(const=m)
value	0..1	Float	

6.2.45 Mass datatype

Mass.

Table 47 shows all attributes of Mass.

Table 47 – Attributes of Domain::Mass

name	mult	type	description
multiplier	0..1	UnitMultiplier	(const=k)
unit	0..1	UnitSymbol	(const=g)
value	0..1	Float	

6.2.46 Minutes datatype

Time in minutes.

Table 48 shows all attributes of Minutes.

Table 48 – Attributes of Domain::Minutes

name	mult	type	description
value	0..1	Float	
unit	0..1	UnitSymbol	(const=min)
multiplier	0..1	UnitMultiplier	(const=none)

6.2.47 Money datatype

Amount of money.

Table 49 shows all attributes of Money.

Table 49 – Attributes of Domain::Money

name	mult	type	description
multiplier	0..1	UnitMultiplier	
unit	0..1	Currency	
value	0..1	Decimal	

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6.2.48 MonthDay primitive

MonthDay format as "--mm-dd", which conforms with XSD data type gMonthDay.

6.2.49 MonthDayInterval compound

Interval between two times specified as month and day.

Table 50 shows all attributes of MonthDayInterval.

Table 50 – Attributes of Domain::MonthDayInterval

name	mult	type	description
end	0..1	MonthDay	End time of this interval.
start	0..1	MonthDay	Start time of this interval.

6.2.50 PU datatype

Per Unit – a positive or negative value referred to a defined base. Values typically range from -10 to +10.

Table 51 shows all attributes of PU.

Table 51 – Attributes of Domain::PU

name	mult	type	description
value	0..1	Float	
unit	0..1	UnitSymbol	(const=none)
multiplier	0..1	UnitMultiplier	(const=none)

6.2.51 PerCent datatype

Percentage on a defined base. For example, specify as 100 to indicate at the defined base.

Table 52 shows all attributes of PerCent.

Table 52 – Attributes of Domain::PerCent

name	mult	type	description
value	0..1	Float	Normally 0 to 100 on a defined base.
unit	0..1	UnitSymbol	(const=none)
multiplier	0..1	UnitMultiplier	(const=none)

6.2.52 Pressure datatype

Pressure in pascals.

Table 53 shows all attributes of Pressure.

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Table 53 – Attributes of Domain::Pressure

name	mult	type	description
value	0..1	Float	
unit	0..1	UnitSymbol	(const=Pa)
multiplier	0..1	UnitMultiplier	

6.2.53 Reactance datatype

Reactance (imaginary part of impedance), at rated frequency.

Table 54 shows all attributes of Reactance.

Table 54 – Attributes of Domain::Reactance

name	mult	type	description
value	0..1	Float	
unit	0..1	UnitSymbol	(const=ohm)
multiplier	0..1	UnitMultiplier	

6.2.54 ReactancePerLength datatype

Reactance (imaginary part of impedance) per unit of length, at rated frequency.

Table 55 shows all attributes of ReactancePerLength.

Table 55 – Attributes of Domain::ReactancePerLength

name	mult	type	description
multiplier	0..1	UnitMultiplier	(const=none)
unit	0..1	UnitSymbol	(const=ohmPerm)
value	0..1	Float	

6.2.55 ReactivePower datatype

Product of RMS value of the voltage and the RMS value of the quadrature component of the current.

Table 56 shows all attributes of ReactivePower.

Table 56 – Attributes of Domain::ReactivePower

name	mult	type	description
value	0..1	Float	
unit	0..1	UnitSymbol	(const=VAr)
multiplier	0..1	UnitMultiplier	

6.2.56 RealEnergy datatype

Real electrical energy.

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Table 57 shows all attributes of RealEnergy.

Table 57 – Attributes of Domain::RealEnergy

name	mult	type	description
multiplier	0..1	UnitMultiplier	
unit	0..1	UnitSymbol	(const=Wh)
value	0..1	Float	

6.2.57 Resistance datatype

Resistance (real part of impedance).

Table 58 shows all attributes of Resistance.

Table 58 – Attributes of Domain::Resistance

name	mult	type	description
value	0..1	Float	
unit	0..1	UnitSymbol	(const=ohm)
multiplier	0..1	UnitMultiplier	

6.2.58 ResistancePerLength datatype

Resistance (real part of impedance) per unit of length.

Table 59 shows all attributes of ResistancePerLength.

Table 59 – Attributes of Domain::ResistancePerLength

name	mult	type	description
multiplier	0..1	UnitMultiplier	(const=none)
unit	0..1	UnitSymbol	(const=ohmPerm)
value	0..1	Float	

6.2.59 RotationSpeed datatype

Number of revolutions per second.

Table 60 shows all attributes of RotationSpeed.

Table 60 – Attributes of Domain::RotationSpeed

name	mult	type	description
multiplier	0..1	UnitMultiplier	(const=none)
unit	0..1	UnitSymbol	(const=Hz)
value	0..1	Float	

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6.2.60 Seconds datatype

Time, in seconds.

Table 61 shows all attributes of Seconds.

Table 61 – Attributes of Domain::Seconds

name	mult	type	description
value	0..1	Float	Time, in seconds
unit	0..1	UnitSymbol	(const=s)
multiplier	0..1	UnitMultiplier	(const=none)

6.2.61 Speed datatype

Distance per unit of time.

Table 62 shows all attributes of Speed.

Table 62 – Attributes of Domain::Speed

name	mult	type	description
multiplier	0..1	UnitMultiplier	(const=none)
unit	0..1	UnitSymbol	(const=mPers)
value	0..1	Float	

6.2.62 String primitive

A string consisting of a sequence of characters. The character encoding is UTF-8. The string length is unspecified and unlimited.

6.2.63 StringQuantity compound

Quantity with string value (when it is not important whether it is an integral or a floating point number) and associated unit information.

Table 63 shows all attributes of StringQuantity.

Table 63 – Attributes of Domain::StringQuantity

name	mult	type	description
value	0..1	String	Value of this quantity.
unit	0..1	UnitSymbol	Unit of this quantity.
multiplier	0..1	UnitMultiplier	Unit multiplier of this quantity.

6.2.64 Susceptance datatype

Imaginary part of admittance.

Table 64 shows all attributes of Susceptance.

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Table 64 – Attributes of Domain::Susceptance

name	mult	type	description
value	0..1	Float	
unit	0..1	UnitSymbol	(const=S)
multiplier	0..1	UnitMultiplier	

6.2.65 SusceptancePerLength datatype

Imaginary part of admittance per unit of length.

Table 65 shows all attributes of SusceptancePerLength.

Table 65 – Attributes of Domain::SusceptancePerLength

name	mult	type	description
multiplier	0..1	UnitMultiplier	(const=none)
unit	0..1	UnitSymbol	(const=SPerm)
value	0..1	Float	

6.2.66 Temperature datatype

Value of temperature in degrees Celsius.

Table 66 shows all attributes of Temperature.

Table 66 – Attributes of Domain::Temperature

name	mult	type	description
multiplier	0..1	UnitMultiplier	(const=none)
unit	0..1	UnitSymbol	(const=degC)
value	0..1	Float	

6.2.67 Time primitive

Time as "hh:mm:ss.sss", which conforms with ISO 8601. UTC time zone is specified as "hh:mm:ss.sssZ". A local timezone relative UTC is specified as "hh:mm:ss.sss±hh:mm". The second component (shown here as "ss.sss") could have any number of digits in its fractional part to allow any kind of precision beyond seconds.

6.2.68 TimeInterval compound

Interval between two times.

Table 67 shows all attributes of TimeInterval.

Table 67 – Attributes of Domain::TimeInterval

name	mult	type	description
start	0..1	Time	Start time of this interval.
end	0..1	Time	End time of this interval.

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6.2.69 UnitMultiplier enumeration

The unit multipliers defined for the CIM. When applied to unit symbols, the unit symbol is treated as a derived unit. Regardless of the contents of the unit symbol text, the unit symbol shall be treated as if it were a single-character unit symbol. Unit symbols should not contain multipliers, and it should be left to the multiplier to define the multiple for an entire data type.

For example, if a unit symbol is "m2Pers" and the multiplier is "k", then the value is k(m**2/s), and the multiplier applies to the entire final value, not to any individual part of the value. This can be conceptualized by substituting a derived unit symbol for the unit type. If one imagines that the symbol "Þ" represents the derived unit "m2Pers", then applying the multiplier "k" can be conceptualized simply as "kÞ".

For example, the SI unit for mass is "kg" and not "g". If the unit symbol is defined as "kg", then the multiplier is applied to "kg" as a whole and does not replace the "k" in front of the "g". In this case, the multiplier of "m" would be used with the unit symbol of "kg" to represent one gram. As a text string, this violates the instructions in IEC 80000-1. However, because the unit symbol in CIM is treated as a derived unit instead of as an SI unit, it makes more sense to conceptualize the "kg" as if it were replaced by one of the proposed replacements for the SI mass symbol. If one imagines that the "kg" were replaced by a symbol "Þ", then it is easier to conceptualize the multiplier "m" as creating the proper unit "mÞ", and not the forbidden unit "mkg".

Table 68 shows all literals of UnitMultiplier.

Table 68 – Literals of Domain::UnitMultiplier

literal	value	description
y	-24	Yocto 10**-24.
z	-21	Zepto 10**-21.
a	-18	Atto 10**-18.
f	-15	Femto 10**-15.
p	-12	Pico 10**-12.
n	-9	Nano 10**-9.
micro	-6	Micro 10**-6.
m	-3	Milli 10**-3.
c	-2	Centi 10**-2.
d	-1	Deci 10**-1.
none	0	No multiplier or equivalently multiply by 1.
da	1	Deca 10**1.
h	2	Hecto 10**2.
k	3	Kilo 10**3.
M	6	Mega 10**6.
G	9	Giga 10**9.
T	12	Tera 10**12.
P	15	Peta 10**15.
E	18	Exa 10**18.
Z	21	Zetta 10**21.
Y	24	Yotta 10**24.

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6.2.70 UnitSymbol enumeration

The derived units defined for usage in the CIM. In some cases, the derived unit is equal to an SI unit. Whenever possible, the standard derived symbol is used instead of the formula for the derived unit. For example, the unit symbol Farad is defined as "F" instead of "CPerV". In cases where a standard symbol does not exist for a derived unit, the formula for the unit is used as the unit symbol. For example, density does not have a standard symbol and so it is represented as "kgPerm3". With the exception of the "kg", which is an SI unit, the unit symbols do not contain multipliers and therefore represent the base derived unit to which a multiplier can be applied as a whole.

Every unit symbol is treated as an unparseable text as if it were a single-letter symbol. The meaning of each unit symbol is defined by the accompanying descriptive text and not by the text contents of the unit symbol.

To allow the widest possible range of serializations without requiring special character handling, several substitutions are made which deviate from the format described in IEC 80000-1. The division symbol "/" is replaced by the letters "Per". Exponents are written in plain text after the unit as "m3" instead of being formatted as "m" with a superscript of 3 or introducing a symbol as in "m^3". The degree symbol "°" is replaced with the letters "deg". Any clarification of the meaning for a substitution is included in the description for the unit symbol.

Non-SI units are included in list of unit symbols to allow sources of data to be correctly labelled with their non-SI units (for example, a GPS sensor that is reporting numbers that represent feet instead of meters). This allows software to use the unit symbol information correctly convert and scale the raw data of those sources into SI-based units.

The integer values are used for harmonization with IEC 61850.

Table 69 shows all literals of UnitSymbol.

Table 69 – Literals of Domain::UnitSymbol

literal	value	description
none	0	Dimension less quantity, e.g. count, per unit, etc.
m	2	Length in metres.
kg	3	Mass in kilograms. Note: multiplier “k” is included in this unit symbol for compatibility with IEC 61850-7-3.
s	4	Time in seconds.
A	5	Current in amperes.
K	6	Temperature in kelvins.
mol	7	Amount of substance in moles.
cd	8	Luminous intensity in candelas.
deg	9	Plane angle in degrees.
rad	10	Plane angle in radians (m/m).
sr	11	Solid angle in steradians (m^2/m^2).
Gy	21	Absorbed dose in grays (J/kg).
Bq	22	Radioactivity in becquerels (1/s).
degC	23	Relative temperature in degrees Celsius. In the SI unit system the symbol is °C. Electric charge is measured in coulomb that has the unit symbol C. To distinguish degree Celsius from coulomb the symbol used in the UML is degC. The reason for not using °C is that the special character ° is difficult to manage in software.

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literal	value	description
Sv	24	Dose equivalent in sieverts (J/kg).
F	25	Electric capacitance in farads (C/V).
C	26	Electric charge in coulombs (A·s).
S	27	Conductance in siemens.
H	28	Electric inductance in henrys (Wb/A).
V	29	Electric potential in volts (W/A).
ohm	30	Electric resistance in ohms (V/A).
J	31	Energy in joules (N·m = C·V = W·s).
N	32	Force in newtons (kg·m/s^2).
Hz	33	Frequency in hertz (1/s).
lx	34	Illuminance in lux (lm/m^2).
lm	35	Luminous flux in lumens (cd·sr).
Wb	36	Magnetic flux in webers (V·s).
T	37	Magnetic flux density in teslas (Wb/m^2).
W	38	Real power in watts (J/s). Electrical power may have real and reactive components. The real portion of electrical power (I^{2}R or VIcos(phi)), is expressed in Watts. See also apparent power and reactive power.
Pa	39	Pressure in pascals (N/m^2). Note: the absolute or relative measurement of pressure is implied with this entry. See below for more explicit forms.
m2	41	Area in square metres (m^2).
m3	42	Volume in cubic metres (m^3).
mPers	43	Velocity in metres per second (m/s).
mPers2	44	Acceleration in metres per second squared (m/s^2).
m3Pers	45	Volumetric flow rate in cubic metres per second (m^3/s).
mPerm3	46	Fuel efficiency in metres per cubic metres (m/m^3).
kgm	47	Moment of mass in kilogram metres (kg·m) (first moment of mass). Note: multiplier “k” is included in this unit symbol for compatibility with IEC 61850-7-3.
kgPerm3	48	Density in kilogram/cubic metres (kg/m^3). Note: multiplier “k” is included in this unit symbol for compatibility with IEC 61850-7-3.
m2Pers	49	Viscosity in square metres / second (m^2/s).
WPermK	50	Thermal conductivity in watt/metres kelvin.
JPerK	51	Heat capacity in joules/kelvin.
ppm	52	Concentration in parts per million.
rotPers	53	Rotations per second (1/s). See also Hz (1/s).
radPers	54	Angular velocity in radians per second (rad/s).
WPerm2	55	Heat flux density, irradiance, watts per square metre.
JPerm2	56	Insulation energy density, joules per square metre or watt second per square metre.
SPerm	57	Conductance per length (F/m).

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literal	value	description
KPers	58	Temperature change rate in kelvins per second.
PaPers	59	Pressure change rate in pascals per second.
JPerkgK	60	Specific heat capacity, specific entropy, joules per kilogram Kelvin.
VA	61	Apparent power in volt amperes. See also real power and reactive power.
VAr	63	Reactive power in volt amperes reactive. The “reactive” or “imaginary” component of electrical power (VIsin(phi)). (See also real power and apparent power). Note: Different meter designs use different methods to arrive at their results. Some meters may compute reactive power as an arithmetic value, while others compute the value vectorially. The data consumer should determine the method in use and the suitability of the measurement for the intended purpose.
cosPhi	65	Power factor, dimensionless. NOTE 1 This definition of power factor only holds for balanced systems. See the alternative definition under code 153. NOTE 2 Beware of differing sign conventions in use between the IEC and EEI. It is assumed that the data consumer understands the type of meter in use and the sign convention in use by the utility.
Vs	66	Volt seconds (Ws/A).
V2	67	Volt squared (W^2/A^2).
As	68	Ampere seconds (A·s).
A2	69	Amperes squared (A^2).
A2s	70	Ampere squared time in square amperes (A^2s).
VAh	71	Apparent energy in volt ampere hours.
Wh	72	Real energy in watt hours.
VArh	73	Reactive energy in volt ampere reactive hours.
VPerHz	74	Magnetic flux in volt per hertz.
HzPers	75	Rate of change of frequency in hertz per second.
character	76	Number of characters.
charPers	77	Data rate (baud) in characters per second.
kgm2	78	Moment of mass in kilogram square metres ($kg·m^2$) (Second moment of mass, commonly called the moment of inertia). Note: multiplier “k” is included in this unit symbol for compatibility with IEC 61850-7-3.
dB	79	Sound pressure level in decibels. Note: multiplier “d” is included in this unit symbol for compatibility with IEC 61850-7-3.
WPers	81	Ramp rate in watts per second.
lPers	82	Volumetric flow rate in litres per second.
dBm	83	Power level (logarithmic ratio of signal strength, Bel-mW), normalized to 1mW. Note: multiplier “d” is included in this unit symbol for compatibility with IEC 61850-7-3.
h	84	Time in hours, hour = 60 min = 3600 s.
min	85	Time in minutes, minute = 60 s.
Q	100	Quantity power, Q.

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literal	value	description
Qh	101	Quantity energy, Qh.
ohmm	102	Resistivity, ohm metres, (rho).
APerm	103	A/m, magnetic field strength, amperes per metre.
V2h	104	Volt-squared hour, volt-squared-hours.
A2h	105	Ampere-squared hour, ampere-squared hour.
Ah	106	Ampere-hours, ampere-hours.
count	111	Amount of substance, Counter value.
ft3	119	Volume, cubic feet.
m3Perh	125	Volumetric flow rate, cubic metres per hour.
gal	128	Volume in gallons, US gallon (1 gal = 231 in3 = 128 fl ounce).
Btu	132	Energy, British Thermal Units.
l	134	Volume in litres, litre = dm^3 = m^3/1 000.
lPerh	137	Volumetric flow rate, litres per hour.
lPerl	143	Concentration, The ratio of the volume of a solute divided by the volume of the solution. Note: Users may need use a prefix such a ‘µ’ to express a quantity such as ‘µL/L’.
gPerg	144	Concentration, The ratio of the mass of a solute divided by the mass of the solution. Note: Users may need use a prefix such a ‘µ’ to express a quantity such as ‘µg/g’.
molPerm3	145	Concentration, The amount of substance concentration, (c), the amount of solvent in moles divided by the volume of solution in m^3.
molPermol	146	Concentration, Molar fraction, the ratio of the molar amount of a solute divided by the molar amount of the solution.
molPerkg	147	Concentration, Molality, the amount of solute in moles and the amount of solvent in kilograms.
sPers	149	Time, Ratio of time. Note: Users may need to supply a prefix such as ‘µ’ to show rates such as ‘µs/s’.
HzPerHz	150	Frequency, rate of frequency change. Note: Users may need to supply a prefix such as ‘m’ to show rates such as ‘mHz/Hz’.
VPerV	151	Voltage, ratio of voltages. Note: Users may need to supply a prefix such as ‘m’ to show rates such as ‘mV/V’.
APerA	152	Current, ratio of amperages. Note: Users may need to supply a prefix such as ‘m’ to show rates such as ‘mA/A’.
VPerVA	153	Power factor, PF, the ratio of the active power to the apparent power. Note: The sign convention used for power factor will differ between IEC meters and EEI (ANSI) meters. It is assumed that the data consumers understand the type of meter being used and agree on the sign convention in use at any given utility.
rev	154	Amount of rotation, revolutions.
kat	158	Catalytic activity, katal = mol / s.
JPerkg	165	Specific energy, Joules / kg.
m3Uncompensated	166	Volume, cubic metres, with the value uncompensated for weather effects.

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literal	value	description
m3Compensated	167	Volume, cubic metres, with the value compensated for weather effects.
WPerW	168	Signal Strength, ratio of power. Note: Users may need to supply a prefix such as 'm' to show rates such as 'mW/W'.
therm	169	Energy, therms.
onePerm	173	Wavenumber, reciprocal metres, (1/m).
m3Perkg	174	Specific volume, cubic metres per kilogram, v.
Pas	175	Dynamic viscosity, pascal seconds.
Nm	176	Moment of force, newton metres.
NPerm	177	Surface tension, newton per metre.
radPers2	178	Angular acceleration, radians per second squared.
JPerm3	181	Energy density, joules per cubic metre.
VPerm	182	Electric field strength, volts per metre.
CPerm3	183	Electric charge density, coulombs per cubic metre.
CPerm2	184	Surface charge density, coulombs per square metre.
FPerm	185	Permittivity, farads per metre.
HPerm	186	Permeability, henrys per metre.
JPermol	187	Molar energy, joules per mole.
JPermolK	188	Molar entropy, molar heat capacity, joules per mole kelvin.
CPerkg	189	Exposure (x rays), coulombs per kilogram.
GyPers	190	Absorbed dose rate, grays per second.
WPersr	191	Radiant intensity, watts per steradian.
WPerm2sr	192	Radiance, watts per square metre steradian.
katPerm3	193	Catalytic activity concentration, katals per cubic metre.
d	195	Time in days, day = 24 h = 86 400 s.
anglemin	196	Plane angle, minutes.
anglesec	197	Plane angle, seconds.
ha	198	Area, hectares.
tonne	199	Mass in tons, "tonne" or "metric ton" (1000 kg = 1 Mg).
bar	214	Pressure in bars, (1 bar = 100 kPa).
mmHg	215	Pressure, millimetres of mercury (1 mmHg is approximately 133.3 Pa).
M	217	Length, nautical miles (1 M = 1 852 m).
kn	219	Speed, knots (1 kn = 1 852/3 600) m/s.
Mx	276	Magnetic flux, maxwells (1 Mx = 10-8 Wb).
G	277	Magnetic flux density, gausses (1 G = 10-4 T).
Oe	278	Magnetic field in oersteds, (1 Oe = (103/4p) A/m).
Vh	280	Volt-hour, Volt hours.
WPerA		Active power per current flow, watts per Ampere.
onePerHz		Reciprocal of frequency (1/Hz).

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literal	value	description
VPerVAr		Power factor, PF, the ratio of the active power to the apparent power. Note: The sign convention used for power factor will differ between IEC meters and EEI (ANSI) meters. It is assumed that the data consumers understand the type of meter being used and agree on the sign convention in use at any given utility.
ohmPerm	86	Electric resistance per length in ohms per metre ((V/A)/m).
kgPerJ		Weight per energy in kilograms per joule (kg/J). Note: multiplier “k” is included in this unit symbol for compatibility with IEC 61850-7-3.
JPers		Energy rate in joules per second (J/s).

6.2.71 Voltage datatype

Electrical voltage, can be both AC and DC.

Table 70 shows all attributes of Voltage.

Table 70 – Attributes of Domain::Voltage

name	mult	type	description
multiplier	0..1	UnitMultiplier	
unit	0..1	UnitSymbol	(const=V)
value	0..1	Float	

6.2.72 VoltagePerReactivePower datatype

Voltage variation with reactive power.

Table 71 shows all attributes of VoltagePerReactivePower.

Table 71 – Attributes of Domain::VoltagePerReactivePower

name	mult	type	description
multiplier	0..1	UnitMultiplier	
unit	0..1	UnitSymbol	(const=VPerVAr)
value	0..1	Float	

6.2.73 Volume datatype

Volume.

Table 72 shows all attributes of Volume.

Table 72 – Attributes of Domain::Volume

name	mult	type	description
value	0..1	Float	
unit	0..1	UnitSymbol	(const=m3)
multiplier	0..1	UnitMultiplier	

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6.2.74 VolumeFlowRate datatype

Volume per time.

Table 73 shows all attributes of VolumeFlowRate.

Table 73 – Attributes of Domain::VolumeFlowRate

name	mult	type	description
multiplier	0..1	UnitMultiplier	(const=none)
unit	0..1	UnitSymbol	(const=m3Pers)
value	0..1	Float	

6.2.75 WaterLevel datatype

Reservoir water level referred to a given datum such as mean sea level.

Table 74 shows all attributes of WaterLevel.

Table 74 – Attributes of Domain::WaterLevel

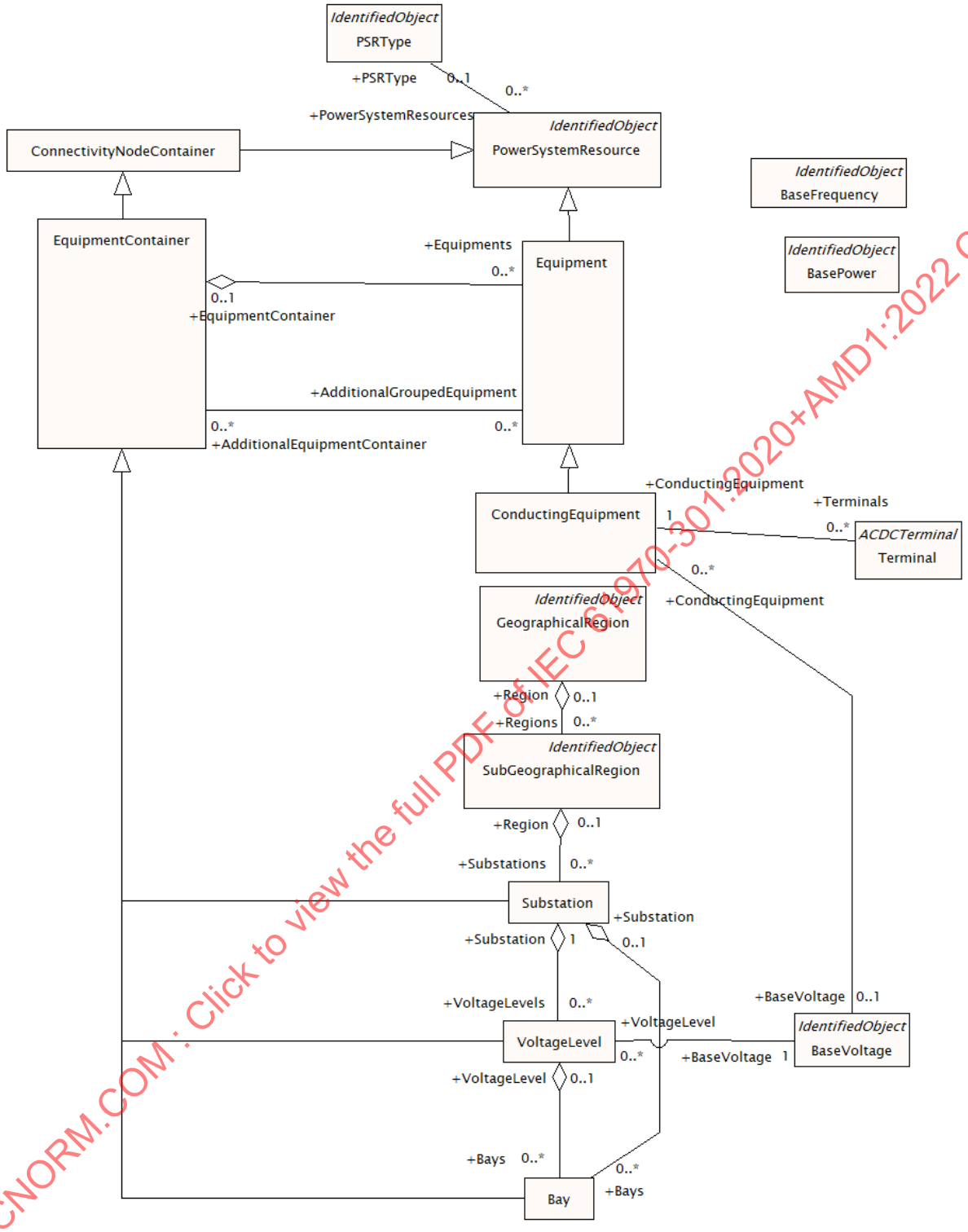
name	mult	type	description
value	0..1	Float	
unit	0..1	UnitSymbol	(const=m)
multiplier	0..1	UnitMultiplier	

6.3 Package Core

6.3.1 General

Contains the core PowerSystemResource and ConductingEquipment entities shared by all applications plus common collections of those entities. Not all applications require all the Core entities. This package does not depend on any other package except the Domain package, but most of the other packages have associations and generalizations that depend on it.

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Figure 79 – Class diagram Core::Main

Figure 79: This diagram shows the main classes needed for any application of the CIM for modelling transmission and generation systems.

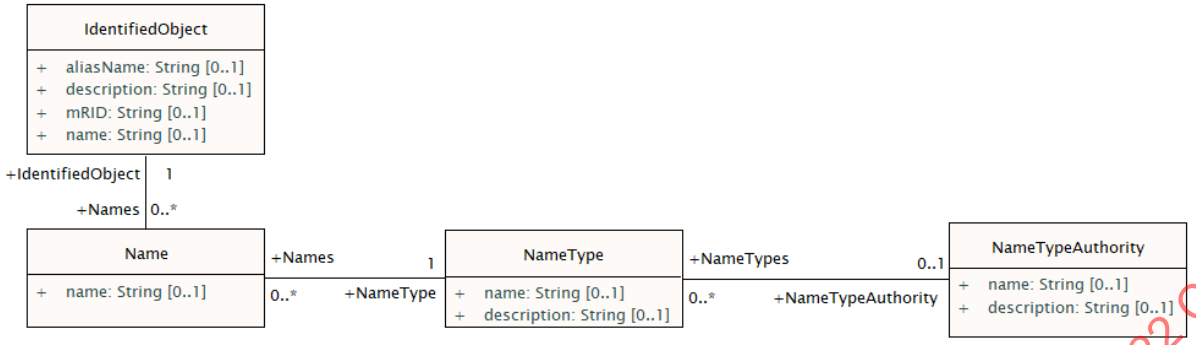


Figure 80 – Class diagram Core::Names

Figure 80: This diagram shows classes used to assign names to identified objects.

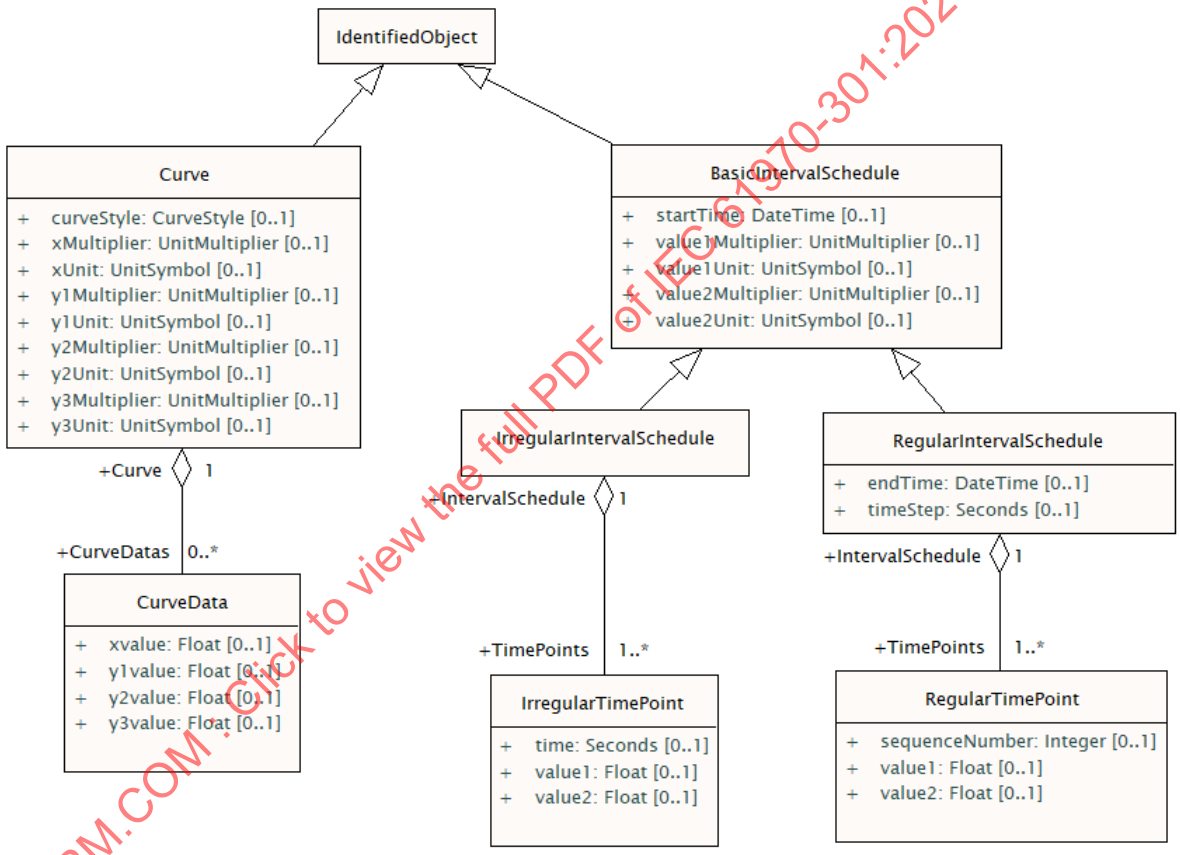


Figure 81 – Class diagram Core::CurveSchedule

Figure 81: This diagram shows the common model for curves and time dependent schedules.

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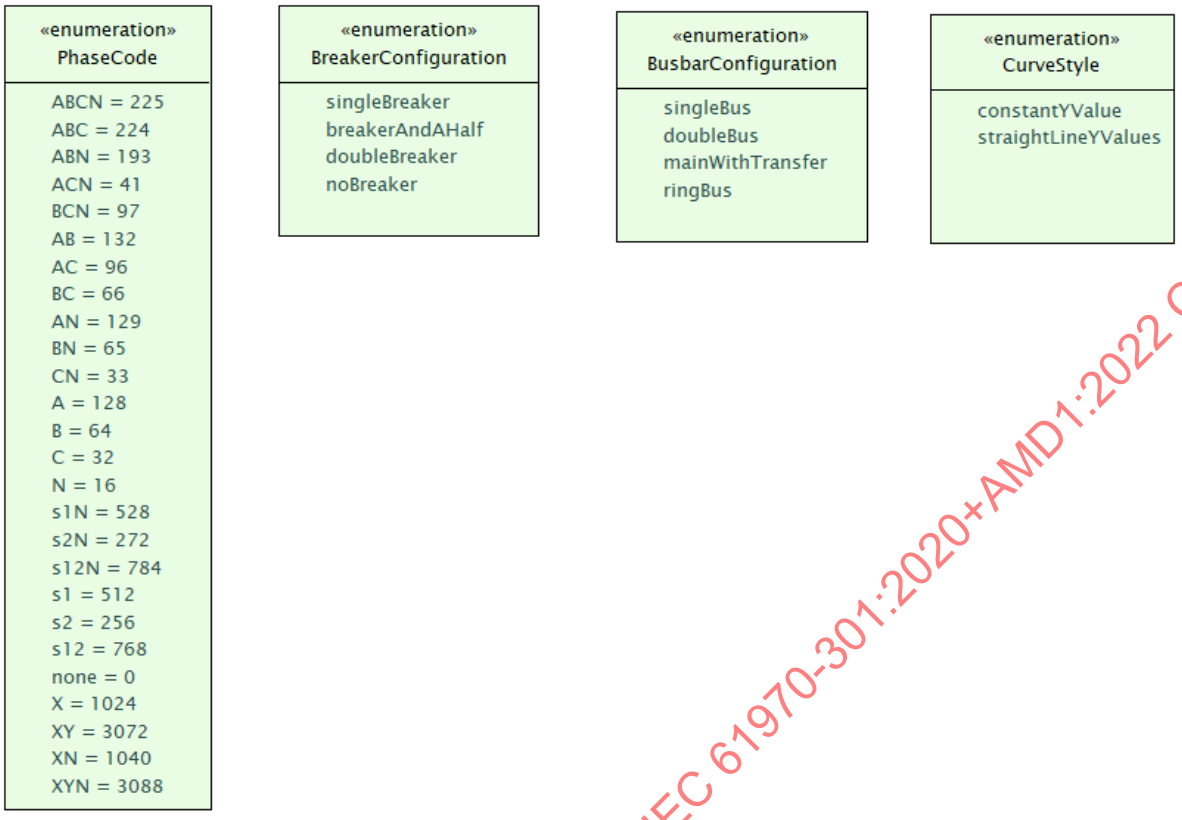


Figure 82 – Class diagram Core::Datatypes

Figure 82: This diagram shows the data types specific to the Core package.

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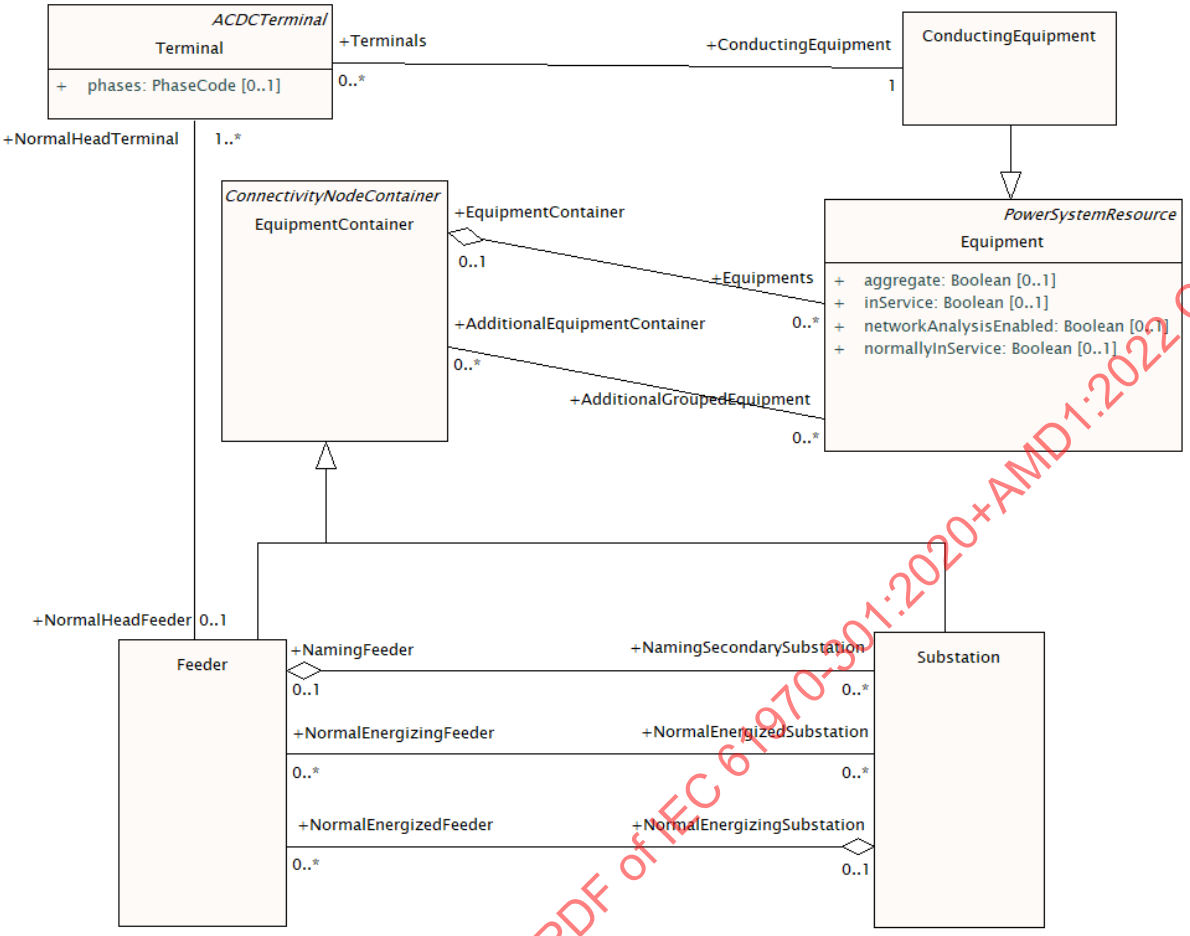


Figure 83 – Class diagram Core::FeederContainment

Figure 83: This diagram shows feeder containment.

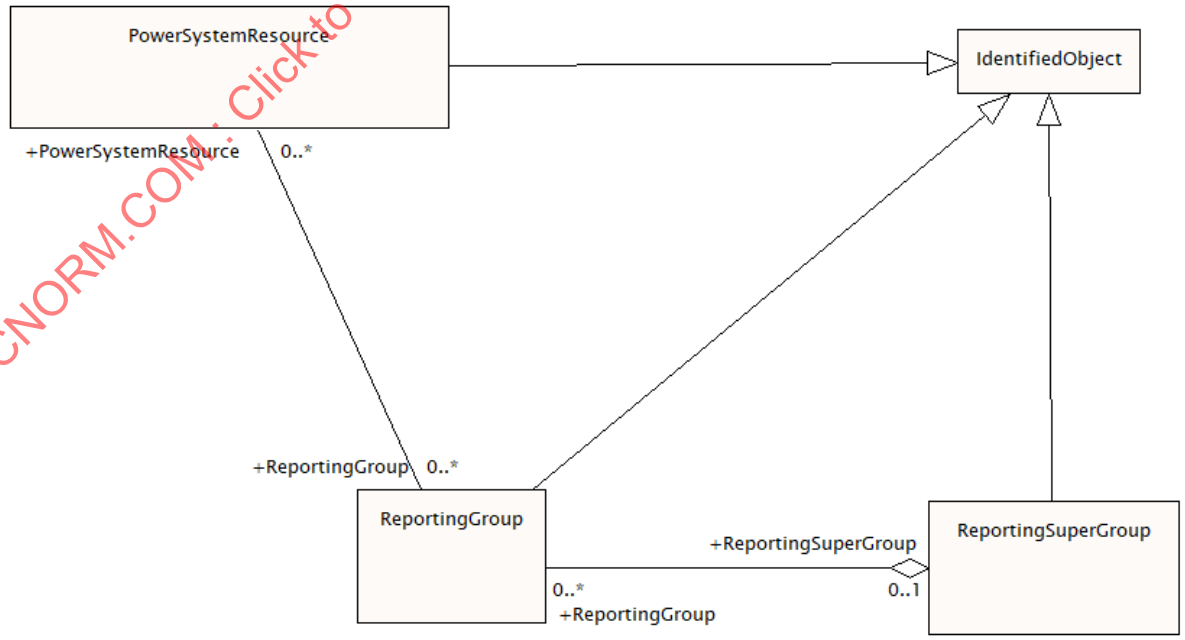


Figure 84 – Class diagram Core::Reporting

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Figure 84: This diagram shows the common model for ad-hoc reporting.

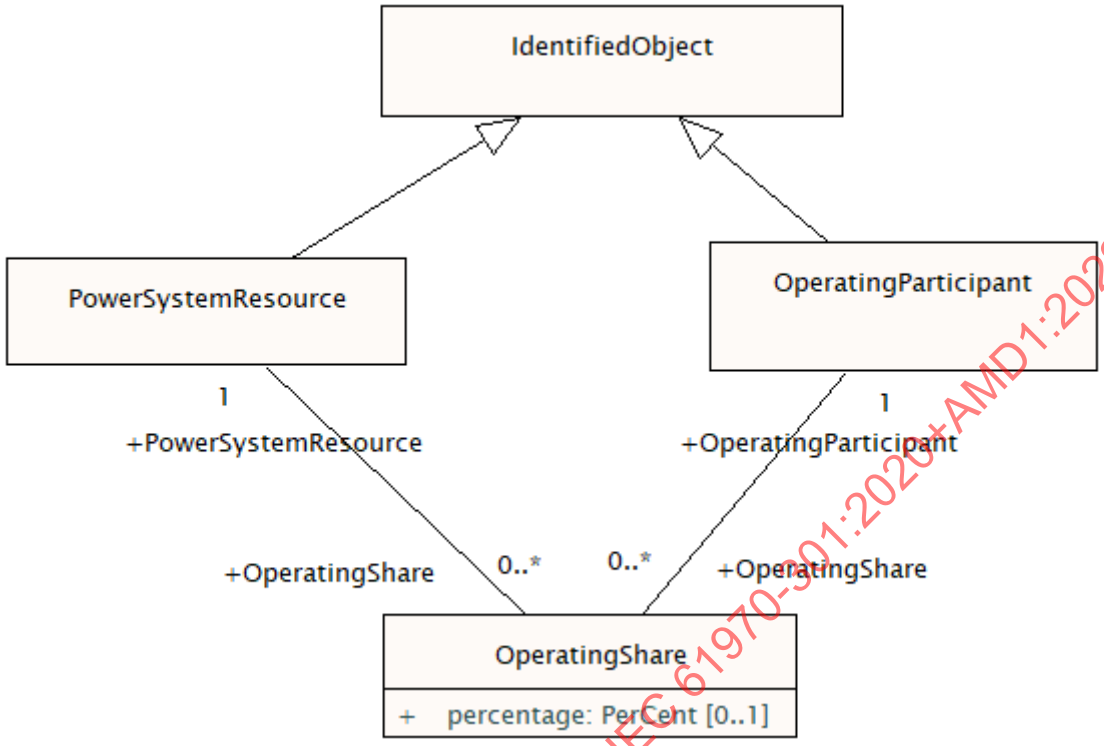


Figure 85 – Class diagram Core::OperatingShare

Figure 85: This diagram shows the common model for operating share.

6.3.2 ACDCTerminal

An electrical connection point (AC or DC) to a piece of conducting equipment. Terminals are connected at physical connection points called connectivity nodes.

Table 75 shows all attributes of ACDCTerminal.

Table 75 – Attributes of Core::ACDCTerminal

name	mult	type	description
connected	0..1	Boolean	The connected status is related to a bus-branch model and the topological node to terminal relation. True implies the terminal is connected to the related topological node and false implies it is not. In a bus-branch model, the connected status is used to tell if equipment is disconnected without having to change the connectivity described by the topological node to terminal relation. A valid case is that conducting equipment can be connected in one end and open in the other. In particular for an AC line segment, where the reactive line charging can be significant, this is a relevant case.
sequenceNumber	0..1	Integer	The orientation of the terminal connections for a multiple terminal conducting equipment. The sequence numbering starts with 1 and additional terminals should follow in increasing order. The

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name	mult	type	description
			first terminal is the "starting point" for a two terminal branch.
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 76 shows all association ends of ACDCTerminal with other classes.

Table 76 – Association ends of Core::ACDCTerminal with other classes

mult from	name	mult to	type	description
1..*	BusNameMarker	0..1	BusNameMarker	The bus name marker used to name the bus (topological node).
0..1	OperationalLimitSet	0..*	OperationalLimitSet	The operational limit sets at the terminal.
0..1	Measurements	0..*	Measurement	Measurements associated with this terminal defining where the measurement is placed in the network topology. It may be used, for instance, to capture the sensor position, such as a voltage transformer (PT) at a busbar or a current transformer (CT) at the bar between a breaker and an isolator.
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.3.3 BaseFrequency

The BaseFrequency class describes a base frequency for a power system network. In case of multiple power networks with different frequencies, e.g. 50 Hz or 60 Hz each network will have its own base frequency class. Hence it is assumed that power system objects having different base frequencies appear in separate documents where each document has a single base frequency instance.

Table 77 shows all attributes of BaseFrequency.

Table 77 – Attributes of Core::BaseFrequency

name	mult	type	description
frequency	0..1	Frequency	The base frequency.
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 78 shows all association ends of BaseFrequency with other classes.

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Table 78 – Association ends of Core::BaseFrequency with other classes

mult from	name	mult to	type	description
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.3.4 BasePower

The BasePower class defines the base power used in the per unit calculations.

Table 79 shows all attributes of BasePower.

Table 79 – Attributes of Core::BasePower

name	mult	type	description
basePower	0..1	ApparentPower	Value used as base power.
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 80 shows all association ends of BasePower with other classes.

Table 80 – Association ends of Core::BasePower with other classes

mult from	name	mult to	type	description
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.3.5 BaseVoltage

Defines a system base voltage which is referenced.

Table 81 shows all attributes of BaseVoltage.

Table 81 – Attributes of Core::BaseVoltage

name	mult	type	description
nominalVoltage	0..1	Voltage	The power system resource's base voltage. Shall be a positive value and not zero.
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 82 shows all association ends of BaseVoltage with other classes.

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Table 82 – Association ends of Core::BaseVoltage with other classes

mult from	name	mult to	type	description
0..1	ConductingEquipment	0..*	ConductingEquipment	All conducting equipment with this base voltage. Use only when there is no voltage level container used and only one base voltage applies. For example, not used for transformers.
1..1	VoltageLevel	0..*	VoltageLevel	The voltage levels having this base voltage.
0..1	TransformerEnds	0..*	TransformerEnd	Transformer ends at the base voltage. This is essential for PU calculation.
0..1	TopologicalNode	0..*	TopologicalNode	The topological nodes at the base voltage.
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.3.6 BasicIntervalSchedule

Schedule of values at points in time.

Table 83 shows all attributes of BasicIntervalSchedule.

Table 83 – Attributes of Core::BasicIntervalSchedule

name	mult	type	description
startTime	0..1	DateTime	The time for the first time point. The value can be a time of day, not a specific date.
value1Multiplier	0..1	UnitMultiplier	Multiplier for value1.
value1Unit	0..1	UnitSymbol	Value1 units of measure.
value2Multiplier	0..1	UnitMultiplier	Multiplier for value2.
value2Unit	0..1	UnitSymbol	Value2 units of measure.
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 84 shows all association ends of BasicIntervalSchedule with other classes.

Table 84 – Association ends of Core::BasicIntervalSchedule with other classes

mult from	name	mult to	type	description
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.3.7 Bay

A collection of power system resources (within a given substation) including conducting equipment, protection relays, measurements, and telemetry. A bay typically represents a physical grouping related to modularization of equipment.

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Table 85 shows all attributes of Bay.

Table 85 – Attributes of Core::Bay

name	mult	type	description
bayEnergyMeasFlag	0..1	Boolean	Indicates the presence/absence of energy measurements.
bayPowerMeasFlag	0..1	Boolean	Indicates the presence/absence of active/reactive power measurements.
breakerConfiguration	0..1	BreakerConfiguration	Breaker configuration.
busBarConfiguration	0..1	BusbarConfiguration	Busbar configuration.
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 86 shows all association ends of Bay with other classes.

Table 86 – Association ends of Core::Bay with other classes

mult from	name	mult to	type	description
0..*	Substation	0..1	Substation	Substation containing the bay.
0..*	VoltageLevel	0..1	VoltageLevel	The voltage level containing this bay.
0..1	Equipments	0..*	Equipment	inherited from: EquipmentContainer
0..*	AdditionalGroupedEquipment	0..*	Equipment	inherited from: EquipmentContainer
1..1	ConnectivityNodes	0..*	ConnectivityNode	inherited from: ConnectivityNodeContainer
0..1	TopologicalNode	0..*	TopologicalNode	inherited from: ConnectivityNodeContainer
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.3.8 BreakerConfiguration enumeration

Switching arrangement for bay.

Table 87 shows all literals of BreakerConfiguration.

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Table 87 – Literals of Core::BreakerConfiguration

literal	value	description
singleBreaker		Single breaker.
breakerAndAHalf		Breaker and a half.
doubleBreaker		Double breaker.
noBreaker		No breaker.

6.3.9 BusbarConfiguration enumeration

Busbar layout for bay.

Table 88 shows all literals of BusbarConfiguration.

Table 88 – Literals of Core::BusbarConfiguration

literal	value	description
singleBus		Single bus.
doubleBus		Double bus.
mainWithTransfer		Main bus with transfer bus.
ringBus		Ring bus.

6.3.10 ConductingEquipment

The parts of the AC power system that are designed to carry current or that are conductively connected through terminals.

Table 89 shows all attributes of ConductingEquipment.

Table 89 – Attributes of Core::ConductingEquipment

name	mult	type	description
aggregate	0..1	Boolean	inherited from: Equipment
inService	0..1	Boolean	inherited from: Equipment
networkAnalysisEnabled	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 90 shows all association ends of ConductingEquipment with other classes.

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Table 90 – Association ends of Core::ConductingEquipment with other classes

mult from	name	mult to	type	description
0..*	BaseVoltage	0..1	BaseVoltage	Base voltage of this conducting equipment. Use only when there is no voltage level container used and only one base voltage applies. For example, not used for transformers.
1..1	SvStatus	0..*	SvStatus	The status state variable associated with this conducting equipment.
0..*	ProtectionEquipments	0..*	ProtectionEquipment	Protection equipment used to protect specific conducting equipment.
1..1	Terminals	0..*	Terminal	Conducting equipment have terminals that may be connected to other conducting equipment terminals via connectivity nodes or topological nodes.
0..1	OperationalLimitSet	0..*	OperationalLimitSet	inherited from: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	inherited from: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment
0..1	Faults	0..*	Fault	inherited from: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	inherited from: Equipment
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.3.11 ConnectivityNode

Connectivity nodes are points where terminals of AC conducting equipment are connected together with zero impedance.

Table 91 shows all attributes of ConnectivityNode.

Table 91 – Attributes of Core::ConnectivityNode

name	mult	type	description
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 92 shows all association ends of ConnectivityNode with other classes.

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Table 92 – Association ends of Core::ConnectivityNode with other classes

mult from	name	mult to	type	description
0..*	TopologicalNode	0..1	TopologicalNode	The topological node to which this connectivity node is assigned. May depend on the current state of switches in the network.
0..*	ConnectivityNodeContainer	1..1	ConnectivityNodeContainer	Container of this connectivity node.
0..1	Terminals	0..*	Terminal	Terminals interconnected with zero impedance at this connectivity node.
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.3.12 ConnectivityNodeContainer

A base class for all objects that may contain connectivity nodes or topological nodes.

Table 93 shows all attributes of ConnectivityNodeContainer.

Table 93 – Attributes of Core::ConnectivityNodeContainer

name	mult	type	description
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 94 shows all association ends of ConnectivityNodeContainer with other classes.

Table 94 – Association ends of Core::ConnectivityNodeContainer with other classes

mult from	name	mult to	type	description
1..1	ConnectivityNodes	0..*	ConnectivityNode	Connectivity nodes which belong to this connectivity node container.
0..1	TopologicalNode	0..*	TopologicalNode	The topological nodes which belong to this connectivity node container.
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..*	Controls	0..*	Control	inherited from: PowerSystemResource
0..*	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.3.13 Curve

A multi-purpose curve or functional relationship between an independent variable (X-axis) and dependent (Y-axis) variables.

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Table 95 shows all attributes of Curve.

Table 95 – Attributes of Core::Curve

name	mult	type	description
curveStyle	0..1	CurveStyle	The style or shape of the curve.
xMultiplier	0..1	UnitMultiplier	Multiplier for X-axis.
xUnit	0..1	UnitSymbol	The X-axis units of measure.
y1Multiplier	0..1	UnitMultiplier	Multiplier for Y1-axis.
y1Unit	0..1	UnitSymbol	The Y1-axis units of measure.
y2Multiplier	0..1	UnitMultiplier	Multiplier for Y2-axis.
y2Unit	0..1	UnitSymbol	The Y2-axis units of measure.
y3Multiplier	0..1	UnitMultiplier	Multiplier for Y3-axis.
y3Unit	0..1	UnitSymbol	The Y3-axis units of measure.
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 96 shows all association ends of Curve with other classes.

Table 96 – Association ends of Core::Curve with other classes

mult from	name	mult to	type	description
1..1	CurveDatas	0..*	CurveData	The point data values that define this curve.
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.3.14 CurveData root class

Multi-purpose data points for defining a curve. The use of this generic class is discouraged if a more specific class can be used to specify the X and Y axis values along with their specific data types.

Table 97 shows all attributes of CurveData.

Table 97 – Attributes of Core::CurveData

name	mult	type	description
xvalue	0..1	Float	The data value of the X-axis variable, depending on the X-axis units.
y1value	0..1	Float	The data value of the first Y-axis variable, depending on the Y-axis units.
y2value	0..1	Float	The data value of the second Y-axis variable (if present), depending on the Y-axis units.
y3value	0..1	Float	The data value of the third Y-axis variable (if present), depending on the Y-axis units.

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Table 98 shows all association ends of CurveData with other classes.

Table 98 – Association ends of Core::CurveData with other classes

mult from	name	mult to	type	description
0..*	Curve	1..1	Curve	The curve of this curve data point.

6.3.15 CurveStyle enumeration

Style or shape of curve.

Table 99 shows all literals of CurveStyle.

Table 99 – Literals of Core::CurveStyle

literal	value	description
constantYValue		The Y-axis values are assumed constant until the next curve point and prior to the first curve point.
straightLineYValues		The Y-axis values are assumed to be a straight line between values. Also known as linear interpolation.

6.3.16 Equipment

The parts of a power system that are physical devices, electronic or mechanical.

Table 100 shows all attributes of Equipment.

Table 100 – Attributes of Core::Equipment

name	mult	type	description
aggregate	0..1	Boolean	The aggregate flag provides an alternative way of representing an aggregated (equivalent) element. It is applicable in cases when the dedicated classes for equivalent equipment do not have all of the attributes necessary to represent the required level of detail. In case the flag is set to “true” the single instance of equipment represents multiple pieces of equipment that have been modelled together as an aggregate equivalent obtained by a network reduction procedure. Examples would be power transformers or synchronous machines operating in parallel modelled as a single aggregate power transformer or aggregate synchronous machine. The attribute is not used for EquivalentBranch, EquivalentShunt and EquivalentInjection.
inService	0..1	Boolean	Specifies the availability of the equipment. True means the equipment is available for topology processing, which determines if the equipment is energized or not. False means that the equipment is treated by network applications as if it is not in the model.
networkAnalysisEnabled	0..1	Boolean	The equipment is enabled to participate in network analysis. If unspecified, the value is assumed to be true.

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name	mult	type	description
normallyInService	0..1	Boolean	Specifies the availability of the equipment under normal operating conditions. True means the equipment is available for topology processing, which determines if the equipment is energized or not. False means that the equipment is treated by network applications as if it is not in the model.
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 101 shows all association ends of Equipment with other classes.

Table 101 – Association ends of Core::Equipment with other classes

mult from	name	mult to	type	description
0..1	OperationalLimitSet	0..*	OperationalLimitSet	The operational limit sets associated with this equipment.
1..1	ContingencyEquipment	0..*	ContingencyEquipment	The contingency equipments in which this equipment participates.
0..*	EquipmentContainer	0..1	EquipmentContainer	Container of this equipment.
0..1	Faults	0..*	Fault	All faults on this equipment.
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	Additional equipment container beyond the primary equipment container. The equipment is contained in another equipment container, but also grouped with this equipment container.
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.3.17 EquipmentContainer

A modelling construct to provide a root class for containing equipment.

Table 102 shows all attributes of EquipmentContainer.

Table 102 – Attributes of Core::EquipmentContainer

name	mult	type	description
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

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Table 103 shows all association ends of EquipmentContainer with other classes.

Table 103 – Association ends of Core::EquipmentContainer with other classes

mult from	name	mult to	type	description
0..1	Equipments	0..*	Equipment	Contained equipment.
0..*	AdditionalGroupedEquipment	0..*	Equipment	The additonal contained equipment. The equipment belong to the equipment container. The equipment is contained in another equipment container, but also grouped with this equipment container. Examples include when a switch contained in a substation is also desired to be grouped with a line container or when a switch is included in a secondary substation and also grouped in a feeder.
1..1	ConnectivityNodes	0..*	ConnectivityNode	inherited from: ConnectivityNodeContainer
0..1	TopologicalNode	0..*	TopologicalNode	inherited from: ConnectivityNodeContainer
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.3.18 Feeder

A collection of equipment for organizational purposes, used for grouping distribution resources.

The organization a feeder does not necessarily reflect connectivity or current operation state.

Table 104 shows all attributes of Feeder.

Table 104 – Attributes of Core::Feeder

name	mult	type	description
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 105 shows all association ends of Feeder with other classes.

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Table 105 – Association ends of Core::Feeder with other classes

mult from	name	mult to	type	description
0..*	NormalEnergizingSubstation	0..1	Substation	The substation that nominally energizes the feeder. Also used for naming purposes.
0..1	NamingSecondarySubstation	0..*	Substation	The secondary substations that are normally energized from the feeder. Used for naming purposes. Should be consistent with the other associations for energizing terminal specification and the feeder energization specification.
0..1	NormalHeadTerminal	1..*	Terminal	The normal head terminal or terminals of the feeder.
0..*	NormalEnergizedSubstation	0..*	Substation	The substations that are normally energized by the feeder.
0..1	Equipments	0..*	Equipment	inherited from: EquipmentContainer
0..*	AdditionalGroupedEquipment	0..*	Equipment	inherited from: EquipmentContainer
1..1	ConnectivityNodes	0..*	ConnectivityNode	inherited from: ConnectivityNodeContainer
0..1	TopologicalNode	0..*	TopologicalNode	inherited from: ConnectivityNodeContainer
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.3.19 GeographicalRegion

A geographical region of a power system network model.

Table 106 shows all attributes of GeographicalRegion.

Table 106 – Attributes of Core::GeographicalRegion

name	mult	type	description
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 107 shows all association ends of GeographicalRegion with other classes.

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Table 107 – Association ends of Core::GeographicalRegion with other classes

mult from	name	mult to	type	description
0..1	Regions	0..*	SubGeographicalRegion	All sub-geographical regions within this geographical region.
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.3.20 IdentifiedObject root class

This is a root class to provide common identification for all classes needing identification and naming attributes.

Table 108 shows all attributes of IdentifiedObject.

Table 108 – Attributes of Core::IdentifiedObject

name	mult	type	description
aliasName	0..1	String	The aliasName is free text human readable name of the object alternative to IdentifiedObject.name. It may be non unique and may not correlate to a naming hierarchy. The attribute aliasName is retained because of backwards compatibility between CIM relases. It is however recommended to replace aliasName with the Name class as aliasName is planned for retirement at a future time.
description	0..1	String	The description is a free human readable text describing or naming the object. It may be non unique and may not correlate to a naming hierarchy.
mRID	0..1	String	Master resource identifier issued by a model authority. The mRID is unique within an exchange context. Global uniqueness is easily achieved by using a UUID, as specified in RFC 4122, for the mRID. The use of UUID is strongly recommended. For CIMXML data files in RDF syntax conforming to IEC 61970-552, the mRID is mapped to rdf:ID or rdf:about attributes that identify CIM object elements.
name	0..1	String	The name is any free human readable and possibly non unique text naming the object.

Table 109 shows all association ends of IdentifiedObject with other classes.

Table 109 – Association ends of Core::IdentifiedObject with other classes

mult from	name	mult to	type	description
0..1	DiagramObjects	0..*	DiagramObject	The diagram objects that are associated with the domain object.
1..1	Names	0..*	Name	All names of this identified object.

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6.3.21 IrregularIntervalSchedule

The schedule has time points where the time between them varies.

Table 110 shows all attributes of IrregularIntervalSchedule.

Table 110 – Attributes of Core::IrregularIntervalSchedule

name	mult	type	description
startTime	0..1	DateTime	inherited from: BasicIntervalSchedule
value1Multiplier	0..1	UnitMultiplier	inherited from: BasicIntervalSchedule
value1Unit	0..1	UnitSymbol	inherited from: BasicIntervalSchedule
value2Multiplier	0..1	UnitMultiplier	inherited from: BasicIntervalSchedule
value2Unit	0..1	UnitSymbol	inherited from: BasicIntervalSchedule
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 111 shows all association ends of IrregularIntervalSchedule with other classes.

Table 111 – Association ends of Core::IrregularIntervalSchedule with other classes

mult from	name	mult to	type	description
1..1	TimePoints	1..*	IrregularTimePoint	The point data values that define a curve.
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.3.22 IrregularTimePoint root class

TimePoints for a schedule where the time between the points varies.

Table 112 shows all attributes of IrregularTimePoint.

Table 112 – Attributes of Core::IrregularTimePoint

name	mult	type	description
time	0..1	Seconds	The time is relative to the schedule starting time.
value1	0..1	Float	The first value at the time. The meaning of the value is defined by the derived type of the associated schedule.
value2	0..1	Float	The second value at the time. The meaning of the value is defined by the derived type of the associated schedule.

Table 113 shows all association ends of IrregularTimePoint with other classes.

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Table 113 – Association ends of Core::IrregularTimePoint with other classes

mult from	name	mult to	type	description
1..*	IntervalSchedule	1..1	IrregularIntervalSchedule	An IrregularTimePoint belongs to an IrregularIntervalSchedule.

6.3.23 Name root class

The Name class provides the means to define any number of human readable names for an object. A name is not to be used for defining inter-object relationships. For inter-object relationships instead use the object identification 'mRID'.

Table 114 shows all attributes of Name.

Table 114 – Attributes of Core::Name

name	mult	type	description
name	0..1	String	Any free text that name the object.

Table 115 shows all association ends of Name with other classes.

Table 115 – Association ends of Core::Name with other classes

mult from	name	mult to	type	description
0..*	IdentifiedObject	1..1	IdentifiedObject	Identified object that this name designates.
0..*	NameType	1..1	NameType	Type of this name.

6.3.24 NameType root class

Type of name. Possible values for attribute 'name' are implementation dependent but standard profiles may specify types. An enterprise may have multiple IT systems each having its own local name for the same object, e.g. a planning system may have different names from an EMS. An object may also have different names within the same IT system, e.g. localName as defined in CIM version 14. The definition from CIM14 is:

The localName is a human readable name of the object. It is a free text name local to a node in a naming hierarchy similar to a file directory structure. A power system related naming hierarchy may be: Substation, VoltageLevel, Equipment etc. Children of the same parent in such a hierarchy have names that typically are unique among them.

Table 116 shows all attributes of NameType.

Table 116 – Attributes of Core::NameType

name	mult	type	description
name	0..1	String	Name of the name type.
description	0..1	String	Description of the name type.

Table 117 shows all association ends of NameType with other classes.

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Table 117 – Association ends of Core::NameType with other classes

mult from	name	mult to	type	description
0..*	NameTypeAuthority	0..1	NameTypeAuthority	Authority responsible for managing names of this type.
1..1	Names	0..*	Name	All names of this type.

6.3.25 NameTypeAuthority root class

Authority responsible for creation and management of names of a given type; typically an organization or an enterprise system.

Table 118 shows all attributes of NameTypeAuthority.

Table 118 – Attributes of Core::NameTypeAuthority

name	mult	type	description
name	0..1	String	Name of the name type authority.
description	0..1	String	Description of the name type authority.

Table 119 shows all association ends of NameTypeAuthority with other classes.

Table 119 – Association ends of Core::NameTypeAuthority with other classes

mult from	name	mult to	type	description
0..1	NameTypes	0..*	NameType	All name types managed by this authority.

6.3.26 OperatingParticipant

An operator of multiple power system resource objects. Note multple operating participants may operate the same power system resource object. This can be used for modeling jointly owned units where each owner operates as a contractual share.

Table 120 shows all attributes of OperatingParticipant.

Table 120 – Attributes of Core::OperatingParticipant

name	mult	type	description
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 121 shows all association ends of OperatingParticipant with other classes.

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Table 121 – Association ends of Core::OperatingParticipant with other classes

mult from	name	mult to	type	description
1..1	OperatingShare	0..*	OperatingShare	The operating shares of this operating participant. An operating participant can be resused for any number of power system resources.
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.3.27 OperatingShare root class

Specifies the operations contract relationship between a power system resource and a contract participant.

Table 122 shows all attributes of OperatingShare.

Table 122 – Attributes of Core::OperatingShare

name	mult	type	description
percentage	0..1	PerCent	Percentage operational ownership between the pair (power system resource and operating participant) associated with this share. The total percentage ownership for a power system resource should add to 100%.

Table 123 shows all association ends of OperatingShare with other classes.

Table 123 – Association ends of Core::OperatingShare with other classes

mult from	name	mult to	type	description
0..*	OperatingParticipant	1..1	OperatingParticipant	The operating participant having this share with the associated power system resource.
0..*	PowerSystemResource	1..1	PowerSystemResource	The power system resource to which the share applies.

6.3.28 PSRType

Classifying instances of the same class, e.g. overhead and underground ACLineSegments. This classification mechanism is intended to provide flexibility outside the scope of this document, i.e. provide customisation that is non standard.

Table 124 shows all attributes of PSRType.

Table 124 – Attributes of Core::PSRType

name	mult	type	description
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 125 shows all association ends of PSRType with other classes.

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Table 125 – Association ends of Core::PSRType with other classes

mult from	name	mult to	type	description
0..1	PowerSystemResources	0..*	PowerSystemResource	Power system resources classified with this power system resource type.
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.3.29 PhaseCode enumeration

An unordered enumeration of phase identifiers. Allows designation of phases for both transmission and distribution equipment, circuits and loads. The enumeration, by itself, does not describe how the phases are connected together or connected to ground. Ground is not explicitly denoted as a phase.

Residential and small commercial loads are often served from single-phase, or split-phase, secondary circuits. For the example of s12N, phases 1 and 2 refer to hot wires that are 180 degrees out of phase, while N refers to the neutral wire. Through single-phase transformer connections, these secondary circuits may be served from one or two of the primary phases A, B, and C. For three-phase loads, use the A, B, C phase codes instead of s12N.

The integer values are from IEC 61968-9 to support revenue metering applications.

Table 126 shows all literals of PhaseCode.

Table 126 – Literals of Core::PhaseCode

literal	value	description
ABCN	225	Phases A, B, C, and N.
ABC	224	Phases A, B, and C.
ABN	193	Phases A, B, and neutral.
ACN	41	Phases A, C and neutral.
BCN	97	Phases B, C, and neutral.
AB	132	Phases A and B.
AC	96	Phases A and C.
BC	66	Phases B and C.
AN	129	Phases A and neutral.
BN	65	Phases B and neutral.
CN	33	Phases C and neutral.
A	128	Phase A.
B	64	Phase B.
C	32	Phase C.
N	16	Neutral phase.
s1N	528	Secondary phase 1 and neutral.
s2N	272	Secondary phase 2 and neutral.
s12N	784	Secondary phases 1, 2, and neutral.
s1	512	Secondary phase 1.
s2	256	Secondary phase 2.
s12	768	Secondary phase 1 and 2.

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literal	value	description
none	0	No phases specified.
X	1024	Unknown non-neutral phase.
XY	3072	Two unknown non-neutral phases.
XN	1040	Unknown non-neutral phase plus neutral.
XYN	3088	Two unknown non-neutral phases plus neutral.

6.3.30 PowerSystemResource

A power system resource (PSR) can be an item of equipment such as a switch, an equipment container containing many individual items of equipment such as a substation, or an organisational entity such as sub-control area. Power system resources can have measurements associated.

Table 127 shows all attributes of PowerSystemResource.

Table 127 – Attributes of Core::PowerSystemResource

name	mult	type	description
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 128 shows all association ends of PowerSystemResource with other classes.

Table 128 – Association ends of Core::PowerSystemResource with other classes

mult from	name	mult to	type	description
0..*	PSRType	0..1	PSRType	Custom classification for this power system resource.
0..1	Controls	0..*	Control	The controller outputs used to actually govern a regulating device, e.g. the magnetization of a synchronous machine or capacitor bank breaker actuator.
0..1	Measurements	0..*	Measurement	The measurements associated with this power system resource.
1..1	OperatingShare	0..*	OperatingShare	The operating shares of this power system resource.
0..*	ReportingGroup	0..*	ReportingGroup	Reporting groups to which this power system resource belongs.
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.3.31 RegularIntervalSchedule

The schedule has time points where the time between them is constant.

Table 129 shows all attributes of RegularIntervalSchedule.

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Table 129 – Attributes of Core::RegularIntervalSchedule

name	mult	type	description
endTime	0..1	DateTime	The time for the last time point. The value can be a time of day, not a specific date.
timeStep	0..1	Seconds	The time between each pair of subsequent regular time points in sequence order.
startTime	0..1	DateTime	inherited from: BasicIntervalSchedule
value1Multiplier	0..1	UnitMultiplier	inherited from: BasicIntervalSchedule
value1Unit	0..1	UnitSymbol	inherited from: BasicIntervalSchedule
value2Multiplier	0..1	UnitMultiplier	inherited from: BasicIntervalSchedule
value2Unit	0..1	UnitSymbol	inherited from: BasicIntervalSchedule
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 130 shows all association ends of RegularIntervalSchedule with other classes.

Table 130 – Association ends of Core::RegularIntervalSchedule with other classes

mult from	name	mult to	type	description
1..1	TimePoints	1..*	RegularTimePoint	The regular interval time point data values that define this schedule.
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.3.32 RegularTimePoint root class

Time point for a schedule where the time between the consecutive points is constant.

Table 131 shows all attributes of RegularTimePoint.

Table 131 – Attributes of Core::RegularTimePoint

name	mult	type	description
sequenceNumber	0..1	Integer	The position of the regular time point in the sequence. Note that time points don't have to be sequential, i.e. time points may be omitted. The actual time for a RegularTimePoint is computed by multiplying the associated regular interval schedule's time step with the regular time point sequence number and adding the associated schedules start time. To specify values for the start time, use sequence number 0. The sequence number cannot be negative.
value1	0..1	Float	The first value at the time. The meaning of the value is defined by the derived type of the associated schedule.
value2	0..1	Float	The second value at the time. The meaning of the value is defined by the derived type of the associated schedule.

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Table 132 shows all association ends of RegularTimePoint with other classes.

Table 132 – Association ends of Core::RegularTimePoint with other classes

mult from	name	mult to	type	description
1..*	IntervalSchedule	1..1	RegularIntervalSchedule	Regular interval schedule containing this time point.

6.3.33 ReportingGroup

A reporting group is used for various ad-hoc groupings used for reporting.

Table 133 shows all attributes of ReportingGroup.

Table 133 – Attributes of Core::ReportingGroup

name	mult	type	description
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 134 shows all association ends of ReportingGroup with other classes.

Table 134 – Association ends of Core::ReportingGroup with other classes

mult from	name	mult to	type	description
0..*	PowerSystemResource	0..*	PowerSystemResource	Power system resources which belong to this reporting group.
0..*	ReportingSuperGroup	0..1	ReportingSuperGroup	Reporting super group to which this reporting group belongs.
0..1	BusNameMarker	0..*	BusNameMarker	The bus name markers that belong to this reporting group.
0..1	TopologicalNode	0..*	TopologicalNode	The topological nodes that belong to the reporting group.
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.3.34 ReportingSuperGroup

A reporting super group, groups reporting groups for a higher level report.

Table 135 shows all attributes of ReportingSuperGroup.

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Table 135 – Attributes of Core::ReportingSuperGroup

name	mult	type	description
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 136 shows all association ends of ReportingSuperGroup with other classes.

Table 136 – Association ends of Core::ReportingSuperGroup with other classes

mult from	name	mult to	type	description
0..1	ReportingGroup	0..*	ReportingGroup	Reporting groups that are grouped under this super group.
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.3.35 SubGeographicalRegion

A subset of a geographical region of a power system network model.

Table 137 shows all attributes of SubGeographicalRegion.

Table 137 – Attributes of Core::SubGeographicalRegion

name	mult	type	description
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 138 shows all association ends of SubGeographicalRegion with other classes.

Table 138 – Association ends of Core::SubGeographicalRegion with other classes

mult from	name	mult to	type	description
0..1	Lines	0..*	Line	The lines within the sub-geographical region.
0..1	Substations	0..*	Substation	The substations in this sub-geographical region.
0..*	Region	0..1	GeographicalRegion	The geographical region which this sub-geographical region is within.
0..1	DCLines	0..*	DCLine	The DC lines in this sub-geographical region.
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

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6.3.36 Substation

A collection of equipment for purposes other than generation or utilization, through which electric energy in bulk is passed for the purposes of switching or modifying its characteristics.

Table 139 shows all attributes of Substation.

Table 139 – Attributes of Core::Substation

name	mult	type	description
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 140 shows all association ends of Substation with other classes.

Table 140 – Association ends of Core::Substation with other classes

mult from	name	mult to	type	description
1..1	VoltageLevels	0..*	VoltageLevel	The voltage levels within this substation.
0..1	Bays	0..*	Bay	Bays contained in the substation.
0..1	NormalEnergizedFeeder	0..*	Feeder	The normal energized feeders of the substation. Also used for naming purposes.
0..*	NamingFeeder	0..1	Feeder	The primary feeder that normally energizes the secondary substation. Used for naming purposes. Either this association or the substation to subgeographical region should be used for hierarchical containment specification.
0..*	NormalEnergizingFeeder	0..*	Feeder	The feeders that potentially energize the downstream substation. Should be consistent with the associations that describe the naming hierarchy.
0..*	Region	0..1	SubGeographicalRegion	The SubGeographicalRegion containing the substation.
0..1	DCConverterUnit	0..*	DCConverterUnit	The DC converter unit belonging of the substation.
0..1	Equipments	0..*	Equipment	inherited from: EquipmentContainer
0..*	AdditionalGroupedEquipment	0..*	Equipment	inherited from: EquipmentContainer
1..1	ConnectivityNodes	0..*	ConnectivityNode	inherited from: ConnectivityNodeContainer
0..1	TopologicalNode	0..*	TopologicalNode	inherited from: ConnectivityNodeContainer
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

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6.3.37 Terminal

An AC electrical connection point to a piece of conducting equipment. Terminals are connected at physical connection points called connectivity nodes.

Table 141 shows all attributes of Terminal.

Table 141 – Attributes of Core::Terminal

name	mult	type	description
phases	0..1	PhaseCode	Represents the normal network phasing condition. If the attribute is missing, three phases (ABC) shall be assumed, except for terminals of grounding classes (specializations of EarthFaultCompensator, GroundDisconnector and Ground) which will be assumed to be N. Therefore, phase code ABCN is explicitly declared when needed, e.g. for star point grounding equipment. The phase code on terminals connecting same ConnectivityNode or same TopologicalNode as well as for equipment between two terminals shall be consistent.
connected	0..1	Boolean	inherited from: ACDCTerminal
sequenceNumber	0..1	Integer	inherited from: ACDCTerminal
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 142 shows all association ends of Terminal with other classes.

Table 142 – Association ends of Core::Terminal with other classes

mult from	name	mult to	type	description
0..*	ConductingEquipment	1..1	ConductingEquipment	The conducting equipment of the terminal. Conducting equipment have terminals that may be connected to other conducting equipment terminals via connectivity nodes or topological nodes.
0..*	ConnectivityNode	0..1	ConnectivityNode	The connectivity node to which this terminal connects with zero impedance.
0..*	TopologicalNode	0..1	TopologicalNode	The topological node associated with the terminal. This can be used as an alternative to the connectivity node path to topological node, thus making it unnecessary to model connectivity nodes in some cases. Note that the if connectivity nodes are in the model, this association would probably not be used as an input specification.
0..1	RegulatingControl	0..*	RegulatingControl	The controls regulating this terminal.
1..*	NormalHeadFeeder	0..1	Feeder	The feeder that this terminal normally feeds. Only specified for the terminals at head of feeders.
1..1	HasFirstMutualCoupling	0..*	MutualCoupling	Mutual couplings associated with the branch as the first branch.
0..1	TransformerEnd	0..*	TransformerEnd	All transformer ends connected at this terminal.

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mult from	name	mult to	type	description
1..1	BranchGroupTerminal	0..*	BranchGroupTerminal	The directed branch group terminals for which this terminal is monitored.
1..1	SvPowerFlow	0..*	SvPowerFlow	The power flow state variable associated with the terminal.
1..1	AuxiliaryEquipment	0..*	AuxiliaryEquipment	The auxiliary equipment connected to the terminal.
1..1	HasSecondMutualCoupling	0..*	MutualCoupling	Mutual couplings with the branch associated as the first branch.
1..1	TieFlow	0..2	TieFlow	The control area tie flows to which this terminal associates.
0..1	EquipmentFaults	0..*	EquipmentFault	The equipment faults at this terminal.
0..1	ConverterDCSides	0..*	ACDCConverter	All converters' DC sides linked to this point of common coupling terminal.
1..1	RemoteInputSignal	0..*	RemoteInputSignal	Input signal coming from this terminal.
1..*	BusNameMarker	0..1	BusNameMarker	inherited from: ACDCTerminal
0..1	OperationalLimitSet	0..*	OperationalLimitSet	inherited from: ACDCTerminal
0..1	Measurements	0..*	Measurement	inherited from: ACDCTerminal
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.3.38 VoltageLevel

A collection of equipment at one common system voltage forming a switchgear. The equipment typically consists of breakers, busbars, instrumentation, control, regulation and protection devices as well as assemblies of all these.

Table 143 shows all attributes of VoltageLevel.

Table 143 – Attributes of Core::VoltageLevel

name	mult	type	description
highVoltageLimit	0..1	Voltage	The bus bar's high voltage limit. The limit applies to all equipment and nodes contained in a given VoltageLevel. It is not required that it is exchanged in pair with lowVoltageLimit. It is preferable to use operational VoltageLimit, which prevails, if present.
lowVoltageLimit	0..1	Voltage	The bus bar's low voltage limit. The limit applies to all equipment and nodes contained in a given VoltageLevel. It is not required that it is exchanged in pair with highVoltageLimit. It is preferable to use operational VoltageLimit, which prevails, if present.
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 144 shows all association ends of VoltageLevel with other classes.

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Table 144 – Association ends of Core::VoltageLevel with other classes

mult from	name	mult to	type	description
0..*	BaseVoltage	1..1	BaseVoltage	The base voltage used for all equipment within the voltage level.
0..1	Bays	0..*	Bay	The bays within this voltage level.
0..*	Substation	1..1	Substation	The substation of the voltage level.
0..1	Equipments	0..*	Equipment	inherited from: EquipmentContainer
0..*	AdditionalGroupedEquipment	0..*	Equipment	inherited from: EquipmentContainer
1..1	ConnectivityNodes	0..*	ConnectivityNode	inherited from: ConnectivityNodeContainer
0..1	TopologicalNode	0..*	TopologicalNode	inherited from: ConnectivityNodeContainer
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.4 Package Wires

6.4.1 General

An extension to the Core and Topology package that models information on the electrical characteristics of Transmission and Distribution networks. This package is used by network applications such as State Estimation, Load Flow and Optimal Power Flow.

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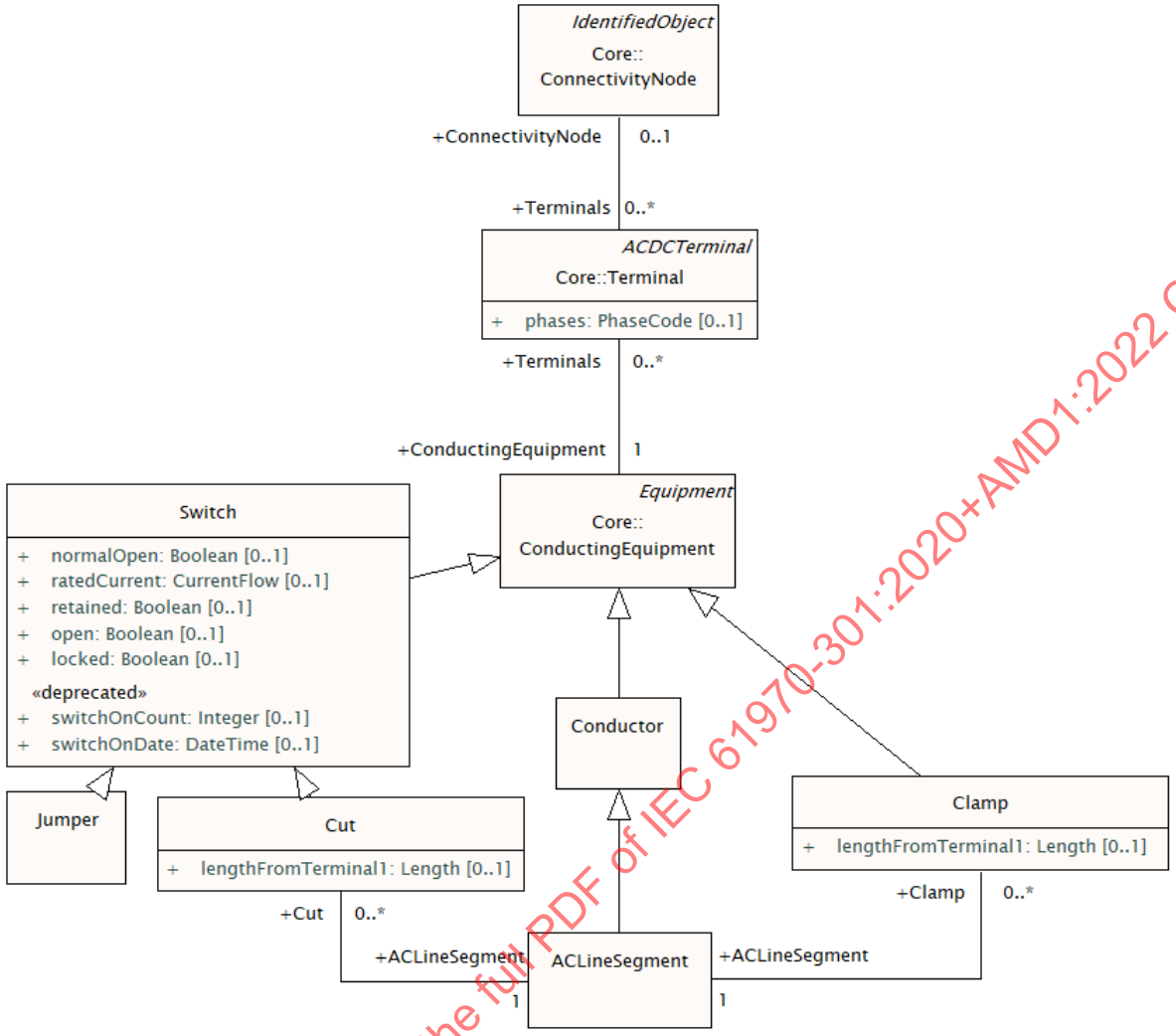


Figure 86 – Class diagram Wires::CutsAndJumpers

Figure 86: The diagram show the cuts and jumpers data model.

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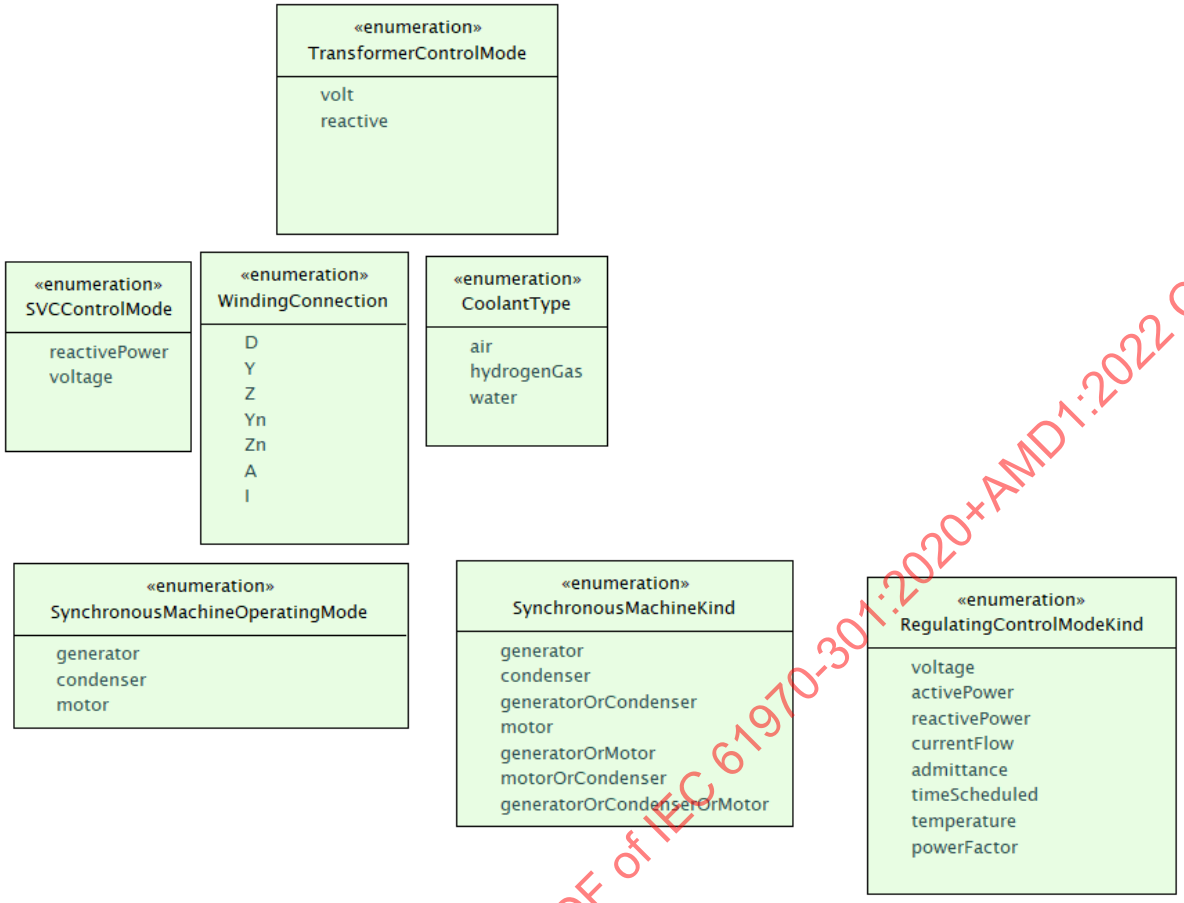


Figure 87 – Class diagram Wires::Datatypes

Figure 87: This diagram shows the data types specific to the Wires package.

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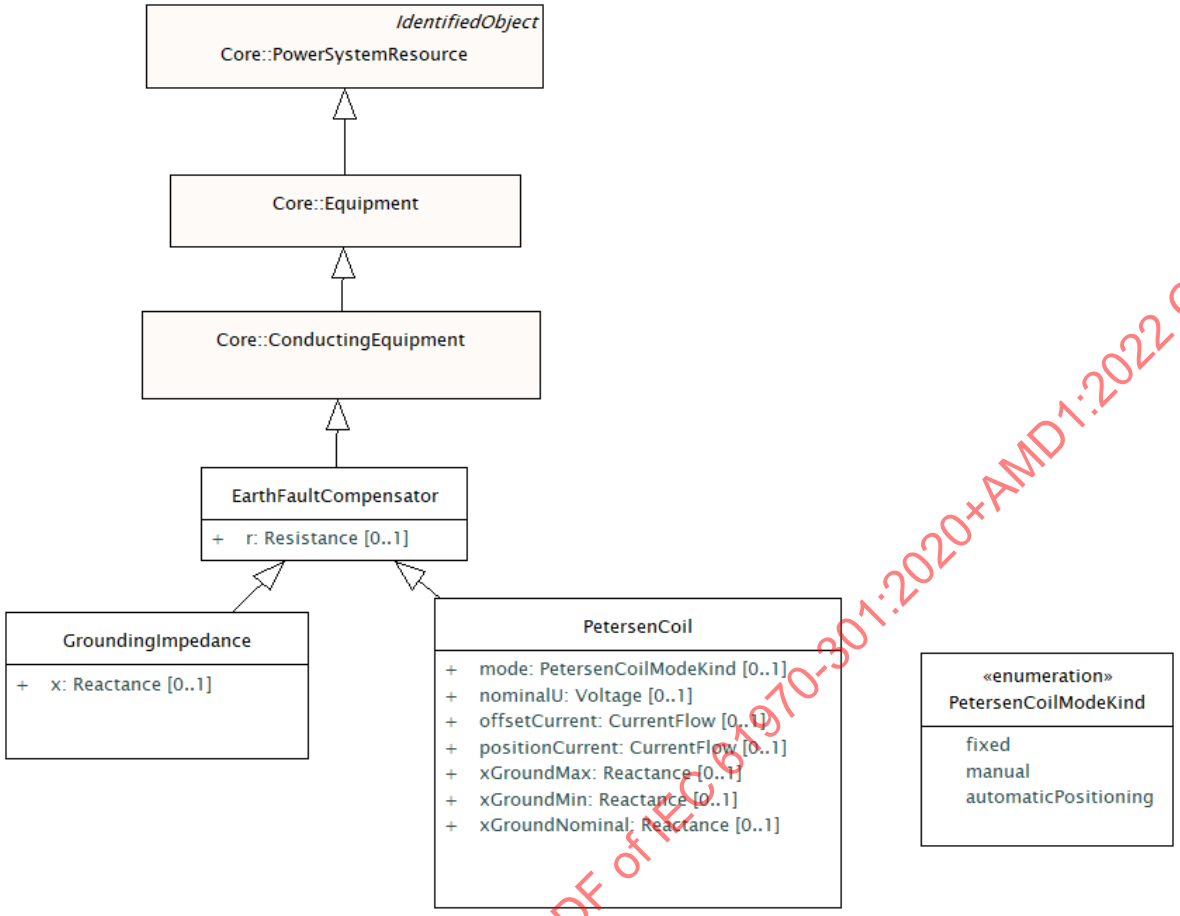
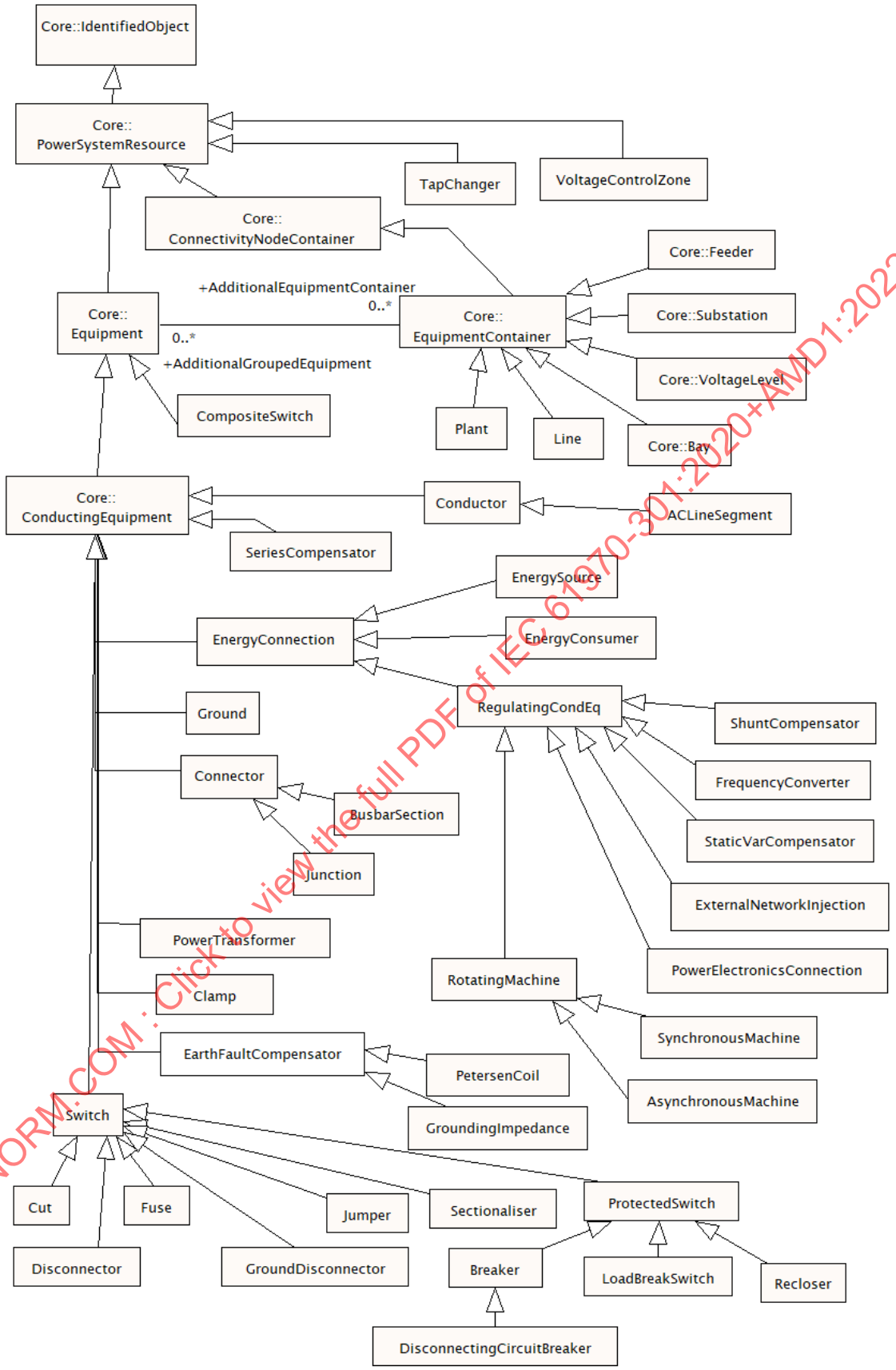


Figure 88 – Class diagram Wires::EarthFaultCompensator

Figure 88: Shows earth fault compensating devices.

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Figure 89 – Class diagram Wires::InheritanceHierarchy

Figure 89: This diagram describes inheritance between classes in and related to the Wires package.

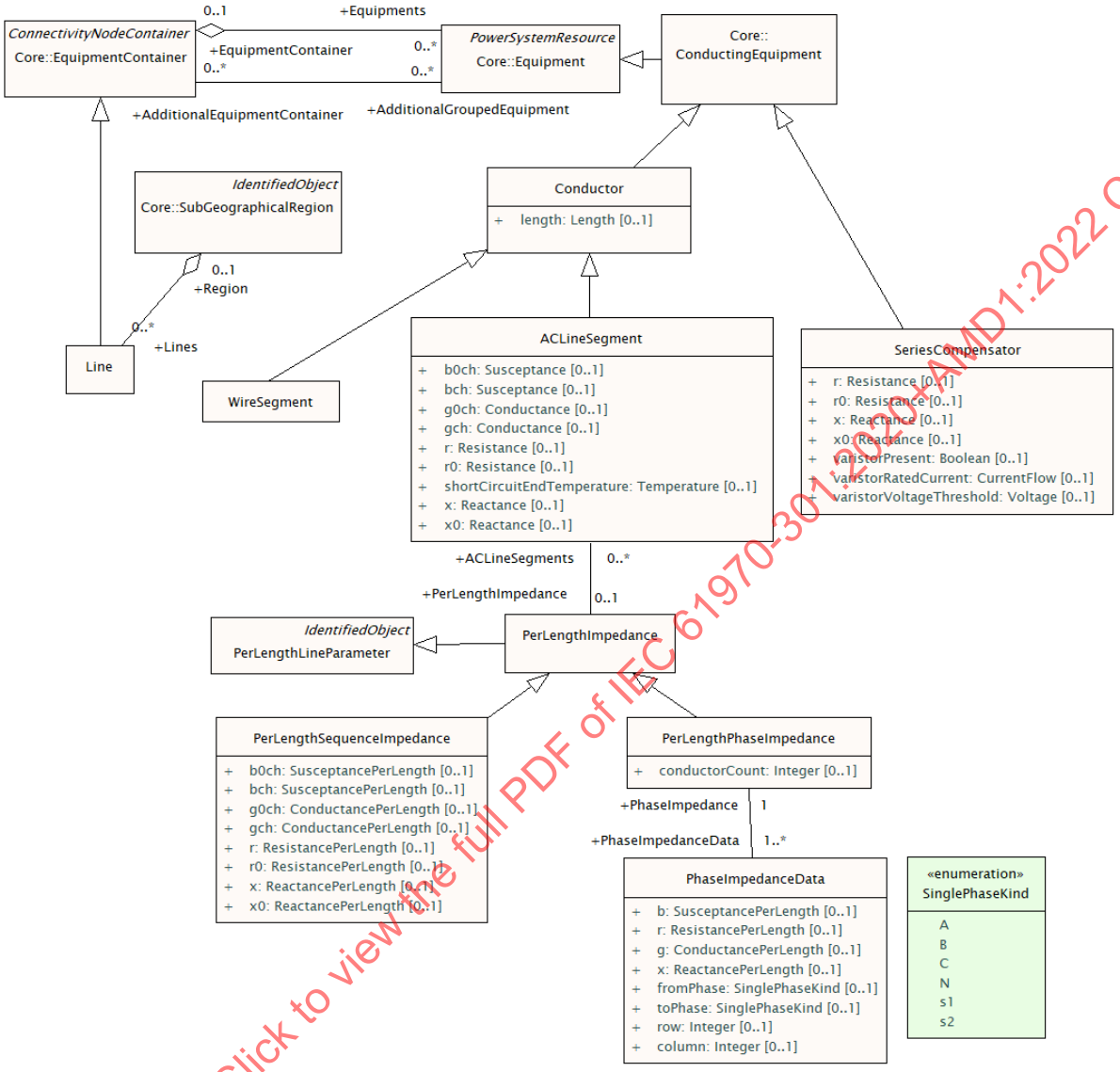


Figure 90 – Class diagram Wires::LineModel

Figure 90: This diagram shows all classes related to the transmission line model.

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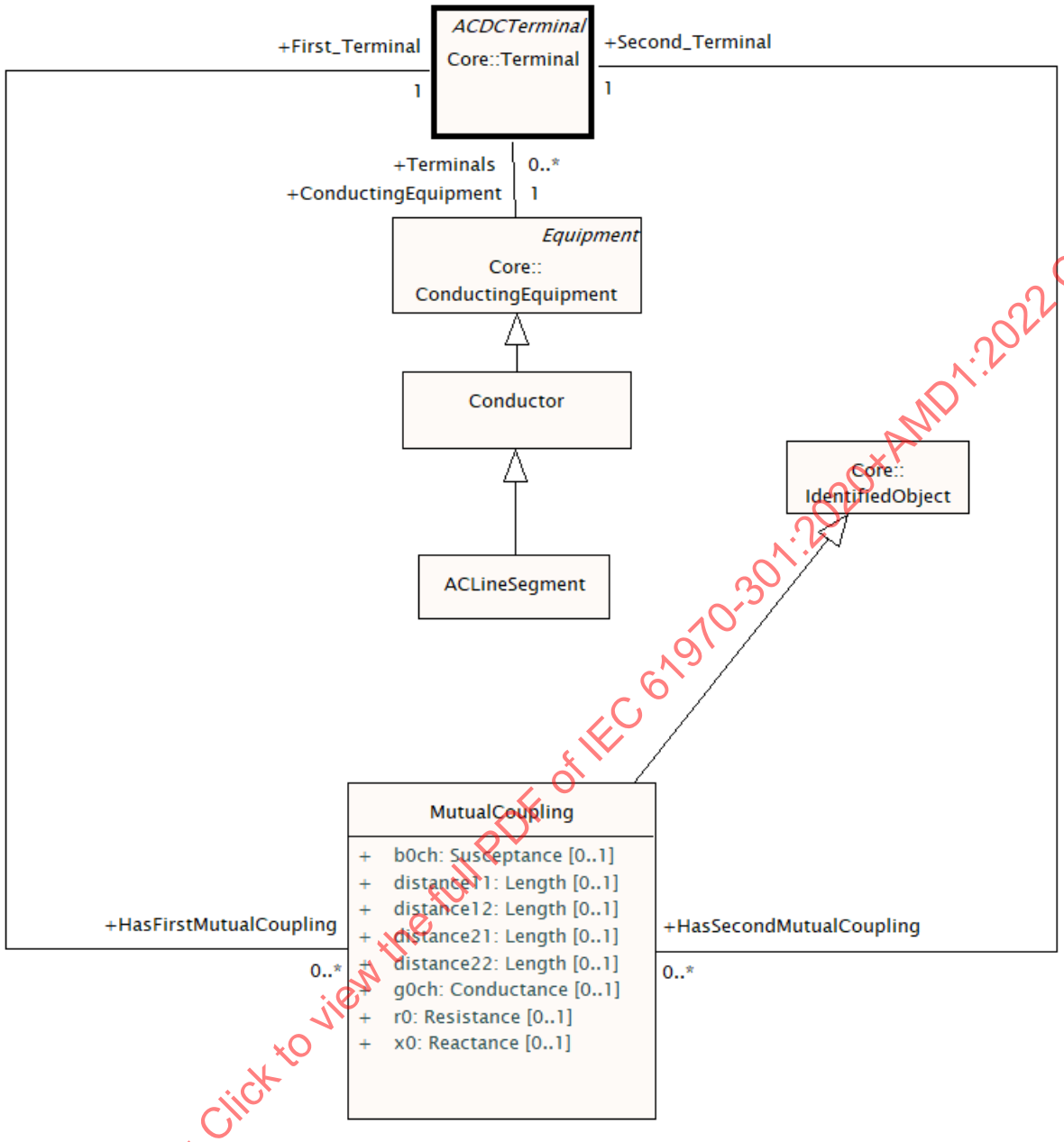
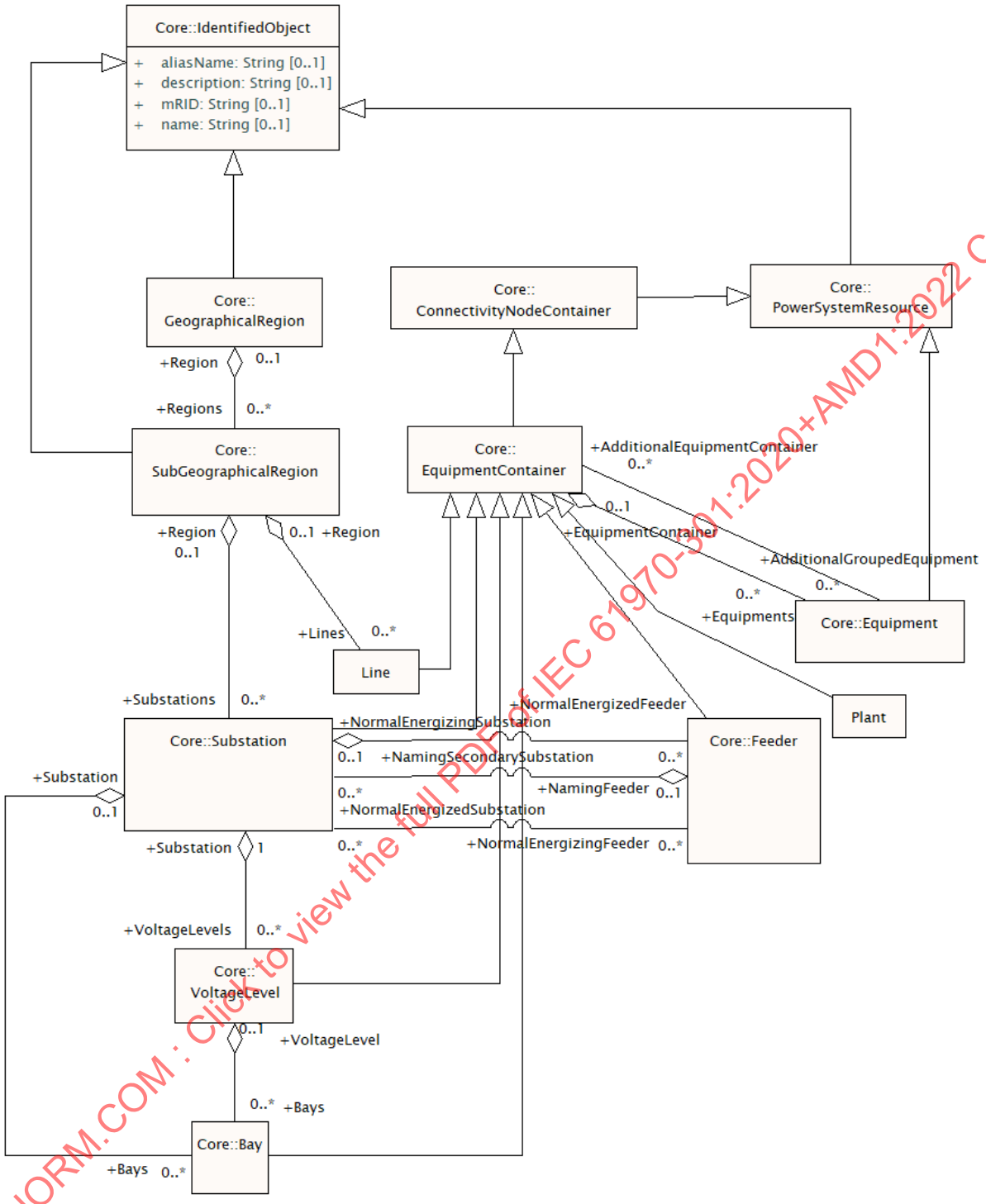


Figure 91 – Class diagram Wires::MutualCoupling

Figure 91: Shows mutual coupling models.

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Figure 92 – Class diagram Wires::NamingHierarchyPart1

Figure 92: The diagram shows the upper part of the naming hierarchy. The hierarchy is a way to organize and name equipment. Hence it is tightly related to the IdentifiedObject and its attributes. The Equipment class is further specialized into many subtypes that are all contained by subclasses of the EquipmentContainer.

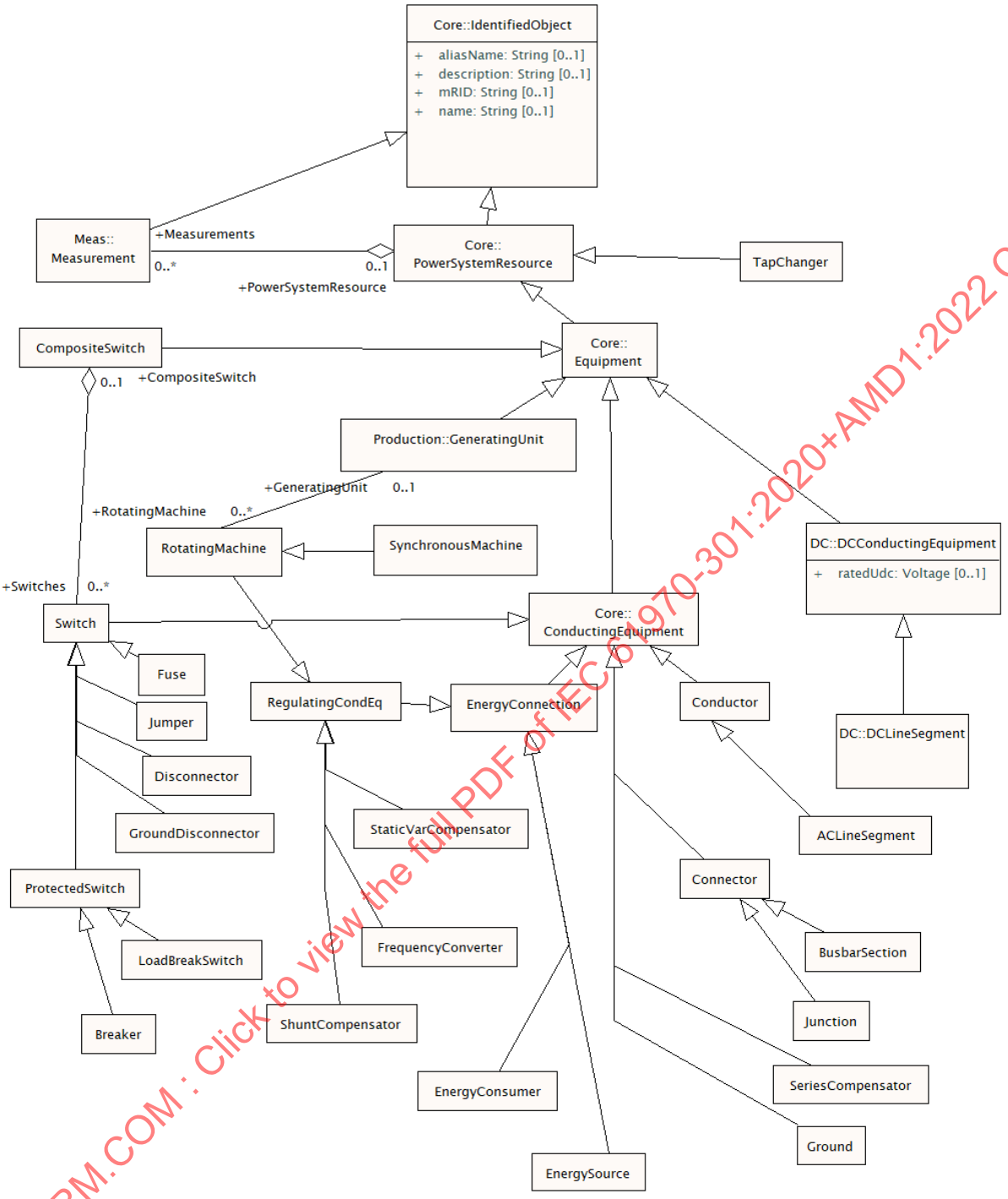


Figure 93 – Class diagram Wires::NamingHierarchyPart2

Figure 93: The diagram shows the lower part of the naming hierarchy. It shows how the Equipment class is further specialized into many subtypes that are all contained by subclasses of the EquipmentContainer. For the subclasses of equipment container refer to part 1 of the diagram.

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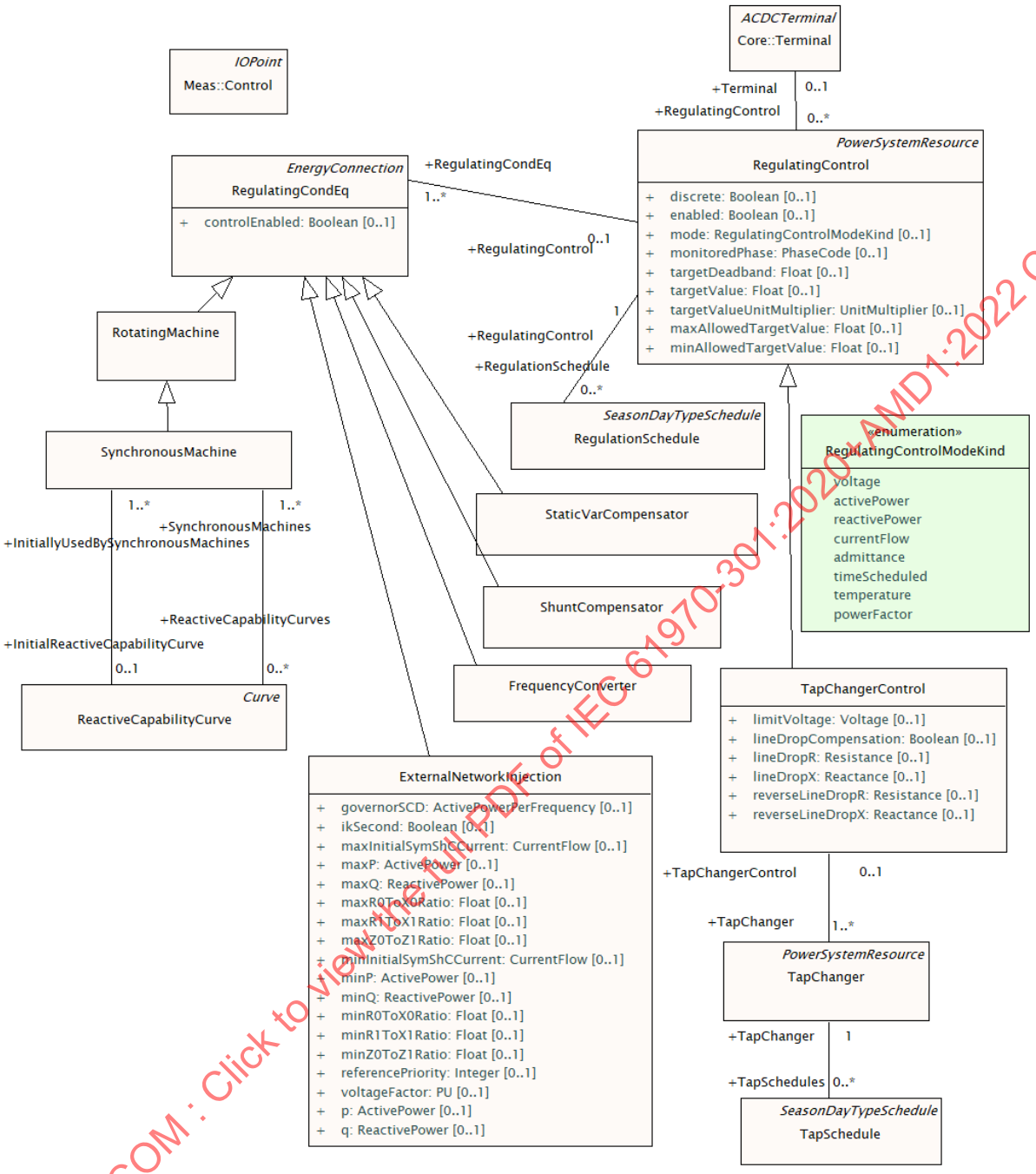


Figure 94 – Class diagram Wires::RegulatingEquipment

Figure 94: The diagram shows all classes related to equipment regulation and reactive power compensation.

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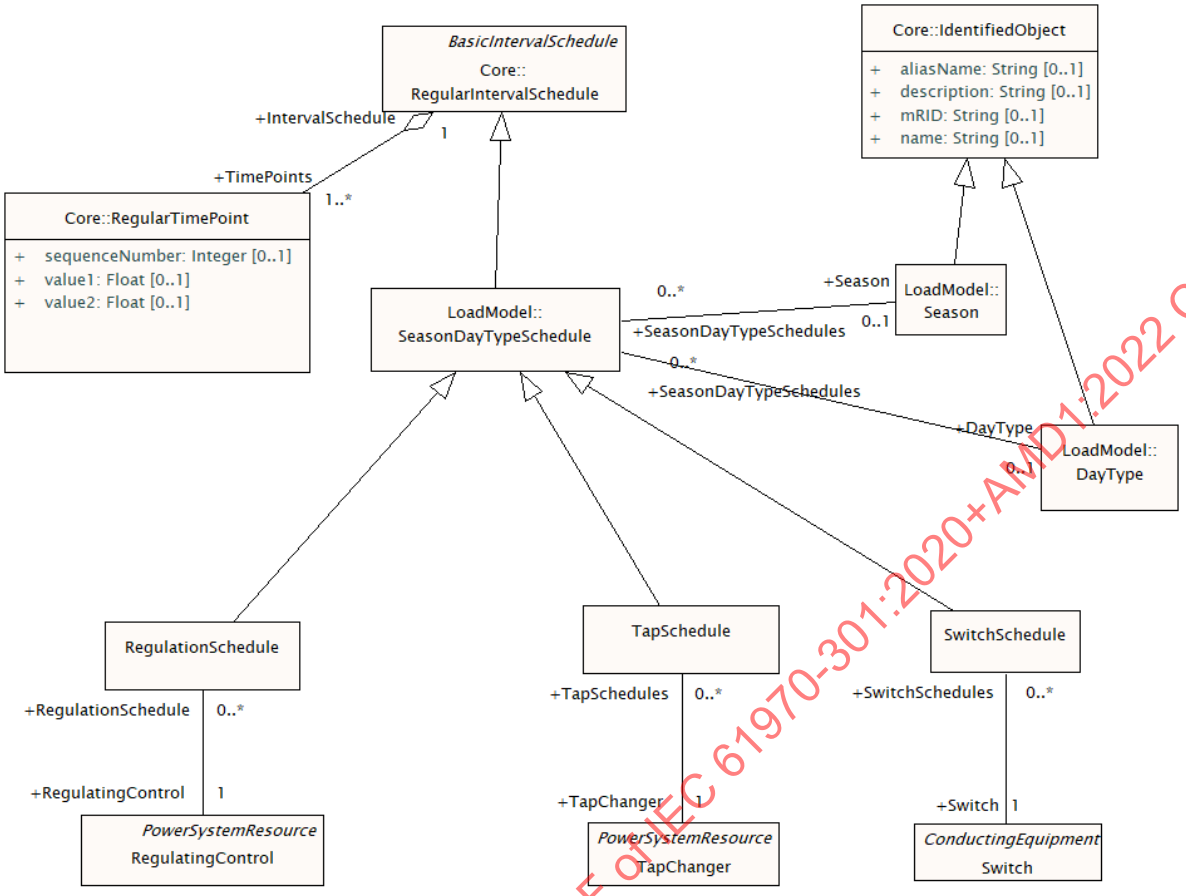


Figure 95 – Class diagram Wires::Schedules

Figure 95: Shows schedules of wires model.

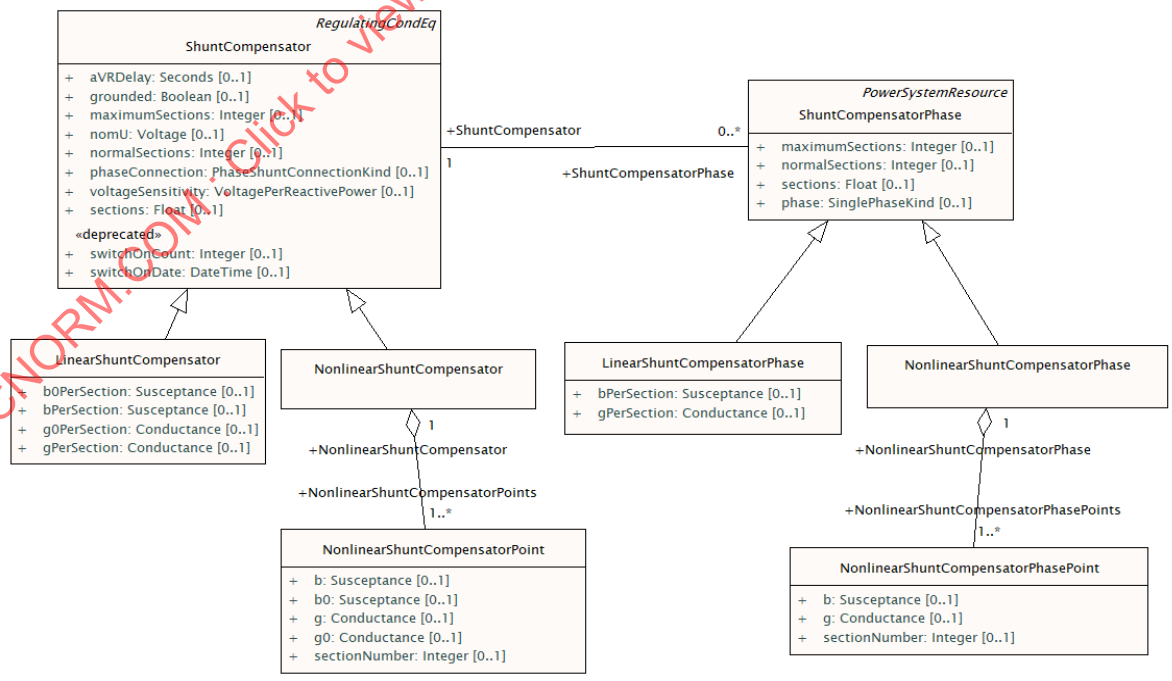


Figure 96 – Class diagram Wires::ShuntCompensator

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Figure 96: Shows shunt compensator inheritance structure.

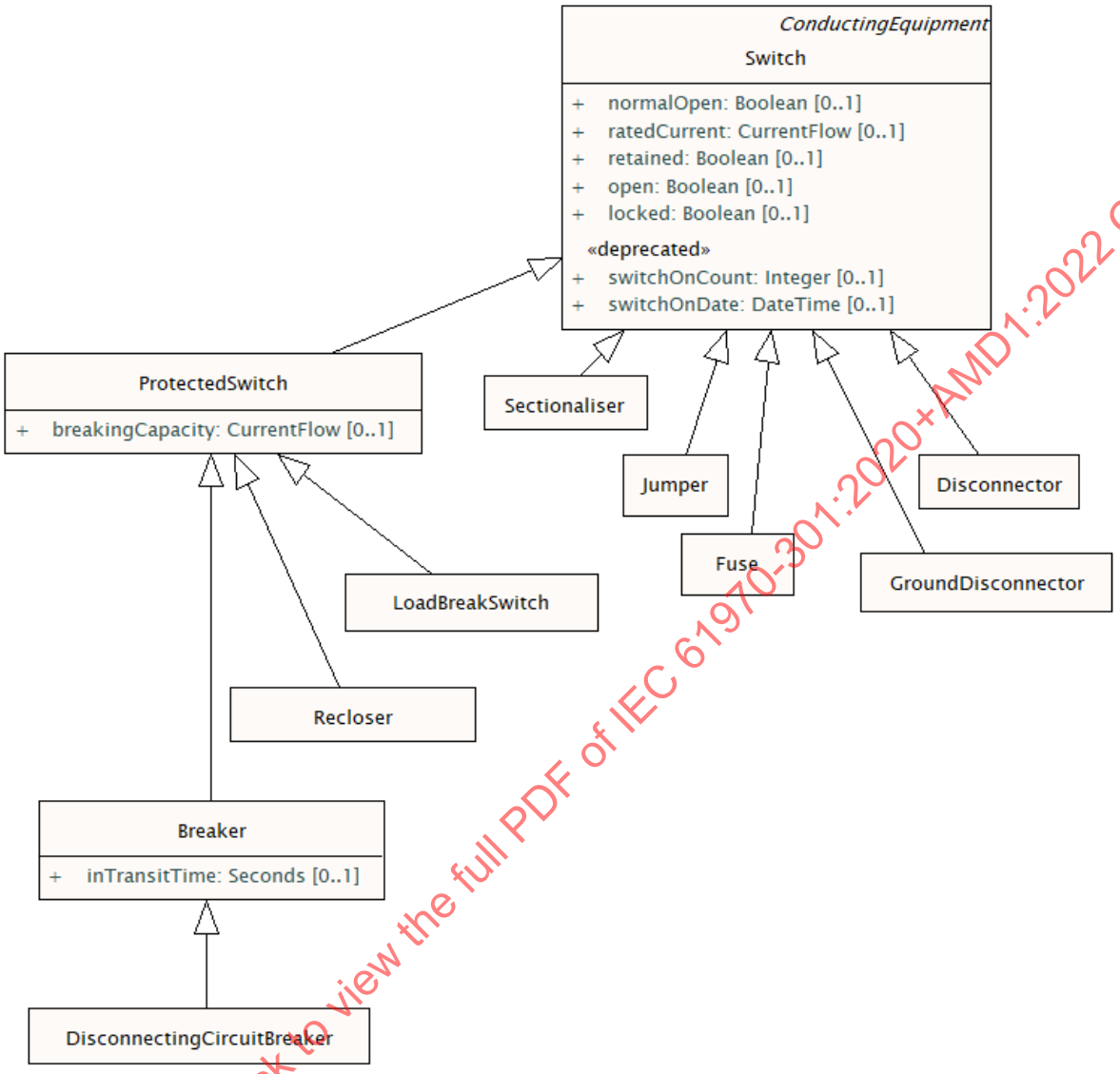
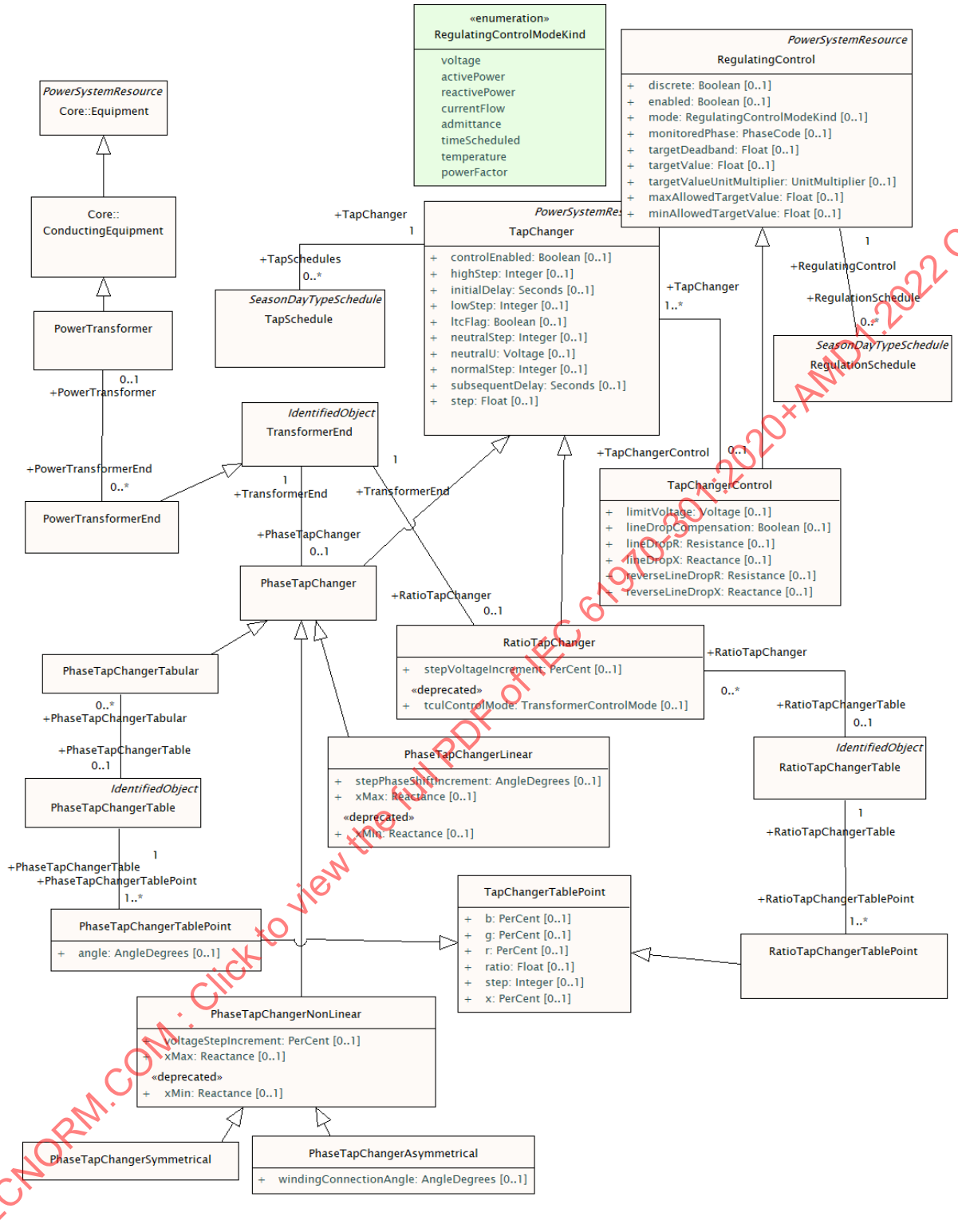


Figure 97 – Class diagram Wires::SwitchingEquipment

Figure 97: Shows switching equipment inheritance structure.

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Figure 98 – Class diagram Wires::TapChanger

Figure 98: This diagram shows all classes related to the transformer tap model.

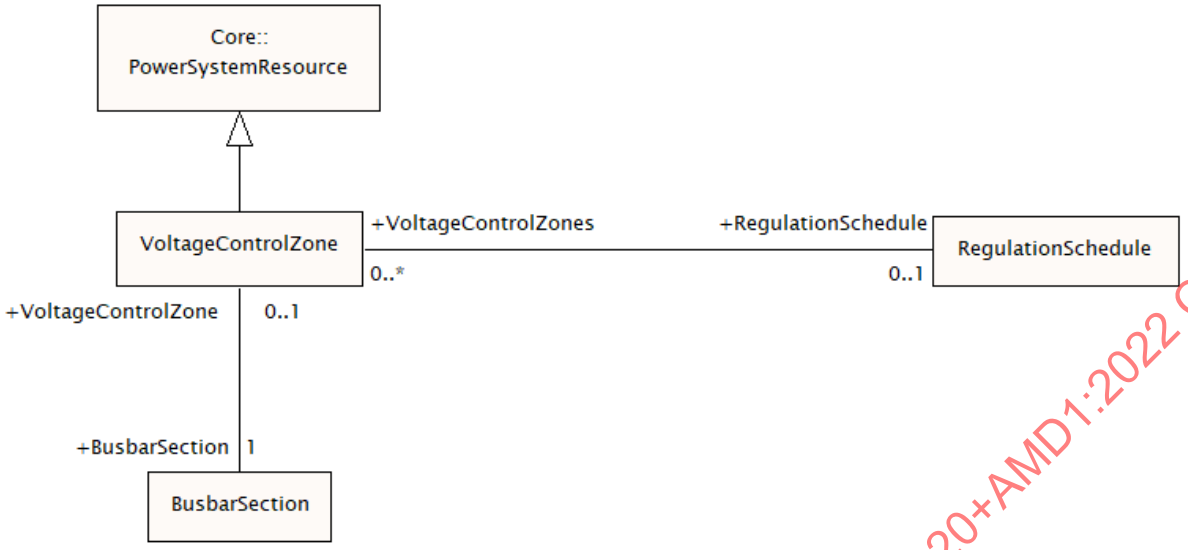
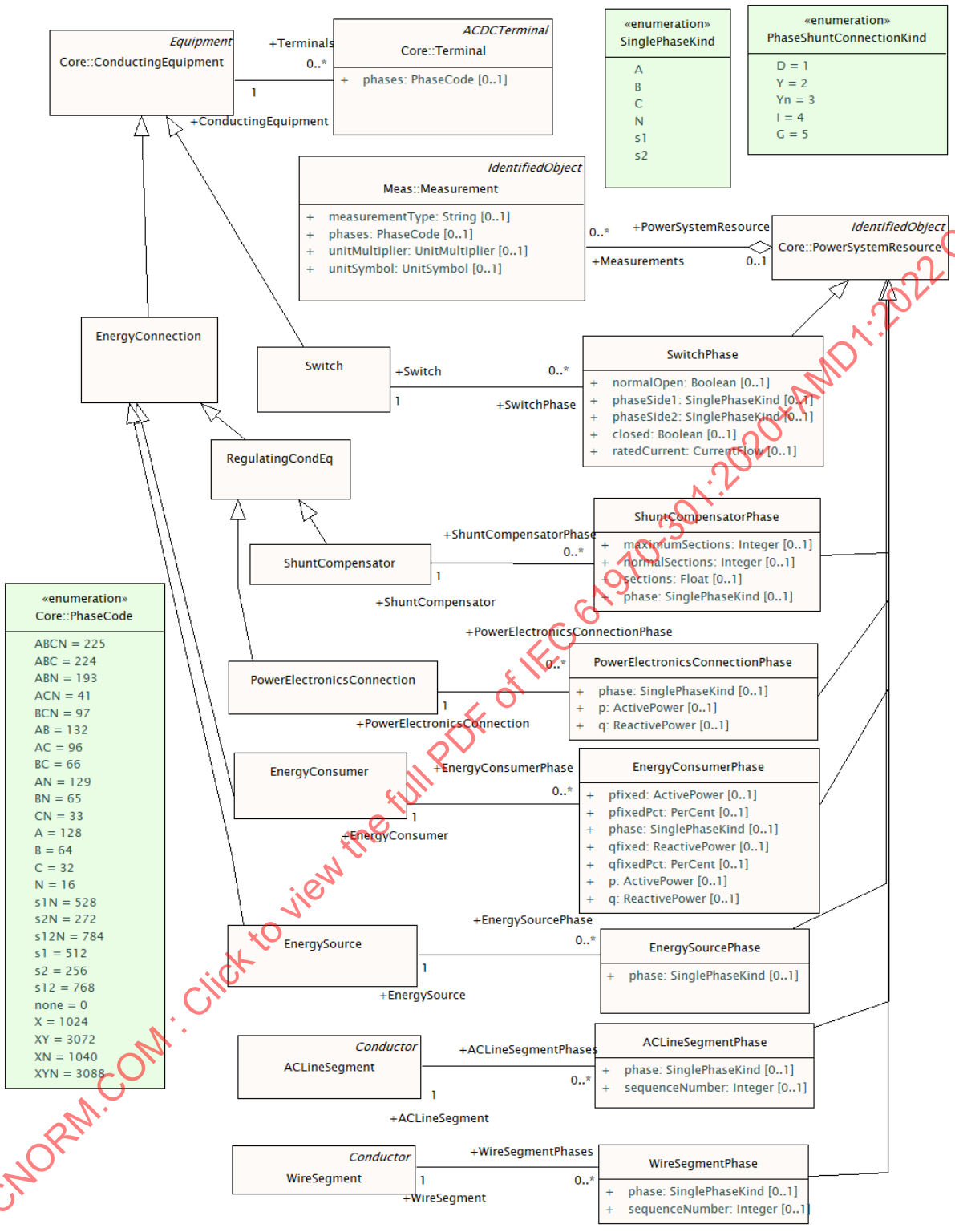


Figure 99 – Class diagram Wires::VoltageControl

Figure 99: This diagram shows all classes related to area voltage control.

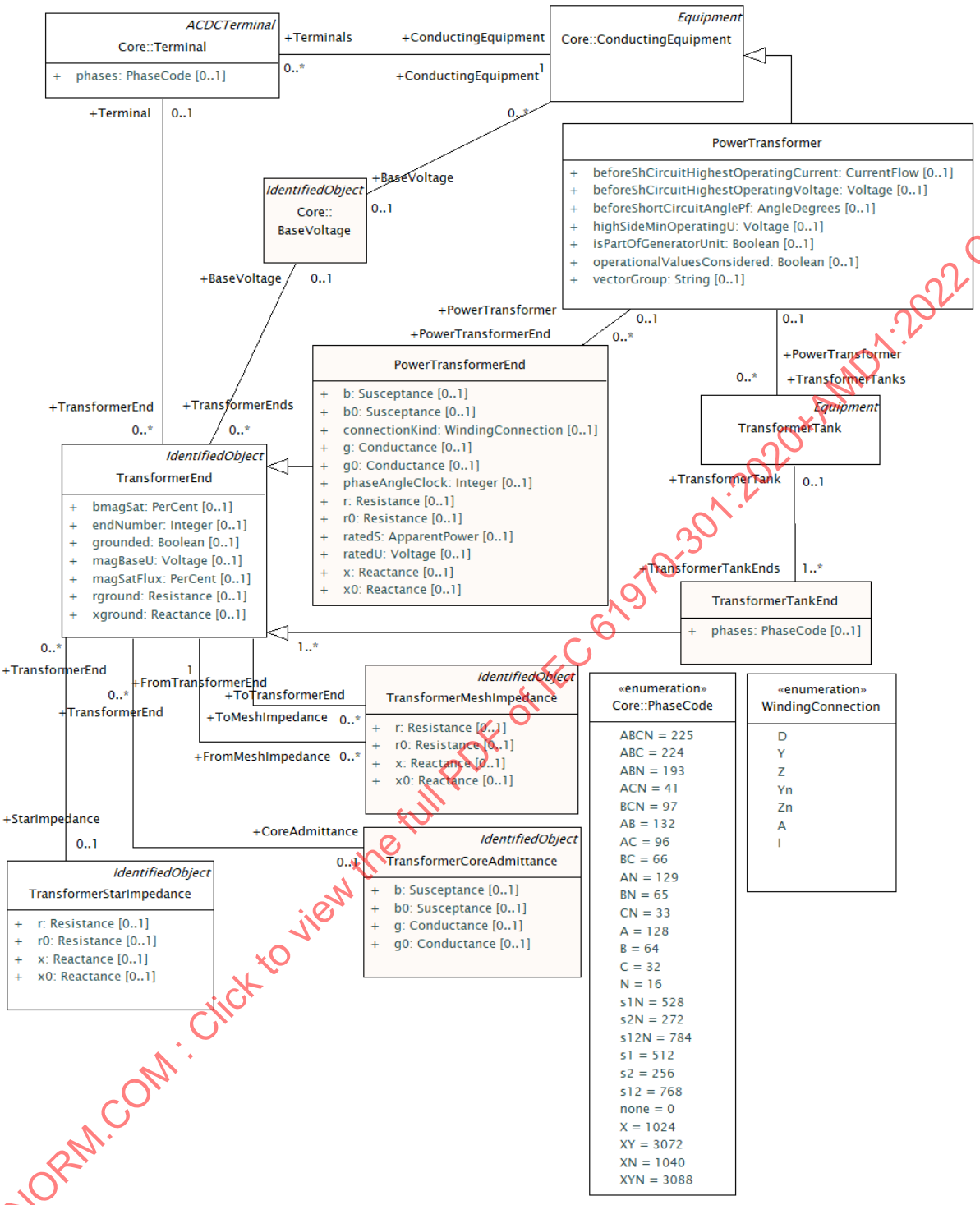
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Figure 100 – Class diagram Wires::WiresPhaseModel

Figure 100: Show the phase connection detail when modelling devices down to the phase components within a conducting equipment.



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Figure 101 – Class diagram Wires::Transformer

Figure 101: This diagram shows classes related to the core transformer model but does not show the tap changer details.

6.4.2 AsynchronousMachineKind enumeration

Kind of Asynchronous Machine.

Table 145 shows all literals of AsynchronousMachineKind.

Table 145 – Literals of Wires::AsynchronousMachineKind

literal	value	description
generator		The Asynchronous Machine is a generator.
motor		The Asynchronous Machine is a motor.

6.4.3 ACLineSegment

A wire or combination of wires, with consistent electrical characteristics, building a single electrical system, used to carry alternating current between points in the power system.

For symmetrical, transposed three phase lines, it is sufficient to use attributes of the line segment, which describe impedances and admittances for the entire length of the segment. Additionally, impedances can be computed by using length and associated per length impedances.

The BaseVoltage at the two ends of ACLineSegments in a Line shall have the same BaseVoltage.nominalVoltage. However, boundary lines may have slightly different BaseVoltage.nominalVoltages and variation is allowed. Larger voltage difference in general requires use of an equivalent branch.

Table 146 shows all attributes of ACLineSegment.

Table 146 – Attributes of Wires::ACLineSegment

name	mult	type	description
b0ch	0..1	Susceptance	Zero sequence shunt (charging) susceptance, uniformly distributed, of the entire line section.
bch	0..1	Susceptance	Positive sequence shunt (charging) susceptance, uniformly distributed, of the entire line section. This value represents the full charging over the full length of the line.
g0ch	0..1	Conductance	Zero sequence shunt (charging) conductance, uniformly distributed, of the entire line section.
gch	0..1	Conductance	Positive sequence shunt (charging) conductance, uniformly distributed, of the entire line section.
r	0..1	Resistance	Positive sequence series resistance of the entire line section.
r0	0..1	Resistance	Zero sequence series resistance of the entire line section.
shortCircuitEndTemperature	0..1	Temperature	Maximum permitted temperature at the end of SC for the calculation of minimum short-circuit currents. Used for short circuit data exchange according to IEC 60909.
x	0..1	Reactance	Positive sequence series reactance of the entire line section.
x0	0..1	Reactance	Zero sequence series reactance of the entire line section.
length	0..1	Length	inherited from: Conductor
aggregate	0..1	Boolean	inherited from: Equipment
inService	0..1	Boolean	inherited from: Equipment
networkAnalysisEnabled	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
aliasName	0..1	String	inherited from: IdentifiedObject

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name	mult	type	description
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 147 shows all association ends of ACLineSegment with other classes.

Table 147 – Association ends of Wires::ACLineSegment with other classes

mult from	name	mult to	type	description
1..1	Clamp	0..*	Clamp	The clamps connected to the line segment.
0..*	PerLengthImpedance	0..1	PerLengthImpedance	Per-length impedance of this line segment.
1..1	Cut	0..*	Cut	Cuts applied to the line segment.
0..1	LineFaults	0..*	LineFault	The line faults of the line segment.
1..1	ACLineSegmentPhases	0..*	ACLineSegmentPhase	The line segment phases which belong to the line segment.
0..*	BaseVoltage	0..1	BaseVoltage	inherited from: ConductingEquipment
1..1	SvStatus	0..*	SvStatus	inherited from: ConductingEquipment
0..*	ProtectionEquipments	0..*	ProtectionEquipment	inherited from: ConductingEquipment
1..1	Terminals	0..*	Terminal	inherited from: ConductingEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	inherited from: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	inherited from: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment
0..1	Faults	0..*	Fault	inherited from: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	inherited from: Equipment
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.4.4 ACLineSegmentPhase

Represents a single wire of an alternating current line segment.

Table 148 shows all attributes of ACLineSegmentPhase.

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Table 148 – Attributes of Wires::ACLineSegmentPhase

name	mult	type	description
phase	0..1	SinglePhaseKind	The phase connection of the wire at both ends.
sequenceNumber	0..1	Integer	Number designation for this line segment phase. Each line segment phase within a line segment should have a unique sequence number. This is useful for unbalanced modelling to bind the mathematical model (PhaseImpedanceData of PerLengthPhaseImpedance) with the connectivity model (this class) and the physical model (WirePosition) without tight coupling.
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 149 shows all association ends of ACLineSegmentPhase with other classes.

Table 149 – Association ends of Wires::ACLineSegmentPhase with other classes

mult from	name	mult to	type	description
0..*	ACLineSegment	1..1	ACLineSegment	The line segment to which the phase belongs.
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.4.5 AsynchronousMachine

A rotating machine whose shaft rotates asynchronously with the electrical field. Also known as an induction machine with no external connection to the rotor windings, e.g. squirrel-cage induction machine.

Table 150 shows all attributes of AsynchronousMachine.

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Table 150 – Attributes of Wires::AsynchronousMachine

name	mult	type	description
asynchronousMachineType	0..1	AsynchronousMachineKind	Indicates the type of Asynchronous Machine (motor or generator).
converterFedDrive	0..1	Boolean	Indicates whether the machine is a converter fed drive. Used for short circuit data exchange according to IEC 60909.
efficiency	0..1	PerCent	Efficiency of the asynchronous machine at nominal operation as a percentage. Indicator for converter drive motors. Used for short circuit data exchange according to IEC 60909.
iaIrRatio	0..1	Float	Ratio of locked-rotor current to the rated current of the motor (Ia/Ir). Used for short circuit data exchange according to IEC 60909.
nominalFrequency	0..1	Frequency	Nameplate data indicates if the machine is 50 Hz or 60 Hz.
nominalSpeed	0..1	RotationSpeed	Nameplate data. Depends on the slip and number of pole pairs.
polePairNumber	0..1	Integer	Number of pole pairs of stator. Used for short circuit data exchange according to IEC 60909.
ratedMechanicalPower	0..1	ActivePower	Rated mechanical power (Pr in IEC 60909-0). Used for short circuit data exchange according to IEC 60909.
reversible	0..1	Boolean	Indicates for converter drive motors if the power can be reversible. Used for short circuit data exchange according to IEC 60909.
rr1	0..1	Resistance	Damper 1 winding resistance.
rr2	0..1	Resistance	Damper 2 winding resistance.
rxLockedRotorRatio	0..1	Float	Locked rotor ratio (R/X). Used for short circuit data exchange according to IEC 60909.
tpo	0..1	Seconds	Transient rotor time constant (greater than tppo).
tppo	0..1	Seconds	Sub-transient rotor time constant (greater than 0).
xlr1	0..1	Reactance	Damper 1 winding leakage reactance.
xlr2	0..1	Reactance	Damper 2 winding leakage reactance.
xm	0..1	Reactance	Magnetizing reactance.
xp	0..1	Reactance	Transient reactance (unsaturated) (greater than or equal to xpp).
xpp	0..1	Reactance	Sub-transient reactance (unsaturated).
xs	0..1	Reactance	Synchronous reactance (greater than xp).
ratedPowerFactor	0..1	Float	inherited from: RotatingMachine
p	0..1	ActivePower	inherited from: RotatingMachine
ratedS	0..1	ApparentPower	inherited from: RotatingMachine
q	0..1	ReactivePower	inherited from: RotatingMachine
ratedU	0..1	Voltage	inherited from: RotatingMachine
controlEnabled	0..1	Boolean	inherited from: RegulatingCondEq
aggregate	0..1	Boolean	inherited from: Equipment
inService	0..1	Boolean	inherited from: Equipment
networkAnalysisEnabled	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment

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name	mult	type	description
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 151 shows all association ends of AsynchronousMachine with other classes.

Table 151 – Association ends of Wires::AsynchronousMachine with other classes

mult from	name	mult to	type	description
1..1	AsynchronousMachineDynamics	0..1	AsynchronousMachineDynamics	Asynchronous machine dynamics model used to describe dynamic behaviour of this asynchronous machine.
1..1	HydroPump	0..1	HydroPump	inherited from: RotatingMachine
0..*	GeneratingUnit	0..1	GeneratingUnit	inherited from: RotatingMachine
0..*	RegulatingControl	0..1	RegulatingControl	inherited from: RegulatingCondEq
0..*	BaseVoltage	0..1	BaseVoltage	inherited from: ConductingEquipment
1..1	SvStatus	0..*	SvStatus	inherited from: ConductingEquipment
0..*	ProtectionEquipments	0..*	ProtectionEquipment	inherited from: ConductingEquipment
1..1	Terminals	0..*	Terminal	inherited from: ConductingEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	inherited from: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	inherited from: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment
0..1	Faults	0..*	Fault	inherited from: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	inherited from: Equipment
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.4.6 Breaker

A mechanical switching device capable of making, carrying, and breaking currents under normal circuit conditions and also making, carrying for a specified time, and breaking currents under specified abnormal circuit conditions e.g. those of short circuit.

Table 152 shows all attributes of Breaker.

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Table 152 – Attributes of Wires::Breaker

name	mult	type	description
inTransitTime	0..1	Seconds	The transition time from open to close.
breakingCapacity	0..1	CurrentFlow	inherited from: ProtectedSwitch
normalOpen	0..1	Boolean	inherited from: Switch
ratedCurrent	0..1	CurrentFlow	inherited from: Switch
switchOnCount	0..1	Integer	(deprecated) inherited from: Switch
switchOnDate	0..1	DateTime	(deprecated) inherited from: Switch
retained	0..1	Boolean	inherited from: Switch
open	0..1	Boolean	inherited from: Switch
locked	0..1	Boolean	inherited from: Switch
aggregate	0..1	Boolean	inherited from: Equipment
inService	0..1	Boolean	inherited from: Equipment
networkAnalysisEnabled	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 153 shows all association ends of Breaker with other classes.

Table 153 – Association ends of Wires::Breaker with other classes

mult from	name	mult to	type	description
0..*	OperatedByProtectionEquipment	0..*	ProtectionEquipment	inherited from: ProtectedSwitch
1..1	RecloseSequences	0..*	RecloseSequence	inherited from: ProtectedSwitch
1..1	SwitchPhase	0..*	SwitchPhase	inherited from: Switch
1..1	SwitchSchedules	0..*	SwitchSchedule	inherited from: Switch
0..*	CompositeSwitch	0..1	CompositeSwitch	inherited from: Switch
1..1	SvSwitch	0..*	SvSwitch	inherited from: Switch
0..*	BaseVoltage	0..1	BaseVoltage	inherited from: ConductingEquipment
1..1	SvStatus	0..*	SvStatus	inherited from: ConductingEquipment
0..*	ProtectionEquipments	0..*	ProtectionEquipment	inherited from: ConductingEquipment
1..1	Terminals	0..*	Terminal	inherited from: ConductingEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	inherited from: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	inherited from: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment
0..1	Faults	0..*	Fault	inherited from: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	inherited from: Equipment
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource

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mult from	name	mult to	type	description
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.4.7 BusbarSection

A conductor, or group of conductors, with negligible impedance, that serve to connect other conducting equipment within a single substation.

Voltage measurements are typically obtained from voltage transformers that are connected to busbar sections. A bus bar section may have many physical terminals but for analysis is modelled with exactly one logical terminal.

Table 154 shows all attributes of BusbarSection.

Table 154 – Attributes of Wires::BusbarSection

name	mult	type	description
ipMax	0..1	CurrentFlow	Maximum allowable peak short-circuit current of busbar (Ipmax in IEC 60909-0). Mechanical limit of the busbar in the substation itself. Used for short circuit data exchange according to IEC 60909.
aggregate	0..1	Boolean	inherited from: Equipment
inService	0..1	Boolean	inherited from: Equipment
networkAnalysisEnabled	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 155 shows all association ends of BusbarSection with other classes.

Table 155 – Association ends of Wires::BusbarSection with other classes

mult from	name	mult to	type	description
1..1	VoltageControlZone	0..1	VoltageControlZone	A VoltageControlZone is controlled by a designated BusbarSection.
0..*	BaseVoltage	0..1	BaseVoltage	inherited from: ConductingEquipment
1..1	SvStatus	0..*	SvStatus	inherited from: ConductingEquipment
0..*	ProtectionEquipments	0..*	ProtectionEquipment	inherited from: ConductingEquipment
1..1	Terminals	0..*	Terminal	inherited from: ConductingEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	inherited from: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	inherited from: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment

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mult from	name	mult to	type	description
0..1	Faults	0..*	Fault	inherited from: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	inherited from: Equipment
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.4.8 Clamp

A Clamp is a galvanic connection at a line segment where other equipment is connected. A Clamp does not cut the line segment.

A Clamp is ConductingEquipment and has one Terminal with an associated ConnectivityNode. Any other ConductingEquipment can be connected to the Clamp ConnectivityNode.

Table 156 shows all attributes of Clamp.

Table 156 – Attributes of Wires::Clamp

name	mult	type	description
lengthFromTerminal1	0..1	Length	The length to the place where the clamp is located starting from side one of the line segment, i.e. the line segment terminal with sequence number equal to 1.
aggregate	0..1	Boolean	inherited from: Equipment
inService	0..1	Boolean	inherited from: Equipment
networkAnalysisEnabled	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 157 shows all association ends of Clamp with other classes.

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Table 157 – Association ends of Wires::Clamp with other classes

mult from	name	mult to	type	description
0..*	ACLineSegment	1..1	ACLineSegment	The line segment to which the clamp is connected.
0..*	BaseVoltage	0..1	BaseVoltage	inherited from: ConductingEquipment
1..1	SvStatus	0..*	SvStatus	inherited from: ConductingEquipment
0..*	ProtectionEquipments	0..*	ProtectionEquipment	inherited from: ConductingEquipment
1..1	Terminals	0..*	Terminal	inherited from: ConductingEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	inherited from: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	inherited from: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment
0..1	Faults	0..*	Fault	inherited from: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	inherited from: Equipment
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.4.9 CompositeSwitch

A model of a set of individual Switches normally enclosed within the same cabinet and possibly with interlocks that restrict the combination of switch positions. These are typically found in medium voltage distribution networks.

A CompositeSwitch could represent a Ring-Main-Unit (RMU), or pad-mounted switchgear, with primitive internal devices such as an internal bus-bar plus 3 or 4 internal switches each of which may individually be open or closed. A CompositeSwitch and a set of contained Switches can also be used to represent a multi-position switch e.g. a switch that can connect a circuit to Ground, Open or Busbar.

Table 158 shows all attributes of CompositeSwitch.

Table 158 – Attributes of Wires::CompositeSwitch

name	mult	type	description
compositeSwitchType	0..1	String	An alphanumeric code that can be used as a reference to extra information such as the description of the interlocking scheme if any.
aggregate	0..1	Boolean	inherited from: Equipment
inService	0..1	Boolean	inherited from: Equipment
networkAnalysisEnabled	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject

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name	mult	type	description
name	0..1	String	inherited from: IdentifiedObject

Table 159 shows all association ends of CompositeSwitch with other classes.

Table 159 – Association ends of Wires::CompositeSwitch with other classes

mult from	name	mult to	type	description
0..1	Switches	0..*	Switch	Switches contained in this Composite switch.
0..1	OperationalLimitSet	0..*	OperationalLimitSet	inherited from: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	inherited from: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment
0..1	Faults	0..*	Fault	inherited from: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	inherited from: Equipment
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.4.10 Conductor

Combination of conducting material with consistent electrical characteristics, building a single electrical system, used to carry current between points in the power system.

Table 160 shows all attributes of Conductor.

Table 160 – Attributes of Wires::Conductor

name	mult	type	description
length	0..1	Length	Segment length for calculating line section capabilities.
aggregate	0..1	Boolean	inherited from: Equipment
inService	0..1	Boolean	inherited from: Equipment
networkAnalysisEnabled	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 161 shows all association ends of Conductor with other classes.

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Table 161 – Association ends of Wires::Conductor with other classes

mult from	name	mult to	type	description
0..*	BaseVoltage	0..1	BaseVoltage	inherited from: ConductingEquipment
1..1	SvStatus	0..*	SvStatus	inherited from: ConductingEquipment
0..*	ProtectionEquipments	0..*	ProtectionEquipment	inherited from: ConductingEquipment
1..1	Terminals	0..*	Terminal	inherited from: ConductingEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	inherited from: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	inherited from: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment
0..1	Faults	0..*	Fault	inherited from: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	inherited from: Equipment
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.4.11 Connector

A conductor, or group of conductors, with negligible impedance, that serve to connect other conducting equipment within a single substation and are modelled with a single logical terminal.

Table 162 shows all attributes of Connector.

Table 162 – Attributes of Wires::Connector

name	mult	type	description
aggregate	0..1	Boolean	inherited from: Equipment
inService	0..1	Boolean	inherited from: Equipment
networkAnalysisEnabled	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 163 shows all association ends of Connector with other classes.

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Table 163 – Association ends of Wires::Connector with other classes

mult from	name	mult to	type	description
0..*	BaseVoltage	0..1	BaseVoltage	inherited from: ConductingEquipment
1..1	SvStatus	0..*	SvStatus	inherited from: ConductingEquipment
0..*	ProtectionEquipments	0..*	ProtectionEquipment	inherited from: ConductingEquipment
1..1	Terminals	0..*	Terminal	inherited from: ConductingEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	inherited from: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	inherited from: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment
0..1	Faults	0..*	Fault	inherited from: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	inherited from: Equipment
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.4.12 CoolantType enumeration

Method of cooling a machine.

Table 164 shows all literals of CoolantType.

Table 164 – Literals of Wires::CoolantType

literal	value	description
air		Air.
hydrogenGas		Hydrogen gas.
water		Water.

6.4.13 Cut

A cut separates a line segment into two parts. The cut appears as a switch inserted between these two parts and connects them together. As the cut is normally open there is no galvanic connection between the two line segment parts. But it is possible to close the cut to get galvanic connection.

The cut terminals are oriented towards the line segment terminals with the same sequence number. Hence the cut terminal with sequence number equal to 1 is oriented to the line segment's terminal with sequence number equal to 1.

The cut terminals also act as connection points for jumpers and other equipment, e.g. a mobile generator. To enable this, connectivity nodes are placed at the cut terminals. Once the connectivity nodes are in place any conducting equipment can be connected at them.

Table 165 shows all attributes of Cut.

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Table 165 – Attributes of Wires::Cut

name	mult	type	description
lengthFromTerminal1	0..1	Length	The length to the place where the cut is located starting from side one of the cut line segment, i.e. the line segment Terminal with sequenceNumber equal to 1.
normalOpen	0..1	Boolean	inherited from: Switch
ratedCurrent	0..1	CurrentFlow	inherited from: Switch
switchOnCount	0..1	Integer	(deprecated) inherited from: Switch
switchOnDate	0..1	DateTime	(deprecated) inherited from: Switch
retained	0..1	Boolean	inherited from: Switch
open	0..1	Boolean	inherited from: Switch
locked	0..1	Boolean	inherited from: Switch
aggregate	0..1	Boolean	inherited from: Equipment
inService	0..1	Boolean	inherited from: Equipment
networkAnalysisEnabled	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 166 shows all association ends of Cut with other classes.

Table 166 – Association ends of Wires::Cut with other classes

mult from	name	mult to	type	description
0..*	ACLineSegment	1..1	ACLineSegment	The line segment to which the cut is applied.
1..1	SwitchPhase	0..*	SwitchPhase	inherited from: Switch
1..1	SwitchSchedules	0..*	SwitchSchedule	inherited from: Switch
0..*	CompositeSwitch	0..1	CompositeSwitch	inherited from: Switch
1..1	SvSwitch	0..*	SvSwitch	inherited from: Switch
0..*	BaseVoltage	0..1	BaseVoltage	inherited from: ConductingEquipment
1..1	SvStatus	0..*	SvStatus	inherited from: ConductingEquipment
0..*	ProtectionEquipments	0..*	ProtectionEquipment	inherited from: ConductingEquipment
1..1	Terminals	0..*	Terminal	inherited from: ConductingEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	inherited from: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	inherited from: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment
0..1	Faults	0..*	Fault	inherited from: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	inherited from: Equipment
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource

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mult from	name	mult to	type	description
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.4.14 Disconnector

A manually operated or motor operated mechanical switching device used for changing the connections in a circuit, or for isolating a circuit or equipment from a source of power. It is required to open or close circuits when negligible current is broken or made.

Table 167 shows all attributes of Disconnector.

Table 167 – Attributes of Wires::Disconnector

name	mult	type	description
normalOpen	0..1	Boolean	inherited from: Switch
ratedCurrent	0..1	CurrentFlow	inherited from: Switch
switchOnCount	0..1	Integer	(deprecated) inherited from: Switch
switchOnDate	0..1	DateTime	(deprecated) inherited from: Switch
retained	0..1	Boolean	inherited from: Switch
open	0..1	Boolean	inherited from: Switch
locked	0..1	Boolean	inherited from: Switch
aggregate	0..1	Boolean	inherited from: Equipment
inService	0..1	Boolean	inherited from: Equipment
networkAnalysisEnabled	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 168 shows all association ends of Disconnector with other classes.

Table 168 – Association ends of Wires::Disconnector with other classes

mult from	name	mult to	type	description
1..1	SwitchPhase	0..*	SwitchPhase	inherited from: Switch
1..1	SwitchSchedules	0..*	SwitchSchedule	inherited from: Switch
0..*	CompositeSwitch	0..1	CompositeSwitch	inherited from: Switch
1..1	SvSwitch	0..*	SvSwitch	inherited from: Switch
0..*	BaseVoltage	0..1	BaseVoltage	inherited from: ConductingEquipment
1..1	SvStatus	0..*	SvStatus	inherited from: ConductingEquipment
0..*	ProtectionEquipments	0..*	ProtectionEquipment	inherited from: ConductingEquipment
1..1	Terminals	0..*	Terminal	inherited from: ConductingEquipment

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mult from	name	mult to	type	description
0..1	OperationalLimitSet	0..*	OperationalLimitSet	inherited from: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	inherited from: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment
0..1	Faults	0..*	Fault	inherited from: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	inherited from: Equipment
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.4.15 DisconnectingCircuitBreaker

A circuit breaking device including disconnecting function, eliminating the need for separate disconnectors.

Table 169 shows all attributes of DisconnectingCircuitBreaker.

Table 169 – Attributes of Wires::DisconnectingCircuitBreaker

name	mult	type	description
inTransitTime	0..1	Seconds	inherited from: Breaker
breakingCapacity	0..1	CurrentFlow	inherited from: ProtectedSwitch
normalOpen	0..1	Boolean	inherited from: Switch
ratedCurrent	0..1	CurrentFlow	inherited from: Switch
switchOnCount	0..1	Integer	(deprecated) inherited from: Switch
switchOnDate	0..1	DateTime	(deprecated) inherited from: Switch
retained	0..1	Boolean	inherited from: Switch
open	0..1	Boolean	inherited from: Switch
locked	0..1	Boolean	inherited from: Switch
aggregate	0..1	Boolean	inherited from: Equipment
inService	0..1	Boolean	inherited from: Equipment
networkAnalysisEnabled	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 170 shows all association ends of DisconnectingCircuitBreaker with other classes.

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Table 170 – Association ends of Wires::DisconnectingCircuitBreaker with other classes

mult from	name	mult to	type	description
0..*	OperatedByProtectionEquipment	0..*	ProtectionEquipment	inherited from: ProtectedSwitch
1..1	RecloseSequences	0..*	RecloseSequence	inherited from: ProtectedSwitch
1..1	SwitchPhase	0..*	SwitchPhase	inherited from: Switch
1..1	SwitchSchedules	0..*	SwitchSchedule	inherited from: Switch
0..*	CompositeSwitch	0..1	CompositeSwitch	inherited from: Switch
1..1	SvSwitch	0..*	SvSwitch	inherited from: Switch
0..*	BaseVoltage	0..1	BaseVoltage	inherited from: ConductingEquipment
1..1	SvStatus	0..*	SvStatus	inherited from: ConductingEquipment
0..*	ProtectionEquipments	0..*	ProtectionEquipment	inherited from: ConductingEquipment
1..1	Terminals	0..*	Terminal	inherited from: ConductingEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	inherited from: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	inherited from: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment
0..1	Faults	0..*	Fault	inherited from: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	inherited from: Equipment
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.4.16 EarthFaultCompensator

A conducting equipment used to represent a connection to ground which is typically used to compensate earth faults. An earth fault compensator device modelled with a single terminal implies a second terminal solidly connected to ground. If two terminals are modelled, the ground is not assumed and normal connection rules apply.

Table 171 shows all attributes of EarthFaultCompensator.

Table 171 – Attributes of Wires::EarthFaultCompensator

name	mult	type	description
r	0..1	Resistance	Nominal resistance of device.
aggregate	0..1	Boolean	inherited from: Equipment
inService	0..1	Boolean	inherited from: Equipment
networkAnalysisEnabled	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject

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name	mult	type	description
name	0..1	String	inherited from: IdentifiedObject

Table 172 shows all association ends of EarthFaultCompensator with other classes.

Table 172 – Association ends of Wires::EarthFaultCompensator with other classes

mult from	name	mult to	type	description
0..*	BaseVoltage	0..1	BaseVoltage	inherited from: ConductingEquipment
1..1	SvStatus	0..*	SvStatus	inherited from: ConductingEquipment
0..*	ProtectionEquipments	0..*	ProtectionEquipment	inherited from: ConductingEquipment
1..1	Terminals	0..*	Terminal	inherited from: ConductingEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	inherited from: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	inherited from: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment
0..1	Faults	0..*	Fault	inherited from: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	inherited from: Equipment
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.4.17 EnergyConnection

A connection of energy generation or consumption on the power system model.

Table 173 shows all attributes of EnergyConnection.

Table 173 – Attributes of Wires::EnergyConnection

name	mult	type	description
aggregate	0..1	Boolean	inherited from: Equipment
inService	0..1	Boolean	inherited from: Equipment
networkAnalysisEnabled	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 174 shows all association ends of EnergyConnection with other classes.

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Table 174 – Association ends of Wires::EnergyConnection with other classes

mult from	name	mult to	type	description
0..*	BaseVoltage	0..1	BaseVoltage	inherited from: ConductingEquipment
1..1	SvStatus	0..*	SvStatus	inherited from: ConductingEquipment
0..*	ProtectionEquipments	0..*	ProtectionEquipment	inherited from: ConductingEquipment
1..1	Terminals	0..*	Terminal	inherited from: ConductingEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	inherited from: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	inherited from: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment
0..1	Faults	0..*	Fault	inherited from: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	inherited from: Equipment
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.4.18 EnergyConsumer

Generic user of energy – a point of consumption on the power system model.

EnergyConsumer.pfixed, .qfixed, .pfixedPct and .qfixedPct have meaning only if there is no LoadResponseCharacteristic associated with EnergyConsumer or if LoadResponseCharacteristic.exponentModel is set to False.

Table 175 shows all attributes of EnergyConsumer.

Table 175 – Attributes of Wires::EnergyConsumer

name	mult	type	description
customerCount	0..1	Integer	Number of individual customers represented by this demand.
grounded	0..1	Boolean	Used for Yn and Zn connections. True if the neutral is solidly grounded.
pfixed	0..1	ActivePower	Active power of the load that is a fixed quantity and does not vary as load group value varies. Load sign convention is used, i.e. positive sign means flow out from a node.
pfixedPct	0..1	PerCent	Fixed active power as a percentage of load group fixed active power. Used to represent the time-varying components. Load sign convention is used, i.e. positive sign means flow out from a node.
phaseConnection	0..1	PhaseShuntConnectionKind	The type of phase connection, such as wye or delta.
qfixed	0..1	ReactivePower	Reactive power of the load that is a fixed quantity and does not vary as load group value varies. Load sign convention is used, i.e. positive sign means flow out from a node.

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name	mult	type	description
qfixedPct	0..1	PerCent	Fixed reactive power as a percentage of load group fixed reactive power. Used to represent the time-varying components. Load sign convention is used, i.e. positive sign means flow out from a node.
p	0..1	ActivePower	Active power of the load. Load sign convention is used, i.e. positive sign means flow out from a node. For voltage dependent loads the value is at rated voltage. Starting value for a steady state solution.
q	0..1	ReactivePower	Reactive power of the load. Load sign convention is used, i.e. positive sign means flow out from a node. For voltage dependent loads the value is at rated voltage. Starting value for a steady state solution.
aggregate	0..1	Boolean	inherited from: EquipmentContent
inService	0..1	Boolean	inherited from: Equipment
networkAnalysisEnabled	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 176 shows all association ends of EnergyConsumer with other classes.

Table 176 – Association ends of Wires::EnergyConsumer with other classes

mult from	name	mult to	type	description
0..*	LoadResponse	0..1	LoadResponseCharacteristic	The load response characteristic of this load. If missing, this load is assumed to be constant power.
1..1	EnergyConsumerPhase	0..*	EnergyConsumerPhase	The individual phase models for this energy consumer.
1..*	PowerCutZone	0..1	PowerCutZone	The energy consumer is assigned to this power cut zone.
0..*	LoadDynamics	0..1	LoadDynamics	Load dynamics model used to describe dynamic behaviour of this energy consumer.
0..*	BaseVoltage	0..1	BaseVoltage	inherited from: ConductingEquipment
1..1	SvStatus	0..*	SvStatus	inherited from: ConductingEquipment
0..*	ProtectionEquipments	0..*	ProtectionEquipment	inherited from: ConductingEquipment
1..1	Terminals	0..*	Terminal	inherited from: ConductingEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	inherited from: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	inherited from: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment
0..1	Faults	0..*	Fault	inherited from: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	inherited from: Equipment

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mult from	name	mult to	type	description
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.4.19 EnergyConsumerPhase

A single phase of an energy consumer.

Table 177 shows all attributes of EnergyConsumerPhase.

Table 177 – Attributes of Wires::EnergyConsumerPhase

name	mult	type	description
pfixed	0..1	ActivePower	Active power of the load that is a fixed quantity. Load sign convention is used, i.e. positive sign means flow out from a node.
pfixedPct	0..1	PerCent	Fixed active power as per cent of load group fixed active power. Load sign convention is used, i.e. positive sign means flow out from a node.
phase	0..1	SinglePhaseKind	Phase of this energy consumer component. If the energy consumer is wye connected, the connection is from the indicated phase to the central ground or neutral point. If the energy consumer is delta connected, the phase indicates an energy consumer connected from the indicated phase to the next logical non-neutral phase.
qfixed	0..1	ReactivePower	Reactive power of the load that is a fixed quantity. Load sign convention is used, i.e. positive sign means flow out from a node.
qfixedPct	0..1	PerCent	Fixed reactive power as per cent of load group fixed reactive power. Load sign convention is used, i.e. positive sign means flow out from a node.
p	0..1	ActivePower	Active power of the load. Load sign convention is used, i.e. positive sign means flow out from a node. For voltage dependent loads the value is at rated voltage. Starting value for a steady state solution.
q	0..1	ReactivePower	Reactive power of the load. Load sign convention is used, i.e. positive sign means flow out from a node. For voltage dependent loads the value is at rated voltage. Starting value for a steady state solution.
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject

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name	mult	type	description
name	0..1	String	inherited from: IdentifiedObject

Table 178 shows all association ends of EnergyConsumerPhase with other classes.

Table 178 – Association ends of Wires::EnergyConsumerPhase with other classes

mult from	name	mult to	type	description
0..*	EnergyConsumer	1..1	EnergyConsumer	The energy consumer to which this phase belongs.
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.4.20 EnergySchedulingType

Used to define the type of generation for scheduling purposes.

Table 179 shows all attributes of EnergySchedulingType.

Table 179 – Attributes of Wires::EnergySchedulingType

name	mult	type	description
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 180 shows all association ends of EnergySchedulingType with other classes.

Table 180 – Association ends of Wires::EnergySchedulingType with other classes

mult from	name	mult to	type	description
0..1	EnergySource	0..*	EnergySource	Energy Source of a particular Energy Scheduling Type.
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.4.21 EnergySource

A generic equivalent for an energy supplier on a transmission or distribution voltage level.

Table 181 shows all attributes of EnergySource.

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Table 181 – Attributes of Wires::EnergySource

name	mult	type	description
activePower	0..1	ActivePower	High voltage source active injection. Load sign convention is used, i.e. positive sign means flow out from a node. Starting value for steady state solutions.
reactivePower	0..1	ReactivePower	High voltage source reactive injection. Load sign convention is used, i.e. positive sign means flow out from a node. Starting value for steady state solutions.
nominalVoltage	0..1	Voltage	Phase-to-phase nominal voltage.
r	0..1	Resistance	Positive sequence Thevenin resistance.
r0	0..1	Resistance	Zero sequence Thevenin resistance.
rn	0..1	Resistance	Negative sequence Thevenin resistance.
voltageAngle	0..1	AngleRadians	Phase angle of a-phase open circuit used when voltage characteristics need to be imposed at the node associated with the terminal of the energy source, such as when voltages and angles from the transmission level are used as input to the distribution network. The attribute shall be a positive value or zero.
voltageMagnitude	0..1	Voltage	Phase-to-phase open circuit voltage magnitude used when voltage characteristics need to be imposed at the node associated with the terminal of the energy source, such as when voltages and angles from the transmission level are used as input to the distribution network. The attribute shall be a positive value or zero.
x	0..1	Reactance	Positive sequence Thevenin reactance.
x0	0..1	Reactance	Zero sequence Thevenin reactance.
xn	0..1	Reactance	Negative sequence Thevenin reactance.
pMin	0..1	ActivePower	This is the minimum active power that can be produced by the source. Load sign convention is used, i.e. positive sign means flow out from a TopologicalNode (bus) into the conducting equipment.
pMax	0..1	ActivePower	This is the maximum active power that can be produced by the source. Load sign convention is used, i.e. positive sign means flow out from a TopologicalNode (bus) into the conducting equipment.
aggregate	0..1	Boolean	inherited from: Equipment
inService	0..1	Boolean	inherited from: Equipment
networkAnalysisEnabled	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 182 shows all association ends of EnergySource with other classes.

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Table 182 – Association ends of Wires::EnergySource with other classes

mult from	name	mult to	type	description
0..*	EnergySchedulingType	0..1	EnergySchedulingType	Energy Scheduling Type of an Energy Source.
1..1	EnergySourcePhase	0..*	EnergySourcePhase	The individual phase information of the energy source.
0..*	BaseVoltage	0..1	BaseVoltage	inherited from: ConductingEquipment
1..1	SvStatus	0..*	SvStatus	inherited from: ConductingEquipment
0..*	ProtectionEquipments	0..*	ProtectionEquipment	inherited from: ConductingEquipment
1..1	Terminals	0..*	Terminal	inherited from: ConductingEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	inherited from: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	inherited from: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment
0..1	Faults	0..*	Fault	inherited from: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	inherited from: Equipment
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.4.22 EnergySourcePhase

Represents the single phase information of an unbalanced energy source.

Table 183 shows all attributes of EnergySourcePhase.

Table 183 – Attributes of Wires::EnergySourcePhase

name	mult	type	description
phase	0..1	SinglePhaseKind	Phase of this energy source component. If the energy source wye connected, the connection is from the indicated phase to the central ground or neutral point. If the energy source is delta connected, the phase indicates an energy source connected from the indicated phase to the next logical non-neutral phase.
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 184 shows all association ends of EnergySourcePhase with other classes.

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Table 184 – Association ends of Wires::EnergySourcePhase with other classes

mult from	name	mult to	type	description
0..*	EnergySource	1..1	EnergySource	The energy sourceto which the phase belongs.
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.4.23 ExternalNetworkInjection

This class represents the external network and it is used for IEC 60909 calculations.

Table 185 shows all attributes of ExternalNetworkInjection.

Table 185 – Attributes of Wires::ExternalNetworkInjection

name	mult	type	description
governorSCD	0..1	ActivePowerPerFrequency	Power Frequency Bias. This is the change in power injection divided by the change in frequency and negated. A positive value of the power frequency bias provides additional power injection upon a drop in frequency.
ikSecond	0..1	Boolean	Indicates whether initial symmetrical short-circuit current and power have been calculated according to IEC (Ik"). Used only if short circuit calculations are done according to superposition method.
maxInitialSymShCCurrent	0..1	CurrentFlow	Maximum initial symmetrical short-circuit currents (Ik" max) in A (Ik" = Sk"/(SQRT(3) Un)). Used for short circuit data exchange according to IEC 60909.
maxP	0..1	ActivePower	Maximum active power of the injection.
maxQ	0..1	ReactivePower	Maximum reactive power limit. It is used for modelling of infeed for load flow exchange and not for short circuit modelling.
maxR0ToX0Ratio	0..1	Float	Maximum ratio of zero sequence resistance of Network Feeder to its zero sequence reactance (R(0)/X(0) max). Used for short circuit data exchange according to IEC 60909.
maxR1ToX1Ratio	0..1	Float	Maximum ratio of positive sequence resistance of Network Feeder to its positive sequence reactance (R(1)/X(1) max). Used for short circuit data exchange according to IEC 60909.
maxZ0ToZ1Ratio	0..1	Float	Maximum ratio of zero sequence impedance to its positive sequence impedance (Z(0)/Z(1) max). Used for short circuit data exchange according to IEC 60909.
minInitialSymShCCurrent	0..1	CurrentFlow	Minimum initial symmetrical short-circuit currents (Ik" min) in A (Ik" = Sk"/(SQRT(3) Un)). Used for short circuit data exchange according to IEC 60909.
minP	0..1	ActivePower	Minimum active power of the injection.

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name	mult	type	description
minQ	0..1	ReactivePower	Minimum reactive power limit. It is used for modelling of infeed for load flow exchange and not for short circuit modelling.
minR0ToX0Ratio	0..1	Float	Indicates whether initial symmetrical short-circuit current and power have been calculated according to IEC (Ik"). Used for short circuit data exchange according to IEC 6090.
minR1ToX1Ratio	0..1	Float	Minimum ratio of positive sequence resistance of Network Feeder to its positive sequence reactance (R(1)/X(1) min). Used for short circuit data exchange according to IEC 60909.
minZ0ToZ1Ratio	0..1	Float	Minimum ratio of zero sequence impedance to its positive sequence impedance (Z(0)/Z(1) min). Used for short circuit data exchange according to IEC 60909.
referencePriority	0..1	Integer	Priority of unit for use as powerflow voltage phase angle reference bus selection. 0 = don t care (default) 1 = highest priority. 2 is less than 1 and so on.
voltageFactor	0..1	PU	Voltage factor in pu, which was used to calculate short-circuit current Ik" and power Sk". Used only if short circuit calculations are done according to superposition method.
p	0..1	ActivePower	Active power injection. Load sign convention is used, i.e. positive sign means flow out from a node. Starting value for steady state solutions.
q	0..1	ReactivePower	Reactive power injection. Load sign convention is used, i.e. positive sign means flow out from a node. Starting value for steady state solutions.
controlEnabled	0..1	Boolean	inherited from: RegulatingCondEq
aggregate	0..1	Boolean	inherited from: Equipment
inService	0..1	Boolean	inherited from: Equipment
networkAnalysisEnabled	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 186 shows all association ends of ExternalNetworkInjection with other classes.

Table 186 – Association ends of Wires::ExternalNetworkInjection with other classes

mult from	name	mult to	type	description
0..*	RegulatingControl	0..1	RegulatingControl	inherited from: RegulatingCondEq
0..*	BaseVoltage	0..1	BaseVoltage	inherited from: ConductingEquipment
1..1	SvStatus	0..*	SvStatus	inherited from: ConductingEquipment
0..*	ProtectionEquipments	0..*	ProtectionEquipment	inherited from: ConductingEquipment
1..1	Terminals	0..*	Terminal	inherited from: ConductingEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	inherited from: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	inherited from: Equipment

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mult from	name	mult to	type	description
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment
0..1	Faults	0..*	Fault	inherited from: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	inherited from: Equipment
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.4.24 FrequencyConverter

A device to convert from one frequency to another (e.g., frequency F1 to F2) comprises a pair of FrequencyConverter instances. One converts from F1 to DC, the other converts the DC to F2.

Table 187 shows all attributes of FrequencyConverter.

Table 187 – Attributes of Wires::FrequencyConverter

name	mult	type	description
frequency	0..1	Frequency	Frequency on the AC side.
maxP	0..1	ActivePower	The maximum active power on the DC side at which the frequency converter should operate.
maxU	0..1	Voltage	The maximum voltage on the DC side at which the frequency converter should operate.
minP	0..1	ActivePower	The minimum active power on the DC side at which the frequency converter should operate.
minU	0..1	Voltage	The minimum voltage on the DC side at which the frequency converter should operate.
controlEnabled	0..1	Boolean	inherited from: RegulatingCondEq
aggregate	0..1	Boolean	inherited from: Equipment
inService	0..1	Boolean	inherited from: Equipment
networkAnalysisEnabled	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 188 shows all association ends of FrequencyConverter with other classes.

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Table 188 – Association ends of Wires::FrequencyConverter with other classes

mult from	name	mult to	type	description
0..*	RegulatingControl	0..1	RegulatingControl	inherited from: RegulatingCondEq
0..*	BaseVoltage	0..1	BaseVoltage	inherited from: ConductingEquipment
1..1	SvStatus	0..*	SvStatus	inherited from: ConductingEquipment
0..*	ProtectionEquipments	0..*	ProtectionEquipment	inherited from: ConductingEquipment
1..1	Terminals	0..*	Terminal	inherited from: ConductingEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	inherited from: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	inherited from: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment
0..1	Faults	0..*	Fault	inherited from: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	inherited from: Equipment
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.4.25 Fuse

An overcurrent protective device with a circuit opening fusible part that is heated and severed by the passage of overcurrent through it. A fuse is considered a switching device because it breaks current.

Table 189 shows all attributes of Fuse.

Table 189 – Attributes of Wires::Fuse

name	mult	type	description
normalOpen	0..1	Boolean	inherited from: Switch
ratedCurrent	0..1	CurrentFlow	inherited from: Switch
switchOnCount	0..1	Integer	(deprecated) inherited from: Switch
switchOnDate	0..1	DateTime	(deprecated) inherited from: Switch
retained	0..1	Boolean	inherited from: Switch
open	0..1	Boolean	inherited from: Switch
locked	0..1	Boolean	inherited from: Switch
aggregate	0..1	Boolean	inherited from: Equipment
inService	0..1	Boolean	inherited from: Equipment
networkAnalysisEnabled	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject

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name	mult	type	description
name	0..1	String	inherited from: IdentifiedObject

Table 190 shows all association ends of Fuse with other classes.

Table 190 – Association ends of Wires::Fuse with other classes

mult from	name	mult to	type	description
1..1	SwitchPhase	0..*	SwitchPhase	inherited from: Switch
1..1	SwitchSchedules	0..*	SwitchSchedule	inherited from: Switch
0..*	CompositeSwitch	0..1	CompositeSwitch	inherited from: Switch
1..1	SvSwitch	0..*	SvSwitch	inherited from: Switch
0..*	BaseVoltage	0..1	BaseVoltage	inherited from: ConductingEquipment
1..1	SvStatus	0..*	SvStatus	inherited from: ConductingEquipment
0..*	ProtectionEquipments	0..*	ProtectionEquipment	inherited from: ConductingEquipment
1..1	Terminals	0..*	Terminal	inherited from: ConductingEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	inherited from: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	inherited from: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment
0..1	Faults	0..*	Fault	inherited from: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	inherited from: Equipment
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.4.26 Ground

A point where the system is grounded used for connecting conducting equipment to ground. The power system model can have any number of grounds.

Table 191 shows all attributes of Ground.

Table 191 – Attributes of Wires::Ground

name	mult	type	description
aggregate	0..1	Boolean	inherited from: Equipment
inService	0..1	Boolean	inherited from: Equipment
networkAnalysisEnabled	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject

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name	mult	type	description
name	0..1	String	inherited from: IdentifiedObject

Table 192 shows all association ends of Ground with other classes.

Table 192 – Association ends of Wires::Ground with other classes

mult from	name	mult to	type	description
0..*	BaseVoltage	0..1	BaseVoltage	inherited from: ConductingEquipment
1..1	SvStatus	0..*	SvStatus	inherited from: ConductingEquipment
0..*	ProtectionEquipments	0..*	ProtectionEquipment	inherited from: ConductingEquipment
1..1	Terminals	0..*	Terminal	inherited from: ConductingEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	inherited from: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	inherited from: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment
0..1	Faults	0..*	Fault	inherited from: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	inherited from: Equipment
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.4.27 GroundingImpedance

A fixed impedance device used for grounding.

Table 193 shows all attributes of GroundingImpedance.

Table 193 – Attributes of Wires::GroundingImpedance

name	mult	type	description
x	0..1	Reactance	Reactance of device.
r	0..1	Resistance	inherited from: EarthFaultCompensator
aggregate	0..1	Boolean	inherited from: Equipment
inService	0..1	Boolean	inherited from: Equipment
networkAnalysisEnabled	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

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Table 194 shows all association ends of GroundingImpedance with other classes.

Table 194 – Association ends of Wires::GroundingImpedance with other classes

mult from	name	mult to	type	description
0..*	BaseVoltage	0..1	BaseVoltage	inherited from: ConductingEquipment
1..1	SvStatus	0..*	SvStatus	inherited from: ConductingEquipment
0..*	ProtectionEquipments	0..*	ProtectionEquipment	inherited from: ConductingEquipment
1..1	Terminals	0..*	Terminal	inherited from: ConductingEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	inherited from: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	inherited from: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment
0..1	Faults	0..*	Fault	inherited from: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	inherited from: Equipment
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.4.28 GroundDisconnector

A manually operated or motor operated mechanical switching device used for isolating a circuit or equipment from ground.

Table 195 shows all attributes of GroundDisconnector.

Table 195 – Attributes of Wires::GroundDisconnector

name	mult	type	description
normalOpen	0..1	Boolean	inherited from: Switch
ratedCurrent	0..1	CurrentFlow	inherited from: Switch
switchOnCount	0..1	Integer	(deprecated) inherited from: Switch
switchOnDate	0..1	DateTime	(deprecated) inherited from: Switch
retained	0..1	Boolean	inherited from: Switch
open	0..1	Boolean	inherited from: Switch
locked	0..1	Boolean	inherited from: Switch
aggregate	0..1	Boolean	inherited from: Equipment
inService	0..1	Boolean	inherited from: Equipment
networkAnalysisEnabled	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject

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name	mult	type	description
name	0..1	String	inherited from: IdentifiedObject

Table 196 shows all association ends of GroundDisconnector with other classes.

Table 196 – Association ends of Wires::GroundDisconnector with other classes

mult from	name	mult to	type	description
1..1	SwitchPhase	0..*	SwitchPhase	inherited from: Switch
1..1	SwitchSchedules	0..*	SwitchSchedule	inherited from: Switch
0..*	CompositeSwitch	0..1	CompositeSwitch	inherited from: Switch
1..1	SvSwitch	0..*	SvSwitch	inherited from: Switch
0..*	BaseVoltage	0..1	BaseVoltage	inherited from: ConductingEquipment
1..1	SvStatus	0..*	SvStatus	inherited from: ConductingEquipment
0..*	ProtectionEquipments	0..*	ProtectionEquipment	inherited from: ConductingEquipment
1..1	Terminals	0..*	Terminal	inherited from: ConductingEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	inherited from: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	inherited from: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment
0..1	Faults	0..*	Fault	inherited from: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	inherited from: Equipment
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.4.29 Jumper

A short section of conductor with negligible impedance which can be manually removed and replaced if the circuit is de-energized. Note that zero-impedance branches can potentially be modelled by other equipment types.

Table 197 shows all attributes of Jumper.

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Table 197 – Attributes of Wires::Jumper

name	mult	type	description
normalOpen	0..1	Boolean	inherited from: Switch
ratedCurrent	0..1	CurrentFlow	inherited from: Switch
switchOnCount	0..1	Integer	(deprecated) inherited from: Switch
switchOnDate	0..1	DateTime	(deprecated) inherited from: Switch
retained	0..1	Boolean	inherited from: Switch
open	0..1	Boolean	inherited from: Switch
locked	0..1	Boolean	inherited from: Switch
aggregate	0..1	Boolean	inherited from: Equipment
inService	0..1	Boolean	inherited from: Equipment
networkAnalysisEnabled	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 198 shows all association ends of Jumper with other classes.

Table 198 – Association ends of Wires::Jumper with other classes

mult from	name	mult to	type	description
1..1	SwitchPhase	0..*	SwitchPhase	inherited from: Switch
1..1	SwitchSchedules	0..*	SwitchSchedule	inherited from: Switch
0..*	CompositeSwitch	0..1	CompositeSwitch	inherited from: Switch
1..1	SvSwitch	0..*	SvSwitch	inherited from: Switch
0..*	BaseVoltage	0..1	BaseVoltage	inherited from: ConductingEquipment
1..1	SvStatus	0..*	SvStatus	inherited from: ConductingEquipment
0..*	ProtectionEquipments	0..*	ProtectionEquipment	inherited from: ConductingEquipment
1..1	Terminals	0..*	Terminal	inherited from: ConductingEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	inherited from: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	inherited from: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment
0..1	Faults	0..*	Fault	inherited from: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	inherited from: Equipment
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

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6.4.30 Junction

A point where one or more conducting equipments are connected with zero resistance.

Table 199 shows all attributes of Junction.

Table 199 – Attributes of Wires::Junction

name	mult	type	description
aggregate	0..1	Boolean	inherited from: Equipment
inService	0..1	Boolean	inherited from: Equipment
networkAnalysisEnabled	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 200 shows all association ends of Junction with other classes.

Table 200 – Association ends of Wires::Junction with other classes

mult from	name	mult to	type	description
0..*	BaseVoltage	0..1	BaseVoltage	inherited from: ConductingEquipment
1..1	SvStatus	0..*	SvStatus	inherited from: ConductingEquipment
0..*	ProtectionEquipments	0..*	ProtectionEquipment	inherited from: ConductingEquipment
1..1	Terminals	0..*	Terminal	inherited from: ConductingEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	inherited from: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	inherited from: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment
0..1	Faults	0..*	Fault	inherited from: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	inherited from: Equipment
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

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6.4.31 Line

Contains equipment beyond a substation belonging to a power transmission line.

Table 201 shows all attributes of Line.

Table 201 – Attributes of Wires::Line

name	mult	type	description
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 202 shows all association ends of Line with other classes.

Table 202 – Association ends of Wires::Line with other classes

mult from	name	mult to	type	description
0..*	Region	0..1	SubGeographicalRegion	The sub-geographical region of the line.
0..1	Equipments	0..*	Equipment	inherited from: EquipmentContainer
0..*	AdditionalGroupedEquipment	0..*	Equipment	inherited from: EquipmentContainer
1..1	ConnectivityNodes	0..*	ConnectivityNode	inherited from: ConnectivityNodeContainer
0..1	TopologicalNode	0..*	TopologicalNode	inherited from: ConnectivityNodeContainer
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.4.32 LinearShuntCompensator

A linear shunt compensator has banks or sections with equal admittance values.

Table 203 shows all attributes of LinearShuntCompensator.

Table 203 – Attributes of Wires::LinearShuntCompensator

name	mult	type	description
b0PerSection	0..1	Susceptance	Zero sequence shunt (charging) susceptance per section.
bPerSection	0..1	Susceptance	Positive sequence shunt (charging) susceptance per section.
g0PerSection	0..1	Conductance	Zero sequence shunt (charging) conductance per section.
gPerSection	0..1	Conductance	Positive sequence shunt (charging) conductance per section.
aVRDelay	0..1	Seconds	inherited from: ShuntCompensator
grounded	0..1	Boolean	inherited from: ShuntCompensator
maximumSections	0..1	Integer	inherited from: ShuntCompensator
nomU	0..1	Voltage	inherited from: ShuntCompensator

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name	mult	type	description
normalSections	0..1	Integer	inherited from: ShuntCompensator
phaseConnection	0..1	PhaseShuntConnectionKind	inherited from: ShuntCompensator
switchOnCount	0..1	Integer	(deprecated) inherited from: ShuntCompensator
switchOnDate	0..1	DateTime	(deprecated) inherited from: ShuntCompensator
voltageSensitivity	0..1	VoltagePerReactivePower	inherited from: ShuntCompensator
sections	0..1	Float	inherited from: ShuntCompensator
controlEnabled	0..1	Boolean	inherited from: RegulatingCondEq
aggregate	0..1	Boolean	inherited from: Equipment
inService	0..1	Boolean	inherited from: Equipment
networkAnalysisEnabled	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 204 shows all association ends of LinearShuntCompensator with other classes.

Table 204 – Association ends of Wires::LinearShuntCompensator with other classes

mult from	name	mult to	type	description
1..1	ShuntCompensatorPhase	0..*	ShuntCompensatorPhase	inherited from: ShuntCompensator
1..1	SvShuntCompensatorSections	0..*	SvShuntCompensatorSections	inherited from: ShuntCompensator
0..*	RegulatingControl	0..1	RegulatingControl	inherited from: RegulatingCondEq
0..*	BaseVoltage	0..1	BaseVoltage	inherited from: ConductingEquipment
1..1	SvStatus	0..*	SvStatus	inherited from: ConductingEquipment
0..*	ProtectionEquipments	0..*	ProtectionEquipment	inherited from: ConductingEquipment
1..1	Terminals	0..*	Terminal	inherited from: ConductingEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	inherited from: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	inherited from: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment
0..1	Faults	0..*	Fault	inherited from: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	inherited from: Equipment
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

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6.4.33 LinearShuntCompensatorPhase

A per phase linear shunt compensator has banks or sections with equal admittance values.

Table 205 shows all attributes of LinearShuntCompensatorPhase.

Table 205 – Attributes of Wires::LinearShuntCompensatorPhase

name	mult	type	description
bPerSection	0..1	Susceptance	Susceptance per section of the phase if shunt compensator is wye connected. Susceptance per section phase to phase if shunt compensator is delta connected.
gPerSection	0..1	Conductance	Conductance per section for this phase if shunt compensator is wye connected. Conductance per section phase to phase if shunt compensator is delta connected.
maximumSections	0..1	Integer	inherited from: ShuntCompensatorPhase
normalSections	0..1	Integer	inherited from: ShuntCompensatorPhase
sections	0..1	Float	inherited from: ShuntCompensatorPhase
phase	0..1	SinglePhaseKind	inherited from: ShuntCompensatorPhase
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 206 shows all association ends of LinearShuntCompensatorPhase with other classes.

Table 206 – Association ends of Wires::LinearShuntCompensatorPhase with other classes

mult from	name	mult to	type	description
0..*	ShuntCompensator	1..1	ShuntCompensator	inherited from: ShuntCompensatorPhase
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

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6.4.34 LoadBreakSwitch

A mechanical switching device capable of making, carrying, and breaking currents under normal operating conditions.

Table 207 shows all attributes of LoadBreakSwitch.

Table 207 – Attributes of Wires::LoadBreakSwitch

name	mult	type	description
breakingCapacity	0..1	CurrentFlow	inherited from: ProtectedSwitch
normalOpen	0..1	Boolean	inherited from: Switch
ratedCurrent	0..1	CurrentFlow	inherited from: Switch
switchOnCount	0..1	Integer	(deprecated) inherited from: Switch
switchOnDate	0..1	DateTime	(deprecated) inherited from: Switch
retained	0..1	Boolean	inherited from: Switch
open	0..1	Boolean	inherited from: Switch
locked	0..1	Boolean	inherited from: Switch
aggregate	0..1	Boolean	inherited from: Equipment
inService	0..1	Boolean	inherited from: Equipment
networkAnalysisEnabled	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 208 shows all association ends of LoadBreakSwitch with other classes.

Table 208 – Association ends of Wires::LoadBreakSwitch with other classes

mult from	name	mult to	type	description
0..*	OperatedByProtectionEquipment	0..*	ProtectionEquipment	inherited from: ProtectedSwitch
1..1	RecloseSequences	0..*	RecloseSequence	inherited from: ProtectedSwitch
1..1	SwitchPhase	0..*	SwitchPhase	inherited from: Switch
1..1	SwitchSchedules	0..*	SwitchSchedule	inherited from: Switch
0..*	CompositeSwitch	0..1	CompositeSwitch	inherited from: Switch
1..1	SvSwitch	0..*	SvSwitch	inherited from: Switch
0..*	BaseVoltage	0..1	BaseVoltage	inherited from: ConductingEquipment
1..1	SvStatus	0..*	SvStatus	inherited from: ConductingEquipment
0..*	ProtectionEquipments	0..*	ProtectionEquipment	inherited from: ConductingEquipment
1..*	Terminals	0..*	Terminal	inherited from: ConductingEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	inherited from: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	inherited from: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment
0..1	Faults	0..*	Fault	inherited from: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	inherited from: Equipment
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource

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mult from	name	mult to	type	description
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.4.35 MutualCoupling

This class represents the zero sequence line mutual coupling.

Table 209 shows all attributes of MutualCoupling.

Table 209 – Attributes of Wires::MutualCoupling

name	mult	type	description
b0ch	0..1	Susceptance	Zero sequence mutual coupling shunt (charging) susceptance, uniformly distributed, of the entire line section.
distance11	0..1	Length	Distance to the start of the coupled region from the first line's terminal having sequence number equal to 1.
distance12	0..1	Length	Distance to the end of the coupled region from the first line's terminal with sequence number equal to 1.
distance21	0..1	Length	Distance to the start of coupled region from the second line's terminal with sequence number equal to 1.
distance22	0..1	Length	Distance to the end of coupled region from the second line's terminal with sequence number equal to 1.
g0ch	0..1	Conductance	Zero sequence mutual coupling shunt (charging) conductance, uniformly distributed, of the entire line section.
r0	0..1	Resistance	Zero sequence branch-to-branch mutual impedance coupling, resistance.
x0	0..1	Reactance	Zero sequence branch-to-branch mutual impedance coupling, reactance.
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 210 shows all association ends of MutualCoupling with other classes.

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Table 210 – Association ends of Wires::MutualCoupling with other classes

mult from	name	mult to	type	description
0..*	First_Terminal	1..1	Terminal	The starting terminal for the calculation of distances along the first branch of the mutual coupling. Normally MutualCoupling would only be used for terminals of AC line segments. The first and second terminals of a mutual coupling should point to different AC line segments.
0..*	Second_Terminal	1..1	Terminal	The starting terminal for the calculation of distances along the second branch of the mutual coupling.
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.4.36 NonlinearShuntCompensator

A non linear shunt compensator has bank or section admittance values that differ. The attributes g, b, g0 and b0 of the associated NonlinearShuntCompensatorPoint describe the total conductance and admittance of a NonlinearShuntCompensatorPoint at a section number specified by NonlinearShuntCompensatorPoint.sectionNumber.

Table 211 shows all attributes of NonlinearShuntCompensator.

Table 211 – Attributes of Wires::NonlinearShuntCompensator

name	mult	type	description
aVRDelay	0..1	Seconds	inherited from: ShuntCompensator
grounded	0..1	Boolean	inherited from: ShuntCompensator
maximumSections	0..1	Integer	inherited from: ShuntCompensator
nomU	0..1	Voltage	inherited from: ShuntCompensator
normalSections	0..1	Integer	inherited from: ShuntCompensator
phaseConnection	0..1	PhaseShuntConnectionKind	inherited from: ShuntCompensator
switchOnCount	0..1	Integer	(deprecated) inherited from: ShuntCompensator
switchOnDate	0..1	DateTime	(deprecated) inherited from: ShuntCompensator
voltageSensitivity	0..1	VoltagePerReactivePower	inherited from: ShuntCompensator
sections	0..1	Float	inherited from: ShuntCompensator
controlEnabled	0..1	Boolean	inherited from: RegulatingCondEq
aggregate	0..1	Boolean	inherited from: Equipment
inService	0..1	Boolean	inherited from: Equipment
networkAnalysisEnabled	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

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Table 212 shows all association ends of NonlinearShuntCompensator with other classes.

Table 212 – Association ends of Wires::NonlinearShuntCompensator with other classes

mult from	name	mult to	type	description
1..1	NonlinearShuntCompensatorPoints	1..*	NonlinearShuntCompensatorPoint	All points of the non-linear shunt compensator.
1..1	ShuntCompensatorPhase	0..*	ShuntCompensatorPhase	inherited from: ShuntCompensator
1..1	SvShuntCompensatorSections	0..*	SvShuntCompensatorSections	inherited from: ShuntCompensator
0..*	RegulatingControl	0..1	RegulatingControl	inherited from: RegulatingCondEq
0..*	BaseVoltage	0..1	BaseVoltage	inherited from: ConductingEquipment
1..1	SvStatus	0..*	SvStatus	inherited from: ConductingEquipment
0..*	ProtectionEquipments	0..*	ProtectionEquipment	inherited from: ConductingEquipment
1..1	Terminals	0..*	Terminal	inherited from: ConductingEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	inherited from: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	inherited from: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment
0..1	Faults	0..*	Fault	inherited from: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	inherited from: Equipment
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.4.37 NonlinearShuntCompensatorPhase

A per phase non linear shunt compensator has bank or section admittance values that differ. The attributes g and b of the associated NonlinearShuntCompensatorPhasePoint describe the total conductance and admittance of a NonlinearShuntCompensatorPhasePoint at a section number specified by NonlinearShuntCompensatorPhasePoint.sectionNumber.

Table 213 shows all attributes of NonlinearShuntCompensatorPhase.

Table 213 – Attributes of Wires::NonlinearShuntCompensatorPhase

name	mult	type	description
maximumSections	0..1	Integer	inherited from: ShuntCompensatorPhase
normalSections	0..1	Integer	inherited from: ShuntCompensatorPhase
sections	0..1	Float	inherited from: ShuntCompensatorPhase
phase	0..1	SinglePhaseKind	inherited from: ShuntCompensatorPhase
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject

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name	mult	type	description
name	0..1	String	inherited from: IdentifiedObject

Table 214 shows all association ends of NonlinearShuntCompensatorPhase with other classes.

Table 214 – Association ends of Wires::NonlinearShuntCompensatorPhase with other classes

mult from	name	mult to	type	description
1..1	NonlinearShuntCompensatorPhasePoints	1..*	NonlinearShuntCompensatorPhasePoint	All points of the non-linear shunt compensator phase.
0..*	ShuntCompensator	1..1	ShuntCompensator	inherited from: ShuntCompensatorPhase
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.4.38 NonlinearShuntCompensatorPhasePoint root class

A per phase non linear shunt compensator bank or section admittance value. The number of NonlinearShuntCompenstorPhasePoint instances associated with a NonlinearShuntCompensatorPhase shall be equal to ShuntCompensatorPhase.maximumSections. ShuntCompensator.sections shall only be set to one of the NonlinearShuntCompenstorPhasePoint.sectionNumber. There is no interpolation between NonlinearShuntCompenstorPhasePoint-s.

Table 215 shows all attributes of NonlinearShuntCompensatorPhasePoint.

Table 215 – Attributes of Wires::NonlinearShuntCompensatorPhasePoint

name	mult	type	description
b	0..1	Susceptance	Positive sequence shunt (charging) susceptance per section.
g	0..1	Conductance	Positive sequence shunt (charging) conductance per section.
sectionNumber	0..1	Integer	The number of the section.

Table 216 shows all association ends of NonlinearShuntCompensatorPhasePoint with other classes.

Table 216 – Association ends of Wires::NonlinearShuntCompensatorPhasePoint with other classes

mult from	name	mult to	type	description
1..*	NonlinearShuntCompensatorPhase	1..1	NonlinearShuntCompensatorPhase	Non-linear shunt compensator phase owning this point.

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6.4.39 NonlinearShuntCompensatorPoint root class

A non linear shunt compensator bank or section admittance value. The number of NonlinearShuntCompenstorPoint instances associated with a NonlinearShuntCompensator shall be equal to ShuntCompensator.maximumSections. ShuntCompensator.sections shall only be set to one of the NonlinearShuntCompenstorPoint.sectionNumber. There is no interpolation between NonlinearShuntCompenstorPoint-s.

Table 217 shows all attributes of NonlinearShuntCompensatorPoint.

Table 217 – Attributes of Wires::NonlinearShuntCompensatorPoint

name	mult	type	description
b	0..1	Susceptance	Positive sequence shunt (charging) susceptance per section.
b0	0..1	Susceptance	Zero sequence shunt (charging) susceptance per section.
g	0..1	Conductance	Positive sequence shunt (charging) conductance per section.
g0	0..1	Conductance	Zero sequence shunt (charging) conductance per section.
sectionNumber	0..1	Integer	The number of the section.

Table 218 shows all association ends of NonlinearShuntCompensatorPoint with other classes.

Table 218 – Association ends of Wires::NonlinearShuntCompensatorPoint with other classes

mult from	name	mult to	type	description
1..*	NonlinearShuntCompensator	1..1	NonlinearShuntCompensator	Non-linear shunt compensator owning this point.

6.4.40 PerLengthImpedance

Common type for per-length impedance electrical catalogues.

Table 219 shows all attributes of PerLengthImpedance.

Table 219 – Attributes of Wires::PerLengthImpedance

name	mult	type	description
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 220 shows all association ends of PerLengthImpedance with other classes.

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Table 220 – Association ends of Wires::PerLengthImpedance with other classes

mult from	name	mult to	type	description
0..1	ACLineSegments	0..*	ACLineSegment	All line segments described by this per-length impedance.
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.4.41 PerLengthLineParameter

Common type for per-length electrical catalogues describing line parameters.

Table 221 shows all attributes of PerLengthLineParameter.

Table 221 – Attributes of Wires::PerLengthLineParameter

name	mult	type	description
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 222 shows all association ends of PerLengthLineParameter with other classes.

Table 222 – Association ends of Wires::PerLengthLineParameter with other classes

mult from	name	mult to	type	description
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.4.42 PerLengthPhaseImpedance

Impedance and admittance parameters per unit length for n-wire unbalanced lines, in matrix form.

Table 223 shows all attributes of PerLengthPhaseImpedance.

Table 223 – Attributes of Wires::PerLengthPhaseImpedance

name	mult	type	description
conductorCount	0..1	Integer	Number of phase, neutral, and other wires retained. Constrains the number of matrix elements and the phase codes that can be used with this matrix.
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

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Table 224 shows all association ends of PerLengthPhaseImpedance with other classes.

Table 224 – Association ends of Wires::PerLengthPhaseImpedance with other classes

mult from	name	mult to	type	description
1..1	PhaseImpedanceData	1..*	PhaseImpedanceData	All data that belong to this conductor phase impedance.
0..1	ACLineSegments	0..*	ACLineSegment	inherited from: PerLengthImpedance
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.4.43 PerLengthSequenceImpedance

Sequence impedance and admittance parameters per unit length, for transposed lines of 1, 2, or 3 phases. For 1-phase lines, define x=x0=xself. For 2-phase lines, define x=xs-xm and x0=xs+xm.

Table 225 shows all attributes of PerLengthSequenceImpedance.

Table 225 – Attributes of Wires::PerLengthSequenceImpedance

name	mult	type	description
b0ch	0..1	SusceptancePerLength	Zero sequence shunt (charging) susceptance, per unit of length.
bch	0..1	SusceptancePerLength	Positive sequence shunt (charging) susceptance, per unit of length.
g0ch	0..1	ConductancePerLength	Zero sequence shunt (charging) conductance, per unit of length.
gch	0..1	ConductancePerLength	Positive sequence shunt (charging) conductance, per unit of length.
r	0..1	ResistancePerLength	Positive sequence series resistance, per unit of length.
r0	0..1	ResistancePerLength	Zero sequence series resistance, per unit of length.
x	0..1	ReactancePerLength	Positive sequence series reactance, per unit of length.
x0	0..1	ReactancePerLength	Zero sequence series reactance, per unit of length.
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 226 shows all association ends of PerLengthSequenceImpedance with other classes.

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Table 226 – Association ends of Wires::PerLengthSequenceImpedance with other classes

mult from	name	mult to	type	description
0..1	ACLineSegments	0..*	ACLineSegment	inherited from: PerLengthImpedance
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.4.44 PetersenCoil

A variable impedance device normally used to offset line charging during single line faults in an ungrounded section of network.

Table 227 shows all attributes of PetersenCoil.

Table 227 – Attributes of Wires::PetersenCoil

name	mult	type	description
mode	0..1	PetersenCoilModeKind	The mode of operation of the Petersen coil.
nominalU	0..1	Voltage	The nominal voltage for which the coil is designed.
offsetCurrent	0..1	CurrentFlow	The offset current that the Petersen coil controller is operating from the resonant point. This is normally a fixed amount for which the controller is configured and could be positive or negative. Typically 0 to 60 A depending on voltage and resonance conditions.
positionCurrent	0..1	CurrentFlow	The control current used to control the Petersen coil also known as the position current. Typically in the range of 20 mA to 200 mA.
xGroundMax	0..1	Reactance	The maximum reactance.
xGroundMin	0..1	Reactance	The minimum reactance.
xGroundNominal	0..1	Reactance	The nominal reactance. This is the operating point (normally over compensation) that is defined based on the resonance point in the healthy network condition. The impedance is calculated based on nominal voltage divided by position current.
r	0..1	Resistance	inherited from: EarthFaultCompensator
aggregate	0..1	Boolean	inherited from: Equipment
inService	0..1	Boolean	inherited from: Equipment
networkAnalysisEnabled	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 228 shows all association ends of PetersenCoil with other classes.

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Table 228 – Association ends of Wires::PetersenCoil with other classes

mult from	name	mult to	type	description
0..*	BaseVoltage	0..1	BaseVoltage	inherited from: ConductingEquipment
1..1	SvStatus	0..*	SvStatus	inherited from: ConductingEquipment
0..*	ProtectionEquipments	0..*	ProtectionEquipment	inherited from: ConductingEquipment
1..1	Terminals	0..*	Terminal	inherited from: ConductingEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	inherited from: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	inherited from: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment
0..1	Faults	0..*	Fault	inherited from: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	inherited from: Equipment
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.4.45 PetersenCoilModeKind enumeration

The mode of operation for a Petersen coil.

Table 229 shows all literals of PetersenCoilModeKind.

Table 229 – Literals of Wires::PetersenCoilModeKind

literal	value	description
fixed		Fixed position.
manual		Manual positioning.
automaticPositioning		Automatic positioning.

6.4.46 PhaseImpedanceData root class

Impedance and conductance matrix element values.

The diagonal elements are described by the elements having the same toPhase and fromPhase value and the off diagonal elements have different toPhase and fromPhase values. The matrix can also be stored in symmetric lower triangular format using the row and column attributes, which map to ACLineSegmentPhase.sequenceNumber.

Table 230 shows all attributes of PhaseImpedanceData.

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Table 230 – Attributes of Wires::PhaseImpedanceData

name	mult	type	description
b	0..1	SusceptancePerLength	Susceptance matrix element value, per length of unit.
r	0..1	ResistancePerLength	Resistance matrix element value, per length of unit.
g	0..1	ConductancePerLength	Conductance matrix element value, per length of unit.
x	0..1	ReactancePerLength	Reactance matrix element value, per length of unit.
fromPhase	0..1	SinglePhaseKind	Refer to the class description.
toPhase	0..1	SinglePhaseKind	Refer to the class description.
row	0..1	Integer	The matrix element's row number, in the range 1 to PerLengthPhaseImpedance.conductorCount. Only the lower triangle needs to be stored. This row number matches ACLineSegmentPhase.sequenceNumber.
column	0..1	Integer	The matrix element's column number, in the range 1 to row. Only the lower triangle needs to be stored. This column number matches ACLineSegmentPhase.sequenceNumber.

Table 231 shows all association ends of PhaseImpedanceData with other classes.

Table 231 – Association ends of Wires::PhaseImpedanceData with other classes

mult from	name	mult to	type	description
1..*	PhaseImpedance	1..1	PerLengthPhaseImpedance	Conductor phase impedance to which this data belongs.

6.4.47 PhaseShuntConnectionKind enumeration

The configuration of phase connections for a single terminal device such as a load or capacitor.

Table 232 shows all literals of PhaseShuntConnectionKind.

Table 232 – Literals of Wires::PhaseShuntConnectionKind

literal	value	description
D	1	Delta connection.
Y	2	Wye connection.
Yn	3	Wye, with neutral brought out for grounding.
I	4	Independent winding, for single-phase connections.
G	5	Ground connection; use when explicit connection to ground needs to be expressed in combination with the phase code, such as for electrical wire/cable or for meters.

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6.4.48 PhaseTapChanger

A transformer phase shifting tap model that controls the phase angle difference across the power transformer and potentially the active power flow through the power transformer. This phase tap model may also impact the voltage magnitude.

Table 233 shows all attributes of PhaseTapChanger.

Table 233 – Attributes of Wires::PhaseTapChanger

name	mult	type	description
controlEnabled	0..1	Boolean	inherited from: TapChanger
highStep	0..1	Integer	inherited from: TapChanger
initialDelay	0..1	Seconds	inherited from: TapChanger
lowStep	0..1	Integer	inherited from: TapChanger
ltcFlag	0..1	Boolean	inherited from: TapChanger
neutralStep	0..1	Integer	inherited from: TapChanger
neutralU	0..1	Voltage	inherited from: TapChanger
normalStep	0..1	Integer	inherited from: TapChanger
subsequentDelay	0..1	Seconds	inherited from: TapChanger
step	0..1	Float	inherited from: TapChanger
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 234 shows all association ends of PhaseTapChanger with other classes.

Table 234 – Association ends of Wires::PhaseTapChanger with other classes

mult from	name	mult to	type	description
0..1	TransformerEnd	1..1	TransformerEnd	Transformer end to which this phase tap changer belongs.
1..*	TapChangerControl	0..1	TapChangerControl	inherited from: TapChanger
1..1	SvTapStep	0..1	SvTapStep	inherited from: TapChanger
1..1	TapSchedules	0..*	TapSchedule	inherited from: TapChanger
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

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6.4.49 PhaseTapChangerAsymmetrical

Describes the tap model for an asymmetrical phase shifting transformer in which the difference voltage vector adds to the in-phase winding. The out-of-phase winding is the transformer end where the tap changer is located. The angle between the in-phase and out-of-phase windings is named the winding connection angle. The phase shift depends on both the difference voltage magnitude and the winding connection angle.

Table 235 shows all attributes of PhaseTapChangerAsymmetrical.

Table 235 – Attributes of Wires::PhaseTapChangerAsymmetrical

name	mult	type	description
windingConnectionAngle	0..1	AngleDegrees	The phase angle between the in-phase winding and the out-of -phase winding used for creating phase shift. The out-of-phase winding produces what is known as the difference voltage. Setting this angle to 90 degrees is not the same as a symmetrical transformer. The attribute can only be multiples of 30 degrees. The allowed range is -150 degrees to 150 degrees excluding 0.
voltageStepIncrement	0..1	PerCent	inherited from: PhaseTapChangerNonLinear
xMax	0..1	Reactance	inherited from: PhaseTapChangerNonLinear
xMin	0..1	Reactance	(deprecated) inherited from: PhaseTapChangerNonLinear
controlEnabled	0..1	Boolean	inherited from: TapChanger
highStep	0..1	Integer	inherited from: TapChanger
initialDelay	0..1	Seconds	inherited from: TapChanger
lowStep	0..1	Integer	inherited from: TapChanger
ltcFlag	0..1	Boolean	inherited from: TapChanger
neutralStep	0..1	Integer	inherited from: TapChanger
neutralU	0..1	Voltage	inherited from: TapChanger
normalStep	0..1	Integer	inherited from: TapChanger
subsequentDelay	0..1	Seconds	inherited from: TapChanger
step	0..1	Float	inherited from: TapChanger
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 236 shows all association ends of PhaseTapChangerAsymmetrical with other classes.

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Table 236 – Association ends of Wires::PhaseTapChangerAsymmetrical with other classes

mult from	name	mult to	type	description
0..1	TransformerEnd	1..1	TransformerEnd	inherited from: PhaseTapChanger
1..*	TapChangerControl	0..1	TapChangerControl	inherited from: TapChanger
1..1	SvTapStep	0..1	SvTapStep	inherited from: TapChanger
1..1	TapSchedules	0..*	TapSchedule	inherited from: TapChanger
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.4.50 PhaseTapChangerLinear

Describes a tap changer with a linear relation between the tap step and the phase angle difference across the transformer. This is a mathematical model that is an approximation of a real phase tap changer.

The phase angle is computed as stepPhaseShiftIncrement times the tap position.

The voltage magnitude of both sides is the same.

Table 237 shows all attributes of PhaseTapChangerLinear.

Table 237 – Attributes of Wires::PhaseTapChangerLinear

name	mult	type	description
stepPhaseShiftIncrement	0..1	AngleDegrees	Phase shift per step position. A positive value indicates a positive angle variation from the Terminal at the PowerTransformerEnd, where the TapChanger is located, into the transformer. The actual phase shift increment might be more accurately computed from the symmetrical or asymmetrical models or a tap step table lookup if those are available.
xMax	0..1	Reactance	The reactance depends on the tap position according to a "u" shaped curve. The maximum reactance (xMax) appears at the low and high tap positions. Depending on the “u” curve the attribute can be either higher or lower than PowerTransformerEnd.x.
xMin	0..1	Reactance	(deprecated) The reactance depends on the tap position according to a "u" shaped curve. The minimum reactance (xMin) appears at the mid tap position. PowerTransformerEnd.x shall be consistent with PhaseTapChangerLinear.xMin and PhaseTapChangerNonLinear.xMin. In case of inconsistency, PowerTransformerEnd.x shall be used.
controlEnabled	0..1	Boolean	inherited from: TapChanger
highStep	0..1	Integer	inherited from: TapChanger

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name	mult	type	description
initialDelay	0..1	Seconds	inherited from: TapChanger
lowStep	0..1	Integer	inherited from: TapChanger
ltcFlag	0..1	Boolean	inherited from: TapChanger
neutralStep	0..1	Integer	inherited from: TapChanger
neutralU	0..1	Voltage	inherited from: TapChanger
normalStep	0..1	Integer	inherited from: TapChanger
subsequentDelay	0..1	Seconds	inherited from: TapChanger
step	0..1	Float	inherited from: TapChanger
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 238 shows all association ends of PhaseTapChangerLinear with other classes.

Table 238 – Association ends of Wires::PhaseTapChangerLinear with other classes

mult from	name	mult to	type	description
0..1	TransformerEnd	1..1	TransformerEnd	inherited from: PhaseTapChanger
1..*	TapChangerControl	0..1	TapChangerControl	inherited from: TapChanger
1..1	SvTapStep	0..1	SvTapStep	inherited from: TapChanger
1..1	TapSchedules	0..*	TapSchedule	inherited from: TapChanger
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.4.51 PhaseTapChangerNonLinear

The non-linear phase tap changer describes the non-linear behaviour of a phase tap changer. This is a base class for the symmetrical and asymmetrical phase tap changer models. The details of these models can be found in IEC 61970-301.

Table 239 shows all attributes of PhaseTapChangerNonLinear.

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Table 239 – Attributes of Wires::PhaseTapChangerNonLinear

name	mult	type	description
voltageStepIncrement	0..1	PerCent	The voltage step increment on the out of phase winding (the PowerTransformerEnd where the TapChanger is located) specified in percent of rated voltage of the PowerTransformerEnd. A positive value means a positive voltage variation from the Terminal at the PowerTransformerEnd, where the TapChanger is located, into the transformer. When the increment is negative, the voltage decreases when the tap step increases.
xMax	0..1	Reactance	The reactance depends on the tap position according to a "u" shaped curve. The maximum reactance (xMax) appears at the low and high tap positions. Depending on the "u" curve the attribute can be either higher or lower than PowerTransformerEnd.x.
xMin	0..1	Reactance	(deprecated) The reactance depend on the tap position according to a "u" shaped curve. The minimum reactance (xMin) appear at the mid tap position. PowerTransformerEnd.x shall be consistent with PhaseTapChangerLinear.xMin and PhaseTapChangerNonLinear.xMin. In case of inconsistency, PowerTransformerEnd.x shall be used.
controlEnabled	0..1	Boolean	inherited from: TapChanger
highStep	0..1	Integer	inherited from: TapChanger
initialDelay	0..1	Seconds	inherited from: TapChanger
lowStep	0..1	Integer	inherited from: TapChanger
ltcFlag	0..1	Boolean	inherited from: TapChanger
neutralStep	0..1	Integer	inherited from: TapChanger
neutralU	0..1	Voltage	inherited from: TapChanger
normalStep	0..1	Integer	inherited from: TapChanger
subsequentDelay	0..1	Seconds	inherited from: TapChanger
step	0..1	Float	inherited from: TapChanger
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 240 shows all association ends of PhaseTapChangerNonLinear with other classes.

Table 240 – Association ends of Wires::PhaseTapChangerNonLinear with other classes

mult from	name	mult to	type	description
0..1	TransformerEnd	1..1	TransformerEnd	inherited from: PhaseTapChanger
1..*	TapChangerControl	0..1	TapChangerControl	inherited from: TapChanger
1..1	SvTapStep	0..1	SvTapStep	inherited from: TapChanger
1..1	TapSchedules	0..*	TapSchedule	inherited from: TapChanger
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource

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mult from	name	mult to	type	description
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.4.52 PhaseTapChangerSymmetrical

Describes a symmetrical phase shifting transformer tap model in which the voltage magnitude of both sides is the same. The difference voltage magnitude is the base in an equal-sided triangle where the sides corresponds to the primary and secondary voltages. The phase angle difference corresponds to the top angle and can be expressed as twice the arctangent of half the total difference voltage.

Table 241 shows all attributes of PhaseTapChangerSymmetrical.

Table 241 – Attributes of Wires::PhaseTapChangerSymmetrical

name	mult	type	description
voltageStepIncrement	0..1	PerCent	inherited from: PhaseTapChangerNonLinear
xMax	0..1	Reactance	inherited from: PhaseTapChangerNonLinear
xMin	0..1	Reactance	(deprecated) inherited from: PhaseTapChangerNonLinear
controlEnabled	0..1	Boolean	inherited from: TapChanger
highStep	0..1	Integer	inherited from: TapChanger
initialDelay	0..1	Seconds	inherited from: TapChanger
lowStep	0..1	Integer	inherited from: TapChanger
ltcFlag	0..1	Boolean	inherited from: TapChanger
neutralStep	0..1	Integer	inherited from: TapChanger
neutralU	0..1	Voltage	inherited from: TapChanger
normalStep	0..1	Integer	inherited from: TapChanger
subsequentDelay	0..1	Seconds	inherited from: TapChanger
step	0..1	Float	inherited from: TapChanger
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 242 shows all association ends of PhaseTapChangerSymmetrical with other classes.

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Table 242 – Association ends of Wires::PhaseTapChangerSymmetrical with other classes

mult from	name	mult to	type	description
0..1	TransformerEnd	1..1	TransformerEnd	inherited from: PhaseTapChanger
1..*	TapChangerControl	0..1	TapChangerControl	inherited from: TapChanger
1..1	SvTapStep	0..1	SvTapStep	inherited from: TapChanger
1..1	TapSchedules	0..*	TapSchedule	inherited from: TapChanger
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.4.53 PhaseTapChangerTable

Describes a tabular curve for how the phase angle difference and impedance varies with the tap step.

Table 243 shows all attributes of PhaseTapChangerTable.

Table 243 – Attributes of Wires::PhaseTapChangerTable

name	mult	type	description
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 244 shows all association ends of PhaseTapChangerTable with other classes.

Table 244 – Association ends of Wires::PhaseTapChangerTable with other classes

mult from	name	mult to	type	description
0..1	PhaseTapChangerTabular	0..*	PhaseTapChangerTabular	The phase tap changers to which this phase tap table applies.
1..1	PhaseTapChangerTablePoint	1..*	PhaseTapChangerTablePoint	The points of this table.
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.4.54 PhaseTapChangerTablePoint

Describes each tap step in the phase tap changer tabular curve.

Table 245 shows all attributes of PhaseTapChangerTablePoint.

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Table 245 – Attributes of Wires::PhaseTapChangerTablePoint

name	mult	type	description
angle	0..1	AngleDegrees	The angle difference in degrees. A positive value indicates a positive angle variation from the Terminal at the PowerTransformerEnd, where the TapChanger is located, into the transformer.
b	0..1	PerCent	inherited from: TapChangerTablePoint
g	0..1	PerCent	inherited from: TapChangerTablePoint
r	0..1	PerCent	inherited from: TapChangerTablePoint
ratio	0..1	Float	inherited from: TapChangerTablePoint
step	0..1	Integer	inherited from: TapChangerTablePoint
x	0..1	PerCent	inherited from: TapChangerTablePoint

Table 246 shows all association ends of PhaseTapChangerTablePoint with other classes.

Table 246 – Association ends of Wires::PhaseTapChangerTablePoint with other classes

mult from	name	mult to	type	description
1..*	PhaseTapChangerTable	1..1	PhaseTapChangerTable	The table of this point.

6.4.55 PhaseTapChangerTabular

Describes a tap changer with a table defining the relation between the tap step and the phase angle difference across the transformer.

Table 247 shows all attributes of PhaseTapChangerTabular.

Table 247 – Attributes of Wires::PhaseTapChangerTabular

name	mult	type	description
controlEnabled	0..1	Boolean	inherited from: TapChanger
highStep	0..1	Integer	inherited from: TapChanger
initialDelay	0..1	Seconds	inherited from: TapChanger
lowStep	0..1	Integer	inherited from: TapChanger
ltcFlag	0..1	Boolean	inherited from: TapChanger
neutralStep	0..1	Integer	inherited from: TapChanger
neutralU	0..1	Voltage	inherited from: TapChanger
normalStep	0..1	Integer	inherited from: TapChanger
subsequentDelay	0..1	Seconds	inherited from: TapChanger
step	0..1	Float	inherited from: TapChanger
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 248 shows all association ends of PhaseTapChangerTabular with other classes.

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Table 248 – Association ends of Wires::PhaseTapChangerTabular with other classes

mult from	name	mult to	type	description
0..*	PhaseTapChangerTable	0..1	PhaseTapChangerTable	The phase tap changer table for this phase tap changer.
0..1	TransformerEnd	1..1	TransformerEnd	inherited from: PhaseTapChanger
1..*	TapChangerControl	0..1	TapChangerControl	inherited from: TapChanger
1..1	SvTapStep	0..1	SvTapStep	inherited from: TapChanger
1..1	TapSchedules	0..*	TapSchedule	inherited from: TapChanger
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.4.56 Plant

A Plant is a collection of equipment for purposes of generation.

Table 249 shows all attributes of Plant.

Table 249 – Attributes of Wires::Plant

name	mult	type	description
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 250 shows all association ends of Plant with other classes.

Table 250 – Association ends of Wires::Plant with other classes

mult from	name	mult to	type	description
0..1	Equipments	0..*	Equipment	inherited from: EquipmentContainer
0..*	AdditionalGroupedEquipment	0..*	Equipment	inherited from: EquipmentContainer
1..1	ConnectivityNodes	0..*	ConnectivityNode	inherited from: ConnectivityNodeContainer
0..1	TopologicalNode	0..*	TopologicalNode	inherited from: ConnectivityNodeContainer
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource

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mult from	name	mult to	type	description
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.4.57 PowerElectronicsConnection

A connection to the AC network for energy production or consumption that uses power electronics rather than rotating machines.

Table 251 shows all attributes of PowerElectronicsConnection.

Table 251 – Attributes of Wires::PowerElectronicsConnection

name	mult	type	description
maxQ	0..1	ReactivePower	Maximum reactive power limit. This is the maximum (nameplate) limit for the unit.
minQ	0..1	ReactivePower	Minimum reactive power limit for the unit. This is the minimum (nameplate) limit for the unit.
ratedS	0..1	ApparentPower	Nameplate apparent power rating for the unit. The attribute shall have a positive value.
ratedU	0..1	Voltage	Rated voltage (nameplate data, Ur in IEC 60909-0). It is primarily used for short circuit data exchange according to IEC 60909. The attribute shall be a positive value.
p	0..1	ActivePower	Active power injection. Load sign convention is used, i.e. positive sign means flow out from a node. Starting value for a steady state solution.
q	0..1	ReactivePower	Reactive power injection. Load sign convention is used, i.e. positive sign means flow out from a node. Starting value for a steady state solution.
r	0..1	Resistance	(deprecated) Equivalent resistance (RG) of generator. RG is considered for the calculation of all currents, except for the calculation of the peak current ip. Used for short circuit data exchange according to IEC 60909.
r0	0..1	Resistance	(deprecated) Zero sequence resistance of the synchronous machine.
rn	0..1	Resistance	(deprecated) Negative sequence Thevenin resistance.
x	0..1	Reactance	(deprecated) Positive sequence Thevenin reactance.
x0	0..1	Reactance	(deprecated) Zero sequence Thevenin reactance.
xn	0..1	Reactance	(deprecated) Negative sequence Thevenin reactance.
maxIFault	0..1	PU	Maximum fault current this device will contribute, in per-unit of rated current, before the converter protection will trip or bypass.
controlEnabled	0..1	Boolean	inherited from: RegulatingCondEq
aggregate	0..1	Boolean	inherited from: Equipment
inService	0..1	Boolean	inherited from: Equipment
networkAnalysisEnabled	0..1	Boolean	inherited from: Equipment

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name	mult	type	description
normallyInService	0..1	Boolean	inherited from: Equipment
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 252 shows all association ends of PowerElectronicsConnection with other classes.

Table 252 – Association ends of Wires::PowerElectronicsConnection with other classes

mult from	name	mult to	type	description
1..1	PowerElectronicsUnit	0..*	PowerElectronicsUnit	An AC network connection may have several power electronics units connecting through it.
1..1	PowerElectronicsConnectionPhase	0..*	PowerElectronicsConnectionPhase	The individual phases models for the power electronics connection.
1..1	WindTurbineType3or4Dynamics	0..1	WindTurbineType3or4Dynamics	The wind turbine type 3 or type 4 dynamics model associated with this power electronics connection.
0..*	RegulatingControl	0..1	RegulatingControl	inherited from: RegulatingCondEq
0..*	BaseVoltage	0..1	BaseVoltage	inherited from: ConductingEquipment
1..1	SvStatus	0..*	SvStatus	inherited from: ConductingEquipment
0..*	ProtectionEquipments	0..*	ProtectionEquipment	inherited from: ConductingEquipment
1..1	Terminals	0..*	Terminal	inherited from: ConductingEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	inherited from: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	inherited from: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment
0..1	Faults	0..*	Fault	inherited from: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	inherited from: Equipment
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

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6.4.58 PowerElectronicsConnectionPhase

A single phase of a power electronics connection.

Table 253 shows all attributes of PowerElectronicsConnectionPhase.

Table 253 – Attributes of Wires::PowerElectronicsConnectionPhase

name	mult	type	description
phase	0..1	SinglePhaseKind	Phase of this energy producer component. If the energy producer is wye connected, the connection is from the indicated phase to the central ground or neutral point. If the energy producer is delta connected, the phase indicates an energy producer connected from the indicated phase to the next logical non-neutral phase.
p	0..1	ActivePower	Active power injection. Load sign convention is used, i.e. positive sign means flow into the equipment from the network.
q	0..1	ReactivePower	Reactive power injection. Load sign convention is used, i.e. positive sign means flow into the equipment from the network.
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 254 shows all association ends of PowerElectronicsConnectionPhase with other classes.

Table 254 – Association ends of Wires::PowerElectronicsConnectionPhase with other classes

mult from	name	mult to	type	description
0..*	PowerElectronicsConnection	1..1	PowerElectronicsConnection	Power electronics connection of this power electronics connection phase.
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.4.59 PowerTransformer

An electrical device consisting of two or more coupled windings, with or without a magnetic core, for introducing mutual coupling between electric circuits. Transformers can be used to control voltage and phase shift (active power flow).

A power transformer may be composed of separate transformer tanks that need not be identical.

A power transformer can be modelled with or without tanks and is intended for use in both balanced and unbalanced representations. A power transformer typically has two terminals, but may have one (grounding), three or more terminals.

The inherited association ConductingEquipment.BaseVoltage should not be used. The association from TransformerEnd to BaseVoltage should be used instead.

Table 255 shows all attributes of PowerTransformer.

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Table 255 – Attributes of Wires::PowerTransformer

name	mult	type	description
beforeShCircuitHighestOperatingCurrent	0..1	CurrentFlow	The highest operating current (Ib in IEC 60909-0) before short circuit (depends on network configuration and relevant reliability philosophy). It is used for calculation of the impedance correction factor KT defined in IEC 60909-0.
beforeShCircuitHighestOperatingVoltage	0..1	Voltage	The highest operating voltage (Ub in IEC 60909-0) before short circuit. It is used for calculation of the impedance correction factor KT defined in IEC 60909-0. This is worst case voltage on the low side winding (3.7.1 of IEC 60909:2001). Used to define operating conditions.
beforeShortCircuitAnglePf	0..1	AngleDegrees	The angle of power factor before short circuit (phib in IEC 60909-0). It is used for calculation of the impedance correction factor KT defined in IEC 60909-0. This is the worst case power factor. Used to define operating conditions.
highSideMinOperatingU	0..1	Voltage	The minimum operating voltage (uQmin in IEC 60909-0) at the high voltage side (Q side) of the unit transformer of the power station unit. A value well established from long-term operating experience of the system. It is used for calculation of the impedance correction factor KG defined in IEC 60909-0.
isPartOfGeneratorUnit	0..1	Boolean	Indicates whether the machine is part of a power station unit. Used for short circuit data exchange according to IEC 60909. It has an impact on how the correction factors are calculated for transformers, since the transformer is not necessarily part of a synchronous machine and generating unit. It is not always possible to derive this information from the model. This is why the attribute is necessary.
operationalValuesConsidered	0..1	Boolean	It is used to define if the data (other attributes related to short circuit data exchange) defines long term operational conditions or not. Used for short circuit data exchange according to IEC 60909.
vectorGroup	0..1	String	Vector group of the transformer for protective relaying, e.g., Dyn1. For unbalanced transformers, this may not be simply determined from the constituent winding connections and phase angle displacements. The vectorGroup string consists of the following components in the order listed: high voltage winding connection, mid voltage winding connection (for three winding transformers), phase displacement clock number from 0 to 11, low voltage winding connection phase displacement clock number from 0 to 11. The winding connections are D (delta), Y (wye), YN (wye with neutral), Z (zigzag), ZN (zigzag with neutral), A (auto transformer). Upper case means the high voltage, lower case mid or low. The high voltage winding always has clock position 0 and is not included in the vector group string. Some examples: YNy0 (two winding wye to wye with no phase displacement), YNd11 (two winding wye to delta with 330 degrees phase displacement), YNyn0d5 (three winding transformer wye with neutral high voltage, wye with neutral mid voltage and no phase displacement, delta low voltage with 150 degrees displacement). Phase displacement is defined as the angular difference between the phasors representing the voltages between the neutral point (real or

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name	mult	type	description
			imaginary) and the corresponding terminals of two windings, a positive sequence voltage system being applied to the high-voltage terminals, following each other in alphabetical sequence if they are lettered, or in numerical sequence if they are numbered: the phasors are assumed to rotate in a counter-clockwise sense.
aggregate	0..1	Boolean	inherited from: Equipment
inService	0..1	Boolean	inherited from: Equipment
networkAnalysisEnabled	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 256 shows all association ends of PowerTransformer with other classes.

Table 256 – Association ends of Wires::PowerTransformer with other classes

mult from	name	mult to	type	description
0..1	PowerTransformerEnd	0..*	PowerTransformerEnd	The ends of this power transformer.
0..1	TransformerTanks	0..*	TransformerTank	All transformers that belong to this bank.
0..*	BaseVoltage	0..1	BaseVoltage	inherited from: ConductingEquipment
1..1	SvStatus	0..*	SvStatus	inherited from: ConductingEquipment
0..*	ProtectionEquipments	0..*	ProtectionEquipment	inherited from: ConductingEquipment
1..1	Terminals	0..*	Terminal	inherited from: ConductingEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	inherited from: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	inherited from: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment
0..1	Faults	0..*	Fault	inherited from: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	inherited from: Equipment
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

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6.4.60 PowerTransformerEnd

A PowerTransformerEnd is associated with each Terminal of a PowerTransformer.

The impedance values r, r0, x, and x0 of a PowerTransformerEnd represents a star equivalent as follows.

1) for a two Terminal PowerTransformer the high voltage (TransformerEnd.endNumber=1) PowerTransformerEnd has non zero values on r, r0, x, and x0 while the low voltage (TransformerEnd.endNumber=2) PowerTransformerEnd has zero values for r, r0, x, and x0. Parameters are always provided, even if the PowerTransformerEnds have the same rated voltage. In this case, the parameters are provided at the PowerTransformerEnd which has TransformerEnd.endNumber equal to 1.
2) for a three Terminal PowerTransformer the three PowerTransformerEnds represent a star equivalent with each leg in the star represented by r, r0, x, and x0 values.
3) For a three Terminal transformer each PowerTransformerEnd shall have g, g0, b and b0 values corresponding to the no load losses distributed on the three PowerTransformerEnds. The total no load loss shunt impedances may also be placed at one of the PowerTransformerEnds, preferably the end numbered 1, having the shunt values on end 1. This is the preferred way.
4) for a PowerTransformer with more than three Terminals the PowerTransformerEnd impedance values cannot be used. Instead use the TransformerMeshImpedance or split the transformer into multiple PowerTransformers.

Each PowerTransformerEnd must be contained by a PowerTransformer. Because a PowerTransformerEnd (or any other object) can not be contained by more than one parent, a PowerTransformerEnd can not have an association to an EquipmentContainer (Substation, VoltageLevel, etc).

Table 257 shows all attributes of PowerTransformerEnd.

Table 257 – Attributes of Wires::PowerTransformerEnd

name	mult	type	description
b	0..1	Susceptance	Magnetizing branch susceptance (B mag). The value can be positive or negative.
b0	0..1	Susceptance	Zero sequence magnetizing branch susceptance.
connectionKind	0..1	WindingConnection	Kind of connection.
g	0..1	Conductance	Magnetizing branch conductance.
g0	0..1	Conductance	Zero sequence magnetizing branch conductance (star-model).
phaseAngleClock	0..1	Integer	Terminal voltage phase angle displacement where 360 degrees are represented with clock hours. The valid values are 0 to 11. For example, for the secondary side end of a transformer with vector group code of 'Dyn11', specify the connection kind as wye with neutral and specify the phase angle of the clock as 11. The clock value of the transformer end number specified as 1, is assumed to be zero. Note the transformer end number is not assumed to be the same as the terminal sequence number.
r	0..1	Resistance	Resistance (star-model) of the transformer end. The attribute shall be equal to or greater than zero for non-equivalent transformers.
r0	0..1	Resistance	Zero sequence series resistance (star-model) of the transformer end.
ratedS	0..1	ApparentPower	Normal apparent power rating. The attribute shall be a positive value. For a two-winding transformer the values for the high and low voltage sides shall be identical.

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name	mult	type	description
ratedU	0..1	Voltage	Rated voltage: phase-phase for three-phase windings, and either phase-phase or phase-neutral for single-phase windings. A high voltage side, as given by TransformerEnd.endNumber, shall have a ratedU that is greater than or equal to ratedU for the lower voltage sides. The attribute shall be a positive value.
x	0..1	Reactance	Positive sequence series reactance (star-model) of the transformer end.
x0	0..1	Reactance	Zero sequence series reactance of the transformer end.
bmagSat	0..1	PerCent	inherited from: TransformerEnd
endNumber	0..1	Integer	inherited from: TransformerEnd
grounded	0..1	Boolean	inherited from: TransformerEnd
magBaseU	0..1	Voltage	inherited from: TransformerEnd
magSatFlux	0..1	PerCent	inherited from: TransformerEnd
rground	0..1	Resistance	inherited from: TransformerEnd
xground	0..1	Reactance	inherited from: TransformerEnd
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 258 shows all association ends of PowerTransformerEnd with other classes.

Table 258 – Association ends of Wires::PowerTransformerEnd with other classes

mult from	name	mult to	type	description
0..*	PowerTransformer	0..1	PowerTransformer	The power transformer of this power transformer end.
0..*	BaseVoltage	0..1	BaseVoltage	inherited from: TransformerEnd
0..*	Terminal	0..1	Terminal	inherited from: TransformerEnd
1..1	PhaseTapChanger	0..1	PhaseTapChanger	inherited from: TransformerEnd
1..1	RatioTapChanger	0..1	RatioTapChanger	inherited from: TransformerEnd
0..*	StarImpedance	0..1	TransformerStarImpedance	inherited from: TransformerEnd
0..*	CoreAdmittance	0..1	TransformerCoreAdmittance	inherited from: TransformerEnd
1..*	ToMeshImpedance	0..*	TransformerMeshImpedance	inherited from: TransformerEnd
1..1	FromMeshImpedance	0..*	TransformerMeshImpedance	inherited from: TransformerEnd
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.4.61 ProtectedSwitch

A ProtectedSwitch is a switching device that can be operated by ProtectionEquipment.

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Table 259 shows all attributes of ProtectedSwitch.

Table 259 – Attributes of Wires::ProtectedSwitch

name	mult	type	description
breakingCapacity	0..1	CurrentFlow	The maximum fault current a breaking device can break safely under prescribed conditions of use.
normalOpen	0..1	Boolean	inherited from: Switch
ratedCurrent	0..1	CurrentFlow	inherited from: Switch
switchOnCount	0..1	Integer	(deprecated) inherited from: Switch
switchOnDate	0..1	DateTime	(deprecated) inherited from: Switch
retained	0..1	Boolean	inherited from: Switch
open	0..1	Boolean	inherited from: Switch
locked	0..1	Boolean	inherited from: Switch
aggregate	0..1	Boolean	inherited from: Equipment
inService	0..1	Boolean	inherited from: Equipment
networkAnalysisEnabled	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 260 shows all association ends of ProtectedSwitch with other classes.

Table 260 – Association ends of Wires::ProtectedSwitch with other classes

mult from	name	mult to	type	description
0..*	OperatedByProtectionEquipment	0..*	ProtectionEquipment	Protection equipments that operate this ProtectedSwitch.
1..1	RecloseSequences	0..*	RecloseSequence	A breaker may have zero or more automatic reclosures after a trip occurs.
1..1	SwitchPhase	0..*	SwitchPhase	inherited from: Switch
1..1	SwitchSchedules	0..*	SwitchSchedule	inherited from: Switch
0..*	CompositeSwitch	0..1	CompositeSwitch	inherited from: Switch
1..1	SvSwitch	0..*	SvSwitch	inherited from: Switch
0..*	BaseVoltage	0..1	BaseVoltage	inherited from: ConductingEquipment
1..1	SvStatus	0..*	SvStatus	inherited from: ConductingEquipment
0..*	ProtectionEquipments	0..*	ProtectionEquipment	inherited from: ConductingEquipment
1..1	Terminals	0..*	Terminal	inherited from: ConductingEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	inherited from: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	inherited from: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment
0..1	Faults	0..*	Fault	inherited from: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	inherited from: Equipment
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource

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mult from	name	mult to	type	description
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.4.62 RatioTapChanger

A tap changer that changes the voltage ratio impacting the voltage magnitude but not the phase angle across the transformer.

Angle sign convention (general): Positive value indicates a positive phase shift from the winding where the tap is located to the other winding (for a two-winding transformer).

Table 261 shows all attributes of RatioTapChanger.

Table 261 – Attributes of Wires::RatioTapChanger

name	mult	type	description
stepVoltageIncrement	0..1	PerCent	Tap step increment, in per cent of rated voltage of the power transformer end, per step position. When the increment is negative, the voltage decreases when the tap step increases.
tculControlMode	0..1	TransformerControlMode	(deprecated) Specifies the regulation control mode (voltage or reactive) of the RatioTapChanger.
controlEnabled	0..1	Boolean	inherited from: TapChanger
highStep	0..1	Integer	inherited from: TapChanger
initialDelay	0..1	Seconds	inherited from: TapChanger
lowStep	0..1	Integer	inherited from: TapChanger
ltcFlag	0..1	Boolean	inherited from: TapChanger
neutralStep	0..1	Integer	inherited from: TapChanger
neutralU	0..1	Voltage	inherited from: TapChanger
normalStep	0..1	Integer	inherited from: TapChanger
subsequentDelay	0..1	Seconds	inherited from: TapChanger
step	0..1	Float	inherited from: TapChanger
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 262 shows all association ends of RatioTapChanger with other classes.

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Table 262 – Association ends of Wires::RatioTapChanger with other classes

mult from	name	mult to	type	description
0..*	RatioTapChangerTable	0..1	RatioTapChangerTable	The tap ratio table for this ratio tap changer.
0..1	TransformerEnd	1..1	TransformerEnd	Transformer end to which this ratio tap changer belongs.
1..*	TapChangerControl	0..1	TapChangerControl	inherited from: TapChanger
1..1	SvTapStep	0..1	SvTapStep	inherited from: TapChanger
1..1	TapSchedules	0..*	TapSchedule	inherited from: TapChanger
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.4.63 RatioTapChangerTable

Describes a curve for how the voltage magnitude and impedance varies with the tap step.

Table 263 shows all attributes of RatioTapChangerTable.

Table 263 – Attributes of Wires::RatioTapChangerTable

name	mult	type	description
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 264 shows all association ends of RatioTapChangerTable with other classes.

Table 264 – Association ends of Wires::RatioTapChangerTable with other classes

mult from	name	mult to	type	description
0..1	RatioTapChanger	0..*	RatioTapChanger	The ratio tap changer of this tap ratio table.
1..1	RatioTapChangerTablePoint	1..*	RatioTapChangerTablePoint	Points of this table.
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.4.64 RatioTapChangerTablePoint

Describes each tap step in the ratio tap changer tabular curve.

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Table 265 shows all attributes of RatioTapChangerTablePoint.

Table 265 – Attributes of Wires::RatioTapChangerTablePoint

name	mult	type	description
b	0..1	PerCent	inherited from: TapChangerTablePoint
g	0..1	PerCent	inherited from: TapChangerTablePoint
r	0..1	PerCent	inherited from: TapChangerTablePoint
ratio	0..1	Float	inherited from: TapChangerTablePoint
step	0..1	Integer	inherited from: TapChangerTablePoint
x	0..1	PerCent	inherited from: TapChangerTablePoint

Table 266 shows all association ends of RatioTapChangerTablePoint with other classes.

Table 266 – Association ends of Wires::RatioTapChangerTablePoint with other classes

mult from	name	mult to	type	description
1..*	RatioTapChangerTable	1..1	RatioTapChangerTable	Table of this point.

6.4.65 ReactiveCapabilityCurve

Reactive power rating envelope versus the synchronous machine's active power, in both the generating and motoring modes. For each active power value there is a corresponding high and low reactive power limit value. Typically there will be a separate curve for each coolant condition, such as hydrogen pressure. The Y1 axis values represent reactive minimum and the Y2 axis values represent reactive maximum.

Table 267 shows all attributes of ReactiveCapabilityCurve.

Table 267 – Attributes of Wires::ReactiveCapabilityCurve

name	mult	type	description
coolantTemperature	0..1	Temperature	The machine's coolant temperature (e.g., ambient air or stator circulating water).
hydrogenPressure	0..1	Pressure	The hydrogen coolant pressure.
curveStyle	0..1	CurveStyle	inherited from: Curve
xMultiplier	0..1	UnitMultiplier	inherited from: Curve
xUnit	0..1	UnitSymbol	inherited from: Curve
y1Multiplier	0..1	UnitMultiplier	inherited from: Curve
y1Unit	0..1	UnitSymbol	inherited from: Curve
y2Multiplier	0..1	UnitMultiplier	inherited from: Curve
y2Unit	0..1	UnitSymbol	inherited from: Curve
y3Multiplier	0..1	UnitMultiplier	inherited from: Curve
y3Unit	0..1	UnitSymbol	inherited from: Curve
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

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Table 268 shows all association ends of ReactiveCapabilityCurve with other classes.

Table 268 – Association ends of Wires::ReactiveCapabilityCurve with other classes

mult from	name	mult to	type	description
0..1	EquivalentInjection	0..*	EquivalentInjection	The equivalent injection using this reactive capability curve.
0..1	InitiallyUsedBySynchronousMachines	1..*	SynchronousMachine	Synchronous machines using this curve as default.
0..*	SynchronousMachines	1..*	SynchronousMachine	Synchronous machines using this curve.
1..1	CurveDatas	0..*	CurveData	inherited from: Curve
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.4.66 Recloser

Pole-mounted fault interrupter with built-in phase and ground relays, current transformer (CT), and supplemental controls.

Table 269 shows all attributes of Recloser.

Table 269 – Attributes of Wires::Recloser

name	mult	type	description
breakingCapacity	0..1	CurrentFlow	inherited from: ProtectedSwitch
normalOpen	0..1	Boolean	inherited from: Switch
ratedCurrent	0..1	CurrentFlow	inherited from: Switch
switchOnCount	0..1	Integer	(deprecated) inherited from: Switch
switchOnDate	0..1	DateTime	(deprecated) inherited from: Switch
retained	0..1	Boolean	inherited from: Switch
open	0..1	Boolean	inherited from: Switch
locked	0..1	Boolean	inherited from: Switch
aggregate	0..1	Boolean	inherited from: Equipment
inService	0..1	Boolean	inherited from: Equipment
networkAnalysisEnabled	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 270 shows all association ends of Recloser with other classes.

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Table 270 – Association ends of Wires::Recloser with other classes

mult from	name	mult to	type	description
0..*	OperatedByProtectionEquipment	0..*	ProtectionEquipment	inherited from: ProtectedSwitch
1..1	RecloseSequences	0..*	RecloseSequence	inherited from: ProtectedSwitch
1..1	SwitchPhase	0..*	SwitchPhase	inherited from: Switch
1..1	SwitchSchedules	0..*	SwitchSchedule	inherited from: Switch
0..*	CompositeSwitch	0..1	CompositeSwitch	inherited from: Switch
1..1	SvSwitch	0..*	SvSwitch	inherited from: Switch
0..*	BaseVoltage	0..1	BaseVoltage	inherited from: ConductingEquipment
1..1	SvStatus	0..*	SvStatus	inherited from: ConductingEquipment
0..*	ProtectionEquipments	0..*	ProtectionEquipment	inherited from: ConductingEquipment
1..1	Terminals	0..*	Terminal	inherited from: ConductingEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	inherited from: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	inherited from: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment
0..1	Faults	0..*	Fault	inherited from: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	inherited from: Equipment
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.4.67 RegulatingCondEq

A type of conducting equipment that can regulate a quantity (i.e. voltage or flow) at a specific point in the network.

Table 271 shows all attributes of RegulatingCondEq.

Table 271 – Attributes of Wires::RegulatingCondEq

name	mult	type	description
controlEnabled	0..1	Boolean	Specifies the regulation status of the equipment. True is regulating, false is not regulating.
aggregate	0..1	Boolean	inherited from: Equipment
inService	0..1	Boolean	inherited from: Equipment
networkAnalysisEnabled	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

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Table 272 shows all association ends of RegulatingCondEq with other classes.

Table 272 – Association ends of Wires::RegulatingCondEq with other classes

mult from	name	mult to	type	description
0..*	RegulatingControl	0..1	RegulatingControl	The regulating control scheme in which this equipment participates.
0..*	BaseVoltage	0..1	BaseVoltage	inherited from: ConductingEquipment
1..1	SvStatus	0..*	SvStatus	inherited from: ConductingEquipment
0..*	ProtectionEquipments	0..*	ProtectionEquipment	inherited from: ConductingEquipment
1..1	Terminals	0..*	Terminal	inherited from: ConductingEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	inherited from: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	inherited from: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment
0..1	Faults	0..*	Fault	inherited from: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	inherited from: Equipment
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.4.68 RegulatingControl

Specifies a set of equipment that works together to control a power system quantity such as voltage or flow.

Remote bus voltage control is possible by specifying the controlled terminal located at some place remote from the controlling equipment.

The specified terminal shall be associated with the connectivity node of the controlled point. The most specific subtype of RegulatingControl shall be used in case such equipment participate in the control, e.g. TapChangerControl for tap changers.

For flow control, load sign convention is used, i.e. positive sign means flow out from a TopologicalNode (bus) into the conducting equipment.

The attribute minAllowedTargetValue and maxAllowedTargetValue are required in the following cases:

– For a power generating module operated in power factor control mode to specify maximum and minimum power factor values;

– Whenever it is necessary to have an off center target voltage for the tap changer regulator. For instance, due to long cables to off shore wind farms and the need to have a simpler setup at the off shore transformer platform, the voltage is controlled from the land at the connection point for the off shore wind farm. Since there usually is a voltage rise along the cable, there is typical and overvoltage of up 3-4 kV compared to the on shore station. Thus in normal operation the tap changer on the on shore station is operated with a target set point, which is in the lower parts of the dead band.

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The attributes minAllowedTargetValue and maxAllowedTargetValue are not related to the attribute targetDeadband and thus they are not treated as an alternative of the targetDeadband. They are needed due to limitations in the local substation controller. The attribute targetDeadband is used to prevent the power flow from move the tap position in circles (hunting) that is to be used regardless of the attributes minAllowedTargetValue and maxAllowedTargetValue.

Table 273 shows all attributes of RegulatingControl.

Table 273 – Attributes of Wires::RegulatingControl

name	mult	type	description
discrete	0..1	Boolean	The regulation is performed in a discrete mode. This applies to equipment with discrete controls, e.g. tap changers and shunt compensators.
enabled	0..1	Boolean	The flag tells if regulation is enabled.
mode	0..1	RegulatingControlModeKind	The regulating control mode presently available. This specification allows for determining the kind of regulation without need for obtaining the units from a schedule.
monitoredPhase	0..1	PhaseCode	Phase voltage controlling this regulator, measured at regulator location.
targetDeadband	0..1	Float	This is a deadband used with discrete control to avoid excessive update of controls like tap changers and shunt compensator banks while regulating. The units of those appropriate for the mode. The attribute shall be a positive value or zero. If RegulatingControl.discrete is set to "false", the RegulatingControl.targetDeadband is to be ignored. Note that for instance, if the targetValue is 100 kV and the targetDeadband is 2 kV the range is from 99 to 101 kV.
targetValue	0..1	Float	The target value specified for case input. This value can be used for the target value without the use of schedules. The value has the units appropriate to the mode attribute.
targetValueUnitMultiplier	0..1	UnitMultiplier	Specify the multiplier for used for the targetValue.
maxAllowedTargetValue	0..1	Float	Maximum allowed target value (RegulatingControl.targetValue).
minAllowedTargetValue	0..1	Float	Minimum allowed target value (RegulatingControl.targetValue).
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 274 shows all association ends of RegulatingControl with other classes.

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Table 274 – Association ends of Wires::RegulatingControl with other classes

mult from	name	mult to	type	description
0..*	Terminal	0..1	Terminal	The terminal associated with this regulating control. The terminal is associated instead of a node, since the terminal could connect into either a topological node or a connectivity node. Sometimes it is useful to model regulation at a terminal of a bus bar object.
0..1	RegulatingCondEq	0..*	RegulatingCondEq	The equipment that participates in this regulating control scheme.
1..1	RegulationSchedule	0..*	RegulationSchedule	Schedule for this regulating control.
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.4.69 RegulatingControlModeKind enumeration

The kind of regulation model. For example regulating voltage, reactive power, active power, etc.

Table 275 shows all literals of RegulatingControlModeKind.

Table 275 – Literals of Wires::RegulatingControlModeKind

literal	value	description
voltage		Voltage is specified.
activePower		Active power is specified.
reactivePower		Reactive power is specified.
currentFlow		Current flow is specified.
admittance		Admittance is specified.
timeScheduled		Control switches on/off by time of day. The times may change on the weekend, or in different seasons.
temperature		Control switches on/off based on the local temperature (i.e., a thermostat).
powerFactor		Power factor is specified.

6.4.70 RegulationSchedule

A pre-established pattern over time for a controlled variable, e.g., busbar voltage.

Table 276 shows all attributes of RegulationSchedule.

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Table 276 – Attributes of Wires::RegulationSchedule

name	mult	type	description
endTime	0..1	DateTime	inherited from: RegularIntervalSchedule
timeStep	0..1	Seconds	inherited from: RegularIntervalSchedule
startTime	0..1	DateTime	inherited from: BasicIntervalSchedule
value1Multiplier	0..1	UnitMultiplier	inherited from: BasicIntervalSchedule
value1Unit	0..1	UnitSymbol	inherited from: BasicIntervalSchedule
value2Multiplier	0..1	UnitMultiplier	inherited from: BasicIntervalSchedule
value2Unit	0..1	UnitSymbol	inherited from: BasicIntervalSchedule
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 277 shows all association ends of RegulationSchedule with other classes.

Table 277 – Association ends of Wires::RegulationSchedule with other classes

mult from	name	mult to	type	description
0..*	RegulatingControl	1..1	RegulatingControl	Regulating controls that have this schedule.
0..1	VoltageControlZones	0..*	VoltageControlZone	A VoltageControlZone may have a voltage regulation schedule.
0..*	DayType	0..1	DayType	inherited from: SeasonDayTypeSchedule
0..*	Season	0..1	Season	inherited from: SeasonDayTypeSchedule
1..1	TimePoints	1..*	RegularTimePoint	inherited from: RegularIntervalSchedule
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.4.71 RotatingMachine

A rotating machine which may be used as a generator or motor.

Table 278 shows all attributes of RotatingMachine.

Table 278 – Attributes of Wires::RotatingMachine

name	mult	type	description
ratedPowerFactor	0..1	Float	Power factor (nameplate data). It is primarily used for short circuit data exchange according to IEC 60909. The attribute cannot be a negative value.
p	0..1	ActivePower	Active power injection. Load sign convention is used, i.e. positive sign means flow out from a node. Starting value for a steady state solution.
ratedS	0..1	ApparentPower	Nameplate apparent power rating for the unit. The attribute shall have a positive value.

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name	mult	type	description
q	0..1	ReactivePower	Reactive power injection. Load sign convention is used, i.e. positive sign means flow out from a node. Starting value for a steady state solution.
ratedU	0..1	Voltage	Rated voltage (nameplate data, Ur in IEC 60909-0). It is primarily used for short circuit data exchange according to IEC 60909. The attribute shall be a positive value.
controlEnabled	0..1	Boolean	inherited from: RegulatingCondEq
aggregate	0..1	Boolean	inherited from: Equipment
inService	0..1	Boolean	inherited from: Equipment
networkAnalysisEnabled	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 279 shows all association ends of RotatingMachine with other classes.

Table 279 – Association ends of Wires::RotatingMachine with other classes

mult from	name	mult to	type	description
1..1	HydroPump	0..1	HydroPump	The synchronous machine drives the turbine which moves the water from a low elevation to a higher elevation. The direction of machine rotation for pumping may or may not be the same as for generating.
0..*	GeneratingUnit	0..1	GeneratingUnit	A synchronous machine may operate as a generator and as such becomes a member of a generating unit.
0..*	RegulatingControl	0..1	RegulatingControl	inherited from: RegulatingCondEq
0..*	BaseVoltage	0..1	BaseVoltage	inherited from: ConductingEquipment
1..1	SvStatus	0..*	SvStatus	inherited from: ConductingEquipment
0..*	ProtectionEquipments	0..*	ProtectionEquipment	inherited from: ConductingEquipment
1..1	Terminals	0..*	Terminal	inherited from: ConductingEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	inherited from: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	inherited from: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment
0..1	Faults	0..*	Fault	inherited from: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	inherited from: Equipment
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject

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mult from	name	mult to	type	description
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.4.72 Sectionaliser

Automatic switch that will lock open to isolate a faulted section. It may, or may not, have load breaking capability. Its primary purpose is to provide fault sectionalising at locations where the fault current is either too high, or too low, for proper coordination of fuses.

Table 280 shows all attributes of Sectionaliser.

Table 280 – Attributes of Wires::Sectionaliser

name	mult	type	description
normalOpen	0..1	Boolean	inherited from: Switch
ratedCurrent	0..1	CurrentFlow	inherited from: Switch
switchOnCount	0..1	Integer	(deprecated) inherited from: Switch
switchOnDate	0..1	DateTime	(deprecated) inherited from: Switch
retained	0..1	Boolean	inherited from: Switch
open	0..1	Boolean	inherited from: Switch
locked	0..1	Boolean	inherited from: Switch
aggregate	0..1	Boolean	inherited from: Equipment
inService	0..1	Boolean	inherited from: Equipment
networkAnalysisEnabled	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 281 shows all association ends of Sectionaliser with other classes.

Table 281 – Association ends of Wires::Sectionaliser with other classes

mult from	name	mult to	type	description
1..1	SwitchPhase	0..*	SwitchPhase	inherited from: Switch
1..1	SwitchSchedules	0..*	SwitchSchedule	inherited from: Switch
0..*	CompositeSwitch	0..1	CompositeSwitch	inherited from: Switch
1..1	SvSwitch	0..*	SvSwitch	inherited from: Switch
0..*	BaseVoltage	0..1	BaseVoltage	inherited from: ConductingEquipment
1..1	SvStatus	0..*	SvStatus	inherited from: ConductingEquipment
0..*	ProtectionEquipments	0..*	ProtectionEquipment	inherited from: ConductingEquipment
1..1	Terminals	0..*	Terminal	inherited from: ConductingEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	inherited from: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	inherited from: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment

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mult from	name	mult to	type	description
0..1	Faults	0..*	Fault	inherited from: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	inherited from: Equipment
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.4.73 SeriesCompensator

A Series Compensator is a series capacitor or reactor or an AC transmission line without charging susceptance. It is a two terminal device.

Table 282 shows all attributes of SeriesCompensator.

Table 282 – Attributes of Wires::SeriesCompensator

name	mult	type	description
r	0..1	Resistance	Positive sequence resistance.
r0	0..1	Resistance	Zero sequence resistance.
x	0..1	Reactance	Positive sequence reactance.
x0	0..1	Reactance	Zero sequence reactance.
varistorPresent	0..1	Boolean	Describe if a metal oxide varistor (mov) for over voltage protection is configured in parallel with the series compensator. It is used for short circuit calculations.
varistorRatedCurrent	0..1	CurrentFlow	The maximum current the varistor is designed to handle at specified duration. It is used for short circuit calculations and exchanged only if SeriesCompensator.varistorPresent is true. The attribute shall be a positive value.
varistorVoltageThreshold	0..1	Voltage	The DC voltage at which the varistor starts conducting. It is used for short circuit calculations and exchanged only if SeriesCompensator.varistorPresent is true.
aggregate	0..1	Boolean	inherited from: Equipment
inService	0..1	Boolean	inherited from: Equipment
networkAnalysisEnabled	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 283 shows all association ends of SeriesCompensator with other classes.

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Table 283 – Association ends of Wires::SeriesCompensator with other classes

mult from	name	mult to	type	description
0..*	BaseVoltage	0..1	BaseVoltage	inherited from: ConductingEquipment
1..1	SvStatus	0..*	SvStatus	inherited from: ConductingEquipment
0..*	ProtectionEquipments	0..*	ProtectionEquipment	inherited from: ConductingEquipment
1..1	Terminals	0..*	Terminal	inherited from: ConductingEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	inherited from: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	inherited from: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment
0..1	Faults	0..*	Fault	inherited from: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	inherited from: Equipment
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.4.74 ShortCircuitRotorKind enumeration

Type of rotor, used by short circuit applications.

Table 284 shows all literals of ShortCircuitRotorKind.

Table 284 – Literals of Wires::ShortCircuitRotorKind

literal	value	description
salientPole1		Salient pole 1 in IEC 60909.
salientPole2		Salient pole 2 in IEC 60909.
turboSeries1		Turbo Series 1 in IEC 60909.
turboSeries2		Turbo series 2 in IEC 60909.

6.4.75 ShuntCompensator

A shunt capacitor or reactor or switchable bank of shunt capacitors or reactors. A section of a shunt compensator is an individual capacitor or reactor. A negative value for bPerSection indicates that the compensator is a reactor. ShuntCompensator is a single terminal device. Ground is implied.

Table 285 shows all attributes of ShuntCompensator.

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Table 285 – Attributes of Wires::ShuntCompensator

name	mult	type	description
aVRDelay	0..1	Seconds	An automatic voltage regulation delay (AVRDelay) which is the time delay from a change in voltage to when the capacitor is allowed to change state. This filters out temporary changes in voltage.
grounded	0..1	Boolean	Used for Yn and Zn connections. True if the neutral is solidly grounded.
maximumSections	0..1	Integer	The maximum number of sections that may be switched in.
nomU	0..1	Voltage	The voltage at which the nominal reactive power may be calculated. This should normally be within 10% of the voltage at which the capacitor is connected to the network.
normalSections	0..1	Integer	The normal number of sections switched in. The value shall be between zero and ShuntCompensator.maximumSections.
phaseConnection	0..1	PhaseShuntConnectionKind	The type of phase connection, such as wye or delta.
switchOnCount	0..1	Integer	(deprecated) The switch on count since the capacitor count was last reset or initialized.
switchOnDate	0..1	DateTime	(deprecated) The date and time when the capacitor bank was last switched on.
voltageSensitivity	0..1	VoltagePerReactivePower	Voltage sensitivity required for the device to regulate the bus voltage, in voltage/reactive power.
sections	0..1	Float	Shunt compensator sections in use. Starting value for steady state solution. The attribute shall be a positive value or zero. Non integer values are allowed to support continuous variables. The reasons for continuous value are to support study cases where no discrete shunt compensators has yet been designed, a solutions where a narrow voltage band force the sections to oscillate or accommodate for a continuous solution as input. For LinearShuntConpensator the value shall be between zero and ShuntCompensator.maximumSections. At value zero the shunt compensator conductance and admittance is zero. Linear interpolation of conductance and admittance between the previous and next integer section is applied in case of non-integer values. For NonlinearShuntCompensator-s shall only be set to one of the NonlinearShuntCompenstorPoint.sectionNumber. There is no interpolation between NonlinearShuntCompenstorPoint-s.
controlEnabled	0..1	Boolean	inherited from: RegulatingCondEq
aggregate	0..1	Boolean	inherited from: Equipment
inService	0..1	Boolean	inherited from: Equipment
networkAnalysisEnabled	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

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Table 286 shows all association ends of ShuntCompensator with other classes.

Table 286 – Association ends of Wires::ShuntCompensator with other classes

mult from	name	mult to	type	description
1..1	ShuntCompensatorPhase	0..*	ShuntCompensatorPhase	The individual phases models for the shunt compensator.
1..1	SvShuntCompensatorSections	0..*	SvShuntCompensatorSections	The state for the number of shunt compensator sections in service.
0..*	RegulatingControl	0..1	RegulatingControl	inherited from: RegulatingCondEq
0..*	BaseVoltage	0..1	BaseVoltage	inherited from: ConductingEquipment
1..1	SvStatus	0..*	SvStatus	inherited from: ConductingEquipment
0..*	ProtectionEquipments	0..*	ProtectionEquipment	inherited from: ConductingEquipment
1..1	Terminals	0..*	Terminal	inherited from: ConductingEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	inherited from: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	inherited from: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment
0..1	Faults	0..*	Fault	inherited from: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	inherited from: Equipment
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.4.76 ShuntCompensatorPhase

Single phase of a multi-phase shunt compensator when its attributes might be different per phase.

Table 287 shows all attributes of ShuntCompensatorPhase.

Table 287 – Attributes of Wires::ShuntCompensatorPhase

name	mult	type	description
maximumSections	0..1	Integer	The maximum number of sections that may be switched in for this phase.
normalSections	0..1	Integer	For the capacitor phase, the normal number of sections switched in. The value shall be between zero and ShuntCompensatorPhase.maximumSections.
sections	0..1	Float	Shunt compensator sections in use. Starting value for steady state solution. The attribute shall be a positive value or zero. Non integer values are allowed to support continuous variables. The reasons for continuous value are to support study cases where no discrete shunt compensators has yet been designed, a solutions where a narrow voltage band force the sections to oscillate or accommodate for a continuous solution as input.

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name	mult	type	description
			For LinearShuntConpensator the value shall be between zero and ShuntCompensatorPhase.maximumSections. At value zero the shunt compensator conductance and admittance is zero. Linear interpolation of conductance and admittance between the previous and next integer section is applied in case of non-integer values. For NonlinearShuntCompensator-s shall only be set to one of the NonlinearShuntCompenstorPhasePoint.sectionNumber. There is no interpolation between NonlinearShuntCompenstorPhasePoint-s.
phase	0..1	SinglePhaseKind	Phase of this shunt compensator component. If the shunt compensator is wye connected, the connection is from the indicated phase to the central ground or neutral point. If the shunt compensator is delta connected, the phase indicates a shunt compensator connected from the indicated phase to the next logical non-neutral phase.
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 288 shows all association ends of ShuntCompensatorPhase with other classes.

Table 288 – Association ends of Wires::ShuntCompensatorPhase with other classes

mult from	name	mult to	type	description
0..*	ShuntCompensator	1..1	ShuntCompensator	Shunt compensator of this shunt compensator phase.
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.4.77 SinglePhaseKind enumeration

Enumeration of single phase identifiers. Allows designation of single phases for both transmission and distribution equipment, circuits and loads.

Table 289 shows all literals of SinglePhaseKind.

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Table 289 – Literals of Wires::SinglePhaseKind

literal	value	description
A		Phase A.
B		Phase B.
C		Phase C.
N		Neutral.
s1		Secondary phase 1.
s2		Secondary phase 2.

6.4.78 StaticVarCompensator

A facility for providing variable and controllable shunt reactive power. The SVC typically consists of a stepdown transformer, filter, thyristor-controlled reactor, and thyristor-switched capacitor arms.

The SVC may operate in fixed MVar output mode or in voltage control mode. When in voltage control mode, the output of the SVC will be proportional to the deviation of voltage at the controlled bus from the voltage setpoint. The SVC characteristic slope defines the proportion. If the voltage at the controlled bus is equal to the voltage setpoint, the SVC MVar output is zero.

Table 290 shows all attributes of StaticVarCompensator.

Table 290 – Attributes of Wires::StaticVarCompensator

name	mult	type	description
capacitiveRating	0..1	Reactance	Capacitive reactance at maximum capacitive reactive power. Shall always be positive.
inductiveRating	0..1	Reactance	Inductive reactance at maximum inductive reactive power. Shall always be negative.
slope	0..1	VoltagePerReactivePower	The characteristics slope of an SVC defines how the reactive power output changes in proportion to the difference between the regulated bus voltage and the voltage setpoint. The attribute shall be a positive value or zero.
q	0..1	ReactivePower	Reactive power injection. Load sign convention is used, i.e. positive sign means flow out from a node. Starting value for a steady state solution.
sVCControlMode	0..1	SVCControlMode	SVC control mode.
voltageSetPoint	0..1	Voltage	The reactive power output of the SVC is proportional to the difference between the voltage at the regulated bus and the voltage setpoint. When the regulated bus voltage is equal to the voltage setpoint, the reactive power output is zero.
controlEnabled	0..1	Boolean	inherited from: RegulatingCondEq
aggregate	0..1	Boolean	inherited from: Equipment
inService	0..1	Boolean	inherited from: Equipment
networkAnalysisEnabled	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject

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name	mult	type	description
name	0..1	String	inherited from: IdentifiedObject

Table 291 shows all association ends of StaticVarCompensator with other classes.

Table 291 – Association ends of Wires::StaticVarCompensator with other classes

mult from	name	mult to	type	description
1..1	StaticVarCompensatorDynamics	0..1	StaticVarCompensatorDynamics	Static Var Compensator dynamics model used to describe dynamic behaviour of this Static Var Compensator.
0..*	RegulatingControl	0..1	RegulatingControl	inherited from: RegulatingCondEq
0..*	BaseVoltage	0..1	BaseVoltage	inherited from: ConductingEquipment
1..1	SvStatus	0..*	SvStatus	inherited from: ConductingEquipment
0..*	ProtectionEquipments	0..*	ProtectionEquipment	inherited from: ConductingEquipment
1..1	Terminals	0..*	Terminal	inherited from: ConductingEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	inherited from: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	inherited from: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment
0..1	Faults	0..*	Fault	inherited from: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	inherited from: Equipment
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.4.79 SVCControlMode enumeration

Static VAr Compensator control mode.

Table 292 shows all literals of SVCControlMode.

Table 292 – Literals of Wires::SVCControlMode

literal	value	description
reactivePower		Reactive power control.
voltage		Voltage control.

6.4.80 Switch

A generic device designed to close, or open, or both, one or more electric circuits. All switches are two terminal devices including grounding switches. The ACDCTerminal.connected at the two sides of the switch shall not be considered for assessing switch connectivity, i.e. only Switch.open, .normalOpen and .locked are relevant.

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Table 293 shows all attributes of Switch.

Table 293 – Attributes of Wires::Switch

name	mult	type	description
normalOpen	0..1	Boolean	The attribute is used in cases when no Measurement for the status value is present. If the Switch has a status measurement the Discrete.normalValue is expected to match with the Switch.normalOpen.
ratedCurrent	0..1	CurrentFlow	The maximum continuous current carrying capacity in amps governed by the device material and construction. The attribute shall be a positive value.
switchOnCount	0..1	Integer	(deprecated) The switch on count since the switch was last reset or initialized.
switchOnDate	0..1	DateTime	(deprecated) The date and time when the switch was last switched on.
retained	0..1	Boolean	Branch is retained in the topological solution. The flow through retained switches will normally be calculated in power flow.
open	0..1	Boolean	The attribute tells if the switch is considered open when used as input to topology processing.
locked	0..1	Boolean	If true, the switch is locked. The resulting switch state is a combination of locked and Switch.open attributes as follows: – locked=true and Switch.open=true. The resulting state is open and locked; – locked=false and Switch.open=true. The resulting state is open; – locked=false and Switch.open=false. The resulting state is closed.
aggregate	0..1	Boolean	inherited from: Equipment
inService	0..1	Boolean	inherited from: Equipment
networkAnalysisEnabled	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 294 shows all association ends of Switch with other classes.

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Table 294 – Association ends of Wires::Switch with other classes

mult from	name	mult to	type	description
1..1	SwitchPhase	0..*	SwitchPhase	The individual switch phases for the switch.
1..1	SwitchSchedules	0..*	SwitchSchedule	A Switch can be associated with SwitchSchedules.
0..*	CompositeSwitch	0..1	CompositeSwitch	Composite switch to which this Switch belongs.
1..1	SvSwitch	0..*	SvSwitch	The switch state associated with the switch.
0..*	BaseVoltage	0..1	BaseVoltage	inherited from: ConductingEquipment
1..1	SvStatus	0..*	SvStatus	inherited from: ConductingEquipment
0..*	ProtectionEquipments	0..*	ProtectionEquipment	inherited from: ConductingEquipment
1..1	Terminals	0..*	Terminal	inherited from: ConductingEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	inherited from: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	inherited from: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment
0..1	Faults	0..*	Fault	inherited from: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	inherited from: Equipment
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.4.81 SwitchPhase

Single phase of a multi-phase switch when its attributes might be different per phase.

Table 295 shows all attributes of SwitchPhase.

Table 295 – Attributes of Wires::SwitchPhase

name	mult	type	description
normalOpen	0..1	Boolean	Used in cases when no Measurement for the status value is present. If the SwitchPhase has a status measurement the Discrete.normalValue is expected to match with this value.
phaseSide1	0..1	SinglePhaseKind	Phase of this SwitchPhase on the side with terminal sequence number equal to 1. Should be a phase contained in that terminal's phases attribute.
phaseSide2	0..1	SinglePhaseKind	Phase of this SwitchPhase on the side with terminal sequence number equal to 2. Should be a phase contained in that terminal's Terminal.phases attribute.
closed	0..1	Boolean	The attribute tells if the switch is considered closed when used as input to topology processing.

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name	mult	type	description
ratedCurrent	0..1	CurrentFlow	The maximum continuous current carrying capacity in amps governed by the device material and construction. The attribute shall be a positive value.
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 296 shows all association ends of SwitchPhase with other classes.

Table 296 – Association ends of Wires::SwitchPhase with other classes

mult from	name	mult to	type	description
0..*	Switch	1..1	Switch	The switch of the switch phase.
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.4.82 SwitchSchedule

A schedule of switch positions. If RegularTimePoint.value1 is 0, the switch is open. If 1, the switch is closed.

Table 297 shows all attributes of SwitchSchedule.

Table 297 – Attributes of Wires::SwitchSchedule

name	mult	type	description
endTime	0..1	DateTime	inherited from: RegularIntervalSchedule
timeStep	0..1	Seconds	inherited from: RegularIntervalSchedule
startTime	0..1	DateTime	inherited from: BasicIntervalSchedule
value1Multiplier	0..1	UnitMultiplier	inherited from: BasicIntervalSchedule
value1Unit	0..1	UnitSymbol	inherited from: BasicIntervalSchedule
value2Multiplier	0..1	UnitMultiplier	inherited from: BasicIntervalSchedule
value2Unit	0..1	UnitSymbol	inherited from: BasicIntervalSchedule
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 298 shows all association ends of SwitchSchedule with other classes.

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Table 298 – Association ends of Wires::SwitchSchedule with other classes

mult from	name	mult to	type	description
0..*	Switch	1..1	Switch	A SwitchSchedule is associated with a Switch.
0..*	DayType	0..1	DayType	inherited from: SeasonDayTypeSchedule
0..*	Season	0..1	Season	inherited from: SeasonDayTypeSchedule
1..1	TimePoints	1..*	RegularTimePoint	inherited from: RegularIntervalSchedule
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.4.83 SynchronousMachine

An electromechanical device that operates with shaft rotating synchronously with the network. It is a single machine operating either as a generator or synchronous condenser or pump.

Table 299 shows all attributes of SynchronousMachine.

Table 299 – Attributes of Wires::SynchronousMachine

name	mult	type	description
aVRToManualLag	0..1	Seconds	Time delay required when switching from Automatic Voltage Regulation (AVR) to Manual for a lagging MVAr violation.
aVRToManualLead	0..1	Seconds	Time delay required when switching from Automatic Voltage Regulation (AVR) to Manual for a leading MVAr violation.
baseQ	0..1	ReactivePower	Default base reactive power value. This value represents the initial reactive power that can be used by any application function.
condenserP	0..1	ActivePower	Active power consumed when in condenser mode operation.
coolantCondition	0..1	Float	Temperature or pressure of coolant medium.
coolantType	0..1	CoolantType	Method of cooling the machine.
earthing	0..1	Boolean	Indicates whether or not the generator is earthed. Used for short circuit data exchange according to IEC 60909.
earthingStarPointR	0..1	Resistance	Generator star point earthing resistance (Re). Used for short circuit data exchange according to IEC 60909.
earthingStarPointX	0..1	Reactance	Generator star point earthing reactance (Xe). Used for short circuit data exchange according to IEC 60909.
ikk	0..1	CurrentFlow	Steady-state short-circuit current (in A for the profile) of generator with compound excitation during 3-phase short circuit. – Ikk=0: Generator with no compound excitation. – Ikk<>0: Generator with compound excitation. Ikk is used to calculate the minimum steady-state short-circuit current for generators with compound excitation. (4.6.1.2 in IEC 60909-0:2001). Used only for single fed short circuit on a generator. (4.3.4.2. in IEC 60909-0:2001).

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name	mult	type	description
manualToAVR	0..1	Seconds	Time delay required when switching from Manual to Automatic Voltage Regulation. This value is used in the accelerating power reference frame for powerflow solutions.
maxQ	0..1	ReactivePower	Maximum reactive power limit. This is the maximum (nameplate) limit for the unit.
maxU	0..1	Voltage	Maximum voltage limit for the unit.
minQ	0..1	ReactivePower	Minimum reactive power limit for the unit.
minU	0..1	Voltage	Minimum voltage limit for the unit.
mu	0..1	Float	Factor to calculate the breaking current (Section 4.5.2.1 in IEC 60909-0). Used only for single fed short circuit on a generator (Section 4.3.4.2. in IEC 60909-0).
operatingMode	0..1	SynchronousMachineOperatingMode	Current mode of operation.
qPercent	0..1	PerCent	Part of the coordinated reactive control that comes from this machine. The attribute is used as a participation factor not necessarily summing up to 100% for the participating devices in the control.
r	0..1	Resistance	Equivalent resistance (RG) of generator. RG is considered for the calculation of all currents, except for the calculation of the peak current ip. Used for short circuit data exchange according to IEC 60909.
r0	0..1	Resistance	Zero sequence resistance of the synchronous machine.
r2	0..1	Resistance	Negative sequence resistance.
referencePriority	0..1	Integer	Priority of unit for use as powerflow voltage phase angle reference bus selection. 0 = don t care (default) 1 = highest priority. 2 is less than 1 and so on.
satDirectSubtransX	0..1	PU	Direct-axis subtransient reactance saturated, also known as Xd"sat.
satDirectSyncX	0..1	PU	Direct-axes saturated synchronous reactance (xdsat); reciprocal of short-circuit ration. Used for short circuit data exchange, only for single fed short circuit on a generator. (4.3.4.2. in IEC 60909-0:2001).
satDirectTransX	0..1	PU	Saturated Direct-axis transient reactance. The attribute is primarily used for short circuit calculations according to ANSI.
shortCircuitRotorType	0..1	ShortCircuitRotorKind	Type of rotor, used by short circuit applications, only for single fed short circuit according to IEC 60909.
type	0..1	SynchronousMachineKind	Modes that this synchronous machine can operate in.
voltageRegulationRange	0..1	PerCent	Range of generator voltage regulation (PG in IEC 60909-0) used for calculation of the impedance correction factor KG defined in IEC 60909-0. This attribute is used to describe the operating voltage of the generating unit.
x0	0..1	Reactance	Zero sequence reactance of the synchronous machine.
x2	0..1	Reactance	Negative sequence reactance.
ratedPowerFactor	0..1	Float	inherited from: RotatingMachine
p	0..1	ActivePower	inherited from: RotatingMachine

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name	mult	type	description
ratedS	0..1	ApparentPower	inherited from: RotatingMachine
q	0..1	ReactivePower	inherited from: RotatingMachine
ratedU	0..1	Voltage	inherited from: RotatingMachine
controlEnabled	0..1	Boolean	inherited from: RegulatingCondEq
aggregate	0..1	Boolean	inherited from: Equipment
inService	0..1	Boolean	inherited from: Equipment
networkAnalysisEnabled	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 300 shows all association ends of SynchronousMachine with other classes.

Table 300 – Association ends of Wires::SynchronousMachine with other classes

mult from	name	mult to	type	description
1..*	InitialReactiveCapabilityCurve	0..1	ReactiveCapabilityCurve	The default reactive capability curve for use by a synchronous machine.
1..*	ReactiveCapabilityCurves	0..*	ReactiveCapabilityCurve	All available reactive capability curves for this synchronous machine.
0..*	PrimeMovers	0..*	PrimeMover	Prime movers that drive this SynchronousMachine.
1..1	SynchronousMachineDynamics	0..1	SynchronousMachineDynamics	Synchronous machine dynamics model used to describe dynamic behaviour of this synchronous machine.
1..1	HydroPump	0..1	HydroPump	inherited from: RotatingMachine
0..*	GeneratingUnit	0..1	GeneratingUnit	inherited from: RotatingMachine
0..*	RegulatingControl	0..1	RegulatingControl	inherited from: RegulatingCondEq
0..*	BaseVoltage	0..1	BaseVoltage	inherited from: ConductingEquipment
1..1	SvStatus	0..*	SvStatus	inherited from: ConductingEquipment
0..*	ProtectionEquipments	0..*	ProtectionEquipment	inherited from: ConductingEquipment
1..1	Terminals	0..*	Terminal	inherited from: ConductingEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	inherited from: Equipment
1..*	ContingencyEquipment	0..*	ContingencyEquipment	inherited from: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment
0..1	Faults	0..*	Fault	inherited from: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	inherited from: Equipment
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject

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mult from	name	mult to	type	description
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.4.84 SynchronousMachineOperatingMode enumeration

Synchronous machine operating mode.

Table 301 shows all literals of SynchronousMachineOperatingMode.

Table 301 – Literals of Wires::SynchronousMachineOperatingMode

literal	value	description
generator		Operating as generator.
condenser		Operating as condenser.
motor		Operating as motor.

6.4.85 SynchronousMachineKind enumeration

Synchronous machine type.

Table 302 shows all literals of SynchronousMachineKind.

Table 302 – Literals of Wires::SynchronousMachineKind

literal	value	description
generator		Indicates the synchronous machine can operate as a generator.
condenser		Indicates the synchronous machine can operate as a condenser.
generatorOrCondenser		Indicates the synchronous machine can operate as a generator or as a condenser.
motor		Indicates the synchronous machine can operate as a motor.
generatorOrMotor		Indicates the synchronous machine can operate as a generator or as a motor.
motorOrCondenser		Indicates the synchronous machine can operate as a motor or as a condenser.
generatorOrCondenserOrMotor		Indicates the synchronous machine can operate as a generator or as a condenser or as a motor.

6.4.86 TapChanger

Mechanism for changing transformer winding tap positions.

Table 303 shows all attributes of TapChanger.

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Table 303 – Attributes of Wires::TapChanger

name	mult	type	description
controlEnabled	0..1	Boolean	Specifies the regulation status of the equipment. True is regulating, false is not regulating.
highStep	0..1	Integer	Highest possible tap step position, advance from neutral. The attribute shall be greater than lowStep.
initialDelay	0..1	Seconds	For an LTC, the delay for initial tap changer operation (first step change).
lowStep	0..1	Integer	Lowest possible tap step position, retard from neutral.
ltcFlag	0..1	Boolean	Specifies whether or not a TapChanger has load tap changing capabilities.
neutralStep	0..1	Integer	The neutral tap step position for this winding. The attribute shall be equal to or greater than lowStep and equal or less than highStep. It is the step position where the voltage is neutralU when the other terminals of the transformer are at the ratedU. If there are other tap changers on the transformer those taps are kept constant at their neutralStep.
neutralU	0..1	Voltage	Voltage at which the winding operates at the neutral tap setting. It is the voltage at the terminal of the PowerTransformerEnd associated with the tap changer when all tap changers on the transformer are at their neutralStep position. Normally neutralU of the tap changer is the same as ratedU of the PowerTransformerEnd, but it can differ in special cases such as when the tapping mechanism is separate from the winding more common on lower voltage transformers. This attribute is not relevant for PhaseTapChangerAsymmetrical, PhaseTapChangerSymmetrical and PhaseTapChangerLinear.
normalStep	0..1	Integer	The tap step position used in "normal" network operation for this winding. For a "Fixed" tap changer indicates the current physical tap setting. The attribute shall be equal to or greater than lowStep and equal to or less than highStep.
subsequentDelay	0..1	Seconds	For an LTC, the delay for subsequent tap changer operation (second and later step changes).
step	0..1	Float	Tap changer position. Starting step for a steady state solution. Non integer values are allowed to support continuous tap variables. The reasons for continuous value are to support study cases where no discrete tap changer has yet been designed, a solution where a narrow voltage band forces the tap step to oscillate or to accommodate for a continuous solution as input. The attribute shall be equal to or greater than lowStep and equal to or less than highStep.
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

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Table 304 shows all association ends of TapChanger with other classes.

Table 304 – Association ends of Wires::TapChanger with other classes

mult from	name	mult to	type	description
1..*	TapChangerControl	0..1	TapChangerControl	The regulating control scheme in which this tap changer participates.
1..1	SvTapStep	0..1	SvTapStep	The tap step state associated with the tap changer.
1..1	TapSchedules	0..*	TapSchedule	A TapChanger can have TapSchedules.
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.4.87 TapChangerControl

Describes behaviour specific to tap changers, e.g. how the voltage at the end of a line varies with the load level and compensation of the voltage drop by tap adjustment.

Table 305 shows all attributes of TapChangerControl.

Table 305 – Attributes of Wires::TapChangerControl

name	mult	type	description
limitVoltage	0..1	Voltage	Maximum allowed regulated voltage on the PT secondary, regardless of line drop compensation. Sometimes referred to as first-house protection.
lineDropCompensation	0..1	Boolean	If true, the line drop compensation is to be applied.
lineDropR	0..1	Resistance	Line drop compensator resistance setting for normal (forward) power flow.
lineDropX	0..1	Reactance	Line drop compensator reactance setting for normal (forward) power flow.
reverseLineDropR	0..1	Resistance	Line drop compensator resistance setting for reverse power flow.
reverseLineDropX	0..1	Reactance	Line drop compensator reactance setting for reverse power flow.
discrete	0..1	Boolean	inherited from: RegulatingControl
enabled	0..1	Boolean	inherited from: RegulatingControl
mode	0..1	RegulatingControlModeKind	inherited from: RegulatingControl
monitoredPhase	0..1	PhaseCode	inherited from: RegulatingControl
targetDeadband	0..1	Float	inherited from: RegulatingControl
targetValue	0..1	Float	inherited from: RegulatingControl
targetValueUnitMultiplier	0..1	UnitMultiplier	inherited from: RegulatingControl
maxAllowedTargetValue	0..1	Float	inherited from: RegulatingControl

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name	mult	type	description
minAllowedTargetValue	0..1	Float	inherited from: RegulatingControl
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 306 shows all association ends of TapChangerControl with other classes.

Table 306 – Association ends of Wires::TapChangerControl with other classes

mult from	name	mult to	type	description
0..1	TapChanger	1..*	TapChanger	The tap changers that participates in this regulating tap control scheme.
0..*	Terminal	0..1	Terminal	inherited from: RegulatingControl
0..1	RegulatingCondEq	0..*	RegulatingCondEq	inherited from: RegulatingControl
1..1	RegulationSchedule	0..*	RegulationSchedule	inherited from: RegulatingControl
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.4.88 TapChangerTablePoint root class

Describes each tap step in the tabular curve.

Table 307 shows all attributes of TapChangerTablePoint.

Table 307 – Attributes of Wires::TapChangerTablePoint

name	mult	type	description
b	0..1	PerCent	The magnetizing branch susceptance deviation as a percentage of nominal value. The actual susceptance is calculated as follows: calculated magnetizing susceptance = b(nominal) * (1 + b(from this class)/100). The b(nominal) is defined as the static magnetizing susceptance on the associated power transformer end or ends. This model assumes the star impedance (pi model) form.
g	0..1	PerCent	The magnetizing branch conductance deviation as a percentage of nominal value. The actual conductance is calculated as follows: calculated magnetizing conductance = g(nominal) * (1 + g(from this class)/100). The g(nominal) is defined as the static magnetizing conductance on the associated power transformer end or ends. This model assumes the star impedance (pi model) form.

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name	mult	type	description
r	0..1	PerCent	The resistance deviation as a percentage of nominal value. The actual reactance is calculated as follows: calculated resistance = r(nominal) * (1 + r(from this class)/100). The r(nominal) is defined as the static resistance on the associated power transformer end or ends. This model assumes the star impedance (pi model) form.
ratio	0..1	Float	The voltage at the tap step divided by rated voltage of the transformer end having the tap changer. Hence this is a value close to one. For example, if the ratio at step 1 is 1.01, and the rated voltage of the transformer end is 110kV, then the voltage obtained by setting the tap changer to step 1 to is 111.1kV.
step	0..1	Integer	The tap step.
x	0..1	PerCent	The series reactance deviation as a percentage of nominal value. The actual reactance is calculated as follows: calculated reactance = x(nominal) * (1 + x(from this class)/100). The x(nominal) is defined as the static series reactance on the associated power transformer end or ends. This model assumes the star impedance (pi model) form.

6.4.89 TapSchedule

A pre-established pattern over time for a tap step.

Table 308 shows all attributes of TapSchedule.

Table 308 – Attributes of Wires::TapSchedule

name	mult	type	description
endTime	0..1	DateTime	inherited from: RegularIntervalSchedule
timeStep	0..1	Seconds	inherited from: RegularIntervalSchedule
startTime	0..1	DateTime	inherited from: BasicIntervalSchedule
value1Multiplier	0..1	UnitMultiplier	inherited from: BasicIntervalSchedule
value1Unit	0..1	UnitSymbol	inherited from: BasicIntervalSchedule
value2Multiplier	0..1	UnitMultiplier	inherited from: BasicIntervalSchedule
value2Unit	0..1	UnitSymbol	inherited from: BasicIntervalSchedule
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 309 shows all association ends of TapSchedule with other classes.

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Table 309 – Association ends of Wires::TapSchedule with other classes

mult from	name	mult to	type	description
0..*	TapChanger	1..1	TapChanger	A TapSchedule is associated with a TapChanger.
0..*	DayType	0..1	DayType	inherited from: SeasonDayTypeSchedule
0..*	Season	0..1	Season	inherited from: SeasonDayTypeSchedule
1..1	TimePoints	1..*	RegularTimePoint	inherited from: RegularIntervalSchedule
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.4.90 TransformerControlMode enumeration

Control modes for a transformer.

Table 310 shows all literals of TransformerControlMode.

Table 310 – Literals of Wires::TransformerControlMode

literal	value	description
volt		Voltage control.
reactive		Reactive power flow control.

6.4.91 TransformerCoreAdmittance

The transformer core admittance. Used to specify the core admittance of a transformer in a manner that can be shared among power transformers.

Table 311 shows all attributes of TransformerCoreAdmittance.

Table 311 – Attributes of Wires::TransformerCoreAdmittance

name	mult	type	description
b	0..1	Susceptance	Magnetizing branch susceptance (B mag). The value can be positive or negative.
b0	0..1	Susceptance	Zero sequence magnetizing branch susceptance.
g	0..1	Conductance	Magnetizing branch conductance (G mag).
g0	0..1	Conductance	Zero sequence magnetizing branch conductance.
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 312 shows all association ends of TransformerCoreAdmittance with other classes.

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Table 312 – Association ends of Wires::TransformerCoreAdmittance with other classes

mult from	name	mult to	type	description
0..1	TransformerEnd	0..*	TransformerEnd	All transformer ends having this core admittance.
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.4.92 TransformerEnd

A conducting connection point of a power transformer. It corresponds to a physical transformer winding terminal. In earlier CIM versions, the TransformerWinding class served a similar purpose, but this class is more flexible because it associates to terminal but is not a specialization of ConductingEquipment.

Table 313 shows all attributes of TransformerEnd.

Table 313 – Attributes of Wires::TransformerEnd

name	mult	type	description
bmagSat	0..1	PerCent	Core shunt magnetizing susceptance in the saturation region.
endNumber	0..1	Integer	Number for this transformer end, corresponding to the end's order in the power transformer vector group or phase angle clock number. Highest voltage winding should be 1. Each end within a power transformer should have a unique subsequent end number. Note the transformer end number need not match the terminal sequence number.
grounded	0..1	Boolean	(for Yn and Zn connections) True if the neutral is solidly grounded.
magBaseU	0..1	Voltage	The reference voltage at which the magnetizing saturation measurements were made.
magSatFlux	0..1	PerCent	Core magnetizing saturation curve knee flux level.
rground	0..1	Resistance	(for Yn and Zn connections) Resistance part of neutral impedance where 'grounded' is true.
xground	0..1	Reactance	(for Yn and Zn connections) Reactive part of neutral impedance where 'grounded' is true.
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 314 shows all association ends of TransformerEnd with other classes.

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Table 314 – Association ends of Wires::TransformerEnd with other classes

mult from	name	mult to	type	description
0..*	BaseVoltage	0..1	BaseVoltage	Base voltage of the transformer end. This is essential for PU calculation.
0..*	Terminal	0..1	Terminal	Terminal of the power transformer to which this transformer end belongs.
1..1	PhaseTapChanger	0..1	PhaseTapChanger	Phase tap changer associated with this transformer end.
1..1	RatioTapChanger	0..1	RatioTapChanger	Ratio tap changer associated with this transformer end.
0..*	StarImpedance	0..1	TransformerStarImpedance	(accurate for 2- or 3-winding transformers only) Pi-model impedances of this transformer end. By convention, for a two winding transformer, the full values of the transformer should be entered on the high voltage end (endNumber=1).
0..*	CoreAdmittance	0..1	TransformerCoreAdmittance	Core admittance of this transformer end, representing magnetising current and core losses. The full values of the transformer should be supplied for one transformer end only.
1..*	ToMeshImpedance	0..*	TransformerMeshImpedance	All mesh impedances between this 'from' and other 'to' transformer ends.
1..1	FromMeshImpedance	0..*	TransformerMeshImpedance	All mesh impedances between this 'to' and other 'from' transformer ends.
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.4.93 TransformerMeshImpedance

Transformer mesh impedance (Delta-model) between transformer ends.

The typical case is that this class describes the impedance between two transformer ends pair-wise, i.e. the cardinalities at both transformer end associations are 1. However, in cases where two or more transformer ends are modelled the cardinalities are larger than 1.

Table 315 shows all attributes of TransformerMeshImpedance.

Table 315 – Attributes of Wires::TransformerMeshImpedance

name	mult	type	description
r	0..1	Resistance	Resistance between the 'from' and the 'to' end, seen from the 'from' end.
r0	0..1	Resistance	Zero-sequence resistance between the 'from' and the 'to' end, seen from the 'from' end.
x	0..1	Reactance	Reactance between the 'from' and the 'to' end, seen from the 'from' end.
x0	0..1	Reactance	Zero-sequence reactance between the 'from' and the 'to' end, seen from the 'from' end.
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

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Table 316 shows all association ends of TransformerMeshImpedance with other classes.

Table 316 – Association ends of Wires::TransformerMeshImpedance with other classes

mult from	name	mult to	type	description
0..*	ToTransformerEnd	1..*	TransformerEnd	All transformer ends this mesh impedance is connected to.
0..*	FromTransformerEnd	1..1	TransformerEnd	From end this mesh impedance is connected to. It determines the voltage reference.
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.4.94 TransformerStarImpedance

Transformer star impedance (Pi-model) that accurately reflects impedance for transformers with 2 or 3 windings. For transformers with 4 or more windings, TransformerMeshImpedance class shall be used.

For transmission networks use PowerTransformerEnd impedances (r, r0, x, x0, b, b0, g and g0).

Table 317 shows all attributes of TransformerStarImpedance.

Table 317 – Attributes of Wires::TransformerStarImpedance

name	mult	type	description
r	0..1	Resistance	Resistance of the transformer end.
r0	0..1	Resistance	Zero sequence series resistance of the transformer end.
x	0..1	Reactance	Positive sequence series reactance of the transformer end.
x0	0..1	Reactance	Zero sequence series reactance of the transformer end.
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 318 shows all association ends of TransformerStarImpedance with other classes.

Table 318 – Association ends of Wires::TransformerStarImpedance with other classes

mult from	name	mult to	type	description
0..1	TransformerEnd	0..*	TransformerEnd	All transformer ends having this star impedance.
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

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6.4.95 TransformerTank

An assembly of two or more coupled windings that transform electrical power between voltage levels. These windings are bound on a common core and placed in the same tank. Transformer tank can be used to model both single-phase and 3-phase transformers.

Table 319 shows all attributes of TransformerTank.

Table 319 – Attributes of Wires::TransformerTank

name	mult	type	description
aggregate	0..1	Boolean	inherited from: Equipment
inService	0..1	Boolean	inherited from: Equipment
networkAnalysisEnabled	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 320 shows all association ends of TransformerTank with other classes.

Table 320 – Association ends of Wires::TransformerTank with other classes

mult from	name	mult to	type	description
0..*	PowerTransformer	0..1	PowerTransformer	Bank this transformer belongs to.
0..1	TransformerTankEnds	1..*	TransformerTankEnd	All windings of this transformer.
0..1	OperationalLimitSet	0..*	OperationalLimitSet	inherited from: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	inherited from: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment
0..1	Faults	0..*	Fault	inherited from: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	inherited from: Equipment
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.4.96 TransformerTankEnd

Transformer tank end represents an individual winding for unbalanced models or for transformer tanks connected into a bank (and bank is modelled with the PowerTransformer).

Table 321 shows all attributes of TransformerTankEnd.

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Table 321 – Attributes of Wires::TransformerTankEnd

name	mult	type	description
phases	0..1	PhaseCode	Describes the phases carried by a conducting equipment.
bmagSat	0..1	PerCent	inherited from: TransformerEnd
endNumber	0..1	Integer	inherited from: TransformerEnd
grounded	0..1	Boolean	inherited from: TransformerEnd
magBaseU	0..1	Voltage	inherited from: TransformerEnd
magSatFlux	0..1	PerCent	inherited from: TransformerEnd
rground	0..1	Resistance	inherited from: TransformerEnd
xground	0..1	Reactance	inherited from: TransformerEnd
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 322 shows all association ends of TransformerTankEnd with other classes.

Table 322 – Association ends of Wires::TransformerTankEnd with other classes

mult from	name	mult to	type	description
1..*	TransformerTank	0..1	TransformerTank	Transformer this winding belongs to.
0..*	BaseVoltage	0..1	BaseVoltage	inherited from: TransformerEnd
0..*	Terminal	0..1	Terminal	inherited from: TransformerEnd
1..1	PhaseTapChanger	0..1	PhaseTapChanger	inherited from: TransformerEnd
1..1	RatioTapChanger	0..1	RatioTapChanger	inherited from: TransformerEnd
0..*	StarImpedance	0..1	TransformerStarImpedance	inherited from: TransformerEnd
0..*	CoreAdmittance	0..1	TransformerCoreAdmittance	inherited from: TransformerEnd
1..*	ToMeshImpedance	0..*	TransformerMeshImpedance	inherited from: TransformerEnd
1..1	FromMeshImpedance	0..*	TransformerMeshImpedance	inherited from: TransformerEnd
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

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6.4.97 VoltageControlZone

An area of the power system network which is defined for secondary voltage control purposes. A voltage control zone consists of a collection of substations with a designated bus bar section whose voltage will be controlled.

Table 323 shows all attributes of VoltageControlZone.

Table 323 – Attributes of Wires::VoltageControlZone

name	mult	type	description
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 324 shows all association ends of VoltageControlZone with other classes.

Table 324 – Association ends of Wires::VoltageControlZone with other classes

mult from	name	mult to	type	description
0..1	BusbarSection	1..1	BusbarSection	A VoltageControlZone is controlled by a designated BusbarSection.
0..*	RegulationSchedule	0..1	RegulationSchedule	A VoltageControlZone may have a voltage regulation schedule.
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.4.98 WireSegment

A two terminal and power conducting device of negligible impedance and length represented as zero impedance device that can be used to connect auxiliary equipment to its terminals.

Table 325 shows all attributes of WireSegment.

Table 325 – Attributes of Wires::WireSegment

name	mult	type	description
length	0..1	Length	inherited from: Conductor
aggregate	0..1	Boolean	inherited from: Equipment
inService	0..1	Boolean	inherited from: Equipment
networkAnalysisEnabled	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 326 shows all association ends of WireSegment with other classes.

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Table 326 – Association ends of Wires::WireSegment with other classes

mult from	name	mult to	type	description
1..1	WireSegmentPhases	0..*	WireSegmentPhase	The wire segment phases which belong to the wire segment.
0..*	BaseVoltage	0..1	BaseVoltage	inherited from: ConductingEquipment
1..1	SvStatus	0..*	SvStatus	inherited from: ConductingEquipment
0..*	ProtectionEquipments	0..*	ProtectionEquipment	inherited from: ConductingEquipment
1..1	Terminals	0..*	Terminal	inherited from: ConductingEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	inherited from: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	inherited from: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment
0..1	Faults	0..*	Fault	inherited from: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	inherited from: Equipment
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.4.99 WireSegmentPhase

Represents a single wire of an alternating current wire segment.

Table 327 shows all attributes of WireSegmentPhase.

Table 327 – Attributes of Wires::WireSegmentPhase

name	mult	type	description
phase	0..1	SinglePhaseKind	The phase connection of the wire at both ends.
sequenceNumber	0..1	Integer	Number designation for this wire segment phase. Each wire segment phase within a wire segment should have a unique sequence number.
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 328 shows all association ends of WireSegmentPhase with other classes.

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Table 328 – Association ends of Wires::WireSegmentPhase with other classes

mult from	name	mult to	type	description
0..*	WireSegment	1..1	WireSegment	The wire segment to which the phase belongs.
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.4.100 WindingConnection enumeration

Winding connection type.

Table 329 shows all literals of WindingConnection.

Table 329 – Literals of Wires::WindingConnection

literal	value	description
D		Delta.
Y		Wye.
Z		ZigZag.
Yn		Wye, with neutral brought out for grounding.
Zn		ZigZag, with neutral brought out for grounding.
A		Autotransformer common winding.
I		Independent winding, for single-phase connections.

6.5 Package LoadModel

6.5.1 General

This package is responsible for modelling the energy consumers and the system load as curves and associated curve data. Special circumstances that may affect the load, such as seasons and day types, are also included here.

This information is used by Load Forecasting and Load Management.

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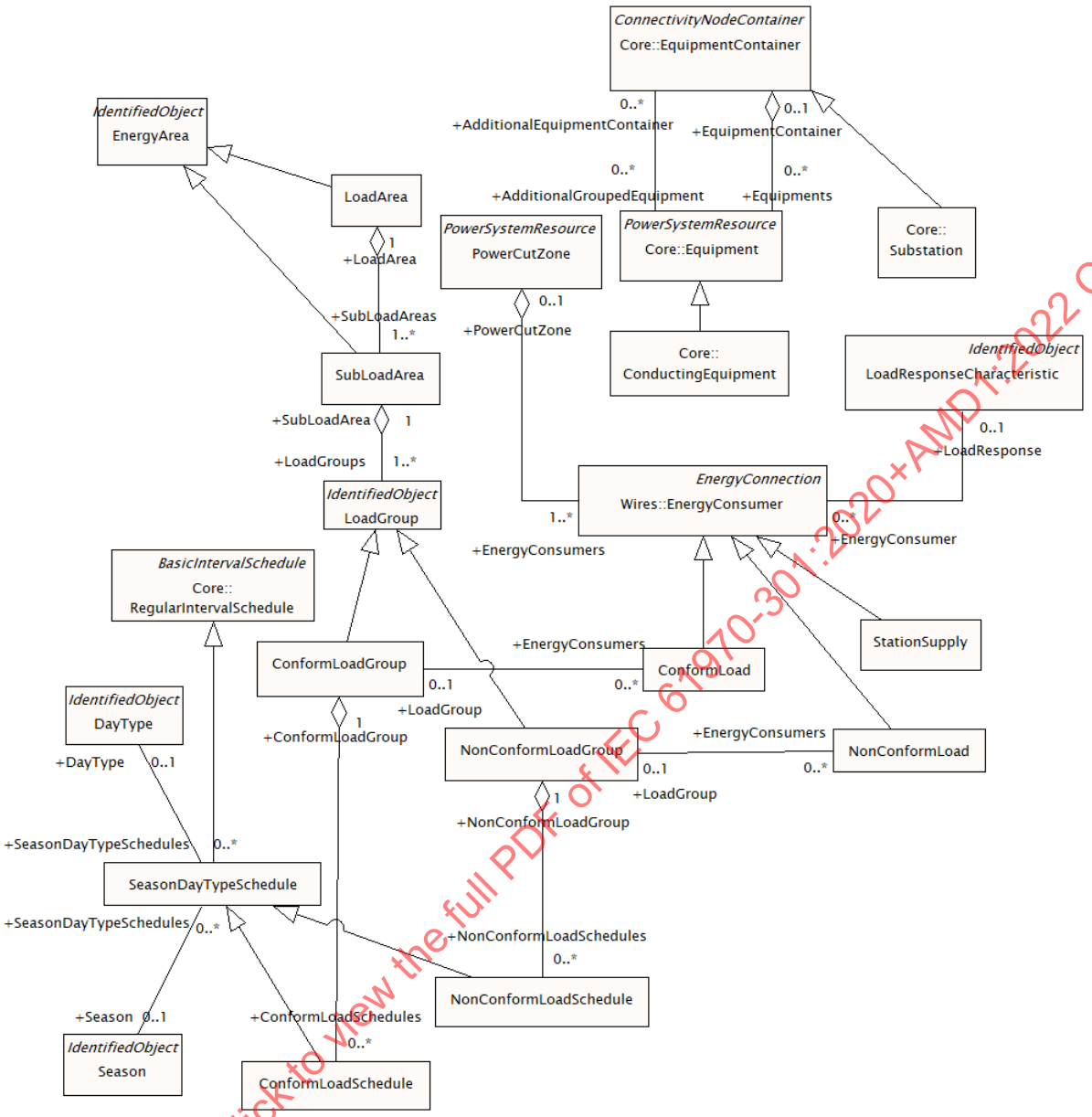


Figure 102 – Class diagram LoadModel::Main

Figure 102: This diagram shows all classes included in the LoadModel package as well as the key external classes that have associations with LoadModel classes.

6.5.2 ConformLoad

ConformLoad represent loads that follow a daily load change pattern where the pattern can be used to scale the load with a system load.

Table 330 shows all attributes of ConformLoad.

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Table 330 – Attributes of LoadModel::ConformLoad

name	mult	type	description
customerCount	0..1	Integer	inherited from: EnergyConsumer
grounded	0..1	Boolean	inherited from: EnergyConsumer
pfixed	0..1	ActivePower	inherited from: EnergyConsumer
pfixedPct	0..1	PerCent	inherited from: EnergyConsumer
phaseConnection	0..1	PhaseShuntConnectionKind	inherited from: EnergyConsumer
qfixed	0..1	ReactivePower	inherited from: EnergyConsumer
qfixedPct	0..1	PerCent	inherited from: EnergyConsumer
p	0..1	ActivePower	inherited from: EnergyConsumer
q	0..1	ReactivePower	inherited from: EnergyConsumer
aggregate	0..1	Boolean	inherited from: Equipment
inService	0..1	Boolean	inherited from: Equipment
networkAnalysisEnabled	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 331 shows all association ends of ConformLoad with other classes.

Table 331 – Association ends of LoadModel::ConformLoad with other classes

mult from	name	mult to	type	description
0..*	LoadGroup	0..1	ConformLoadGroup	Group of this ConformLoad.
0..*	LoadResponse	0..1	LoadResponseCharacteristic	inherited from: EnergyConsumer
1..1	EnergyConsumerPhase	0..*	EnergyConsumerPhase	inherited from: EnergyConsumer
1..*	PowerCutZone	0..1	PowerCutZone	inherited from: EnergyConsumer
0..*	LoadDynamics	0..1	LoadDynamics	inherited from: EnergyConsumer
0..*	BaseVoltage	0..1	BaseVoltage	inherited from: ConductingEquipment
1..1	SvStatus	0..*	SvStatus	inherited from: ConductingEquipment
0..*	ProtectionEquipments	0..*	ProtectionEquipment	inherited from: ConductingEquipment
1..1	Terminals	0..*	Terminal	inherited from: ConductingEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	inherited from: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	inherited from: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment
0..1	Faults	0..*	Fault	inherited from: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	inherited from: Equipment
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource

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mult from	name	mult to	type	description
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.5.3 ConformLoadGroup

A group of loads conforming to an allocation pattern.

Table 332 shows all attributes of ConformLoadGroup.

Table 332 – Attributes of LoadModel::ConformLoadGroup

name	mult	type	description
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 333 shows all association ends of ConformLoadGroup with other classes.

Table 333 – Association ends of LoadModel::ConformLoadGroup with other classes

mult from	name	mult to	type	description
0..1	EnergyConsumers	0..*	ConformLoad	Conform loads assigned to this ConformLoadGroup.
1..1	ConformLoadSchedules	0..*	ConformLoadSchedule	The ConformLoadSchedules in the ConformLoadGroup.
1..*	SubLoadArea	1..1	SubLoadArea	inherited from: LoadGroup
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.5.4 ConformLoadSchedule

A curve of load versus time (X-axis) showing the active power values (Y1-axis) and reactive power (Y2-axis) for each unit of the period covered. This curve represents a typical pattern of load over the time period for a given day type and season.

Table 334 shows all attributes of ConformLoadSchedule.

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Table 334 – Attributes of LoadModel::ConformLoadSchedule

name	mult	type	description
endTime	0..1	DateTime	inherited from: RegularIntervalSchedule
timeStep	0..1	Seconds	inherited from: RegularIntervalSchedule
startTime	0..1	DateTime	inherited from: BasicIntervalSchedule
value1Multiplier	0..1	UnitMultiplier	inherited from: BasicIntervalSchedule
value1Unit	0..1	UnitSymbol	inherited from: BasicIntervalSchedule
value2Multiplier	0..1	UnitMultiplier	inherited from: BasicIntervalSchedule
value2Unit	0..1	UnitSymbol	inherited from: BasicIntervalSchedule
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 335 shows all association ends of ConformLoadSchedule with other classes.

Table 335 – Association ends of LoadModel::ConformLoadSchedule with other classes

mult from	name	mult to	type	description
0..*	ConformLoadGroup	1..1	ConformLoadGroup	The ConformLoadGroup where the ConformLoadSchedule belongs.
0..*	DayType	0..1	DayType	inherited from: SeasonDayTypeSchedule
0..*	Season	0..1	Season	inherited from: SeasonDayTypeSchedule
1..1	TimePoints	1..*	RegularTimePoint	inherited from: RegularIntervalSchedule
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.5.5 DayType

Group of similar days. For example it could be used to represent weekdays, weekend, or holidays.

Table 336 shows all attributes of DayType.

Table 336 – Attributes of LoadModel::DayType

name	mult	type	description
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 337 shows all association ends of DayType with other classes.

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Table 337 – Association ends of LoadModel::DayType with other classes

mult from	name	mult to	type	description
0..1	SeasonDayTypeSchedules	0..*	SeasonDayTypeSchedule	Schedules that use this DayType.
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.5.6 EnergyArea

Describes an area having energy production or consumption. Specializations are intended to support the load allocation function as typically required in energy management systems or planning studies to allocate hypothesized load levels to individual load points for power flow analysis. Often the energy area can be linked to both measured and forecast load levels.

Table 338 shows all attributes of EnergyArea.

Table 338 – Attributes of LoadModel::EnergyArea

name	mult	type	description
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 339 shows all association ends of EnergyArea with other classes.

Table 339 – Association ends of LoadModel::EnergyArea with other classes

mult from	name	mult to	type	description
0..1	ControlArea	0..1	ControlArea	The control area specification that is used for the load forecast.
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.5.7 LoadArea

The class is the root or first level in a hierarchical structure for grouping of loads for the purpose of load flow load scaling.

Table 340 shows all attributes of LoadArea.

Table 340 – Attributes of LoadModel::LoadArea

name	mult	type	description
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 341 shows all association ends of LoadArea with other classes.

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Table 341 – Association ends of LoadModel::LoadArea with other classes

mult from	name	mult to	type	description
1..1	SubLoadAreas	1..*	SubLoadArea	The SubLoadAreas in the LoadArea.
0..1	ControlArea	0..1	ControlArea	inherited from: EnergyArea
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.5.8 LoadGroup

The class is the third level in a hierarchical structure for grouping of loads for the purpose of load flow load scaling.

Table 342 shows all attributes of LoadGroup.

Table 342 – Attributes of LoadModel::LoadGroup

name	mult	type	description
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 343 shows all association ends of LoadGroup with other classes.

Table 343 – Association ends of LoadModel::LoadGroup with other classes

mult from	name	mult to	type	description
1..*	SubLoadArea	1..1	SubLoadArea	The SubLoadArea where the Loadgroup belongs.
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.5.9 LoadResponseCharacteristic

Models the characteristic response of the load demand due to changes in system conditions such as voltage and frequency. It is not related to demand response.

If LoadResponseCharacteristic.exponentModel is True, the exponential voltage or frequency dependent models are specified and used as to calculate active and reactive power components of the load model.

The equations to calculate active and reactive power components of the load model are internal to the power flow calculation, hence they use different quantities depending on the use case of the data exchange.

The equations for exponential voltage dependent load model injected power are:

pInjection= Pnominal* (Voltage/cim:BaseVoltage.nominalVoltage) ** cim:LoadResponseCharacteristic.pVoltageExponent

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qInjection= Qnominal* (Voltage/cim:BaseVoltage.nominalVoltage) ** cim:LoadResponseCharacteristic.qVoltageExponent

Where:

1) * means "multiply" and ** is "raised to power of";
2) Pnominal and Qnominal represent the active power and reactive power at nominal voltage as any load described by the voltage exponential model shall be given at nominal voltage. This means that EnergyConsumer.p and EnergyConsumer.q are at nominal voltage.
3) After power flow is solved:
   – pInjection and qInjection correspond to SvPowerflow.p and SvPowerflow.q respectively.
   – Voltage corresponds to SvVoltage.v at the TopologicalNode where the load is connected.

Table 344 shows all attributes of LoadResponseCharacteristic.

Table 344 – Attributes of LoadModel::LoadResponseCharacteristic

name	mult	type	description
exponentModel	0..1	Boolean	Indicates the exponential voltage dependency model is to be used. If false, the coefficient model is to be used. The exponential voltage dependency model consists of the attributes: – pVoltageExponent – qVoltageExponent – pFrequencyExponent – qFrequencyExponent. The coefficient model consists of the attributes: – pConstantImpedance – pConstantCurrent – pConstantPower – qConstantImpedance – qConstantCurrent – qConstantPower. The sum of pConstantImpedance, pConstantCurrent and pConstantPower shall equal 1. The sum of qConstantImpedance, qConstantCurrent and qConstantPower shall equal 1.
pConstantCurrent	0..1	Float	Portion of active power load modelled as constant current.
pConstantImpedance	0..1	Float	Portion of active power load modelled as constant impedance.
pConstantPower	0..1	Float	Portion of active power load modelled as constant power.
pFrequencyExponent	0..1	Float	Exponent of per unit frequency effecting active power.
pVoltageExponent	0..1	Float	Exponent of per unit voltage effecting real power.
qConstantCurrent	0..1	Float	Portion of reactive power load modelled as constant current.
qConstantImpedance	0..1	Float	Portion of reactive power load modelled as constant impedance.

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name	mult	type	description
qConstantPower	0..1	Float	Portion of reactive power load modelled as constant power.
qFrequencyExponent	0..1	Float	Exponent of per unit frequency effecting reactive power.
qVoltageExponent	0..1	Float	Exponent of per unit voltage effecting reactive power.
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 345 shows all association ends of LoadResponseCharacteristic with other classes.

Table 345 – Association ends of LoadModel::LoadResponseCharacteristic with other classes

mult from	name	mult to	type	description
0..1	EnergyConsumer	0..*	EnergyConsumer	The set of loads that have the response characteristics.
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.5.10 NonConformLoad

NonConformLoad represents loads that do not follow a daily load change pattern and whose changes are not correlated with the daily load change pattern.

Table 346 shows all attributes of NonConformLoad.

Table 346 – Attributes of LoadModel::NonConformLoad

name	mult	type	description
customerCount	0..1	Integer	inherited from: EnergyConsumer
grounded	0..1	Boolean	inherited from: EnergyConsumer
pfixed	0..1	ActivePower	inherited from: EnergyConsumer
pfixedPct	0..1	PerCent	inherited from: EnergyConsumer
phaseConnection	0..1	PhaseShuntConnectionKind	inherited from: EnergyConsumer
qfixed	0..1	ReactivePower	inherited from: EnergyConsumer
qfixedPct	0..1	PerCent	inherited from: EnergyConsumer
p	0..1	ActivePower	inherited from: EnergyConsumer
q	0..1	ReactivePower	inherited from: EnergyConsumer
aggregate	0..1	Boolean	inherited from: Equipment
inService	0..1	Boolean	inherited from: Equipment
networkAnalysisEnabled	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject

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name	mult	type	description
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 347 shows all association ends of NonConformLoad with other classes.

Table 347 – Association ends of LoadModel::NonConformLoad with other classes

mult from	name	mult to	type	description
0..*	LoadGroup	0..1	NonConformLoadGroup	Group of this ConformLoad.
0..*	LoadResponse	0..1	LoadResponseCharacteristic	inherited from: EnergyConsumer
1..1	EnergyConsumerPhase	0..*	EnergyConsumerPhase	inherited from: EnergyConsumer
1..*	PowerCutZone	0..1	PowerCutZone	inherited from: EnergyConsumer
0..*	LoadDynamics	0..1	LoadDynamics	inherited from: EnergyConsumer
0..*	BaseVoltage	0..1	BaseVoltage	inherited from: ConductingEquipment
1..1	SvStatus	0..*	SvStatus	inherited from: ConductingEquipment
0..*	ProtectionEquipments	0..*	ProtectionEquipment	inherited from: ConductingEquipment
1..1	Terminals	0..*	Terminal	inherited from: ConductingEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	inherited from: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	inherited from: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment
0..1	Faults	0..*	Fault	inherited from: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	inherited from: Equipment
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.5.11 NonConformLoadGroup

Loads that do not follow a daily and seasonal load variation pattern.

Table 348 shows all attributes of NonConformLoadGroup.

Table 348 – Attributes of LoadModel::NonConformLoadGroup

name	mult	type	description
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

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Table 349 shows all association ends of NonConformLoadGroup with other classes.

Table 349 – Association ends of LoadModel::NonConformLoadGroup with other classes

mult from	name	mult to	type	description
0..1	EnergyConsumers	0..*	NonConformLoad	Conform loads assigned to this ConformLoadGroup.
1..1	NonConformLoadSchedules	0..*	NonConformLoadSchedule	The NonConformLoadSchedules in the NonConformLoadGroup.
1..*	SubLoadArea	1..1	SubLoadArea	inherited from: LoadGroup
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.5.12 NonConformLoadSchedule

An active power (Y1-axis) and reactive power (Y2-axis) schedule (curves) versus time (X-axis) for non-conforming loads, e.g., large industrial load or power station service (where modelled).

Table 350 shows all attributes of NonConformLoadSchedule.

Table 350 – Attributes of LoadModel::NonConformLoadSchedule

name	mult	type	description
endTime	0..1	DateTime	inherited from: RegularIntervalSchedule
timeStep	0..1	Seconds	inherited from: RegularIntervalSchedule
startTime	0..1	DateTime	inherited from: BasicIntervalSchedule
value1Multiplier	0..1	UnitMultiplier	inherited from: BasicIntervalSchedule
value1Unit	0..1	UnitSymbol	inherited from: BasicIntervalSchedule
value2Multiplier	0..1	UnitMultiplier	inherited from: BasicIntervalSchedule
value2Unit	0..1	UnitSymbol	inherited from: BasicIntervalSchedule
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 351 shows all association ends of NonConformLoadSchedule with other classes.

Table 351 – Association ends of LoadModel::NonConformLoadSchedule with other classes

mult from	name	mult to	type	description
0..*	NonConformLoadGroup	1..1	NonConformLoadGroup	The NonConformLoadGroup where the NonConformLoadSchedule belongs.
0..*	DayType	0..1	DayType	inherited from: SeasonDayTypeSchedule
0..*	Season	0..1	Season	inherited from: SeasonDayTypeSchedule
1..1	TimePoints	1..*	RegularTimePoint	inherited from: RegularIntervalSchedule
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

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6.5.13 PowerCutZone

An area or zone of the power system which is used for load shedding purposes.

Table 352 shows all attributes of PowerCutZone.

Table 352 – Attributes of LoadModel::PowerCutZone

name	mult	type	description
cutLevel1	0..1	PerCent	First level (amount) of load to cut as a percentage of total zone load.
cutLevel2	0..1	PerCent	Second level (amount) of load to cut as a percentage of total zone load.
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 353 shows all association ends of PowerCutZone with other classes.

Table 353 – Association ends of LoadModel::PowerCutZone with other classes

mult from	name	mult to	type	description
0..1	EnergyConsumers	1..*	EnergyConsumer	Energy consumer is assigned to the power cut zone.
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.5.14 Season

A specified time period of the year.

Table 354 shows all attributes of Season.

Table 354 – Attributes of LoadModel::Season

name	mult	type	description
endDate	0..1	MonthDay	Date season ends.
startDate	0..1	MonthDay	Date season starts.
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

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Table 355 shows all association ends of Season with other classes.

Table 355 – Association ends of LoadModel::Season with other classes

mult from	name	mult to	type	description
0..1	SeasonDayTypeSchedules	0..*	SeasonDayTypeSchedule	Schedules that use this Season.
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.5.15 SeasonDayTypeSchedule

A time schedule covering a 24 hour period, with curve data for a specific type of season and day.

Table 356 shows all attributes of SeasonDayTypeSchedule.

Table 356 – Attributes of LoadModel::SeasonDayTypeSchedule

name	mult	type	description
endTime	0..1	DateTime	inherited from: RegularIntervalSchedule
timeStep	0..1	Seconds	inherited from: RegularIntervalSchedule
startTime	0..1	DateTime	inherited from: BasicIntervalSchedule
value1Multiplier	0..1	UnitMultiplier	inherited from: BasicIntervalSchedule
value1Unit	0..1	UnitSymbol	inherited from: BasicIntervalSchedule
value2Multiplier	0..1	UnitMultiplier	inherited from: BasicIntervalSchedule
value2Unit	0..1	UnitSymbol	inherited from: BasicIntervalSchedule
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 357 shows all association ends of SeasonDayTypeSchedule with other classes.

Table 357 – Association ends of LoadModel::SeasonDayTypeSchedule with other classes

mult from	name	mult to	type	description
0..*	DayType	0..1	DayType	DayType for the Schedule.
0..*	Season	0..1	Season	Season for the Schedule.
1..1	TimePoints	1..*	RegularTimePoint	inherited from: RegularIntervalSchedule
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.5.16 StationSupply

Station supply with load derived from the station output.

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Table 358 shows all attributes of StationSupply.

Table 358 – Attributes of LoadModel::StationSupply

name	mult	type	description
customerCount	0..1	Integer	inherited from: EnergyConsumer
grounded	0..1	Boolean	inherited from: EnergyConsumer
pfixed	0..1	ActivePower	inherited from: EnergyConsumer
pfixedPct	0..1	PerCent	inherited from: EnergyConsumer
phaseConnection	0..1	PhaseShuntConnectionKind	inherited from: EnergyConsumer
qfixed	0..1	ReactivePower	inherited from: EnergyConsumer
qfixedPct	0..1	PerCent	inherited from: EnergyConsumer
p	0..1	ActivePower	inherited from: EnergyConsumer
q	0..1	ReactivePower	inherited from: EnergyConsumer
aggregate	0..1	Boolean	inherited from: Equipment
inService	0..1	Boolean	inherited from: Equipment
networkAnalysisEnabled	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 359 shows all association ends of StationSupply with other classes.

Table 359 – Association ends of LoadModel::StationSupply with other classes

mult from	name	mult to	type	description
0..*	LoadResponse	0..1	LoadResponseCharacteristic	inherited from: EnergyConsumer
1..1	EnergyConsumerPhase	0..*	EnergyConsumerPhase	inherited from: EnergyConsumer
1..*	PowerCutZone	0..1	PowerCutZone	inherited from: EnergyConsumer
0..*	LoadDynamics	0..1	LoadDynamics	inherited from: EnergyConsumer
0..*	BaseVoltage	0..1	BaseVoltage	inherited from: ConductingEquipment
1..1	SvStatus	0..*	SvStatus	inherited from: ConductingEquipment
0..*	ProtectionEquipments	0..*	ProtectionEquipment	inherited from: ConductingEquipment
1..1	Terminals	0..*	Terminal	inherited from: ConductingEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	inherited from: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	inherited from: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment
0..1	Faults	0..*	Fault	inherited from: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	inherited from: Equipment
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource

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mult from	name	mult to	type	description
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.5.17 SubLoadArea

The class is the second level in a hierarchical structure for grouping of loads for the purpose of load flow load scaling.

Table 360 shows all attributes of SubLoadArea.

Table 360 – Attributes of LoadModel::SubLoadArea

name	mult	type	description
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 361 shows all association ends of SubLoadArea with other classes.

Table 361 – Association ends of LoadModel::SubLoadArea with other classes

mult from	name	mult to	type	description
1..1	LoadGroups	1..*	LoadGroup	The Loadgroups in the SubLoadArea.
1..*	LoadArea	1..1	LoadArea	The LoadArea where the SubLoadArea belongs.
0..1	ControlArea	0..1	ControlArea	inherited from: EnergyArea
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.6 Package Generation

6.6.1 General

This package contains packages that have information for Unit Commitment and Economic Dispatch of hydro and thermal generating units, Load Forecasting, Automatic Generation Control, and unit modeling for Training Simulation.

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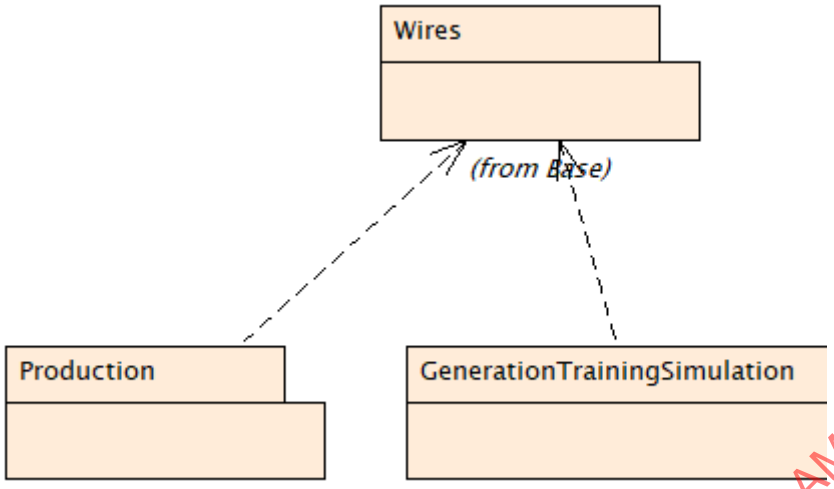


Figure 103 – Class diagram Generation::Main

Figure 103: This diagram shows the main generation packages and their dependency relationships to other packages.

6.6.2 Package GenerationTrainingSimulation

6.6.2.1 General

The GenerationTrainingSimululation package contains prime movers, such as turbines and boilers, which are needed for simulation and educational purposes.

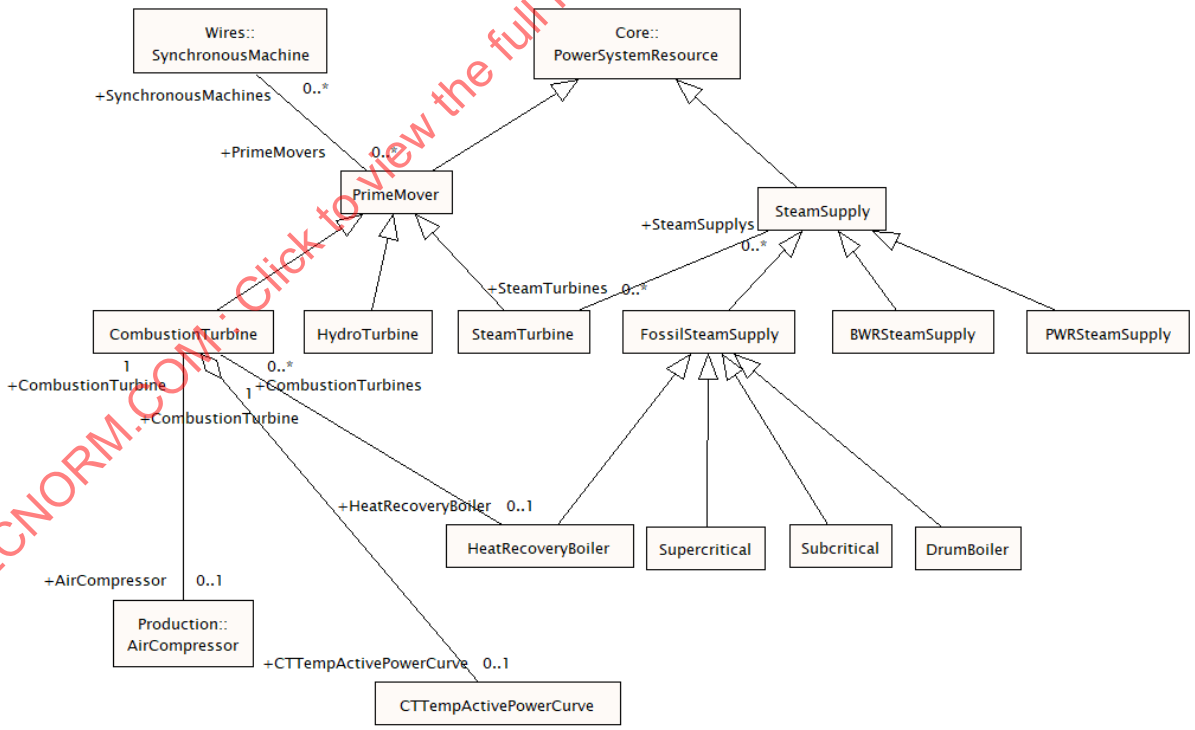


Figure 104 – Class diagram GenerationTrainingSimulation::Main

Figure 104: This diagram shows all classes included in the GenerationDynamics package as well as the key external classes that have associations with these classes.

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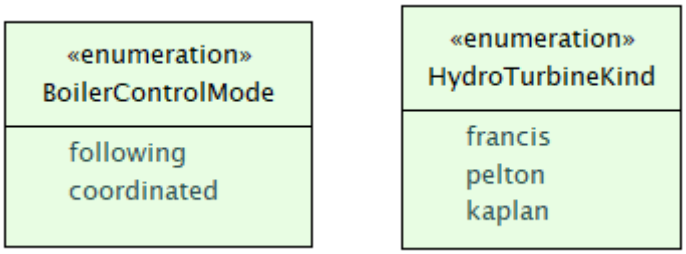


Figure 105 – Class diagram GenerationTrainingSimulation::Datatypes

Figure 105: This diagram shows the data types specific to the GenerationTrainingSimulation package.

6.6.2.2 BWRSteamSupply

Boiling water reactor used as a steam supply to a steam turbine.

Table 362 shows all attributes of BWRSteamSupply.

Table 362 – Attributes of GenerationTrainingSimulation::BWRSteamSupply

name	mult	type	description
highPowerLimit	0..1	PU	High power limit.
inCoreThermalTC	0..1	Seconds	In-core thermal time constant.
integralGain	0..1	Float	Integral gain.
lowerLimit	0..1	PU	Initial lower limit.
lowPowerLimit	0..1	PU	Low power limit.
pressureLimit	0..1	PU	Pressure limit.
pressureSetpointGA	0..1	Float	Pressure setpoint gain adjuster.
pressureSetpointTC1	0..1	Seconds	Pressure setpoint time constant.
pressureSetpointTC2	0..1	Seconds	Pressure setpoint time constant.
proportionalGain	0..1	Float	Proportional gain.
rfAux1	0..1	PU	Coefficient for modelling the effect of off-nominal frequency and voltage on recirculation and core flow, which affects the BWR power output.
rfAux2	0..1	PU	Coefficient for modelling the effect of off-nominal frequency and voltage on recirculation and core flow, which affects the BWR power output.
rfAux3	0..1	PU	Coefficient for modelling the effect of off-nominal frequency and voltage on recirculation and core flow, which affects the BWR power output.
rfAux4	0..1	PU	Coefficient for modelling the effect of off-nominal frequency and voltage on recirculation and core flow, which affects the BWR power output.
rfAux5	0..1	PU	Coefficient for modelling the effect of off-nominal frequency and voltage on recirculation and core flow, which affects the BWR power output.
rfAux6	0..1	PU	Coefficient for modelling the effect of off-nominal frequency and voltage on recirculation and core flow, which affects the BWR power output.
rfAux7	0..1	PU	Coefficient for modelling the effect of off-nominal frequency and voltage on recirculation and core flow, which affects the BWR power output.

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name	mult	type	description
rfAux8	0..1	PU	Coefficient for modelling the effect of off-nominal frequency and voltage on recirculation and core flow, which affects the BWR power output.
rodPattern	0..1	PU	Rod pattern.
rodPatternConstant	0..1	Float	Constant associated with rod pattern.
upperLimit	0..1	PU	Initial upper limit.
steamSupplyRating	0..1	Float	inherited from: SteamSupply
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 363 shows all association ends of BWRSteamSupply with other classes.

Table 363 – Association ends of GenerationTrainingSimulation::BWRSteamSupply with other classes

mult from	name	mult to	type	description
0..*	SteamTurbines	0..*	SteamTurbine	inherited from: SteamSupply
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.6.2.3 BoilerControlMode enumeration

Boiler control mode.

Table 364 shows all literals of BoilerControlMode.

Table 364 – Literals of GenerationTrainingSimulation::BoilerControlMode

literal	value	description
following		Following.
coordinated		Coordinated.

6.6.2.4 CTTempActivePowerCurve

Relationship between the combustion turbine's power output rating in gross active power (X-axis) and the ambient air temperature (Y-axis).

Table 365 shows all attributes of CTTempActivePowerCurve.

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Table 365 – Attributes of GenerationTrainingSimulation::CTTempActivePowerCurve

name	mult	type	description
curveStyle	0..1	CurveStyle	inherited from: Curve
xMultiplier	0..1	UnitMultiplier	inherited from: Curve
xUnit	0..1	UnitSymbol	inherited from: Curve
y1Multiplier	0..1	UnitMultiplier	inherited from: Curve
y1Unit	0..1	UnitSymbol	inherited from: Curve
y2Multiplier	0..1	UnitMultiplier	inherited from: Curve
y2Unit	0..1	UnitSymbol	inherited from: Curve
y3Multiplier	0..1	UnitMultiplier	inherited from: Curve
y3Unit	0..1	UnitSymbol	inherited from: Curve
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 366 shows all association ends of CTTempActivePowerCurve with other classes.

Table 366 – Association ends of GenerationTrainingSimulation::CTTempActivePowerCurve with other classes

mult from	name	mult to	type	description
0..1	CombustionTurbine	1..1	CombustionTurbine	A combustion turbine may have an active power versus ambient temperature relationship.
1..1	CurveDatas	0..*	CurveData	inherited from: Curve
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.6.2.5 CombustionTurbine

A prime mover that is typically fuelled by gas or light oil.

Table 367 shows all attributes of CombustionTurbine.

Table 367 – Attributes of GenerationTrainingSimulation::CombustionTurbine

name	mult	type	description
ambientTemp	0..1	Temperature	Default ambient temperature to be used in modelling applications.
auxPowerVersusFrequency	0..1	PU	Off-nominal frequency effect on turbine auxiliaries. Per unit reduction in auxiliary active power consumption versus per unit reduction in frequency (from rated frequency).
auxPowerVersusVoltage	0..1	PU	Off-nominal voltage effect on turbine auxiliaries. Per unit reduction in auxiliary active power consumption versus per unit reduction in auxiliary bus voltage (from a specified voltage level).

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name	mult	type	description
capabilityVersusFrequency	0..1	PU	Off-nominal frequency effect on turbine capability. Per unit reduction in unit active power capability versus per unit reduction in frequency (from rated frequency).
heatRecoveryFlag	0..1	Boolean	Flag that is set to true if the combustion turbine is associated with a heat recovery boiler.
powerVariationByTemp	0..1	PU	Per unit change in power per (versus) unit change in ambient temperature.
referenceTemp	0..1	Temperature	Reference temperature at which the output of the turbine was defined.
timeConstant	0..1	Seconds	The time constant for the turbine.
primeMoverRating	0..1	Float	inherited from: PrimeMover
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 368 shows all association ends of CombustionTurbine with other classes.

Table 368 – Association ends of GenerationTrainingSimulation::CombustionTurbine with other classes

mult from	name	mult to	type	description
1..1	AirCompressor	0..1	AirCompressor	A CAES air compressor is driven by combustion turbine.
1..1	CTTempActivePowerCurve	0..1	CTTempActivePowerCurve	A combustion turbine may have an active power versus ambient temperature relationship.
0..*	HeatRecoveryBoiler	0..1	HeatRecoveryBoiler	A combustion turbine may have a heat recovery boiler for making steam.
0..*	SynchronousMachines	0..*	SynchronousMachine	inherited from: PrimeMover
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

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6.6.2.6 DrumBoiler

Drum boiler.

Table 369 shows all attributes of DrumBoiler.

Table 369 – Attributes of GenerationTrainingSimulation::DrumBoiler

name	mult	type	description
drumBoilerRating	0..1	Float	Rating of drum boiler in steam units.
auxPowerVersusFrequency	0..1	PU	inherited from: FossilSteamSupply
auxPowerVersusVoltage	0..1	PU	inherited from: FossilSteamSupply
boilerControlMode	0..1	BoilerControlMode	inherited from: FossilSteamSupply
controlErrorBiasP	0..1	Float	inherited from: FossilSteamSupply
controlIC	0..1	Float	inherited from: FossilSteamSupply
controlPC	0..1	Float	inherited from: FossilSteamSupply
controlPEB	0..1	Float	inherited from: FossilSteamSupply
controlPED	0..1	PU	inherited from: FossilSteamSupply
controlTC	0..1	Float	inherited from: FossilSteamSupply
feedWaterIG	0..1	Float	inherited from: FossilSteamSupply
feedWaterPG	0..1	Float	inherited from: FossilSteamSupply
feedWaterTC	0..1	Seconds	inherited from: FossilSteamSupply
fuelDemandLimit	0..1	PU	inherited from: FossilSteamSupply
fuelSupplyDelay	0..1	Seconds	inherited from: FossilSteamSupply
fuelSupplyTC	0..1	Seconds	inherited from: FossilSteamSupply
maxErrorRateP	0..1	Float	inherited from: FossilSteamSupply
mechPowerSensorLag	0..1	Seconds	inherited from: FossilSteamSupply
minErrorRateP	0..1	Float	inherited from: FossilSteamSupply
pressureCtrlDG	0..1	Float	inherited from: FossilSteamSupply
pressureCtrlIG	0..1	Float	inherited from: FossilSteamSupply
pressureCtrlPG	0..1	Float	inherited from: FossilSteamSupply
pressureFeedback	0..1	Integer	inherited from: FossilSteamSupply
superHeater1Capacity	0..1	Float	inherited from: FossilSteamSupply
superHeater2Capacity	0..1	Float	inherited from: FossilSteamSupply
superHeaterPipePD	0..1	Float	inherited from: FossilSteamSupply
throttlePressureSP	0..1	PU	inherited from: FossilSteamSupply
steamSupplyRating	0..1	Float	inherited from: SteamSupply
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 370 shows all association ends of DrumBoiler with other classes.

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Table 370 – Association ends of GenerationTrainingSimulation::DrumBoiler with other classes

mult from	name	mult to	type	description
0..*	SteamTurbines	0..*	SteamTurbine	inherited from: SteamSupply
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.6.2.7 FossilSteamSupply

Fossil fuelled boiler (e.g., coal, oil, gas).

Table 371 shows all attributes of FossilSteamSupply.

Table 371 – Attributes of GenerationTrainingSimulation::FossilSteamSupply

name	mult	type	description
auxPowerVersusFrequency	0..1	PU	Off nominal frequency effect on auxiliary real power. Per unit active power variation versus per unit frequency variation.
auxPowerVersusVoltage	0..1	PU	Off nominal voltage effect on auxiliary real power. Per unit active power variation versus per unit voltage variation.
boilerControlMode	0..1	BoilerControlMode	The control mode of the boiler.
controlErrorBiasP	0..1	Float	Active power error bias ratio.
controlIC	0..1	Float	Integral constant.
controlPC	0..1	Float	Proportional constant.
controlPEB	0..1	Float	Pressure error bias ratio.
controlPED	0..1	PU	Pressure error deadband.
controlTC	0..1	Float	Time constant.
feedWaterIG	0..1	Float	Feedwater integral gain ratio.
feedWaterPG	0..1	Float	Feedwater proportional gain ratio.
feedWaterTC	0..1	Seconds	Feedwater time constant ratio.
fuelDemandLimit	0..1	PU	Fuel demand limit.
fuelSupplyDelay	0..1	Seconds	Fuel delay.
fuelSupplyTC	0..1	Seconds	Fuel supply time constant.
maxErrorRateP	0..1	Float	Active power maximum error rate limit.
mechPowerSensorLag	0..1	Seconds	Mechanical power sensor lag.
minErrorRateP	0..1	Float	Active power minimum error rate limit.
pressureCtrlDG	0..1	Float	Pressure control derivative gain ratio.
pressureCtrlIG	0..1	Float	Pressure control integral gain ratio.
pressureCtrlPG	0..1	Float	Pressure control proportional gain ratio.
pressureFeedback	0..1	Integer	Pressure feedback indicator.

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name	mult	type	description
superHeater1Capacity	0..1	Float	Drum/primary superheater capacity.
superHeater2Capacity	0..1	Float	Secondary superheater capacity.
superHeaterPipePD	0..1	Float	Superheater pipe pressure drop constant.
throttlePressureSP	0..1	PU	Throttle pressure setpoint.
steamSupplyRating	0..1	Float	inherited from: SteamSupply
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 372 shows all association ends of FossilSteamSupply with other classes.

Table 372 – Association ends of GenerationTrainingSimulation::FossilSteamSupply with other classes

mult from	name	mult to	type	description
0..*	SteamTurbines	0..*	SteamTurbine	inherited from: SteamSupply
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.6.2.8 HeatRecoveryBoiler

The heat recovery system associated with combustion turbines in order to produce steam for combined cycle plants.

Table 373 shows all attributes of HeatRecoveryBoiler.

Table 373 – Attributes of GenerationTrainingSimulation::HeatRecoveryBoiler

name	mult	type	description
steamSupplyRating2	0..1	Float	The steam supply rating in kilopounds per hour, if dual pressure boiler.
auxPowerVersusFrequency	0..1	PU	inherited from: FossilSteamSupply
auxPowerVersusVoltage	0..1	PU	inherited from: FossilSteamSupply
boilerControlMode	0..1	BoilerControlMode	inherited from: FossilSteamSupply
controlErrorBiasP	0..1	Float	inherited from: FossilSteamSupply
controlIC	0..1	Float	inherited from: FossilSteamSupply
controlPC	0..1	Float	inherited from: FossilSteamSupply
controlPEB	0..1	Float	inherited from: FossilSteamSupply
controlPED	0..1	PU	inherited from: FossilSteamSupply

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name	mult	type	description
controlTC	0..1	Float	inherited from: FossilSteamSupply
feedWaterIG	0..1	Float	inherited from: FossilSteamSupply
feedWaterPG	0..1	Float	inherited from: FossilSteamSupply
feedWaterTC	0..1	Seconds	inherited from: FossilSteamSupply
fuelDemandLimit	0..1	PU	inherited from: FossilSteamSupply
fuelSupplyDelay	0..1	Seconds	inherited from: FossilSteamSupply
fuelSupplyTC	0..1	Seconds	inherited from: FossilSteamSupply
maxErrorRateP	0..1	Float	inherited from: FossilSteamSupply
mechPowerSensorLag	0..1	Seconds	inherited from: FossilSteamSupply
minErrorRateP	0..1	Float	inherited from: FossilSteamSupply
pressureCtrlDG	0..1	Float	inherited from: FossilSteamSupply
pressureCtrlIG	0..1	Float	inherited from: FossilSteamSupply
pressureCtrlPG	0..1	Float	inherited from: FossilSteamSupply
pressureFeedback	0..1	Integer	inherited from: FossilSteamSupply
superHeater1Capacity	0..1	Float	inherited from: FossilSteamSupply
superHeater2Capacity	0..1	Float	inherited from: FossilSteamSupply
superHeaterPipePD	0..1	Float	inherited from: FossilSteamSupply
throttlePressureSP	0..1	PU	inherited from: FossilSteamSupply
steamSupplyRating	0..1	Float	inherited from: SteamSupply
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 374 shows all association ends of HeatRecoveryBoiler with other classes.

Table 374 – Association ends of GenerationTrainingSimulation::HeatRecoveryBoiler with other classes

mult from	name	mult to	type	description
0..1	CombustionTurbines	0..*	CombustionTurbine	A combustion turbine may have a heat recovery boiler for making steam.
0..*	SteamTurbines	0..*	SteamTurbine	inherited from: SteamSupply
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

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6.6.2.9 HydroTurbine

A water driven prime mover. Typical turbine types are: Francis, Kaplan, and Pelton.

Table 375 shows all attributes of HydroTurbine.

Table 375 – Attributes of GenerationTrainingSimulation::HydroTurbine

name	mult	type	description
gateRateLimit	0..1	Float	Gate rate limit.
gateUpperLimit	0..1	PU	Gate upper limit.
maxHeadMaxP	0..1	ActivePower	Maximum efficiency active power at maximum head conditions.
minHeadMaxP	0..1	ActivePower	Maximum efficiency active power at minimum head conditions.
speedRating	0..1	RotationSpeed	Rated speed in number of revolutions. The attribute shall be a positive value.
speedRegulation	0..1	PU	Speed regulation.
transientDroopTime	0..1	Seconds	Transient droop time constant.
transientRegulation	0..1	PU	Transient regulation.
turbineRating	0..1	ActivePower	Rated turbine active power. The attribute shall be a positive value.
turbineType	0..1	HydroTurbineKind	Type of turbine.
waterStartingTime	0..1	Seconds	Water starting time.
primeMoverRating	0..1	Float	inherited from: PrimeMover
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 376 shows all association ends of HydroTurbine with other classes.

Table 376 – Association ends of GenerationTrainingSimulation::HydroTurbine with other classes

mult from	name	mult to	type	description
0..*	SynchronousMachines	0..*	SynchronousMachine	inherited from: PrimeMover
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

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6.6.2.10 PWRSteamSupply

Pressurized water reactor used as a steam supply to a steam turbine.

Table 377 shows all attributes of PWRSteamSupply.

Table 377 – Attributes of GenerationTrainingSimulation::PWRSteamSupply

name	mult	type	description
coldLegFBLagTC	0..1	PU	Cold leg feedback lag time constant.
coldLegFBLeadTC1	0..1	PU	Cold leg feedback lead time constant.
coldLegFBLeadTC2	0..1	PU	Cold leg feedback lead time constant.
coldLegFG1	0..1	PU	Cold leg feedback gain 1.
coldLegFG2	0..1	PU	Cold leg feedback gain 2.
coldLegLagTC	0..1	PU	Cold leg lag time constant.
coreHTLagTC1	0..1	PU	Core heat transfer lag time constant.
coreHTLagTC2	0..1	PU	Core heat transfer lag time constant.
coreNeutronicsEffTC	0..1	PU	Core neutronics effective time constant.
coreNeutronicsHT	0..1	PU	Core neutronics and heat transfer.
feedbackFactor	0..1	PU	Feedback factor.
hotLegLagTC	0..1	PU	Hot leg lag time constant.
hotLegSteamGain	0..1	PU	Hot leg steam gain.
hotLegToColdLegGain	0..1	PU	Hot leg to cold leg gain.
pressureCG	0..1	PU	Pressure control gain.
steamFlowFG	0..1	PU	Steam flow feedback gain.
steamPressureDropLagTC	0..1	PU	Steam pressure drop lag time constant.
steamPressureFG	0..1	PU	Steam pressure feedback gain.
throttlePressureFactor	0..1	PU	Throttle pressure factor.
throttlePressureSP	0..1	PU	Throttle pressure setpoint.
steamSupplyRating	0..1	Float	inherited from: SteamSupply
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 378 shows all association ends of PWRSteamSupply with other classes.

Table 378 – Association ends of GenerationTrainingSimulation::PWRSteamSupply with other classes

mult from	name	mult to	type	description
0..*	SteamTurbines	0..*	SteamTurbine	inherited from: SteamSupply
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

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6.6.2.11 PrimeMover

The machine used to develop mechanical energy used to drive a generator.

Table 379 shows all attributes of PrimeMover.

Table 379 – Attributes of GenerationTrainingSimulation::PrimeMover

name	mult	type	description
primeMoverRating	0..1	Float	Rating of prime mover.
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 380 shows all association ends of PrimeMover with other classes.

Table 380 – Association ends of GenerationTrainingSimulation::PrimeMover with other classes

mult from	name	mult to	type	description
0..*	SynchronousMachines	0..*	SynchronousMachine	Synchronous machines this Prime mover drives.
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.6.2.12 SteamSupply

Steam supply for steam turbine.

Table 381 shows all attributes of SteamSupply.

Table 381 – Attributes of GenerationTrainingSimulation::SteamSupply

name	mult	type	description
steamSupplyRating	0..1	Float	Rating of steam supply.
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 382 shows all association ends of SteamSupply with other classes.

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Table 382 – Association ends of GenerationTrainingSimulation::SteamSupply with other classes

mult from	name	mult to	type	description
0..*	SteamTurbines	0..*	SteamTurbine	Steam turbines may have steam supplied by a steam supply.
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.6.2.13 SteamTurbine

Steam turbine.

Table 383 shows all attributes of SteamTurbine.

Table 383 – Attributes of GenerationTrainingSimulation::SteamTurbine

name	mult	type	description
crossoverTC	0..1	Seconds	Crossover time constant.
reheater1TC	0..1	Seconds	First reheater time constant.
reheater2TC	0..1	Seconds	Second reheater time constant.
shaft1PowerHP	0..1	Float	Fraction of power from shaft 1 high pressure turbine output.
shaft1PowerIP	0..1	Float	Fraction of power from shaft 1 intermediate pressure turbine output.
shaft1PowerLP1	0..1	Float	Fraction of power from shaft 1 first low pressure turbine output.
shaft1PowerLP2	0..1	Float	Fraction of power from shaft 1 second low pressure turbine output.
shaft2PowerHP	0..1	Float	Fraction of power from shaft 2 high pressure turbine output.
shaft2PowerIP	0..1	Float	Fraction of power from shaft 2 intermediate pressure turbine output.
shaft2PowerLP1	0..1	Float	Fraction of power from shaft 2 first low pressure turbine output.
shaft2PowerLP2	0..1	Float	Fraction of power from shaft 2 second low pressure turbine output.
steamChestTC	0..1	Seconds	Steam chest time constant.
primeMoverRating	0..1	Float	inherited from: PrimeMover
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 384 shows all association ends of SteamTurbine with other classes.

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Table 384 – Association ends of GenerationTrainingSimulation::SteamTurbine with other classes

mult from	name	mult to	type	description
0..*	SteamSupplys	0..*	SteamSupply	Steam turbines may have steam supplied by a steam supply.
0..*	SynchronousMachines	0..*	SynchronousMachine	inherited from: PrimeMover
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.6.2.14 Subcritical

Once-through subcritical boiler.

Table 385 shows all attributes of Subcritical.

Table 385 – Attributes of GenerationTrainingSimulation::Subcritical

name	mult	type	description
auxPowerVersusFrequency	0..1	PU	inherited from: FossilSteamSupply
auxPowerVersusVoltage	0..1	PU	inherited from: FossilSteamSupply
boilerControlMode	0..1	BoilerControlMode	inherited from: FossilSteamSupply
controlErrorBiasP	0..1	Float	inherited from: FossilSteamSupply
controlIC	0..1	Float	inherited from: FossilSteamSupply
controlPC	0..1	Float	inherited from: FossilSteamSupply
controlPEB	0..1	Float	inherited from: FossilSteamSupply
controlPED	0..1	PU	inherited from: FossilSteamSupply
controlTC	0..1	Float	inherited from: FossilSteamSupply
feedWaterIG	0..1	Float	inherited from: FossilSteamSupply
feedWaterPG	0..1	Float	inherited from: FossilSteamSupply
feedWaterTC	0..1	Seconds	inherited from: FossilSteamSupply
fuelDemandLimit	0..1	PU	inherited from: FossilSteamSupply
fuelSupplyDelay	0..1	Seconds	inherited from: FossilSteamSupply
fuelSupplyTC	0..1	Seconds	inherited from: FossilSteamSupply
maxErrorRateP	0..1	Float	inherited from: FossilSteamSupply
mechPowerSensorLag	0..1	Seconds	inherited from: FossilSteamSupply
minErrorRateP	0..1	Float	inherited from: FossilSteamSupply
pressureCtrlDG	0..1	Float	inherited from: FossilSteamSupply
pressureCtrlIG	0..1	Float	inherited from: FossilSteamSupply
pressureCtrlPG	0..1	Float	inherited from: FossilSteamSupply
pressureFeedback	0..1	Integer	inherited from: FossilSteamSupply

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name	mult	type	description
superHeater1Capacity	0..1	Float	inherited from: FossilSteamSupply
superHeater2Capacity	0..1	Float	inherited from: FossilSteamSupply
superHeaterPipePD	0..1	Float	inherited from: FossilSteamSupply
throttlePressureSP	0..1	PU	inherited from: FossilSteamSupply
steamSupplyRating	0..1	Float	inherited from: SteamSupply
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 386 shows all association ends of Subcritical with other classes.

Table 386 – Association ends of GenerationTrainingSimulation::Subcritical with other classes

mult from	name	mult to	type	description
0..*	SteamTurbines	0..*	SteamTurbine	inherited from: SteamSupply
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.6.2.15 Supercritical

Once-through supercritical boiler.

Table 387 shows all attributes of Supercritical.

Table 387 – Attributes of GenerationTrainingSimulation::Supercritical

name	mult	type	description
auxPowerVersusFrequency	0..1	PU	inherited from: FossilSteamSupply
auxPowerVersusVoltage	0..1	PU	inherited from: FossilSteamSupply
boilerControlMode	0..1	BoilerControlMode	inherited from: FossilSteamSupply
controlErrorBiasP	0..1	Float	inherited from: FossilSteamSupply
controlIC	0..1	Float	inherited from: FossilSteamSupply
controlPC	0..1	Float	inherited from: FossilSteamSupply
controlPEB	0..1	Float	inherited from: FossilSteamSupply
controlPED	0..1	PU	inherited from: FossilSteamSupply
controlTC	0..1	Float	inherited from: FossilSteamSupply
feedWaterIG	0..1	Float	inherited from: FossilSteamSupply
feedWaterPG	0..1	Float	inherited from: FossilSteamSupply

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name	mult	type	description
feedWaterTC	0..1	Seconds	inherited from: FossilSteamSupply
fuelDemandLimit	0..1	PU	inherited from: FossilSteamSupply
fuelSupplyDelay	0..1	Seconds	inherited from: FossilSteamSupply
fuelSupplyTC	0..1	Seconds	inherited from: FossilSteamSupply
maxErrorRateP	0..1	Float	inherited from: FossilSteamSupply
mechPowerSensorLag	0..1	Seconds	inherited from: FossilSteamSupply
minErrorRateP	0..1	Float	inherited from: FossilSteamSupply
pressureCtrlDG	0..1	Float	inherited from: FossilSteamSupply
pressureCtrlIG	0..1	Float	inherited from: FossilSteamSupply
pressureCtrlPG	0..1	Float	inherited from: FossilSteamSupply
pressureFeedback	0..1	Integer	inherited from: FossilSteamSupply
superHeater1Capacity	0..1	Float	inherited from: FossilSteamSupply
superHeater2Capacity	0..1	Float	inherited from: FossilSteamSupply
superHeaterPipePD	0..1	Float	inherited from: FossilSteamSupply
throttlePressureSP	0..1	PU	inherited from: FossilSteamSupply
steamSupplyRating	0..1	Float	inherited from: SteamSupply
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 388 shows all association ends of Supercritical with other classes.

Table 388 – Association ends of GenerationTrainingSimulation::Supercritical with other classes

mult from	name	mult to	type	description
0..*	SteamTurbines	0..*	SteamTurbine	inherited from: SteamSupply
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

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6.6.2.16 HydroTurbineKind enumeration

Type of turbine.

Table 389 shows all literals of HydroTurbineKind.

Table 389 – Literals of GenerationTrainingSimulation::HydroTurbineKind

literal	value	description
francis		Francis.
pelton		Pelton.
kaplan		Kaplan.

6.6.3 Package Production

6.6.3.1 General

The production package is responsible for classes which describe various kinds of generators. These classes also provide production costing information which is used to economically allocate demand among committed units and calculate reserve quantities.

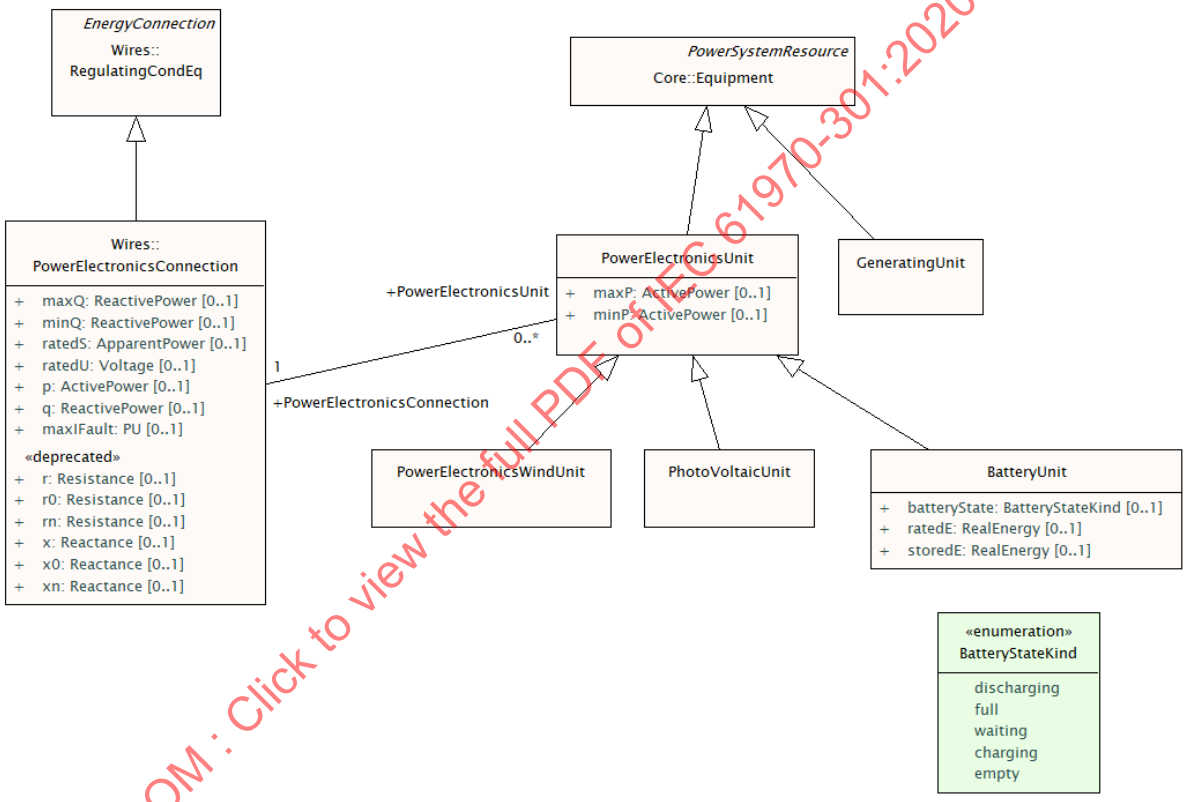


Figure 106 – Class diagram Production::PowerElectronics

Figure 106: This diagram shows power electronics classes and inheritance.

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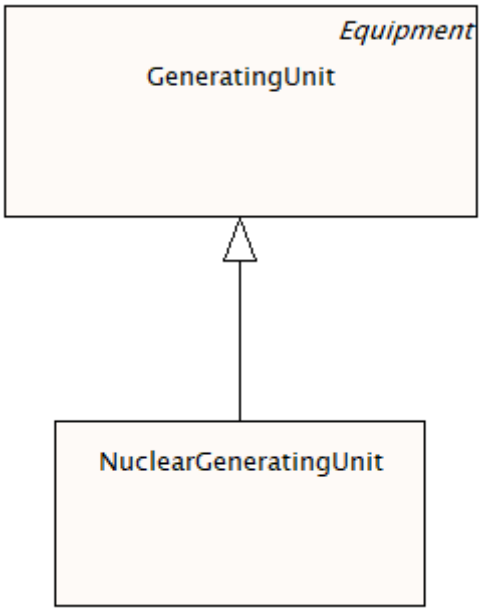


Figure 107 – Class diagram Production::Nuclear

Figure 107: This diagram shows nuclear generation inheritance.

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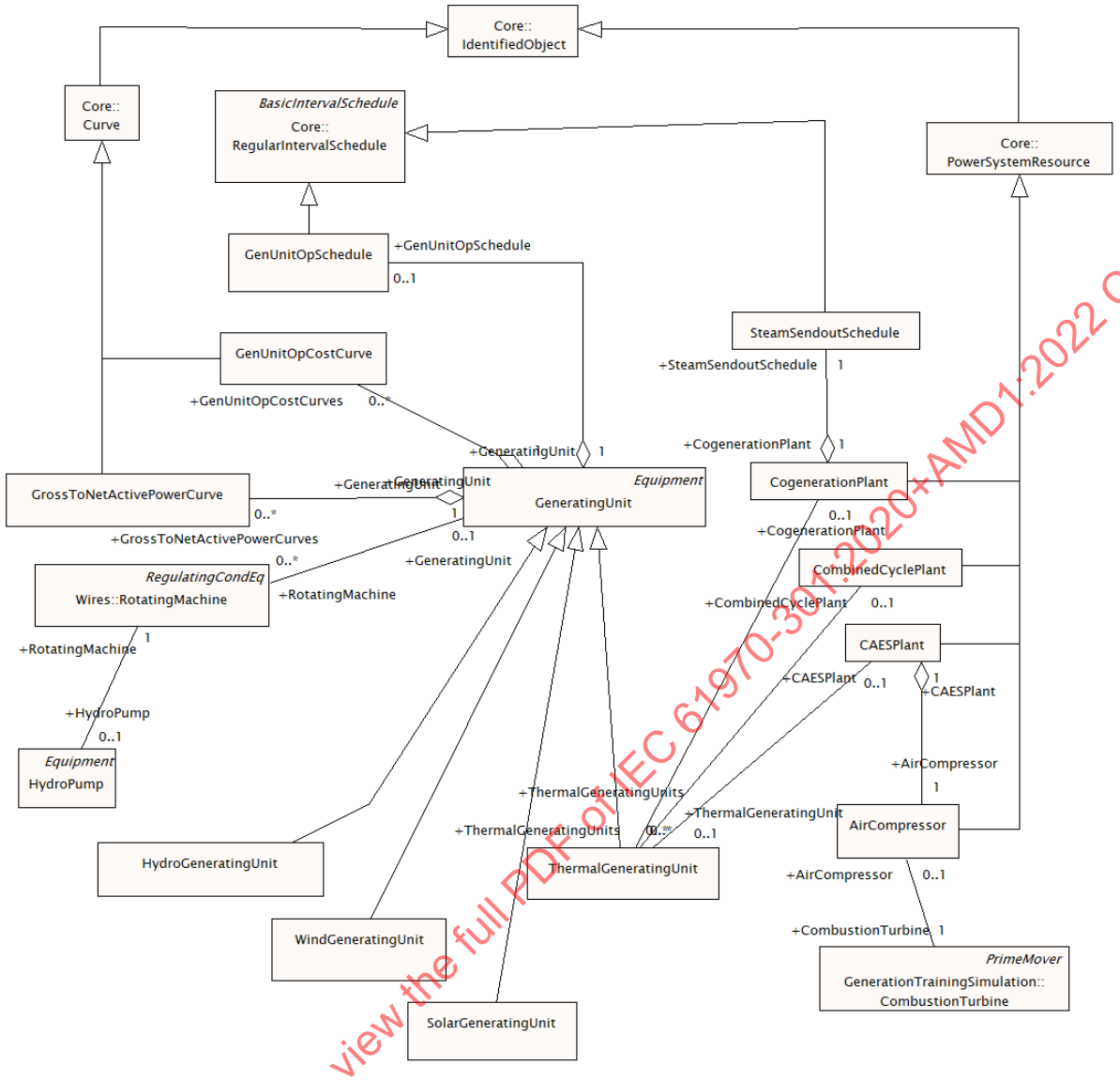


Figure 108 – Class diagram Production::Main

Figure 108: This diagram shows all classes included in the Production package that are needed by both Hydro and Thermal generation. It also shows key external classes that have associations with Production classes.

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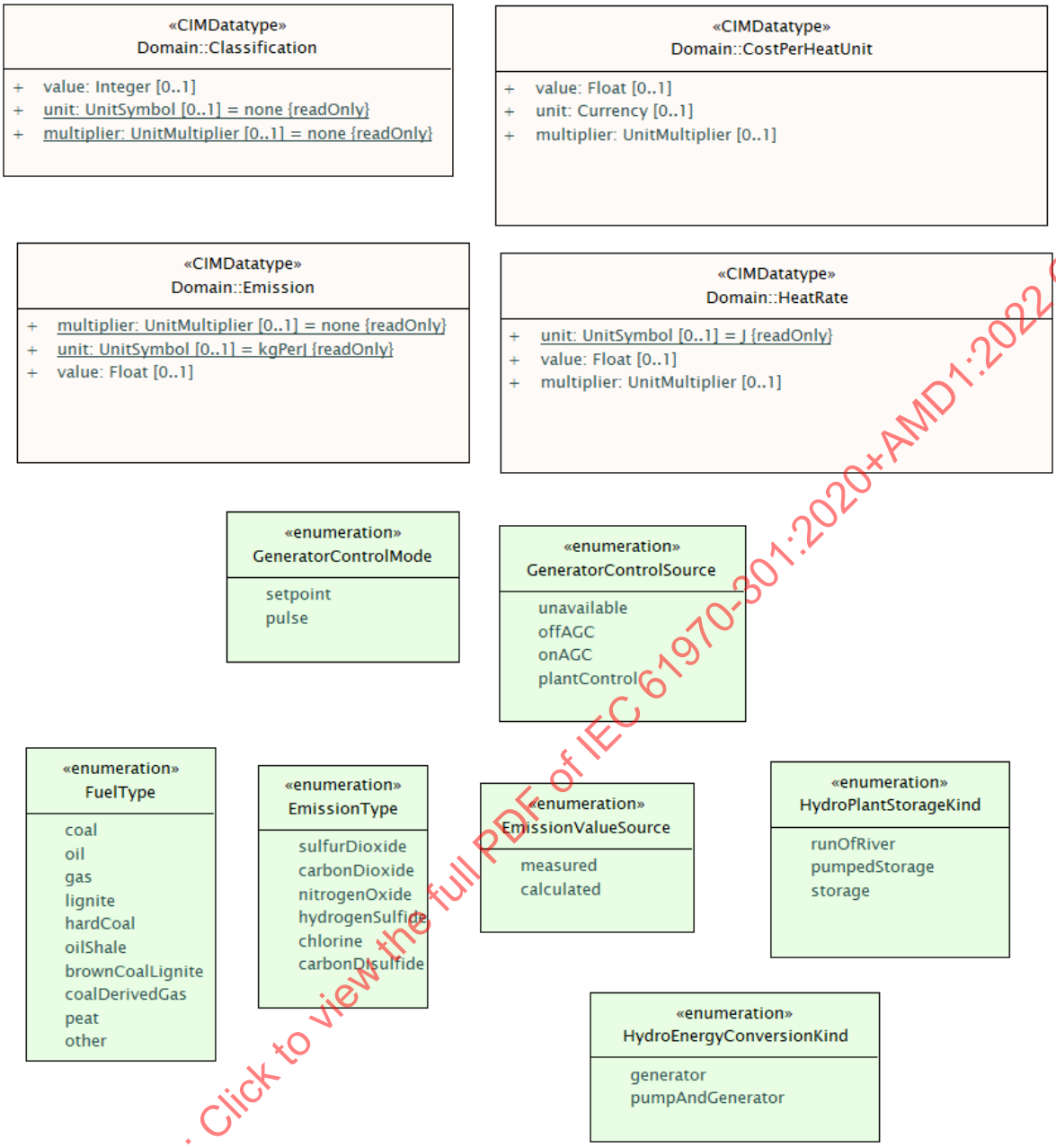


Figure 109 – Class diagram Production::Datatypes

Figure 109: This diagram show the data types specific to the Production package.

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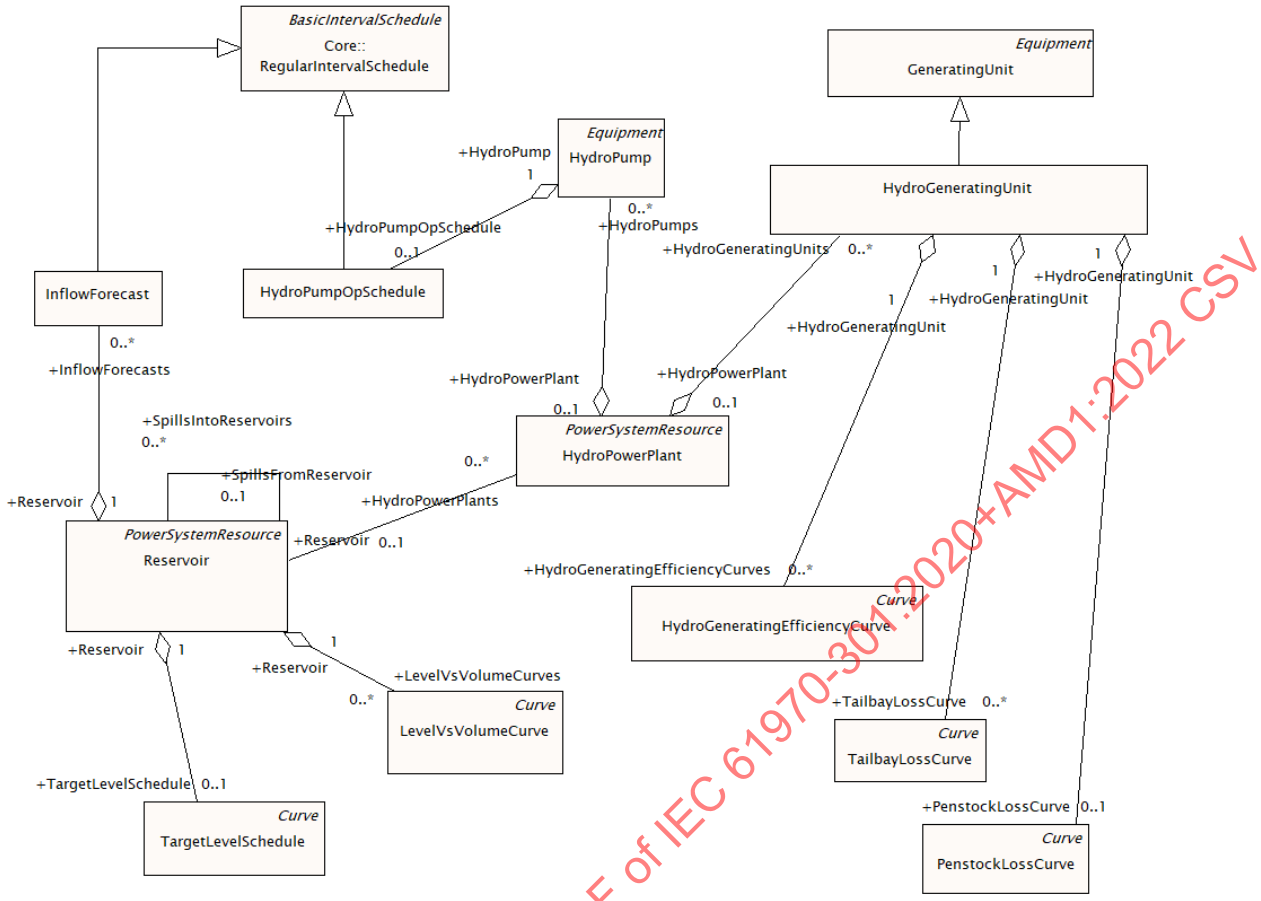


Figure 110 – Class diagram Production::Hydro

Figure 110: This diagram shows all classes included in the Hydro package as well as the key external classes that have associations with Hydro classes.

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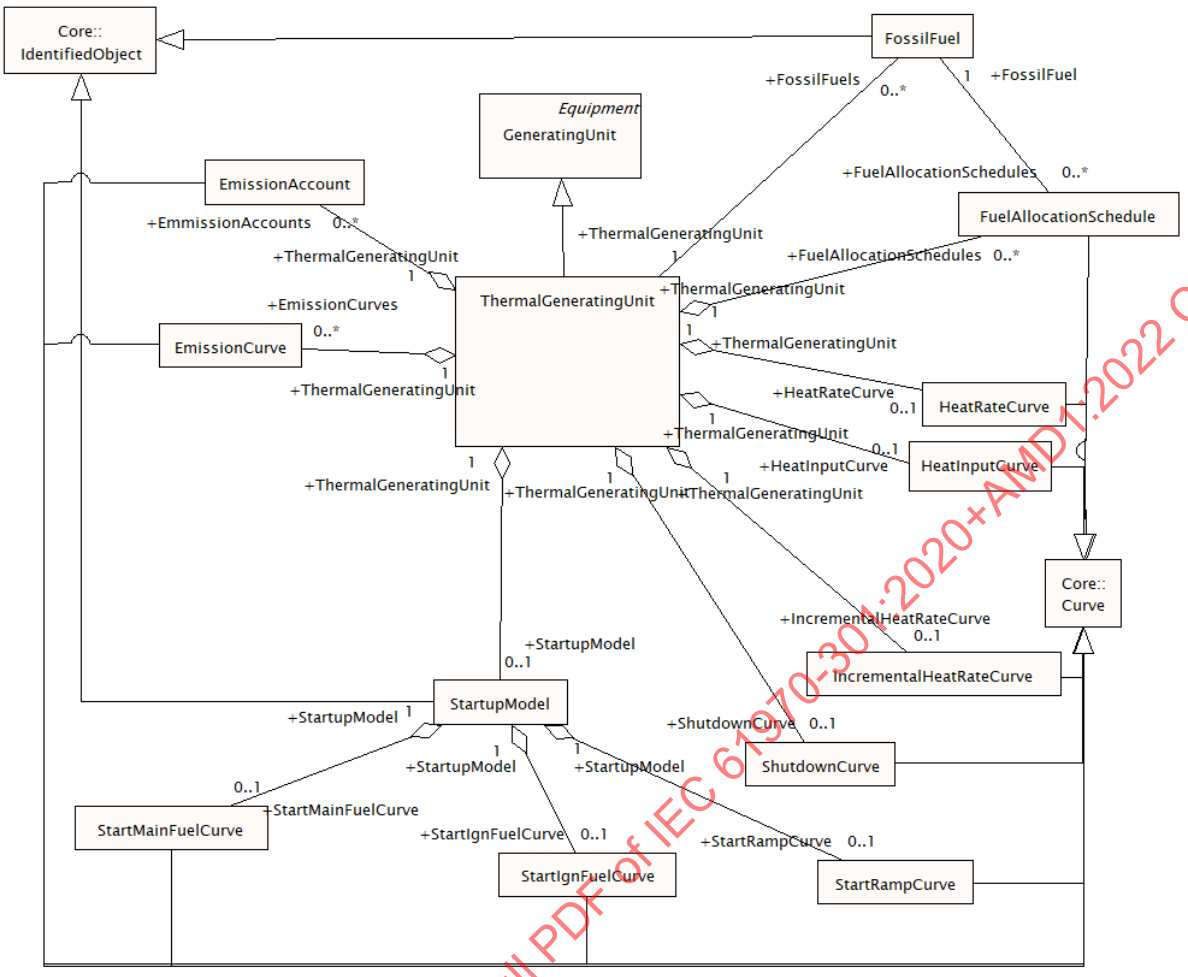


Figure 111 – Class diagram Production::Thermal

Figure 111: This diagram shows all classes included in the Thermal package as well as the key external classes that have associations with Thermal classes.

6.6.3.2 AirCompressor

Combustion turbine air compressor which is an integral part of a compressed air energy storage (CAES) plant.

Table 390 shows all attributes of AirCompressor.

Table 390 – Attributes of Production::AirCompressor

name	mult	type	description
airCompressorRating	0..1	Float	Rating of the CAES air compressor.
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 391 shows all association ends of AirCompressor with other classes.

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Table 391 – Association ends of Production::AirCompressor with other classes

mult from	name	mult to	type	description
0..1	CombustionTurbine	1..1	CombustionTurbine	A CAES air compressor is driven by combustion turbine.
1..1	CAESPlant	1..1	CAESPlant	An air compressor may be a member of a compressed air energy storage plant.
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.6.3.3 BatteryStateKind enumeration

The state of the battery unit.

Table 392 shows all literals of BatteryStateKind.

Table 392 – Literals of Production::BatteryStateKind

literal	value	description
discharging		Stored energy is decreasing.
full		Unable to charge, and not discharging.
waiting		Neither charging nor discharging, but able to do so.
charging		Stored energy is increasing.
empty		Unable to discharge, and not charging.

6.6.3.4 BatteryUnit

An electrochemical energy storage device.

Table 393 shows all attributes of BatteryUnit.

Table 393 – Attributes of Production::BatteryUnit

name	mult	type	description
batteryState	0..1	BatteryStateKind	The current state of the battery (charging, full, etc.).
ratedE	0..1	RealEnergy	Full energy storage capacity of the battery. The attribute shall be a positive value.
storedE	0..1	RealEnergy	Amount of energy currently stored. The attribute shall be a positive value or zero and lower than BatteryUnit.ratedE.
maxP	0..1	ActivePower	inherited from: PowerElectronicsUnit
minP	0..1	ActivePower	inherited from: PowerElectronicsUnit
aggregate	0..1	Boolean	inherited from: Equipment
inService	0..1	Boolean	inherited from: Equipment

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name	mult	type	description
networkAnalysisEnabled	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 394 shows all association ends of BatteryUnit with other classes.

Table 394 – Association ends of Production::BatteryUnit with other classes

mult from	name	mult to	type	description
0..*	PowerElectronicsConnection	1..1	PowerElectronicsConnection	inherited from: PowerElectronicsUnit
0..1	OperationalLimitSet	0..*	OperationalLimitSet	inherited from: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	inherited from: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment
0..1	Faults	0..*	Fault	inherited from: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	inherited from: Equipment
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.6.3.5 CAESPlant

Compressed air energy storage plant.

Table 395 shows all attributes of CAESPlant.

Table 395 – Attributes of Production::CAESPlant

name	mult	type	description
energyStorageCapacity	0..1	RealEnergy	The rated energy storage capacity. The attribute shall be a positive value.
ratedCapacityP	0..1	ActivePower	The CAES plant's gross rated generating capacity. The attribute shall be a positive value.
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

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Table 396 shows all association ends of CAESPlant with other classes.

Table 396 – Association ends of Production::CAESPlant with other classes

mult from	name	mult to	type	description
1..1	AirCompressor	1..1	AirCompressor	An air compressor may be a member of a compressed air energy storage plant.
0..1	ThermalGeneratingUnit	0..1	ThermalGeneratingUnit	A thermal generating unit may be a member of a compressed air energy storage plant.
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.6.3.6 CogenerationPlant

A set of thermal generating units for the production of electrical energy and process steam (usually from the output of the steam turbines). The steam sendout is typically used for industrial purposes or for municipal heating and cooling.

Table 397 shows all attributes of CogenerationPlant.

Table 397 – Attributes of Production::CogenerationPlant

name	mult	type	description
cogenHPSendoutRating	0..1	Float	The high pressure steam sendout.
cogenHPSteamRating	0..1	Float	The high pressure steam rating.
cogenLPSendoutRating	0..1	Float	The low pressure steam sendout.
cogenLPSteamRating	0..1	Float	The low pressure steam rating.
ratedP	0..1	ActivePower	The rated output active power of the cogeneration plant. The attribute shall be a positive value.
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 398 shows all association ends of CogenerationPlant with other classes.

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Table 398 – Association ends of Production::CogenerationPlant with other classes

mult from	name	mult to	type	description
0..1	ThermalGeneratingUnits	0..*	ThermalGeneratingUnit	A thermal generating unit may be a member of a cogeneration plant.
1..1	SteamSendoutSchedule	1..1	SteamSendoutSchedule	A cogeneration plant has a steam sendout schedule.
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.6.3.7 CombinedCyclePlant

A set of combustion turbines and steam turbines where the exhaust heat from the combustion turbines is recovered to make steam for the steam turbines, resulting in greater overall plant efficiency.

Table 399 shows all attributes of CombinedCyclePlant.

Table 399 – Attributes of Production::CombinedCyclePlant

name	mult	type	description
combCyclePlantRating	0..1	ActivePower	The combined cycle plant's active power output rating.
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 400 shows all association ends of CombinedCyclePlant with other classes.

Table 400 – Association ends of Production::CombinedCyclePlant with other classes

mult from	name	mult to	type	description
0..1	ThermalGeneratingUnits	0..*	ThermalGeneratingUnit	A thermal generating unit may be a member of a combined cycle plant.
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

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6.6.3.8 EmissionAccount

Accounts for tracking emissions usage and credits for thermal generating units. A unit may have zero or more emission accounts and will typically have one for tracking usage and one for tracking credits.

Table 401 shows all attributes of EmissionAccount.

Table 401 – Attributes of Production::EmissionAccount

name	mult	type	description
emissionType	0..1	EmissionType	The type of emission, for example sulfur dioxide (SO2). The y1AxisUnits of the curve contains the unit of measure (e.g. kg) and the emissionType is the type of emission (e.g. sulfur dioxide).
emissionValueSource	0..1	EmissionValueSource	The source of the emission value.
curveStyle	0..1	CurveStyle	inherited from: Curve
xMultiplier	0..1	UnitMultiplier	inherited from: Curve
xUnit	0..1	UnitSymbol	inherited from: Curve
y1Multiplier	0..1	UnitMultiplier	inherited from: Curve
y1Unit	0..1	UnitSymbol	inherited from: Curve
y2Multiplier	0..1	UnitMultiplier	inherited from: Curve
y2Unit	0..1	UnitSymbol	inherited from: Curve
y3Multiplier	0..1	UnitMultiplier	inherited from: Curve
y3Unit	0..1	UnitSymbol	inherited from: Curve
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 402 shows all association ends of EmissionAccount with other classes.

Table 402 – Association ends of Production::EmissionAccount with other classes

mult from	name	mult to	type	description
0..*	ThermalGeneratingUnit	1..1	ThermalGeneratingUnit	A thermal generating unit may have one or more emission allowance accounts.
1..1	CurveDatas	0..*	CurveData	inherited from: Curve
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

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6.6.3.9 EmissionCurve

Relationship between the unit's emission rate in units of mass per hour (Y-axis) and output active power (X-axis) for a given type of emission. This curve applies when only one type of fuel is being burned.

Table 403 shows all attributes of EmissionCurve.

Table 403 – Attributes of Production::EmissionCurve

name	mult	type	description
emissionContent	0..1	Emission	The emission content per quantity of fuel burned.
emissionType	0..1	EmissionType	The type of emission, which also gives the production rate measurement unit. The y1AxisUnits of the curve contains the unit of measure (e.g. kg) and the emissionType is the type of emission (e.g. sulfur dioxide).
isNetGrossP	0..1	Boolean	Flag is set to true when output is expressed in net active power.
curveStyle	0..1	CurveStyle	inherited from: Curve
xMultiplier	0..1	UnitMultiplier	inherited from: Curve
xUnit	0..1	UnitSymbol	inherited from: Curve
y1Multiplier	0..1	UnitMultiplier	inherited from: Curve
y1Unit	0..1	UnitSymbol	inherited from: Curve
y2Multiplier	0..1	UnitMultiplier	inherited from: Curve
y2Unit	0..1	UnitSymbol	inherited from: Curve
y3Multiplier	0..1	UnitMultiplier	inherited from: Curve
y3Unit	0..1	UnitSymbol	inherited from: Curve
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 404 shows all association ends of EmissionCurve with other classes.

Table 404 – Association ends of Production::EmissionCurve with other classes

mult from	name	mult to	type	description
0..*	ThermalGeneratingUnit	1..1	ThermalGeneratingUnit	A thermal generating unit may have one or more emission curves.
1..1	CurveDatas	0..*	CurveData	inherited from: Curve
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.6.3.10 EmissionType enumeration

The type of emission.

Table 405 shows all literals of EmissionType.

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Table 405 – Literals of Production::EmissionType

literal	value	description
sulfurDioxide		Sulfur dioxide.
carbonDioxide		Carbon dioxide.
nitrogenOxide		Nitrogen oxide.
hydrogenSulfide		Hydrogen sulfide.
chlorine		Chlorine.
carbonDisulfide		Carbon disulfide.

6.6.3.11 WindGenUnitKind enumeration

Kind of wind generating unit.

Table 406 shows all literals of WindGenUnitKind.

Table 406 – Literals of Production::WindGenUnitKind

literal	value	description
offshore		The wind generating unit is located offshore.
onshore		The wind generating unit is located onshore.

6.6.3.12 EmissionValueSource enumeration

The source of the emission value.

Table 407 shows all literals of EmissionValueSource.

Table 407 – Literals of Production::EmissionValueSource

literal	value	description
measured		Measured.
calculated		Calculated.

6.6.3.13 FossilFuel

The fossil fuel consumed by the non-nuclear thermal generating unit. For example, coal, oil, gas, etc. These are the specific fuels that the generating unit can consume.

Table 408 shows all attributes of FossilFuel.

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Table 408 – Attributes of Production::FossilFuel

name	mult	type	description
fossilFuelType	0..1	FuelType	The type of fossil fuel, such as coal, oil, or gas.
fuelCost	0..1	CostPerHeatUnit	The cost in terms of heat value for the given type of fuel.
fuelDispatchCost	0..1	CostPerHeatUnit	The cost of fuel used for economic dispatching which includes: fuel cost, transportation cost, and incremental maintenance cost.
fuelEffFactor	0..1	PU	The efficiency factor for the fuel (per unit) in terms of the effective energy absorbed.
fuelHandlingCost	0..1	CostPerHeatUnit	Handling and processing cost associated with this fuel.
fuelHeatContent	0..1	Float	The amount of heat per weight (or volume) of the given type of fuel.
fuelMixture	0..1	PerCent	Relative amount of the given type of fuel, when multiple fuels are being consumed.
fuelSulfur	0..1	PU	The fuel's fraction of pollution credit per unit of heat content.
highBreakpointP	0..1	ActivePower	The active power output level of the unit at which the given type of fuel is switched on. This fuel (e.g., oil) is sometimes used to supplement the base fuel (e.g., coal) at high active power output levels.
lowBreakpointP	0..1	ActivePower	The active power output level of the unit at which the given type of fuel is switched off. This fuel (e.g., oil) is sometimes used to stabilize the base fuel (e.g., coal) at low active power output levels.
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 409 shows all association ends of FossilFuel with other classes.

Table 409 – Association ends of Production::FossilFuel with other classes

mult from	name	mult to	type	description
1..1	FuelAllocationSchedules	0..*	FuelAllocationSchedule	A fuel allocation schedule shall have a fossil fuel.
0..*	ThermalGeneratingUnit	1..1	ThermalGeneratingUnit	A thermal generating unit may have one or more fossil fuels.
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

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6.6.3.14 FuelAllocationSchedule

The amount of fuel of a given type which is allocated for consumption over a specified period of time.

Table 410 shows all attributes of FuelAllocationSchedule.

Table 410 – Attributes of Production::FuelAllocationSchedule

name	mult	type	description
fuelAllocationEndDate	0..1	DateTime	The end time and date of the fuel allocation schedule.
fuelAllocationStartDate	0..1	DateTime	The start time and date of the fuel allocation schedule.
fuelType	0..1	FuelType	The type of fuel, which also indicates the corresponding measurement unit.
maxFuelAllocation	0..1	Float	The maximum amount of fuel that is allocated for consumption for the scheduled time period.
minFuelAllocation	0..1	Float	The minimum amount of fuel that is allocated for consumption for the scheduled time period, e.g., based on a "take-or-pay" contract.
curveStyle	0..1	CurveStyle	inherited from: Curve
xMultiplier	0..1	UnitMultiplier	inherited from: Curve
xUnit	0..1	UnitSymbol	inherited from: Curve
y1Multiplier	0..1	UnitMultiplier	inherited from: Curve
y1Unit	0..1	UnitSymbol	inherited from: Curve
y2Multiplier	0..1	UnitMultiplier	inherited from: Curve
y2Unit	0..1	UnitSymbol	inherited from: Curve
y3Multiplier	0..1	UnitMultiplier	inherited from: Curve
y3Unit	0..1	UnitSymbol	inherited from: Curve
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 411 shows all association ends of FuelAllocationSchedule with other classes.

Table 411 – Association ends of Production::FuelAllocationSchedule with other classes

mult from	name	mult to	type	description
0..*	ThermalGeneratingUnit	1..1	ThermalGeneratingUnit	A thermal generating unit may have one or more fuel allocation schedules.
0..*	FossilFuel	1..1	FossilFuel	A fuel allocation schedule shall have a fossil fuel.
1..1	CurveDatas	0..*	CurveData	inherited from: Curve
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

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6.6.3.15 FuelType enumeration

Type of fuel.

Table 412 shows all literals of FuelType.

Table 412 – Literals of Production::FuelType

literal	value	description
coal		Generic coal, not including lignite type.
oil		Oil.
gas		Natural gas.
lignite		The fuel is lignite coal. Note that this is a special type of coal, so the other enum of coal is reserved for hard coal types or if the exact type of coal is not known.
hardCoal		Hard coal.
oilShale		Oil Shale.
brownCoalLignite		Brown coal lignite.
coalDerivedGas		Coal derived gas.
peat		Peat.
other		Any fuel type not included in the rest of the enumerated value.

6.6.3.16 GenUnitOpCostCurve

Relationship between unit operating cost (Y-axis) and unit output active power (X-axis). The operating cost curve for thermal units is derived from heat input and fuel costs. The operating cost curve for hydro units is derived from water flow rates and equivalent water costs.

Table 413 shows all attributes of GenUnitOpCostCurve.

Table 413 – Attributes of Production::GenUnitOpCostCurve

name	mult	type	description
isNetGrossP	0..1	Boolean	Flag is set to true when output is expressed in net active power.
curveStyle	0..1	CurveStyle	inherited from: Curve
xMultiplier	0..1	UnitMultiplier	inherited from: Curve
xUnit	0..1	UnitSymbol	inherited from: Curve
y1Multiplier	0..1	UnitMultiplier	inherited from: Curve
y1Unit	0..1	UnitSymbol	inherited from: Curve
y2Multiplier	0..1	UnitMultiplier	inherited from: Curve
y2Unit	0..1	UnitSymbol	inherited from: Curve
y3Multiplier	0..1	UnitMultiplier	inherited from: Curve
y3Unit	0..1	UnitSymbol	inherited from: Curve
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 414 shows all association ends of GenUnitOpCostCurve with other classes.

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Table 414 – Association ends of Production::GenUnitOpCostCurve with other classes

mult from	name	mult to	type	description
0..*	GeneratingUnit	1..1	GeneratingUnit	A generating unit may have one or more cost curves, depending upon fuel mixture and fuel cost.
1..1	CurveDatas	0..*	CurveData	inherited from: Curve
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.6.3.17 GenUnitOpSchedule

The generating unit's Operator-approved current operating schedule (or plan), typically produced with the aid of unit commitment type analyses. The X-axis represents absolute time. The Y1-axis represents the status (0=off-line and unavailable: 1=available: 2=must run: 3=must run at fixed power value: etc.). The Y2-axis represents the must run fixed power value where required.

Table 415 shows all attributes of GenUnitOpSchedule.

Table 415 – Attributes of Production::GenUnitOpSchedule

name	mult	type	description
endTime	0..1	DateTime	inherited from: RegularIntervalSchedule
timeStep	0..1	Seconds	inherited from: RegularIntervalSchedule
startTime	0..1	DateTime	inherited from: BasicIntervalSchedule
value1Multiplier	0..1	UnitMultiplier	inherited from: BasicIntervalSchedule
value1Unit	0..1	UnitSymbol	inherited from: BasicIntervalSchedule
value2Multiplier	0..1	UnitMultiplier	inherited from: BasicIntervalSchedule
value2Unit	0..1	UnitSymbol	inherited from: BasicIntervalSchedule
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 416 shows all association ends of GenUnitOpSchedule with other classes.

Table 416 – Association ends of Production::GenUnitOpSchedule with other classes

mult from	name	mult to	type	description
0..1	GeneratingUnit	1..1	GeneratingUnit	A generating unit may have an operating schedule, indicating the planned operation of the unit.
1..1	TimePoints	1..*	RegularTimePoint	inherited from: RegularIntervalSchedule
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

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6.6.3.18 GeneratingUnit

A single or set of synchronous machines for converting mechanical power into alternating-current power. For example, individual machines within a set may be defined for scheduling purposes while a single control signal is derived for the set. In this case there would be a GeneratingUnit for each member of the set and an additional GeneratingUnit corresponding to the set.

Table 417 shows all attributes of GeneratingUnit.

Table 417 – Attributes of Production::GeneratingUnit

name	mult	type	description
allocSpinResP	0..1	ActivePower	The planned unused capacity (spinning reserve) which can be used to support emergency load.
autoCntrlMarginP	0..1	ActivePower	The planned unused capacity which can be used to support automatic control overruns.
baseP	0..1	ActivePower	For dispatchable units, this value represents the economic active power basepoint, for units that are not dispatchable, this value represents the fixed generation value. The value shall be between the operating low and high limits.
controlDeadband	0..1	ActivePower	Unit control error deadband. When a unit's desired active power change is less than this deadband, then no control pulses will be sent to the unit.
controlPulseHigh	0..1	Seconds	Pulse high limit which is the largest control pulse that the unit can respond to.
controlPulseLow	0..1	Seconds	Pulse low limit which is the smallest control pulse that the unit can respond to.
controlResponseRate	0..1	ActivePowerChangeRate	Unit response rate which specifies the active power change for a control pulse of one second in the most responsive loading level of the unit.
efficiency	0..1	PerCent	The efficiency of the unit in converting mechanical energy, from the prime mover, into electrical energy.
genControlMode	0..1	GeneratorControlMode	The unit control mode.
genControlSource	0..1	GeneratorControlSource	The source of controls for a generating unit. Defines the control status of the generating unit.
governorMPL	0..1	PU	Governor motor position limit.
governorSCD	0..1	PerCent	Governor Speed Changer Droop. This is the change in generator power output divided by the change in frequency normalized by the nominal power of the generator and the nominal frequency and expressed in percent and negated. A positive value of speed change droop provides additional generator output upon a drop in frequency.
highControlLimit	0..1	ActivePower	High limit for secondary (AGC) control.
initialP	0..1	ActivePower	Default initial active power which is used to store a powerflow result for the initial active power for this unit in this network configuration.
longPF	0..1	Float	Generating unit long term economic participation factor.
lowControlLimit	0..1	ActivePower	Low limit for secondary (AGC) control.
lowerRampRate	0..1	ActivePowerChangeRate	The normal maximum rate the generating unit active power output can be lowered by control actions.

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name	mult	type	description
maxEconomicP	0..1	ActivePower	Maximum high economic active power limit, that should not exceed the maximum operating active power limit.
maximumAllowableSpinningReserve	0..1	ActivePower	Maximum allowable spinning reserve. Spinning reserve will never be considered greater than this value regardless of the current operating point.
maxOperatingP	0..1	ActivePower	This is the maximum operating active power limit the dispatcher can enter for this unit.
minEconomicP	0..1	ActivePower	Low economic active power limit that shall be greater than or equal to the minimum operating active power limit.
minimumOffTime	0..1	Seconds	Minimum time interval between unit shutdown and startup.
minOperatingP	0..1	ActivePower	This is the minimum operating active power limit the dispatcher can enter for this unit.
modelDetail	0..1	Classification	Detail level of the generator model data.
nominalP	0..1	ActivePower	The nominal power of the generating unit. Used to give precise meaning to percentage based attributes such as the governor speed change droop (governorSCD attribute). The attribute shall be a positive value equal to or less than RotatingMachine.ratedS.
normalPF	0..1	Float	Generating unit economic participation factor. The sum of the participation factors across generating units does not have to sum to one. It is used for representing distributed slack participation factor. The attribute shall be a positive value or zero.
penaltyFactor	0..1	Float	Defined as: 1 / (1 – Incremental Transmission Loss); with the Incremental Transmission Loss expressed as a plus or minus value. The typical range of penalty factors is (0.9 to 1.1).
raiseRampRate	0..1	ActivePowerChangeRate	The normal maximum rate the generating unit active power output can be raised by control actions.
ratedGrossMaxP	0..1	ActivePower	The unit's gross rated maximum capacity (book value). The attribute shall be a positive value.
ratedGrossMinP	0..1	ActivePower	The gross rated minimum generation level which the unit can safely operate at while delivering power to the transmission grid. The attribute shall be a positive value.
ratedNetMaxP	0..1	ActivePower	The net rated maximum capacity determined by subtracting the auxiliary power used to operate the internal plant machinery from the rated gross maximum capacity. The attribute shall be a positive value.
shortPF	0..1	Float	Generating unit short term economic participation factor.
startupCost	0..1	Money	The initial startup cost incurred for each start of the GeneratingUnit.
startupTime	0..1	Seconds	Time it takes to get the unit on-line, from the time that the prime mover mechanical power is applied.
tieLinePF	0..1	Float	Generating unit economic participation factor.
totalEfficiency	0..1	PerCent	The efficiency of the unit in converting the fuel into electrical energy.

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name	mult	type	description
variableCost	0..1	Money	The variable cost component of production per unit of ActivePower.
aggregate	0..1	Boolean	inherited from: Equipment
inService	0..1	Boolean	inherited from: Equipment
networkAnalysisEnabled	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 418 shows all association ends of GeneratingUnit with other classes.

Table 418 – Association ends of Production::GeneratingUnit with other classes

mult from	name	mult to	type	description
0..1	RotatingMachine	0..*	RotatingMachine	A synchronous machine may operate as a generator and as such becomes a member of a generating unit.
1..1	GenUnitOpCostCurves	0..*	GenUnitOpCostCurve	A generating unit may have one or more cost curves, depending upon fuel mixture and fuel cost.
1..1	GenUnitOpSchedule	0..1	GenUnitOpSchedule	A generating unit may have an operating schedule, indicating the planned operation of the unit.
1..1	ControlAreaGeneratingUnit	0..*	ControlAreaGeneratingUnit	ControlArea specifications for this generating unit.
1..1	GrossToNetActivePowerCurves	0..*	GrossToNetActivePowerCurve	A generating unit may have a gross active power to net active power curve, describing the losses and auxiliary power requirements of the unit.
0..1	OperationalLimitSet	0..*	OperationalLimitSet	inherited from: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	inherited from: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment
0..1	Faults	0..*	Fault	inherited from: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	inherited from: Equipment
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.6.3.19 GeneratorControlMode enumeration

Unit control modes.

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Table 419 shows all literals of GeneratorControlMode.

Table 419 – Literals of Production::GeneratorControlMode

literal	value	description
setpoint		Setpoint control mode.
pulse		Pulse control mode.

6.6.3.20 GeneratorControlSource enumeration

The source of controls for a generating unit.

Table 420 shows all literals of GeneratorControlSource.

Table 420 – Literals of Production::GeneratorControlSource

literal	value	description
unavailable		Not available.
offAGC		Off of automatic generation control (AGC).
onAGC		On automatic generation control (AGC).
plantControl		Plant is controlling.

6.6.3.21 GrossToNetActivePowerCurve

Relationship between the generating unit's gross active power output on the X-axis (measured at the terminals of the machine(s)) and the generating unit's net active power output on the Y-axis (based on utility-defined measurements at the power station). Station service loads, when modelled, should be treated as non-conforming bus loads. There may be more than one curve, depending on the auxiliary equipment that is in service.

Table 421 shows all attributes of GrossToNetActivePowerCurve.

Table 421 – Attributes of Production::GrossToNetActivePowerCurve

name	mult	type	description
curveStyle	0..1	CurveStyle	inherited from: Curve
xMultiplier	0..1	UnitMultiplier	inherited from: Curve
xUnit	0..1	UnitSymbol	inherited from: Curve
y1Multiplier	0..1	UnitMultiplier	inherited from: Curve
y1Unit	0..1	UnitSymbol	inherited from: Curve
y2Multiplier	0..1	UnitMultiplier	inherited from: Curve
y2Unit	0..1	UnitSymbol	inherited from: Curve
y3Multiplier	0..1	UnitMultiplier	inherited from: Curve
y3Unit	0..1	UnitSymbol	inherited from: Curve
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

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Table 422 shows all association ends of GrossToNetActivePowerCurve with other classes.

Table 422 – Association ends of Production::GrossToNetActivePowerCurve with other classes

mult from	name	mult to	type	description
0..*	GeneratingUnit	1..1	GeneratingUnit	A generating unit may have a gross active power to net active power curve, describing the losses and auxiliary power requirements of the unit.
1..1	CurveDatas	0..*	CurveData	inherited from: Curve
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.6.3.22 HeatInputCurve

Relationship between unit heat input in energy per time for main fuel (Y1-axis) and supplemental fuel (Y2-axis) versus unit output in active power (X-axis). The quantity of main fuel used to sustain generation at this output level is prorated for throttling between definition points. The quantity of supplemental fuel used at this output level is fixed and not prorated.

Table 423 shows all attributes of HeatInputCurve.

Table 423 – Attributes of Production::HeatInputCurve

name	mult	type	description
auxPowerMult	0..1	PU	Power output – auxiliary power multiplier adjustment factor.
auxPowerOffset	0..1	ActivePower	Power output – auxiliary power offset adjustment factor.
heatInputEff	0..1	PU	Heat input – efficiency multiplier adjustment factor.
heatInputOffset	0..1	HeatRate	Heat input – offset adjustment factor.
isNetGrossP	0..1	Boolean	Flag is set to true when output is expressed in net active power.
curveStyle	0..1	CurveStyle	inherited from: Curve
xMultiplier	0..1	UnitMultiplier	inherited from: Curve
xUnit	0..1	UnitSymbol	inherited from: Curve
y1Multiplier	0..1	UnitMultiplier	inherited from: Curve
y1Unit	0..1	UnitSymbol	inherited from: Curve
y2Multiplier	0..1	UnitMultiplier	inherited from: Curve
y2Unit	0..1	UnitSymbol	inherited from: Curve
y3Multiplier	0..1	UnitMultiplier	inherited from: Curve
y3Unit	0..1	UnitSymbol	inherited from: Curve
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 424 shows all association ends of HeatInputCurve with other classes.

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Table 424 – Association ends of Production::HeatInputCurve with other classes

mult from	name	mult to	type	description
0..1	ThermalGeneratingUnit	1..1	ThermalGeneratingUnit	A thermal generating unit may have a heat input curve.
1..1	CurveDatas	0..*	CurveData	inherited from: Curve
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.6.3.23 HeatRateCurve

Relationship between unit heat rate per active power (Y-axis) and unit output (X-axis). The heat input is from all fuels.

Table 425 shows all attributes of HeatRateCurve.

Table 425 – Attributes of Production::HeatRateCurve

name	mult	type	description
isNetGrossP	0..1	Boolean	Flag is set to true when output is expressed in net active power.
curveStyle	0..1	CurveStyle	inherited from: Curve
xMultiplier	0..1	UnitMultiplier	inherited from: Curve
xUnit	0..1	UnitSymbol	inherited from: Curve
y1Multiplier	0..1	UnitMultiplier	inherited from: Curve
y1Unit	0..1	UnitSymbol	inherited from: Curve
y2Multiplier	0..1	UnitMultiplier	inherited from: Curve
y2Unit	0..1	UnitSymbol	inherited from: Curve
y3Multiplier	0..1	UnitMultiplier	inherited from: Curve
y3Unit	0..1	UnitSymbol	inherited from: Curve
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 426 shows all association ends of HeatRateCurve with other classes.

Table 426 – Association ends of Production::HeatRateCurve with other classes

mult from	name	mult to	type	description
0..1	ThermalGeneratingUnit	1..1	ThermalGeneratingUnit	A thermal generating unit may have a heat rate curve.
1..1	CurveDatas	0..*	CurveData	inherited from: Curve
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

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6.6.3.24 HydroEnergyConversionKind enumeration

Specifies the capability of the hydro generating unit to convert energy as a generator or pump.

Table 427 shows all literals of HydroEnergyConversionKind.

Table 427 – Literals of Production::HydroEnergyConversionKind

literal	value	description
generator		Able to generate power, but not able to pump water for energy storage.
pumpAndGenerator		Able to both generate power and pump water for energy storage.

6.6.3.25 HydroGeneratingEfficiencyCurve

Relationship between unit efficiency as percentage and unit output active power for a given net head in meters. The relationship between efficiency, discharge, head, and power output is expressed as follows:

$$E = KP/HQ$$

where: E is the efficiency, as a percentage; P is the active power; H is the height; Q is the discharge, volume/time unit; K is a constant.

For example, a curve instance for a given net head could show efficiency (Y-axis) versus active power output (X-axis) or versus discharge on the X-axis.

Table 428 shows all attributes of HydroGeneratingEfficiencyCurve.

Table 428 – Attributes of Production::HydroGeneratingEfficiencyCurve

name	mult	type	description
curveStyle	0..1	CurveStyle	inherited from: Curve
xMultiplier	0..1	UnitMultiplier	inherited from: Curve
xUnit	0..1	UnitSymbol	inherited from: Curve
y1Multiplier	0..1	UnitMultiplier	inherited from: Curve
y1Unit	0..1	UnitSymbol	inherited from: Curve
y2Multiplier	0..1	UnitMultiplier	inherited from: Curve
y2Unit	0..1	UnitSymbol	inherited from: Curve
y3Multiplier	0..1	UnitMultiplier	inherited from: Curve
y3Unit	0..1	UnitSymbol	inherited from: Curve
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 429 shows all association ends of HydroGeneratingEfficiencyCurve with other classes.

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Table 429 – Association ends of Production::HydroGeneratingEfficiencyCurve with other classes

mult from	name	mult to	type	description
0..*	HydroGeneratingUnit	1..1	HydroGeneratingUnit	A hydro generating unit has an efficiency curve.
1..1	CurveDatas	0..*	CurveData	inherited from: Curve
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.6.3.26 HydroGeneratingUnit

A generating unit whose prime mover is a hydraulic turbine (e.g., Francis, Pelton, Kaplan).

Table 430 shows all attributes of HydroGeneratingUnit.

Table 430 – Attributes of Production::HydroGeneratingUnit

name	mult	type	description
energyConversionCapability	0..1	HydroEnergyConversionKind	Energy conversion capability for generating.
hydroUnitWaterCost	0..1	CostPerVolume	The equivalent cost of water that drives the hydro turbine.
dropHeight	0..1	Length	The height water drops from the reservoir mid-point to the turbine.
turbineType	0..1	HydroTurbineKind	Type of turbine.
allocSpinResP	0..1	ActivePower	inherited from: GeneratingUnit
autoCntrlMarginP	0..1	ActivePower	inherited from: GeneratingUnit
baseP	0..1	ActivePower	inherited from: GeneratingUnit
controlDeadband	0..1	ActivePower	inherited from: GeneratingUnit
controlPulseHigh	0..1	Seconds	inherited from: GeneratingUnit
controlPulseLow	0..1	Seconds	inherited from: GeneratingUnit
controlResponseRate	0..1	ActivePowerChangeRate	inherited from: GeneratingUnit
efficiency	0..1	PerCent	inherited from: GeneratingUnit
genControlMode	0..1	GeneratorControlMode	inherited from: GeneratingUnit
genControlSource	0..1	GeneratorControlSource	inherited from: GeneratingUnit
governorMPL	0..1	PU	inherited from: GeneratingUnit
governorSCD	0..1	PerCent	inherited from: GeneratingUnit
highControlLimit	0..1	ActivePower	inherited from: GeneratingUnit
initialP	0..1	ActivePower	inherited from: GeneratingUnit
longPF	0..1	Float	inherited from: GeneratingUnit
lowControlLimit	0..1	ActivePower	inherited from: GeneratingUnit
lowerRampRate	0..1	ActivePowerChangeRate	inherited from: GeneratingUnit
maxEconomicP	0..1	ActivePower	inherited from: GeneratingUnit
maximumAllowableSpinningReserve	0..1	ActivePower	inherited from: GeneratingUnit
maxOperatingP	0..1	ActivePower	inherited from: GeneratingUnit
minEconomicP	0..1	ActivePower	inherited from: GeneratingUnit
minimumOffTime	0..1	Seconds	inherited from: GeneratingUnit

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name	mult	type	description
minOperatingP	0..1	ActivePower	inherited from: GeneratingUnit
modelDetail	0..1	Classification	inherited from: GeneratingUnit
nominalP	0..1	ActivePower	inherited from: GeneratingUnit
normalPF	0..1	Float	inherited from: GeneratingUnit
penaltyFactor	0..1	Float	inherited from: GeneratingUnit
raiseRampRate	0..1	ActivePowerChangeRate	inherited from: GeneratingUnit
ratedGrossMaxP	0..1	ActivePower	inherited from: GeneratingUnit
ratedGrossMinP	0..1	ActivePower	inherited from: GeneratingUnit
ratedNetMaxP	0..1	ActivePower	inherited from: GeneratingUnit
shortPF	0..1	Float	inherited from: GeneratingUnit
startupCost	0..1	Money	inherited from: GeneratingUnit
startupTime	0..1	Seconds	inherited from: GeneratingUnit
tieLinePF	0..1	Float	inherited from: GeneratingUnit
totalEfficiency	0..1	PerCent	inherited from: GeneratingUnit
variableCost	0..1	Money	inherited from: GeneratingUnit
aggregate	0..1	Boolean	inherited from: Equipment
inService	0..1	Boolean	inherited from: Equipment
networkAnalysisEnabled	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 431 shows all association ends of HydroGeneratingUnit with other classes.

Table 431 – Association ends of Production::HydroGeneratingUnit with other classes

mult from	name	mult to	type	description
1..1	HydroGeneratingEfficiencyCurves	0..*	HydroGeneratingEfficiencyCurve	A hydro generating unit has an efficiency curve.
1..1	TailbayLossCurve	0..*	TailbayLossCurve	A hydro generating unit has a tailbay loss curve.
0..*	HydroPowerPlant	0..1	HydroPowerPlant	The hydro generating unit belongs to a hydro power plant.
1..1	PenstockLossCurve	0..1	PenstockLossCurve	A hydro generating unit has a penstock loss curve.
0..1	RotatingMachine	0..*	RotatingMachine	inherited from: GeneratingUnit
1..1	GenUnitOpCostCurves	0..*	GenUnitOpCostCurve	inherited from: GeneratingUnit
1..1	GenUnitOpSchedule	0..1	GenUnitOpSchedule	inherited from: GeneratingUnit
1..1	ControlAreaGeneratingUnit	0..*	ControlAreaGeneratingUnit	inherited from: GeneratingUnit
1..1	GrossToNetActivePowerCurves	0..*	GrossToNetActivePowerCurve	inherited from: GeneratingUnit
0..1	OperationalLimitSet	0..*	OperationalLimitSet	inherited from: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	inherited from: Equipment

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mult from	name	mult to	type	description
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment
0..1	Faults	0..*	Fault	inherited from: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	inherited from: Equipment
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.6.3.27 HydroPlantStorageKind enumeration

The type of hydro power plant.

Table 432 shows all literals of HydroPlantStorageKind.

Table 432 – Literals of Production::HydroPlantStorageKind

literal	value	description
runOfRiver		Run of river.
pumpedStorage		Pumped storage.
storage		Storage.

6.6.3.28 HydroPowerPlant

A hydro power station which can generate or pump. When generating, the generator turbines receive water from an upper reservoir. When pumping, the pumps receive their water from a lower reservoir.

Table 433 shows all attributes of HydroPowerPlant.

Table 433 – Attributes of Production::HydroPowerPlant

name	mult	type	description
dischargeTravelDelay	0..1	Seconds	Water travel delay from tailbay to next downstream hydro power station.
genRatedP	0..1	ActivePower	The hydro plant's generating rating active power for rated head conditions. The attribute shall be a positive value.
hydroPlantStorageType	0..1	HydroPlantStorageKind	The type of hydro power plant water storage.
penstockType	0..1	String	Type and configuration of hydro plant penstock(s).
plantDischargeCapacity	0..1	VolumeFlowRate	Total plant discharge capacity.
plantRatedHead	0..1	Length	The plant's rated gross head. The attribute shall be a positive value.
pumpRatedP	0..1	ActivePower	The hydro plant's pumping rating active power for rated head conditions.

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name	mult	type	description
			The attribute shall be a positive value.
surgeTankCode	0..1	String	A code describing the type (or absence) of surge tank that is associated with the hydro power plant.
surgeTankCrestLevel	0..1	WaterLevel	The level at which the surge tank spills.
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 434 shows all association ends of HydroPowerPlant with other classes.

Table 434 – Association ends of Production::HydroPowerPlant with other classes

mult from	name	mult to	type	description
0..1	HydroGeneratingUnits	0..*	HydroGeneratingUnit	The hydro generating unit belongs to a hydro power plant.
0..1	HydroPumps	0..*	HydroPump	The hydro pump may be a member of a pumped storage plant or a pump for distributing water.
0..*	Reservoir	0..1	Reservoir	Generators discharge water to or pumps are supplied water from a downstream reservoir.
0..*	GenSourcePumpDischargeReservoir	1..1	Reservoir	Generators are supplied water from or pumps discharge water to an upstream reservoir.
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.6.3.29 HydroPump

A synchronous motor-driven pump, typically associated with a pumped storage plant.

Table 435 shows all attributes of HydroPump.

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Table 435 – Attributes of Production::HydroPump

name	mult	type	description
pumpDischAtMaxHead	0..1	VolumeFlowRate	The pumping discharge under maximum head conditions, usually at full gate.
pumpDischAtMinHead	0..1	VolumeFlowRate	The pumping discharge under minimum head conditions, usually at full gate.
pumpPowerAtMaxHead	0..1	ActivePower	The pumping power under maximum head conditions, usually at full gate.
pumpPowerAtMinHead	0..1	ActivePower	The pumping power under minimum head conditions, usually at full gate.
aggregate	0..1	Boolean	inherited from: Equipment
inService	0..1	Boolean	inherited from: Equipment
networkAnalysisEnabled	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 436 shows all association ends of HydroPump with other classes.

Table 436 – Association ends of Production::HydroPump with other classes

mult from	name	mult to	type	description
0..1	RotatingMachine	1..1	RotatingMachine	The synchronous machine drives the turbine which moves the water from a low elevation to a higher elevation. The direction of machine rotation for pumping may or may not be the same as for generating.
0..*	HydroPowerPlant	0..1	HydroPowerPlant	The hydro pump may be a member of a pumped storage plant or a pump for distributing water.
1..1	HydroPumpOpSchedule	0..1	HydroPumpOpSchedule	The hydro pump has a pumping schedule over time, indicating when pumping is to occur.
0..1	OperationalLimitSet	0..*	OperationalLimitSet	inherited from: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	inherited from: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment
0..1	Faults	0..*	Fault	inherited from: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	inherited from: Equipment
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

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6.6.3.30 HydroPumpOpSchedule

The hydro pump's Operator-approved current operating schedule (or plan), typically produced with the aid of unit commitment type analyses. The unit's operating schedule status is typically given as: (0=unavailable) (1=available to startup or shutdown) (2=must pump).

Table 437 shows all attributes of HydroPumpOpSchedule.

Table 437 – Attributes of Production::HydroPumpOpSchedule

name	mult	type	description
endTime	0..1	DateTime	inherited from: RegularIntervalSchedule
timeStep	0..1	Seconds	inherited from: RegularIntervalSchedule
startTime	0..1	DateTime	inherited from: BasicIntervalSchedule
value1Multiplier	0..1	UnitMultiplier	inherited from: BasicIntervalSchedule
value1Unit	0..1	UnitSymbol	inherited from: BasicIntervalSchedule
value2Multiplier	0..1	UnitMultiplier	inherited from: BasicIntervalSchedule
value2Unit	0..1	UnitSymbol	inherited from: BasicIntervalSchedule
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 438 shows all association ends of HydroPumpOpSchedule with other classes.

Table 438 – Association ends of Production::HydroPumpOpSchedule with other classes

mult from	name	mult to	type	description
0..1	HydroPump	1..1	HydroPump	The hydro pump has a pumping schedule over time, indicating when pumping is to occur.
1..1	TimePoints	1..*	RegularTimePoint	inherited from: RegularIntervalSchedule
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.6.3.31 IncrementalHeatRateCurve

Relationship between unit incremental heat rate in (delta energy/time) per (delta active power) and unit output in active power. The IHR curve represents the slope of the HeatInputCurve. Note that the "incremental heat rate" and the "heat rate" have the same engineering units.

Table 439 shows all attributes of IncrementalHeatRateCurve.

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Table 439 – Attributes of Production::IncrementalHeatRateCurve

name	mult	type	description
isNetGrossP	0..1	Boolean	Flag is set to true when output is expressed in net active power.
curveStyle	0..1	CurveStyle	inherited from: Curve
xMultiplier	0..1	UnitMultiplier	inherited from: Curve
xUnit	0..1	UnitSymbol	inherited from: Curve
y1Multiplier	0..1	UnitMultiplier	inherited from: Curve
y1Unit	0..1	UnitSymbol	inherited from: Curve
y2Multiplier	0..1	UnitMultiplier	inherited from: Curve
y2Unit	0..1	UnitSymbol	inherited from: Curve
y3Multiplier	0..1	UnitMultiplier	inherited from: Curve
y3Unit	0..1	UnitSymbol	inherited from: Curve
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 440 shows all association ends of IncrementalHeatRateCurve with other classes.

Table 440 – Association ends of Production::IncrementalHeatRateCurve with other classes

mult from	name	mult to	type	description
0..1	ThermalGeneratingUnit	1..1	ThermalGeneratingUnit	A thermal generating unit may have an incremental heat rate curve.
1..1	CurveDatas	0..*	CurveData	inherited from: Curve
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.6.3.32 InflowForecast

Natural water inflow to a reservoir, usually forecasted from predicted rain and snowmelt. Typically in one hour increments for up to 10 days. The forecast is given in average cubic meters per second over the time increment.

Table 441 shows all attributes of InflowForecast.

Table 441 – Attributes of Production::InflowForecast

name	mult	type	description
endTime	0..1	DateTime	inherited from: RegularIntervalSchedule
timeStep	0..1	Seconds	inherited from: RegularIntervalSchedule
startTime	0..1	DateTime	inherited from: BasicIntervalSchedule
value1Multiplier	0..1	UnitMultiplier	inherited from: BasicIntervalSchedule
value1Unit	0..1	UnitSymbol	inherited from: BasicIntervalSchedule
value2Multiplier	0..1	UnitMultiplier	inherited from: BasicIntervalSchedule

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name	mult	type	description
value2Unit	0..1	UnitSymbol	inherited from: BasicIntervalSchedule
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 442 shows all association ends of InflowForecast with other classes.

Table 442 – Association ends of Production::InflowForecast with other classes

mult from	name	mult to	type	description
0..*	Reservoir	1..1	Reservoir	A reservoir may have a "natural" inflow forecast.
1..1	TimePoints	1..*	RegularTimePoint	inherited from: RegularIntervalSchedule
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.6.3.33 LevelVsVolumeCurve

Relationship between reservoir volume and reservoir level. The volume is at the Y-axis and the reservoir level at the X-axis.

Table 443 shows all attributes of LevelVsVolumeCurve.

Table 443 – Attributes of Production::LevelVsVolumeCurve

name	mult	type	description
curveStyle	0..1	CurveStyle	inherited from: Curve
xMultiplier	0..1	UnitMultiplier	inherited from: Curve
xUnit	0..1	UnitSymbol	inherited from: Curve
y1Multiplier	0..1	UnitMultiplier	inherited from: Curve
y1Unit	0..1	UnitSymbol	inherited from: Curve
y2Multiplier	0..1	UnitMultiplier	inherited from: Curve
y2Unit	0..1	UnitSymbol	inherited from: Curve
y3Multiplier	0..1	UnitMultiplier	inherited from: Curve
y3Unit	0..1	UnitSymbol	inherited from: Curve
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 444 shows all association ends of LevelVsVolumeCurve with other classes.

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Table 444 – Association ends of Production::LevelVsVolumeCurve with other classes

mult from	name	mult to	type	description
0..*	Reservoir	1..1	Reservoir	A reservoir may have a level versus volume relationship.
1..1	CurveDatas	0..*	CurveData	inherited from: Curve
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.6.3.34 NuclearGeneratingUnit

A nuclear generating unit.

Table 445 shows all attributes of NuclearGeneratingUnit.

Table 445 – Attributes of Production::NuclearGeneratingUnit

name	mult	type	description
allocSpinResP	0..1	ActivePower	inherited from: GeneratingUnit
autoCntrlMarginP	0..1	ActivePower	inherited from: GeneratingUnit
baseP	0..1	ActivePower	inherited from: GeneratingUnit
controlDeadband	0..1	ActivePower	inherited from: GeneratingUnit
controlPulseHigh	0..1	Seconds	inherited from: GeneratingUnit
controlPulseLow	0..1	Seconds	inherited from: GeneratingUnit
controlResponseRate	0..1	ActivePowerChangeRate	inherited from: GeneratingUnit
efficiency	0..1	PerCent	inherited from: GeneratingUnit
genControlMode	0..1	GeneratorControlMode	inherited from: GeneratingUnit
genControlSource	0..1	GeneratorControlSource	inherited from: GeneratingUnit
governorMPL	0..1	PU	inherited from: GeneratingUnit
governorSCD	0..1	PerCent	inherited from: GeneratingUnit
highControlLimit	0..1	ActivePower	inherited from: GeneratingUnit
initialP	0..1	ActivePower	inherited from: GeneratingUnit
longPF	0..1	Float	inherited from: GeneratingUnit
lowControlLimit	0..1	ActivePower	inherited from: GeneratingUnit
lowerRampRate	0..1	ActivePowerChangeRate	inherited from: GeneratingUnit
maxEconomicP	0..1	ActivePower	inherited from: GeneratingUnit
maximumAllowableSpinningReserve	0..1	ActivePower	inherited from: GeneratingUnit
maxOperatingP	0..1	ActivePower	inherited from: GeneratingUnit
minEconomicP	0..1	ActivePower	inherited from: GeneratingUnit
minimumOffTime	0..1	Seconds	inherited from: GeneratingUnit
minOperatingP	0..1	ActivePower	inherited from: GeneratingUnit
modelDetail	0..1	Classification	inherited from: GeneratingUnit
nominalP	0..1	ActivePower	inherited from: GeneratingUnit
normalPF	0..1	Float	inherited from: GeneratingUnit
penaltyFactor	0..1	Float	inherited from: GeneratingUnit
raiseRampRate	0..1	ActivePowerChangeRate	inherited from: GeneratingUnit

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name	mult	type	description
ratedGrossMaxP	0..1	ActivePower	inherited from: GeneratingUnit
ratedGrossMinP	0..1	ActivePower	inherited from: GeneratingUnit
ratedNetMaxP	0..1	ActivePower	inherited from: GeneratingUnit
shortPF	0..1	Float	inherited from: GeneratingUnit
startupCost	0..1	Money	inherited from: GeneratingUnit
startupTime	0..1	Seconds	inherited from: GeneratingUnit
tieLinePF	0..1	Float	inherited from: GeneratingUnit
totalEfficiency	0..1	PerCent	inherited from: GeneratingUnit
variableCost	0..1	Money	inherited from: GeneratingUnit
aggregate	0..1	Boolean	inherited from: Equipment
inService	0..1	Boolean	inherited from: Equipment
networkAnalysisEnabled	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 446 shows all association ends of NuclearGeneratingUnit with other classes.

Table 446 – Association ends of Production::NuclearGeneratingUnit with other classes

mult from	name	mult to	type	description
0..1	RotatingMachine	0..*	RotatingMachine	inherited from: GeneratingUnit
1..1	GenUnitOpCostCurves	0..*	GenUnitOpCostCurve	inherited from: GeneratingUnit
1..1	GenUnitOpSchedule	0..1	GenUnitOpSchedule	inherited from: GeneratingUnit
1..1	ControlAreaGeneratingUnit	0..*	ControlAreaGeneratingUnit	inherited from: GeneratingUnit
1..1	GrossToNetActivePowerCurves	0..*	GrossToNetActivePowerCurve	inherited from: GeneratingUnit
0..1	OperationalLimitSet	0..*	OperationalLimitSet	inherited from: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	inherited from: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment
0..1	Faults	0..*	Fault	inherited from: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	inherited from: Equipment
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

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6.6.3.35 PenstockLossCurve

Relationship between penstock head loss (in meters) and total discharge through the penstock (in cubic meters per second). One or more turbines may be connected to the same penstock.

Table 447 shows all attributes of PenstockLossCurve.

Table 447 – Attributes of Production::PenstockLossCurve

name	mult	type	description
curveStyle	0..1	CurveStyle	inherited from: Curve
xMultiplier	0..1	UnitMultiplier	inherited from: Curve
xUnit	0..1	UnitSymbol	inherited from: Curve
y1Multiplier	0..1	UnitMultiplier	inherited from: Curve
y1Unit	0..1	UnitSymbol	inherited from: Curve
y2Multiplier	0..1	UnitMultiplier	inherited from: Curve
y2Unit	0..1	UnitSymbol	inherited from: Curve
y3Multiplier	0..1	UnitMultiplier	inherited from: Curve
y3Unit	0..1	UnitSymbol	inherited from: Curve
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 448 shows all association ends of PenstockLossCurve with other classes.

Table 448 – Association ends of Production::PenstockLossCurve with other classes

mult from	name	mult to	type	description
0..1	HydroGeneratingUnit	1..1	HydroGeneratingUnit	A hydro generating unit has a penstock loss curve.
1..1	CurveDatas	0..*	CurveData	inherited from: Curve
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.6.3.36 PhotoVoltaicUnit

A photovoltaic device or an aggregation of such devices.

Table 449 shows all attributes of PhotoVoltaicUnit.

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Table 449 – Attributes of Production::PhotoVoltaicUnit

name	mult	type	description
maxP	0..1	ActivePower	inherited from: PowerElectronicsUnit
minP	0..1	ActivePower	inherited from: PowerElectronicsUnit
aggregate	0..1	Boolean	inherited from: Equipment
inService	0..1	Boolean	inherited from: Equipment
networkAnalysisEnabled	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 450 shows all association ends of PhotoVoltaicUnit with other classes.

Table 450 – Association ends of Production::PhotoVoltaicUnit with other classes

mult from	name	mult to	type	description
0..*	PowerElectronicsConnection	1..1	PowerElectronicsConnection	inherited from: PowerElectronicsUnit
0..1	OperationalLimitSet	0..*	OperationalLimitSet	inherited from: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	inherited from: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment
0..1	Faults	0..*	Fault	inherited from: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	inherited from: Equipment
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.6.3.37 PowerElectronicsUnit

A generating unit or battery or aggregation that connects to the AC network using power electronics rather than rotating machines.

Table 451 shows all attributes of PowerElectronicsUnit.

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Table 451 – Attributes of Production::PowerElectronicsUnit

name	mult	type	description
maxP	0..1	ActivePower	Maximum active power limit. This is the maximum (nameplate) limit for the unit.
minP	0..1	ActivePower	Minimum active power limit. This is the minimum (nameplate) limit for the unit.
aggregate	0..1	Boolean	inherited from: Equipment
inService	0..1	Boolean	inherited from: Equipment
networkAnalysisEnabled	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 452 shows all association ends of PowerElectronicsUnit with other classes.

Table 452 – Association ends of Production::PowerElectronicsUnit with other classes

mult from	name	mult to	type	description
0..*	PowerElectronicsConnection	1..1	PowerElectronicsConnection	A power electronics unit has a connection to the AC network.
0..1	OperationalLimitSet	0..*	OperationalLimitSet	inherited from: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	inherited from: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment
0..1	Faults	0..*	Fault	inherited from: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	inherited from: Equipment
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.6.3.38 PowerElectronicsWindUnit

A wind generating unit that connects to the AC network with power electronics rather than rotating machines or an aggregation of such units.

Table 453 shows all attributes of PowerElectronicsWindUnit.

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Table 453 – Attributes of Production::PowerElectronicsWindUnit

name	mult	type	description
maxP	0..1	ActivePower	inherited from: PowerElectronicsUnit
minP	0..1	ActivePower	inherited from: PowerElectronicsUnit
aggregate	0..1	Boolean	inherited from: Equipment
inService	0..1	Boolean	inherited from: Equipment
networkAnalysisEnabled	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 454 shows all association ends of PowerElectronicsWindUnit with other classes.

Table 454 – Association ends of Production::PowerElectronicsWindUnit with other classes

mult from	name	mult to	type	description
0..*	PowerElectronicsConnection	1..1	PowerElectronicsConnection	inherited from: PowerElectronicsUnit
0..1	OperationalLimitSet	0..*	OperationalLimitSet	inherited from: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	inherited from: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment
0..1	Faults	0..*	Fault	inherited from: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	inherited from: Equipment
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.6.3.39 Reservoir

A water storage facility within a hydro system, including: ponds, lakes, lagoons, and rivers. The storage is usually behind some type of dam.

Table 455 shows all attributes of Reservoir.

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Table 455 – Attributes of Production::Reservoir

name	mult	type	description
activeStorageCapacity	0..1	Volume	Storage volume between the full supply level and the normal minimum operating level.
energyStorageRating	0..1	Float	The reservoir's energy storage rating in energy for given head conditions.
fullSupplyLevel	0..1	WaterLevel	Full supply level, above which water will spill. This can be the spillway crest level or the top of closed gates.
grossCapacity	0..1	Volume	Total capacity of reservoir.
normalMinOperateLevel	0..1	WaterLevel	Normal minimum operating level below which the penstocks will draw air.
riverOutletWorks	0..1	String	River outlet works for riparian right releases or other purposes.
spillTravelDelay	0..1	Seconds	The spillway water travel delay to the next downstream reservoir.
spillwayCapacity	0..1	Float	The flow capacity of the spillway in cubic meters per second.
spillwayCrestLength	0..1	Length	The length of the spillway crest.
spillwayCrestLevel	0..1	WaterLevel	Spillway crest level above which water will spill.
spillWayGateType	0..1	String	Type of spillway gate, including parameters.
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 456 shows all association ends of Reservoir with other classes.

Table 456 – Association ends of Production::Reservoir with other classes

mult from	name	mult to	type	description
0..1	SpillsIntoReservoirs	0..*	Reservoir	A reservoir may spill into a downstream reservoir.
0..1	HydroPowerPlants	0..*	HydroPowerPlant	Generators discharge water to or pumps are supplied water from a downstream reservoir.
1..1	UpstreamFromHydroPowerPlants	0..*	HydroPowerPlant	Generators are supplied water from or pumps discharge water to an upstream reservoir.
1..1	InflowForecasts	0..*	InflowForecast	A reservoir may have a "natural" inflow forecast.
1..1	LevelVsVolumeCurves	0..*	LevelVsVolumeCurve	A reservoir may have a level versus volume relationship.
1..1	TargetLevelSchedule	0..1	TargetLevelSchedule	A reservoir may have a water level target schedule.
0..*	SpillsFromReservoir	0..1	Reservoir	A reservoir may spill into a downstream reservoir.
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource

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mult from	name	mult to	type	description
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.6.3.40 ShutdownCurve

Relationship between the rate in gross active power/minute (Y-axis) at which a unit should be shutdown and its present gross MW output (X-axis).

Table 457 shows all attributes of ShutdownCurve.

Table 457 – Attributes of Production::ShutdownCurve

name	mult	type	description
shutdownCost	0..1	Money	Fixed shutdown cost.
shutdownDate	0..1	DateTime	The date and time of the most recent generating unit shutdown.
curveStyle	0..1	CurveStyle	inherited from: Curve
xMultiplier	0..1	UnitMultiplier	inherited from: Curve
xUnit	0..1	UnitSymbol	inherited from: Curve
y1Multiplier	0..1	UnitMultiplier	inherited from: Curve
y1Unit	0..1	UnitSymbol	inherited from: Curve
y2Multiplier	0..1	UnitMultiplier	inherited from: Curve
y2Unit	0..1	UnitSymbol	inherited from: Curve
y3Multiplier	0..1	UnitMultiplier	inherited from: Curve
y3Unit	0..1	UnitSymbol	inherited from: Curve
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 458 shows all association ends of ShutdownCurve with other classes.

Table 458 – Association ends of Production::ShutdownCurve with other classes

mult from	name	mult to	type	description
0..1	ThermalGeneratingUnit	1..1	ThermalGeneratingUnit	A thermal generating unit may have a shutdown curve.
1..1	CurveDatas	0..*	CurveData	inherited from: Curve
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.6.3.41 SolarGeneratingUnit

A solar thermal generating unit, connected to the grid by means of a rotating machine. This class does not represent photovoltaic (PV) generation.

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Table 459 shows all attributes of SolarGeneratingUnit.

Table 459 – Attributes of Production::SolarGeneratingUnit

name	mult	type	description
allocSpinResP	0..1	ActivePower	inherited from: GeneratingUnit
autoCntrlMarginP	0..1	ActivePower	inherited from: GeneratingUnit
baseP	0..1	ActivePower	inherited from: GeneratingUnit
controlDeadband	0..1	ActivePower	inherited from: GeneratingUnit
controlPulseHigh	0..1	Seconds	inherited from: GeneratingUnit
controlPulseLow	0..1	Seconds	inherited from: GeneratingUnit
controlResponseRate	0..1	ActivePowerChangeRate	inherited from: GeneratingUnit
efficiency	0..1	PerCent	inherited from: GeneratingUnit
genControlMode	0..1	GeneratorControlMode	inherited from: GeneratingUnit
genControlSource	0..1	GeneratorControlSource	inherited from: GeneratingUnit
governorMPL	0..1	PU	inherited from: GeneratingUnit
governorSCD	0..1	PerCent	inherited from: GeneratingUnit
highControlLimit	0..1	ActivePower	inherited from: GeneratingUnit
initialP	0..1	ActivePower	inherited from: GeneratingUnit
longPF	0..1	Float	inherited from: GeneratingUnit
lowControlLimit	0..1	ActivePower	inherited from: GeneratingUnit
lowerRampRate	0..1	ActivePowerChangeRate	inherited from: GeneratingUnit
maxEconomicP	0..1	ActivePower	inherited from: GeneratingUnit
maximumAllowableSpinningReserve	0..1	ActivePower	inherited from: GeneratingUnit
maxOperatingP	0..1	ActivePower	inherited from: GeneratingUnit
minEconomicP	0..1	ActivePower	inherited from: GeneratingUnit
minimumOffTime	0..1	Seconds	inherited from: GeneratingUnit
minOperatingP	0..1	ActivePower	inherited from: GeneratingUnit
modelDetail	0..1	Classification	inherited from: GeneratingUnit
nominalP	0..1	ActivePower	inherited from: GeneratingUnit
normalPF	0..1	Float	inherited from: GeneratingUnit
penaltyFactor	0..1	Float	inherited from: GeneratingUnit
raiseRampRate	0..1	ActivePowerChangeRate	inherited from: GeneratingUnit
ratedGrossMaxP	0..1	ActivePower	inherited from: GeneratingUnit
ratedGrossMinP	0..1	ActivePower	inherited from: GeneratingUnit
ratedNetMaxP	0..1	ActivePower	inherited from: GeneratingUnit
shortPF	0..1	Float	inherited from: GeneratingUnit
startupCost	0..1	Money	inherited from: GeneratingUnit
startupTime	0..1	Seconds	inherited from: GeneratingUnit
tieLinePF	0..1	Float	inherited from: GeneratingUnit
totalEfficiency	0..1	PerCent	inherited from: GeneratingUnit
variableCost	0..1	Money	inherited from: GeneratingUnit
aggregate	0..1	Boolean	inherited from: Equipment
inService	0..1	Boolean	inherited from: Equipment
networkAnalysisEnabled	0..1	Boolean	inherited from: Equipment

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name	mult	type	description
normallyInService	0..1	Boolean	inherited from: Equipment
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 460 shows all association ends of SolarGeneratingUnit with other classes.

Table 460 – Association ends of Production::SolarGeneratingUnit with other classes

mult from	name	mult to	type	description
0..1	RotatingMachine	0..*	RotatingMachine	inherited from: GeneratingUnit
1..1	GenUnitOpCostCurves	0..*	GenUnitOpCostCurve	inherited from: GeneratingUnit
1..1	GenUnitOpSchedule	0..1	GenUnitOpSchedule	inherited from: GeneratingUnit
1..1	ControlAreaGeneratingUnit	0..*	ControlAreaGeneratingUnit	inherited from: GeneratingUnit
1..1	GrossToNetActivePowerCurves	0..*	GrossToNetActivePowerCurve	inherited from: GeneratingUnit
0..1	OperationalLimitSet	0..*	OperationalLimitSet	inherited from: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	inherited from: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment
0..1	Faults	0..*	Fault	inherited from: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	inherited from: Equipment
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.6.3.42 StartIgnFuelCurve

The quantity of ignition fuel (Y-axis) used to restart and repay the auxiliary power consumed versus the number of hours (X-axis) the unit was off line.

Table 461 shows all attributes of StartIgnFuelCurve.

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Table 461 – Attributes of Production::StartIgnFuelCurve

name	mult	type	description
ignitionFuelType	0..1	FuelType	Type of ignition fuel.
curveStyle	0..1	CurveStyle	inherited from: Curve
xMultiplier	0..1	UnitMultiplier	inherited from: Curve
xUnit	0..1	UnitSymbol	inherited from: Curve
y1Multiplier	0..1	UnitMultiplier	inherited from: Curve
y1Unit	0..1	UnitSymbol	inherited from: Curve
y2Multiplier	0..1	UnitMultiplier	inherited from: Curve
y2Unit	0..1	UnitSymbol	inherited from: Curve
y3Multiplier	0..1	UnitMultiplier	inherited from: Curve
y3Unit	0..1	UnitSymbol	inherited from: Curve
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 462 shows all association ends of StartIgnFuelCurve with other classes.

Table 462 – Association ends of Production::StartIgnFuelCurve with other classes

mult from	name	mult to	type	description
0..1	StartupModel	1..1	StartupModel	The unit's startup model may have a startup ignition fuel curve.
1..1	CurveDatas	0..*	CurveData	inherited from: Curve
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.6.3.43 StartMainFuelCurve

The quantity of main fuel (Y-axis) used to restart and repay the auxiliary power consumed versus the number of hours (X-axis) the unit was off line.

Table 463 shows all attributes of StartMainFuelCurve.

Table 463 – Attributes of Production::StartMainFuelCurve

name	mult	type	description
mainFuelType	0..1	FuelType	Type of main fuel.
curveStyle	0..1	CurveStyle	inherited from: Curve
xMultiplier	0..1	UnitMultiplier	inherited from: Curve
xUnit	0..1	UnitSymbol	inherited from: Curve
y1Multiplier	0..1	UnitMultiplier	inherited from: Curve
y1Unit	0..1	UnitSymbol	inherited from: Curve
y2Multiplier	0..1	UnitMultiplier	inherited from: Curve
y2Unit	0..1	UnitSymbol	inherited from: Curve

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name	mult	type	description
y3Multiplier	0..1	UnitMultiplier	inherited from: Curve
y3Unit	0..1	UnitSymbol	inherited from: Curve
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 464 shows all association ends of StartMainFuelCurve with other classes.

Table 464 – Association ends of Production::StartMainFuelCurve with other classes

mult from	name	mult to	type	description
0..1	StartupModel	1..1	StartupModel	The unit's startup model may have a startup main fuel curve.
1..1	CurveDatas	0..*	CurveData	inherited from: Curve
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.6.3.44 StartRampCurve

Rate in gross active power per minute (Y-axis) at which a unit can be loaded versus the number of hours (X-axis) the unit was off line.

Table 465 shows all attributes of StartRampCurve.

Table 465 – Attributes of Production::StartRampCurve

name	mult	type	description
hotStandbyRamp	0..1	ActivePowerChangeRate	The startup ramp rate in gross for a unit that is on hot standby.
curveStyle	0..1	CurveStyle	inherited from: Curve
xMultiplier	0..1	UnitMultiplier	inherited from: Curve
xUnit	0..1	UnitSymbol	inherited from: Curve
y1Multiplier	0..1	UnitMultiplier	inherited from: Curve
y1Unit	0..1	UnitSymbol	inherited from: Curve
y2Multiplier	0..1	UnitMultiplier	inherited from: Curve
y2Unit	0..1	UnitSymbol	inherited from: Curve
y3Multiplier	0..1	UnitMultiplier	inherited from: Curve
y3Unit	0..1	UnitSymbol	inherited from: Curve
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 466 shows all association ends of StartRampCurve with other classes.

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Table 466 – Association ends of Production::StartRampCurve with other classes

mult from	name	mult to	type	description
0..1	StartupModel	1..1	StartupModel	The unit's startup model may have a startup ramp curve.
1..1	CurveDatas	0..*	CurveData	inherited from: Curve
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.6.3.45 StartupModel

Unit start up characteristics depending on how long the unit has been off line.

Table 467 shows all attributes of StartupModel.

Table 467 – Attributes of Production::StartupModel

name	mult	type	description
fixedMaintCost	0..1	CostRate	Fixed maintenance cost.
hotStandbyHeat	0..1	HeatRate	The amount of heat input per time unit required for hot standby operation.
incrementalMaintCost	0..1	CostPerEnergyUnit	Incremental maintenance cost.
minimumDownTime	0..1	Hours	The minimum number of hours the unit must be down before restart.
minimumRunTime	0..1	Hours	The minimum number of hours the unit must be operating before being allowed to shut down.
riskFactorCost	0..1	Money	The opportunity cost associated with the return in monetary unit. This represents the restart's "share" of the unit depreciation and risk of an event which would damage the unit.
startupCost	0..1	Money	Total miscellaneous start up costs.
startupDate	0..1	DateTime	The date and time of the most recent generating unit startup.
startupPriority	0..1	Integer	Startup priority within control area where lower numbers indicate higher priorities. More than one unit in an area may be assigned the same priority.
stbyAuxP	0..1	ActivePower	The unit's auxiliary active power consumption to maintain standby mode.
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 468 shows all association ends of StartupModel with other classes.

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Table 468 – Association ends of Production::StartupModel with other classes

mult from	name	mult to	type	description
0..1	ThermalGeneratingUnit	1..1	ThermalGeneratingUnit	A thermal generating unit may have a startup model.
1..1	StartIgnFuelCurve	0..1	StartIgnFuelCurve	The unit's startup model may have a startup ignition fuel curve.
1..1	StartMainFuelCurve	0..1	StartMainFuelCurve	The unit's startup model may have a startup main fuel curve.
1..1	StartRampCurve	0..1	StartRampCurve	The unit's startup model may have a startup ramp curve.
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.6.3.46 SteamSendoutSchedule

The cogeneration plant's steam sendout schedule in volume per time unit.

Table 469 shows all attributes of SteamSendoutSchedule.

Table 469 – Attributes of Production::SteamSendoutSchedule

name	mult	type	description
endTime	0..1	DateTime	inherited from: RegularIntervalSchedule
timeStep	0..1	Seconds	inherited from: RegularIntervalSchedule
startTime	0..1	DateTime	inherited from: BasicIntervalSchedule
value1Multiplier	0..1	UnitMultiplier	inherited from: BasicIntervalSchedule
value1Unit	0..1	UnitSymbol	inherited from: BasicIntervalSchedule
value2Multiplier	0..1	UnitMultiplier	inherited from: BasicIntervalSchedule
value2Unit	0..1	UnitSymbol	inherited from: BasicIntervalSchedule
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 470 shows all association ends of SteamSendoutSchedule with other classes.

Table 470 – Association ends of Production::SteamSendoutSchedule with other classes

mult from	name	mult to	type	description
1..1	CogenerationPlant	1..1	CogenerationPlant	A cogeneration plant has a steam sendout schedule.
1..1	TimePoints	1..*	RegularTimePoint	inherited from: RegularIntervalSchedule
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

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6.6.3.47 TailbayLossCurve

Relationship between tailbay head loss height (Y-axis) and the total discharge into the power station's tailbay volume per time unit (X-axis). There could be more than one curve depending on the level of the tailbay reservoir or river level.

Table 471 shows all attributes of TailbayLossCurve.

Table 471 – Attributes of Production::TailbayLossCurve

name	mult	type	description
curveStyle	0..1	CurveStyle	inherited from: Curve
xMultiplier	0..1	UnitMultiplier	inherited from: Curve
xUnit	0..1	UnitSymbol	inherited from: Curve
y1Multiplier	0..1	UnitMultiplier	inherited from: Curve
y1Unit	0..1	UnitSymbol	inherited from: Curve
y2Multiplier	0..1	UnitMultiplier	inherited from: Curve
y2Unit	0..1	UnitSymbol	inherited from: Curve
y3Multiplier	0..1	UnitMultiplier	inherited from: Curve
y3Unit	0..1	UnitSymbol	inherited from: Curve
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 472 shows all association ends of TailbayLossCurve with other classes.

Table 472 – Association ends of Production::TailbayLossCurve with other classes

mult from	name	mult to	type	description
0..*	HydroGeneratingUnit	1..1	HydroGeneratingUnit	A hydro generating unit has a tailbay loss curve.
1..1	CurveDatas	0..*	CurveData	inherited from: Curve
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.6.3.48 TargetLevelSchedule

Reservoir water level targets from advanced studies or "rule curves". Typically in one hour increments for up to 10 days.

Table 473 shows all attributes of TargetLevelSchedule.

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Table 473 – Attributes of Production::TargetLevelSchedule

name	mult	type	description
highLevelLimit	0..1	WaterLevel	High target level limit, above which the reservoir operation will be penalized.
lowLevelLimit	0..1	WaterLevel	Low target level limit, below which the reservoir operation will be penalized.
curveStyle	0..1	CurveStyle	inherited from: Curve
xMultiplier	0..1	UnitMultiplier	inherited from: Curve
xUnit	0..1	UnitSymbol	inherited from: Curve
y1Multiplier	0..1	UnitMultiplier	inherited from: Curve
y1Unit	0..1	UnitSymbol	inherited from: Curve
y2Multiplier	0..1	UnitMultiplier	inherited from: Curve
y2Unit	0..1	UnitSymbol	inherited from: Curve
y3Multiplier	0..1	UnitMultiplier	inherited from: Curve
y3Unit	0..1	UnitSymbol	inherited from: Curve
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 474 shows all association ends of TargetLevelSchedule with other classes.

Table 474 – Association ends of Production::TargetLevelSchedule with other classes

mult from	name	mult to	type	description
0..1	Reservoir	1..1	Reservoir	A reservoir may have a water level target schedule.
1..1	CurveDatas	0..*	CurveData	inherited from: Curve
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.6.3.49 ThermalGeneratingUnit

A generating unit whose prime mover could be a steam turbine, combustion turbine, or diesel engine.

Table 475 shows all attributes of ThermalGeneratingUnit.

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Table 475 – Attributes of Production::ThermalGeneratingUnit

name	mult	type	description
oMCost	0..1	CostPerHeatUnit	Operating and maintenance cost for the thermal unit.
allocSpinResP	0..1	ActivePower	inherited from: GeneratingUnit
autoCntrlMarginP	0..1	ActivePower	inherited from: GeneratingUnit
baseP	0..1	ActivePower	inherited from: GeneratingUnit
controlDeadband	0..1	ActivePower	inherited from: GeneratingUnit
controlPulseHigh	0..1	Seconds	inherited from: GeneratingUnit
controlPulseLow	0..1	Seconds	inherited from: GeneratingUnit
controlResponseRate	0..1	ActivePowerChangeRate	inherited from: GeneratingUnit
efficiency	0..1	PerCent	inherited from: GeneratingUnit
genControlMode	0..1	GeneratorControlMode	inherited from: GeneratingUnit
genControlSource	0..1	GeneratorControlSource	inherited from: GeneratingUnit
governorMPL	0..1	PU	inherited from: GeneratingUnit
governorSCD	0..1	PerCent	inherited from: GeneratingUnit
highControlLimit	0..1	ActivePower	inherited from: GeneratingUnit
initialP	0..1	ActivePower	inherited from: GeneratingUnit
longPF	0..1	Float	inherited from: GeneratingUnit
lowControlLimit	0..1	ActivePower	inherited from: GeneratingUnit
lowerRampRate	0..1	ActivePowerChangeRate	inherited from: GeneratingUnit
maxEconomicP	0..1	ActivePower	inherited from: GeneratingUnit
maximumAllowableSpinningReserve	0..1	ActivePower	inherited from: GeneratingUnit
maxOperatingP	0..1	ActivePower	inherited from: GeneratingUnit
minEconomicP	0..1	ActivePower	inherited from: GeneratingUnit
minimumOffTime	0..1	Seconds	inherited from: GeneratingUnit
minOperatingP	0..1	ActivePower	inherited from: GeneratingUnit
modelDetail	0..1	Classification	inherited from: GeneratingUnit
nominalP	0..1	ActivePower	inherited from: GeneratingUnit
normalPF	0..1	Float	inherited from: GeneratingUnit
penaltyFactor	0..1	Float	inherited from: GeneratingUnit
raiseRampRate	0..1	ActivePowerChangeRate	inherited from: GeneratingUnit
ratedGrossMaxP	0..1	ActivePower	inherited from: GeneratingUnit
ratedGrossMinP	0..1	ActivePower	inherited from: GeneratingUnit
ratedNetMaxP	0..1	ActivePower	inherited from: GeneratingUnit
shortPF	0..1	Float	inherited from: GeneratingUnit
startupCost	0..1	Money	inherited from: GeneratingUnit
startupTime	0..1	Seconds	inherited from: GeneratingUnit
tieLinePF	0..1	Float	inherited from: GeneratingUnit
totalEfficiency	0..1	PerCent	inherited from: GeneratingUnit
variableCost	0..1	Money	inherited from: GeneratingUnit
aggregate	0..1	Boolean	inherited from: Equipment
inService	0..1	Boolean	inherited from: Equipment

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name	mult	type	description
networkAnalysisEnabled	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 476 shows all association ends of ThermalGeneratingUnit with other classes.

Table 476 – Association ends of Production::ThermalGeneratingUnit with other classes

mult from	name	mult to	type	description
0..1	CAESPlant	0..1	CAESPlant	A thermal generating unit may be a member of a compressed air energy storage plant.
0..*	CogenerationPlant	0..1	CogenerationPlant	A thermal generating unit may be a member of a cogeneration plant.
0..*	CombinedCyclePlant	0..1	CombinedCyclePlant	A thermal generating unit may be a member of a combined cycle plant.
1..1	EmmissionAccounts	0..*	EmissionAccount	A thermal generating unit may have one or more emission allowance accounts.
1..1	EmissionCurves	0..*	EmissionCurve	A thermal generating unit may have one or more emission curves.
1..1	FossilFuels	0..*	FossilFuel	A thermal generating unit may have one or more fossil fuels.
1..1	FuelAllocationSchedules	0..*	FuelAllocationSchedule	A thermal generating unit may have one or more fuel allocation schedules.
1..1	HeatInputCurve	0..1	HeatInputCurve	A thermal generating unit may have a heat input curve.
1..1	HeatRateCurve	0..1	HeatRateCurve	A thermal generating unit may have a heat rate curve.
1..1	IncrementalHeatRateCurve	0..1	IncrementalHeatRateCurve	A thermal generating unit may have an incremental heat rate curve.
1..1	ShutdownCurve	0..1	ShutdownCurve	A thermal generating unit may have a shutdown curve.
1..1	StartupModel	0..1	StartupModel	A thermal generating unit may have a startup model.
0..1	RotatingMachine	0..*	RotatingMachine	inherited from: GeneratingUnit
1..1	GenUnitOpCostCurves	0..*	GenUnitOpCostCurve	inherited from: GeneratingUnit
1..1	GenUnitOpSchedule	0..1	GenUnitOpSchedule	inherited from: GeneratingUnit
1..1	ControlAreaGeneratingUnit	0..*	ControlAreaGeneratingUnit	inherited from: GeneratingUnit
1..1	GrossToNetActivePowerCurves	0..*	GrossToNetActivePowerCurve	inherited from: GeneratingUnit
0..1	OperationalLimitSet	0..*	OperationalLimitSet	inherited from: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	inherited from: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment
0..1	Faults	0..*	Fault	inherited from: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	inherited from: Equipment

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mult from	name	mult to	type	description
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.6.3.50 WindGeneratingUnit

A wind driven generating unit, connected to the grid by means of a rotating machine. May be used to represent a single turbine or an aggregation.

Table 477 shows all attributes of WindGeneratingUnit.

Table 477 – Attributes of Production::WindGeneratingUnit

name	mult	type	description
windGenUnitType	0..1	WindGenUnitKind	The kind of wind generating unit.
allocSpinResP	0..1	ActivePower	inherited from: GeneratingUnit
autoCntrlMarginP	0..1	ActivePower	inherited from: GeneratingUnit
baseP	0..1	ActivePower	inherited from: GeneratingUnit
controlDeadband	0..1	ActivePower	inherited from: GeneratingUnit
controlPulseHigh	0..1	Seconds	inherited from: GeneratingUnit
controlPulseLow	0..1	Seconds	inherited from: GeneratingUnit
controlResponseRate	0..1	ActivePowerChangeRate	inherited from: GeneratingUnit
efficiency	0..1	PerCent	inherited from: GeneratingUnit
genControlMode	0..1	GeneratorControlMode	inherited from: GeneratingUnit
genControlSource	0..1	GeneratorControlSource	inherited from: GeneratingUnit
governorMPL	0..1	PU	inherited from: GeneratingUnit
governorSCD	0..1	PerCent	inherited from: GeneratingUnit
highControlLimit	0..1	ActivePower	inherited from: GeneratingUnit
initialP	0..1	ActivePower	inherited from: GeneratingUnit
longPF	0..1	Float	inherited from: GeneratingUnit
lowControlLimit	0..1	ActivePower	inherited from: GeneratingUnit
lowerRampRate	0..1	ActivePowerChangeRate	inherited from: GeneratingUnit
maxEconomicP	0..1	ActivePower	inherited from: GeneratingUnit
maximumAllowableSpinningReserve	0..1	ActivePower	inherited from: GeneratingUnit
maxOperatingP	0..1	ActivePower	inherited from: GeneratingUnit
minEconomicP	0..1	ActivePower	inherited from: GeneratingUnit
minimumOffTime	0..1	Seconds	inherited from: GeneratingUnit
minOperatingP	0..1	ActivePower	inherited from: GeneratingUnit
modelDetail	0..1	Classification	inherited from: GeneratingUnit
nominalP	0..1	ActivePower	inherited from: GeneratingUnit

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name	mult	type	description
normalPF	0..1	Float	inherited from: GeneratingUnit
penaltyFactor	0..1	Float	inherited from: GeneratingUnit
raiseRampRate	0..1	ActivePowerChangeRate	inherited from: GeneratingUnit
ratedGrossMaxP	0..1	ActivePower	inherited from: GeneratingUnit
ratedGrossMinP	0..1	ActivePower	inherited from: GeneratingUnit
ratedNetMaxP	0..1	ActivePower	inherited from: GeneratingUnit
shortPF	0..1	Float	inherited from: GeneratingUnit
startupCost	0..1	Money	inherited from: GeneratingUnit
startupTime	0..1	Seconds	inherited from: GeneratingUnit
tieLinePF	0..1	Float	inherited from: GeneratingUnit
totalEfficiency	0..1	PerCent	inherited from: GeneratingUnit
variableCost	0..1	Money	inherited from: GeneratingUnit
aggregate	0..1	Boolean	inherited from: Equipment
inService	0..1	Boolean	inherited from: Equipment
networkAnalysisEnabled	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 478 shows all association ends of WindGeneratingUnit with other classes.

Table 478 – Association ends of Production::WindGeneratingUnit with other classes

mult from	name	mult to	type	description
0..1	RotatingMachine	0..*	RotatingMachine	inherited from: GeneratingUnit
1..1	GenUnitOpCostCurves	0..*	GenUnitOpCostCurve	inherited from: GeneratingUnit
1..1	GenUnitOpSchedule	0..1	GenUnitOpSchedule	inherited from: GeneratingUnit
1..1	ControlAreaGeneratingUnit	0..*	ControlAreaGeneratingUnit	inherited from: GeneratingUnit
1..1	GrossToNetActivePowerCurves	0..*	GrossToNetActivePowerCurve	inherited from: GeneratingUnit
0..1	OperationalLimitSet	0..*	OperationalLimitSet	inherited from: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	inherited from: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment
0..1	Faults	0..*	Fault	inherited from: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	inherited from: Equipment
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject

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mult from	name	mult to	type	description
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.7 Package DC

6.7.1 General

This package contains model for direct current equipment and controls.

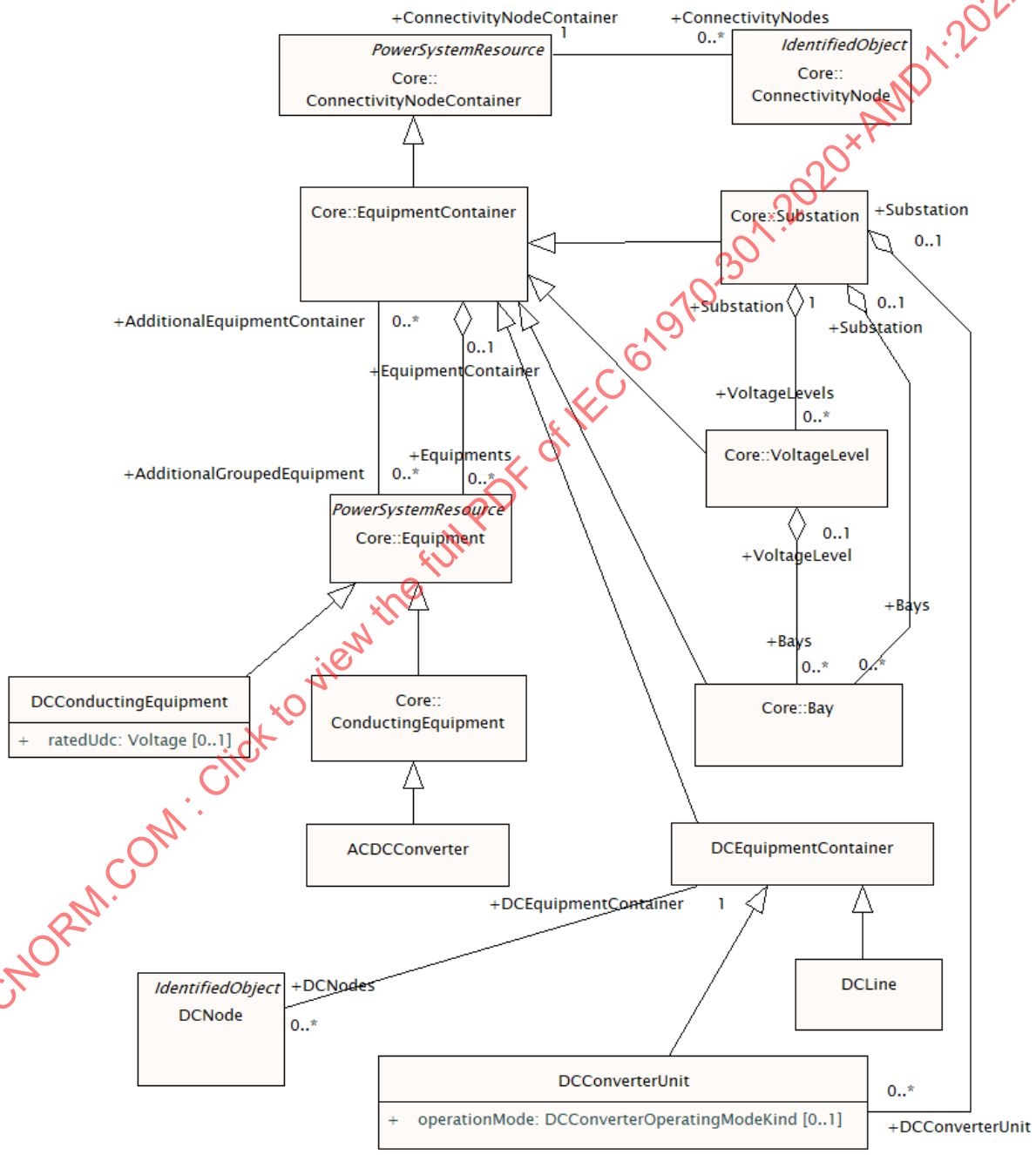


Figure 112 – Class diagram DC::DCContainment

Figure 112: The diagram show the DC containment model.

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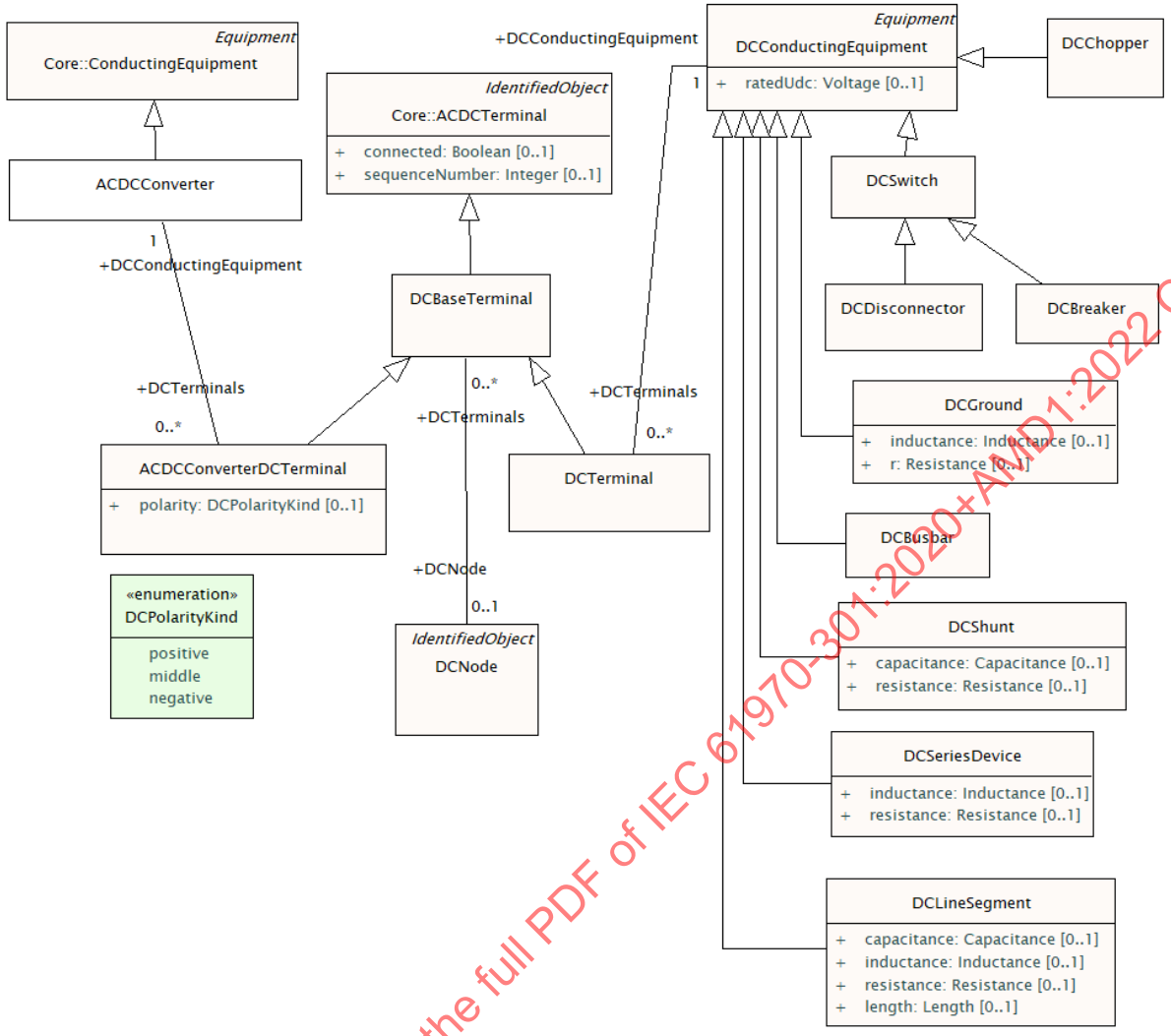


Figure 113 – Class diagram DC::DCEquipment

Figure 113: The diagram show the DC equipment model.

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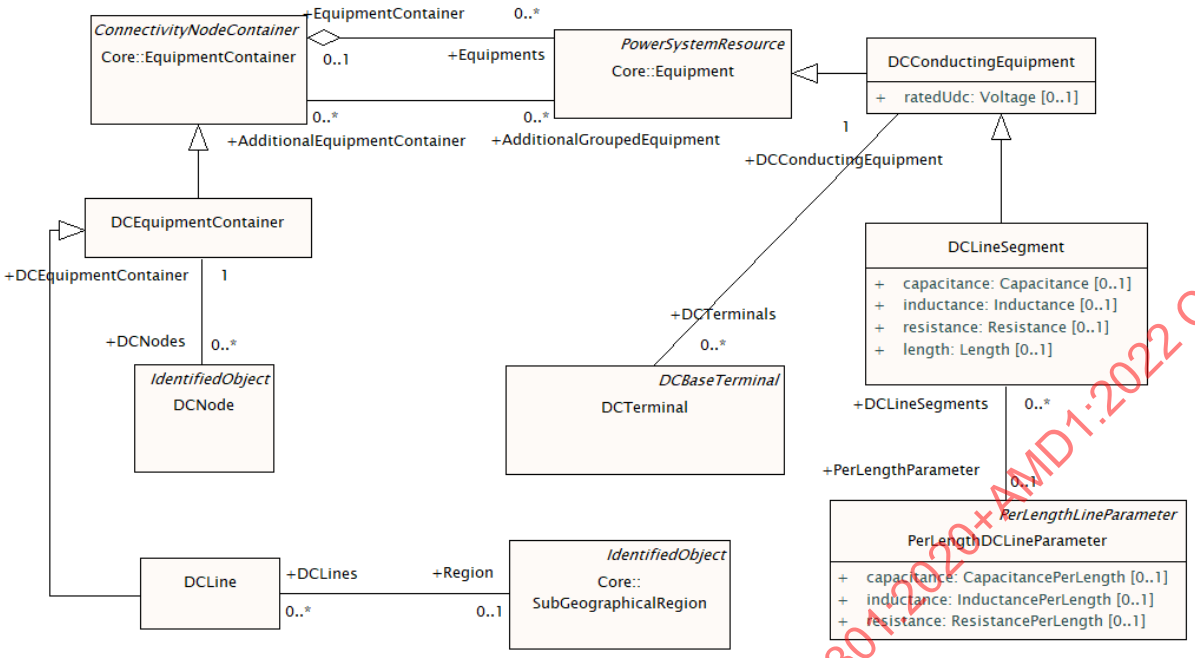
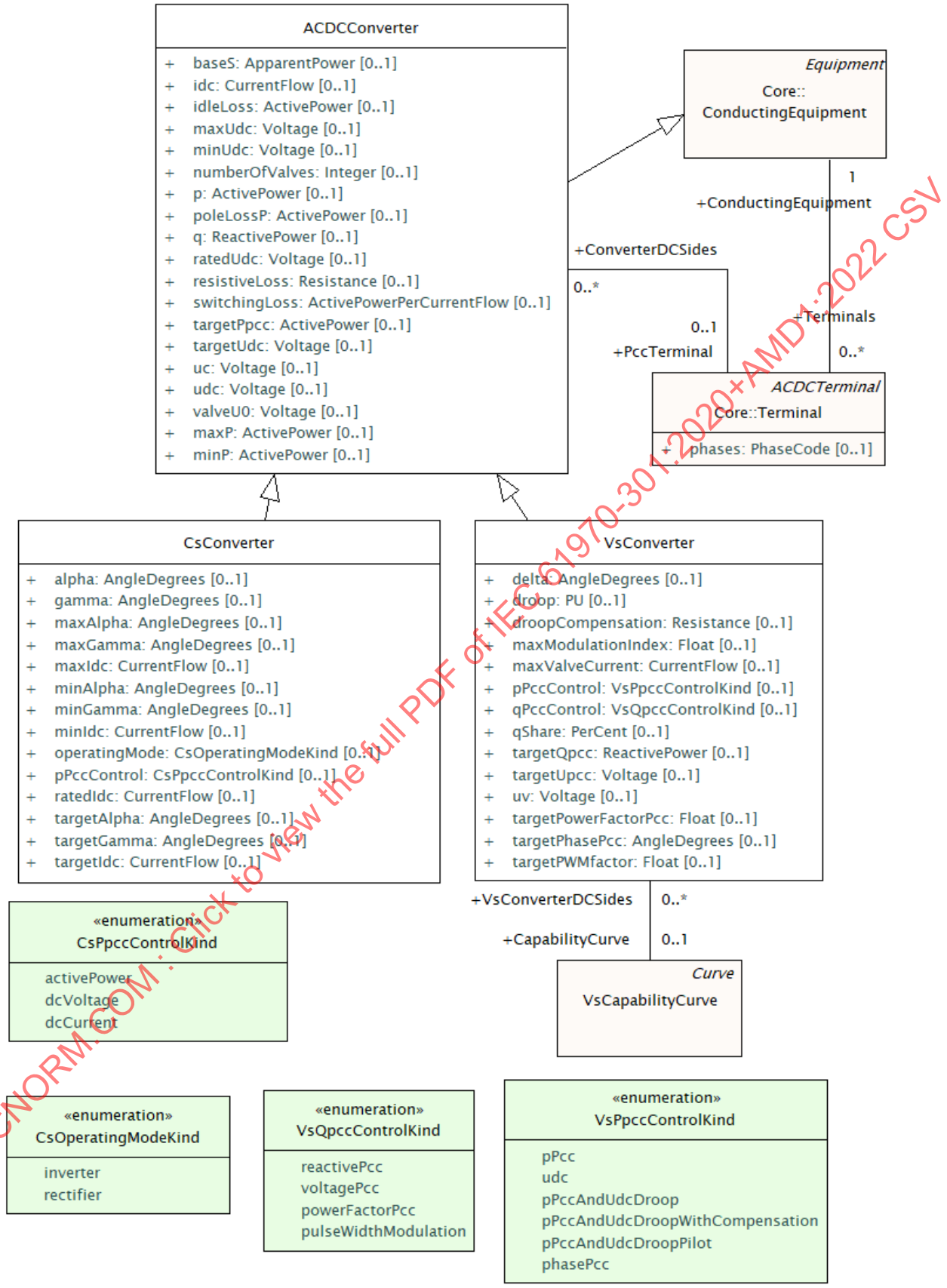


Figure 114 – Class diagram DC::DCLineModel

Figure 114: The diagram show the DC line model.

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Figure 115 – Class diagram DC::ACDCConverter

Figure 115: This diagram shows classes used to model DC converters.

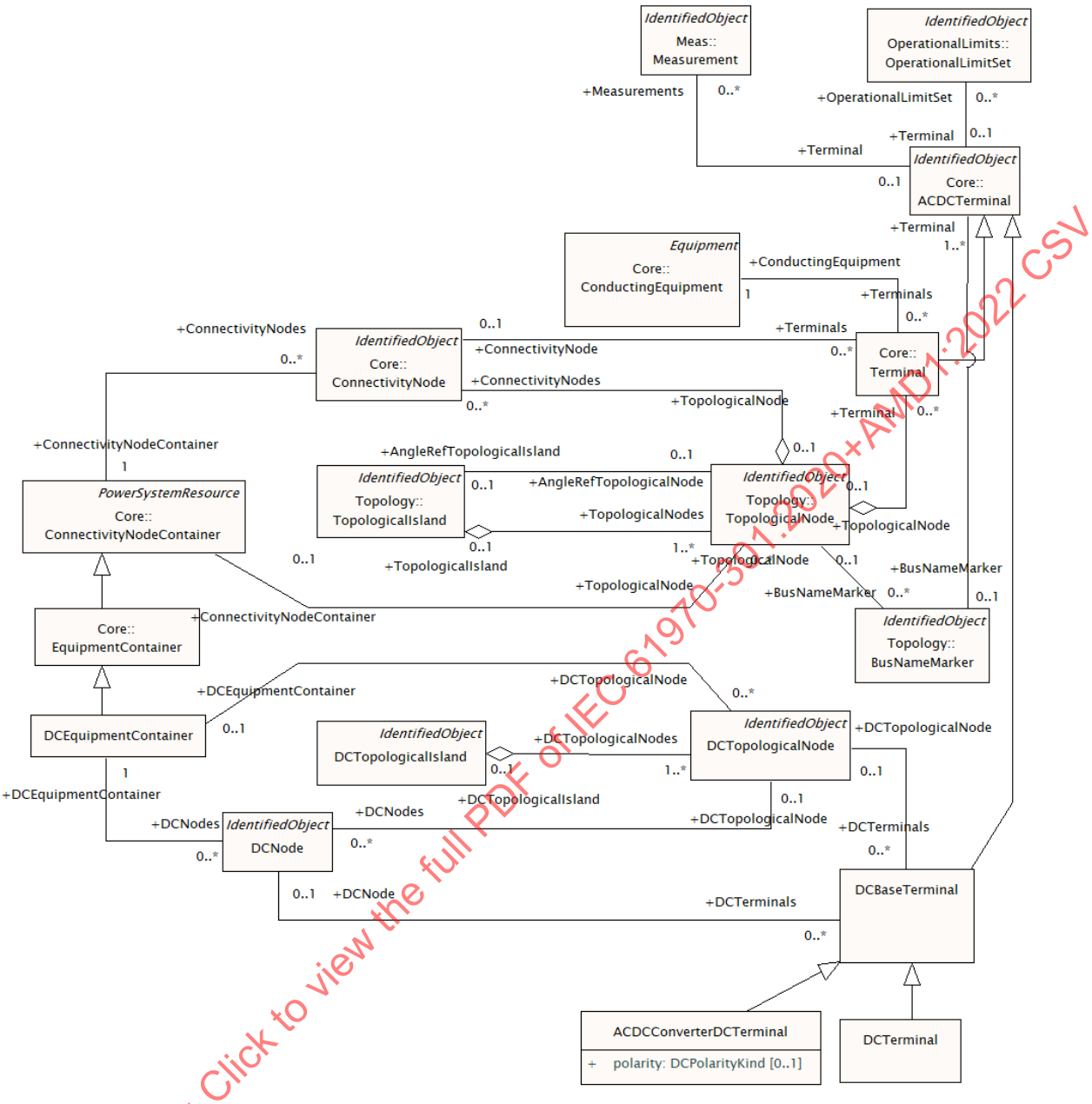


Figure 116 – Class diagram DC::ACDCConnectivityModel

Figure 116: This diagram shows connectivity and topology model for both AC and DC networks.

6.7.2 ACDCConverter

A unit with valves for three phases, together with unit control equipment, essential protective and switching devices, DC storage capacitors, phase reactors and auxiliaries, if any, used for conversion.

Table 479 shows all attributes of ACDCConverter.

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Table 479 – Attributes of DC::ACDCConverter

name	mult	type	description
baseS	0..1	ApparentPower	Base apparent power of the converter pole. The attribute shall be a positive value.
idc	0..1	CurrentFlow	Converter DC current, also called Id. It is converter's state variable, result from power flow.
idleLoss	0..1	ActivePower	Active power loss in pole at no power transfer. It is converter's configuration data used in power flow. The attribute shall be a positive value.
maxUdc	0..1	Voltage	The maximum voltage on the DC side at which the converter should operate. It is converter's configuration data used in power flow. The attribute shall be a positive value.
minUdc	0..1	Voltage	The minimum voltage on the DC side at which the converter should operate. It is converter's configuration data used in power flow. The attribute shall be a positive value.
numberOfValves	0..1	Integer	Number of valves in the converter. Used in loss calculations.
p	0..1	ActivePower	Active power at the point of common coupling. Load sign convention is used, i.e. positive sign means flow out from a node. Starting value for a steady state solution in the case a simplified power flow model is used.
poleLossP	0..1	ActivePower	The active power loss at a DC Pole = idleLoss + switchingLoss*|Idc| + resitiveLoss*Idc^2. For lossless operation Pdc=Pac. For rectifier operation with losses Pdc=Pac-lossP. For inverter operation with losses Pdc=Pac+lossP. It is converter's state variable used in power flow. The attribute shall be a positive value.
q	0..1	ReactivePower	Reactive power at the point of common coupling. Load sign convention is used, i.e. positive sign means flow out from a node. Starting value for a steady state solution in the case a simplified power flow model is used.
ratedUdc	0..1	Voltage	Rated converter DC voltage, also called UdN. The attribute shall be a positive value. It is converter's configuration data used in power flow. For instance a bipolar HVDC link with value 200 kV has a 400kV difference between the DC lines.
resistiveLoss	0..1	Resistance	It is converter's configuration data used in power flow. Refer to poleLossP. The attribute shall be a positive value.
switchingLoss	0..1	ActivePowerPerCurrentFlow	Switching losses, relative to the base apparent power 'baseS'. Refer to poleLossP. The attribute shall be a positive value.
targetPpcc	0..1	ActivePower	Real power injection target in AC grid, at point of common coupling. Load sign convention is used, i.e. positive sign means flow out from a node.
targetUdc	0..1	Voltage	Target value for DC voltage magnitude. The attribute shall be a positive value.

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name	mult	type	description
uc	0..1	Voltage	Line-to-line converter voltage, the voltage at the AC side of the valve. It is converter's state variable, result from power flow. The attribute shall be a positive value.
udc	0..1	Voltage	Converter voltage at the DC side, also called Ud. It is converter's state variable, result from power flow. The attribute shall be a positive value.
valveU0	0..1	Voltage	Valve threshold voltage, also called Uvalve. Forward voltage drop when the valve is conducting. Used in loss calculations, i.e. the switchLoss depend on numberOfValves * valveU0.
maxP	0..1	ActivePower	Maximum active power limit. The value is overwritten by values of VsCapabilityCurve, if present.
minP	0..1	ActivePower	Minimum active power limit. The value is overwritten by values of VsCapabilityCurve, if present.
aggregate	0..1	Boolean	inherited from: Equipment
inService	0..1	Boolean	inherited from: Equipment
networkAnalysisEnabled	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 480 shows all association ends of ACDCConverter with other classes.

Table 480 – Association ends of DC::ACDCConverter with other classes

mult from	name	mult to	type	description
0..*	PccTerminal	0..1	Terminal	Point of common coupling terminal for this converter DC side. It is typically the terminal on the power transformer (or switch) closest to the AC network.
1..1	DCTerminals	0..*	ACDCConverterDCTerminal	A DC converter have DC converter terminals. A converter has two DC converter terminals.
0..*	BaseVoltage	0..1	BaseVoltage	inherited from: ConductingEquipment
1..1	SvStatus	0..*	SvStatus	inherited from: ConductingEquipment
0..*	ProtectionEquipments	0..*	ProtectionEquipment	inherited from: ConductingEquipment
1..1	Terminals	0..*	Terminal	inherited from: ConductingEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	inherited from: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	inherited from: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment
0..1	Faults	0..*	Fault	inherited from: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	inherited from: Equipment
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource

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mult from	name	mult to	type	description
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.7.3 ACDCConverterDCTerminal

A DC electrical connection point at the AC/DC converter. The AC/DC converter is electrically connected also to the AC side. The AC connection is inherited from the AC conducting equipment in the same way as any other AC equipment. The AC/DC converter DC terminal is separate from generic DC terminal to restrict the connection with the AC side to AC/DC converter and so that no other DC conducting equipment can be connected to the AC side.

Table 481 shows all attributes of ACDCConverterDCTerminal.

Table 481 – Attributes of DC::ACDCConverterDCTerminal

name	mult	type	description
polarity	0..1	DCPolarityKind	Represents the normal network polarity condition. Depending on the converter configuration the value shall be set as follows: - For a monopole with two converter terminals use DCPolarityKind “positive” and “negative”. - For a bi-pole or symmetric monopole with three converter terminals use DCPolarityKind “positive”, “middle” and “negative”.
connected	0..1	Boolean	inherited from: ACDCTerminal
sequenceNumber	0..1	Integer	inherited from: ACDCTerminal
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 482 shows all association ends of ACDCConverterDCTerminal with other classes.

Table 482 – Association ends of DC::ACDCConverterDCTerminal with other classes

mult from	name	mult to	type	description
0..*	DCConductingEquipment	1..1	ACDCConverter	A DC converter terminal belong to an DC converter.
0..*	DCTopologicalNode	0..1	DCTopologicalNode	inherited from: DCBaseTerminal
0..*	DCNode	0..1	DCNode	inherited from: DCBaseTerminal
1..*	BusNameMarker	0..1	BusNameMarker	inherited from: ACDCTerminal
0..1	OperationalLimitSet	0..*	OperationalLimitSet	inherited from: ACDCTerminal
0..1	Measurements	0..*	Measurement	inherited from: ACDCTerminal
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

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6.7.4 CsConverter

DC side of the current source converter (CSC).

The firing angle controls the DC voltage at the converter, both for rectifier and inverter. The difference between the DC voltages of the rectifier and inverter determines the DC current. The extinction angle is used to limit the DC voltage at the inverter, if needed, and is not used in active power control. The firing angle, transformer tap position and number of connected filters are the primary means to control a current source DC line. Higher level controls are built on top, e.g. DC voltage, DC current and active power. From a steady state perspective it is sufficient to specify the wanted active power transfer (ACDCConverter.targetPpcc) and the control functions will set the DC voltage, DC current, firing angle, transformer tap position and number of connected filters to meet this. Therefore, attributes targetAlpha and targetGamma are not applicable in this case.

The reactive power consumed by the converter is a function of the firing angle, transformer tap position and number of connected filters, which can be approximated with half of the active power. The losses are a function of the DC voltage and DC current.

The attributes minAlpha and maxAlpha define the range of firing angles for rectifier operation between which no discrete tap changer action takes place. The range is typically 10 to 18 degrees.

The attributes minGamma and maxGamma define the range of extinction angles for inverter operation between which no discrete tap changer action takes place. The range is typically 17 to 20 degrees.

Table 483 shows all attributes of CsConverter.

Table 483 – Attributes of DC::CsConverter

name	mult	type	description
alpha	0..1	AngleDegrees	Firing angle that determines the DC voltage at the converter DC terminal. Typical value between 10 degrees and 18 degrees for a rectifier. It is converter's state variable, result from power flow. The attribute shall be a positive value.
gamma	0..1	AngleDegrees	Extinction angle. It is used to limit the DC voltage at the inverter if needed. Typical value between 17 degrees and 20 degrees for an inverter. It is converter's state variable, result from power flow. The attribute shall be a positive value.
maxAlpha	0..1	AngleDegrees	Maximum firing angle. It is converter's configuration data used in power flow. The attribute shall be a positive value.
maxGamma	0..1	AngleDegrees	Maximum extinction angle. It is converter's configuration data used in power flow. The attribute shall be a positive value.
maxIdc	0..1	CurrentFlow	The maximum direct current (Id) on the DC side at which the converter should operate. It is converter's configuration data use in power flow. The attribute shall be a positive value.
minAlpha	0..1	AngleDegrees	Minimum firing angle. It is converter's configuration data used in power flow. The attribute shall be a positive value.
minGamma	0..1	AngleDegrees	Minimum extinction angle. It is converter's configuration data used in power flow. The attribute shall be a positive value.

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name	mult	type	description
minIdc	0..1	CurrentFlow	The minimum direct current (Id) on the DC side at which the converter should operate. It is converter's configuration data used in power flow. The attribute shall be a positive value.
operatingMode	0..1	CsOperatingModeKind	Indicates whether the DC pole is operating as an inverter or as a rectifier. It is converter's control variable used in power flow.
pPccControl	0..1	CsPpccControlKind	Kind of active power control.
ratedIdc	0..1	CurrentFlow	Rated converter DC current, also called IdN. The attribute shall be a positive value. It is converter's configuration data used in power flow.
targetAlpha	0..1	AngleDegrees	Target firing angle. It is converter's control variable used in power flow. It is only applicable for rectifier if continuous tap changer control is used. Allowed values are within the range minAlpha<=targetAlpha<=maxAlpha. The attribute shall be a positive value.
targetGamma	0..1	AngleDegrees	Target extinction angle. It is converter's control variable used in power flow. It is only applicable for inverter if continuous tap changer control is used. Allowed values are within the range minGamma<=targetGamma<=maxGamma. The attribute shall be a positive value.
targetIdc	0..1	CurrentFlow	DC current target value. It is converter's control variable used in power flow. The attribute shall be a positive value.
baseS	0..1	ApparentPower	inherited from: ACDCConverter
idc	0..1	CurrentFlow	inherited from: ACDCConverter
idleLoss	0..1	ActivePower	inherited from: ACDCConverter
maxUdc	0..1	Voltage	inherited from: ACDCConverter
minUdc	0..1	Voltage	inherited from: ACDCConverter
numberOfValves	0..1	Integer	inherited from: ACDCConverter
p	0..1	ActivePower	inherited from: ACDCConverter
poleLossP	0..1	ActivePower	inherited from: ACDCConverter
q	0..1	ReactivePower	inherited from: ACDCConverter
ratedUdc	0..1	Voltage	inherited from: ACDCConverter
resistiveLoss	0..1	Resistance	inherited from: ACDCConverter
switchingLoss	0..1	ActivePowerPerCurrentFlow	inherited from: ACDCConverter
targetPpcc	0..1	ActivePower	inherited from: ACDCConverter
targetUdc	0..1	Voltage	inherited from: ACDCConverter
uc	0..1	Voltage	inherited from: ACDCConverter
udc	0..1	Voltage	inherited from: ACDCConverter
valveU0	0..1	Voltage	inherited from: ACDCConverter
maxP	0..1	ActivePower	inherited from: ACDCConverter
minP	0..1	ActivePower	inherited from: ACDCConverter
aggregate	0..1	Boolean	inherited from: Equipment
inService	0..1	Boolean	inherited from: Equipment
networkAnalysisEnabled	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject

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name	mult	type	description
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 484 shows all association ends of CsConverter with other classes.

Table 484 – Association ends of DC::CsConverter with other classes

mult from	name	mult to	type	description
1..1	CSCDynamics	0..1	CSCDynamics	Current source converter dynamics model used to describe dynamic behaviour of this converter.
0..*	PccTerminal	0..1	Terminal	inherited from: ACDCConverter
1..1	DCTerminals	0..*	ACDCConverterDCTerminal	inherited from: ACDCConverter
0..*	BaseVoltage	0..1	BaseVoltage	inherited from: ConductingEquipment
1..1	SvStatus	0..*	SvStatus	inherited from: ConductingEquipment
0..*	ProtectionEquipments	0..*	ProtectionEquipment	inherited from: ConductingEquipment
1..1	Terminals	0..*	Terminal	inherited from: ConductingEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	inherited from: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	inherited from: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment
0..1	Faults	0..*	Fault	inherited from: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	inherited from: Equipment
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.7.5 DCTopologicalNode

DC bus.

Table 485 shows all attributes of DCTopologicalNode.

Table 485 – Attributes of DC::DCTopologicalNode

name	mult	type	description
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 486 shows all association ends of DCTopologicalNode with other classes.

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Table 486 – Association ends of DC::DCTopologicalNode with other classes

mult from	name	mult to	type	description
1..*	DCTopologicalIsland	0..1	DCTopologicalIsland	A DC topological node belongs to a DC topological island.
0..1	DCTerminals	0..*	DCBaseTerminal	See association end TopologicalNode.Terminal.
0..1	DCNodes	0..*	DCNode	The DC connectivity nodes combined together to form this DC topological node. May depend on the current state of switches in the network.
0..*	DCEquipmentContainer	0..1	DCEquipmentContainer	The connectivity node container to which the topological node belongs.
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.7.6 CsOperatingModeKind enumeration

Operating mode for HVDC line operating as Current Source Converter.

Table 487 shows all literals of CsOperatingModeKind.

Table 487 – Literals of DC::CsOperatingModeKind

literal	value	description
inverter		Operating as inverter, which is the power receiving end.
rectifier		Operating as rectifier, which is the power sending end.

6.7.7 CsPpccControlKind enumeration

Active power control modes for HVDC line operating as Current Source Converter.

Table 488 shows all literals of CsPpccControlKind.

Table 488 – Literals of DC::CsPpccControlKind

literal	value	description
activePower		Control is active power control at AC side, at point of common coupling. Target is provided by ACDCConverter.targetPpcc.
dcVoltage		Control is DC voltage with target value provided by ACDCConverter.targetUdc.
dcCurrent		Control is DC current with target value provided by CsConverter.targetIdc.

6.7.8 DCBaseTerminal

An electrical connection point at a piece of DC conducting equipment. DC terminals are connected at one physical DC node that may have multiple DC terminals connected. A DC node is similar to an AC connectivity node. The model requires that DC connections are distinct from AC connections.

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Table 489 shows all attributes of DCBaseTerminal.

Table 489 – Attributes of DC::DCBaseTerminal

name	mult	type	description
connected	0..1	Boolean	inherited from: ACDCTerminal
sequenceNumber	0..1	Integer	inherited from: ACDCTerminal
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 490 shows all association ends of DCBaseTerminal with other classes.

Table 490 – Association ends of DC::DCBaseTerminal with other classes

mult from	name	mult to	type	description
0..*	DCTopologicalNode	0..1	DCTopologicalNode	See association end Terminal.TopologicalNode.
0..*	DCNode	0..1	DCNode	The DC connectivity node to which this DC base terminal connects with zero impedance.
1..*	BusNameMarker	0..1	BusNameMarker	inherited from: ACDCTerminal
0..1	OperationalLimitSet	0..*	OperationalLimitSet	inherited from: ACDCTerminal
0..1	Measurements	0..*	Measurement	inherited from: ACDCTerminal
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.7.9 DCBreaker

A breaker within a DC system.

Table 491 shows all attributes of DCBreaker.

Table 491 – Attributes of DC::DCBreaker

name	mult	type	description
ratedUdc	0..1	Voltage	inherited from: DCConductingEquipment
aggregate	0..1	Boolean	inherited from: Equipment
inService	0..1	Boolean	inherited from: Equipment
networkAnalysisEnabled	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 492 shows all association ends of DCBreaker with other classes.

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Table 492 – Association ends of DC::DCBreaker with other classes

mult from	name	mult to	type	description
1..1	DCTerminals	0..*	DCTerminal	inherited from: DCConductingEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	inherited from: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	inherited from: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment
0..1	Faults	0..*	Fault	inherited from: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	inherited from: Equipment
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.7.10 DCBusbar

A busbar within a DC system.

Table 493 shows all attributes of DCBusbar.

Table 493 – Attributes of DC::DCBusbar

name	mult	type	description
ratedUdc	0..1	Voltage	inherited from: DCConductingEquipment
aggregate	0..1	Boolean	inherited from: Equipment
inService	0..1	Boolean	inherited from: Equipment
networkAnalysisEnabled	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 494 shows all association ends of DCBusbar with other classes.

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Table 494 – Association ends of DC::DCBusbar with other classes

mult from	name	mult to	type	description
1..1	DCTerminals	0..*	DCTerminal	inherited from: DCConductingEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	inherited from: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	inherited from: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment
0..1	Faults	0..*	Fault	inherited from: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	inherited from: Equipment
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.7.11 DCChopper

Low resistance equipment used in the internal DC circuit to balance voltages. It has typically positive and negative pole terminals and a ground.

Table 495 shows all attributes of DCChopper.

Table 495 – Attributes of DC::DCChopper

name	mult	type	description
ratedUdc	0..1	Voltage	inherited from: DCConductingEquipment
aggregate	0..1	Boolean	inherited from: Equipment
inService	0..1	Boolean	inherited from: Equipment
networkAnalysisEnabled	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 496 shows all association ends of DCChopper with other classes.

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Table 496 – Association ends of DC::DCChopper with other classes

mult from	name	mult to	type	description
1..1	DCTerminals	0..*	DCTerminal	inherited from: DCConductingEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	inherited from: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	inherited from: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment
0..1	Faults	0..*	Fault	inherited from: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	inherited from: Equipment
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.7.12 DCConductingEquipment

The parts of the DC power system that are designed to carry current or that are conductively connected through DC terminals.

Table 497 shows all attributes of DCConductingEquipment.

Table 497 – Attributes of DC::DCConductingEquipment

name	mult	type	description
ratedUdc	0..1	Voltage	Rated DC device voltage. The attribute shall be a positive value. It is configuration data used in power flow.
aggregate	0..1	Boolean	inherited from: Equipment
inService	0..1	Boolean	inherited from: Equipment
networkAnalysisEnabled	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 498 shows all association ends of DCConductingEquipment with other classes.

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Table 498 – Association ends of DC::DCConductingEquipment with other classes

mult from	name	mult to	type	description
1..1	DCTerminals	0..*	DCTerminal	A DC conducting equipment has DC terminals.
0..1	OperationalLimitSet	0..*	OperationalLimitSet	inherited from: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	inherited from: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment
0..1	Faults	0..*	Fault	inherited from: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	inherited from: Equipment
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.7.13 DCConverterOperatingModeKind enumeration

The operating mode of an HVDC bipole.

Table 499 shows all literals of DCConverterOperatingModeKind.

Table 499 – Literals of DC::DCConverterOperatingModeKind

literal	value	description
bipolar		Bipolar operation.
monopolarMetallicReturn		Monopolar operation with metallic return.
monopolarGroundReturn		Monopolar operation with ground return.

6.7.14 DCConverterUnit

Indivisible operative unit comprising all equipment between the point of common coupling on the AC side and the point of common coupling – DC side, essentially one or more converters, together with one or more converter transformers, converter control equipment, essential protective and switching devices and auxiliaries, if any, used for conversion.

Table 500 shows all attributes of DCConverterUnit.

Table 500 – Attributes of DC::DCConverterUnit

name	mult	type	description
operationMode	0..1	DCConverterOperatingModeKind	The operating mode of an HVDC bipole (bipolar, monopolar metallic return, etc).
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

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Table 501 shows all association ends of DCConverterUnit with other classes.

Table 501 – Association ends of DC::DCConverterUnit with other classes

mult from	name	mult to	type	description
0..*	Substation	0..1	Substation	The containing substation of the DC converter unit.
0..1	DCTopologicalNode	0..*	DCTopologicalNode	inherited from: DCEquipmentContainer
1..1	DCNodes	0..*	DCNode	inherited from: DCEquipmentContainer
0..1	Equipments	0..*	Equipment	inherited from: EquipmentContainer
0..*	AdditionalGroupedEquipment	0..*	Equipment	inherited from: EquipmentContainer
1..1	ConnectivityNodes	0..*	ConnectivityNode	inherited from: ConnectivityNodeContainer
0..1	TopologicalNode	0..*	TopologicalNode	inherited from: ConnectivityNodeContainer
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.7.15 DCDisconnector

A disconnector within a DC system.

Table 502 shows all attributes of DCDisconnector.

Table 502 – Attributes of DC::DCDisconnector

name	mult	type	description
ratedUdc	0..1	Voltage	inherited from: DCConductingEquipment
aggregate	0..1	Boolean	inherited from: Equipment
inService	0..1	Boolean	inherited from: Equipment
networkAnalysisEnabled	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 503 shows all association ends of DCDisconnector with other classes.

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Table 503 – Association ends of DC::DCDisconnector with other classes

mult from	name	mult to	type	description
1..1	DCTerminals	0..*	DCTerminal	inherited from: DCConductingEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	inherited from: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	inherited from: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment
0..1	Faults	0..*	Fault	inherited from: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	inherited from: Equipment
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.7.16 DCEquipmentContainer

A modelling construct to provide a root class for containment of DC as well as AC equipment. The class differ from the EquipmentContaner for AC in that it may also contain DCNode-s. Hence it can contain both AC and DC equipment.

Table 504 shows all attributes of DCEquipmentContainer.

Table 504 – Attributes of DC::DCEquipmentContainer

name	mult	type	description
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 505 shows all association ends of DCEquipmentContainer with other classes.

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Table 505 – Association ends of DC::DCEquipmentContainer with other classes

mult from	name	mult to	type	description
0..1	DCTopologicalNode	0..*	DCTopologicalNode	The topological nodes which belong to this connectivity node container.
1..1	DCNodes	0..*	DCNode	The DC nodes contained in the DC equipment container.
0..1	Equipments	0..*	Equipment	inherited from: EquipmentContainer
0..*	AdditionalGroupedEquipment	0..*	Equipment	inherited from: EquipmentContainer
1..1	ConnectivityNodes	0..*	ConnectivityNode	inherited from: ConnectivityNodeContainer
0..1	TopologicalNode	0..*	TopologicalNode	inherited from: ConnectivityNodeContainer
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.7.17 DCGround

A ground within a DC system.

Table 506 shows all attributes of DCGround.

Table 506 – Attributes of DC::DCGround

name	mult	type	description
inductance	0..1	Inductance	Inductance to ground.
r	0..1	Resistance	Resistance to ground.
ratedUdc	0..1	Voltage	inherited from: DCConductingEquipment
aggregate	0..1	Boolean	inherited from: Equipment
inService	0..1	Boolean	inherited from: Equipment
networkAnalysisEnabled	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 507 shows all association ends of DCGround with other classes.

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Table 507 – Association ends of DC::DCGround with other classes

mult from	name	mult to	type	description
1..1	DCTerminals	0..*	DCTerminal	inherited from: DCConductingEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	inherited from: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	inherited from: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment
0..1	Faults	0..*	Fault	inherited from: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	inherited from: Equipment
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.7.18 DCLine

Overhead lines and/or cables connecting two or more HVDC substations.

Table 508 shows all attributes of DCLine.

Table 508 – Attributes of DC::DCLine

name	mult	type	description
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 509 shows all association ends of DCLine with other classes.

Table 509 – Association ends of DC::DCLine with other classes

mult from	name	mult to	type	description
0..*	Region	0..1	SubGeographicalRegion	The SubGeographicalRegion containing the DC line.
0..1	DCTopologicalNode	0..*	DCTopologicalNode	inherited from: DCEquipmentContainer
1..1	DCNodes	0..*	DCNode	inherited from: DCEquipmentContainer
0..1	Equipments	0..*	Equipment	inherited from: EquipmentContainer
0..*	AdditionalGroupedEquipment	0..*	Equipment	inherited from: EquipmentContainer
1..1	ConnectivityNodes	0..*	ConnectivityNode	inherited from: ConnectivityNodeContainer
0..1	TopologicalNode	0..*	TopologicalNode	inherited from: ConnectivityNodeContainer

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mult from	name	mult to	type	description
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.7.19 DCLineSegment

A wire or combination of wires not insulated from one another, with consistent electrical characteristics, used to carry direct current between points in the DC region of the power system.

Table 510 shows all attributes of DCLineSegment.

Table 510 – Attributes of DC::DCLineSegment

name	mult	type	description
capacitance	0..1	Capacitance	Capacitance of the DC line segment. Significant for cables only.
inductance	0..1	Inductance	Inductance of the DC line segment. Negligible compared with DCSeriesDevice used for smoothing.
resistance	0..1	Resistance	Resistance of the DC line segment.
length	0..1	Length	Segment length for calculating line section capabilities.
ratedUdc	0..1	Voltage	inherited from: DCConductingEquipment
aggregate	0..1	Boolean	inherited from: Equipment
inService	0..1	Boolean	inherited from: Equipment
networkAnalysisEnabled	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 511 shows all association ends of DCLineSegment with other classes.

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Table 511 – Association ends of DC::DCLineSegment with other classes

mult from	name	mult to	type	description
0..*	PerLengthParameter	0..1	PerLengthDCLineParameter	Set of per-length parameters for this line segment.
1..1	DCTerminals	0..*	DCTerminal	inherited from: DCConductingEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	inherited from: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	inherited from: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment
0..1	Faults	0..*	Fault	inherited from: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	inherited from: Equipment
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.7.20 DCNode

DC nodes are points where terminals of DC conducting equipment are connected together with zero impedance.

Table 512 shows all attributes of DCNode.

Table 512 – Attributes of DC::DCNode

name	mult	type	description
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 513 shows all association ends of DCNode with other classes.

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Table 513 – Association ends of DC::DCNode with other classes

mult from	name	mult to	type	description
0..*	DCTopologicalNode	0..1	DCTopologicalNode	The DC topological node to which this DC connectivity node is assigned. May depend on the current state of switches in the network.
0..1	DCTerminals	0..*	DCBaseTerminal	DC base terminals interconnected with zero impedance at this DC connectivity node.
0..*	DCEquipmentContainer	1..1	DCEquipmentContainer	The DC container for the DC nodes.
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.7.21 DCPolarityKind enumeration

Polarity for DC circuits.

Table 514 shows all literals of DCPolarityKind.

Table 514 – Literals of DC::DCPolarityKind

literal	value	description
positive		Positive pole. The converter terminal is intended to operate at a positive voltage relative the midpoint or negative terminal.
middle		Middle pole. The converter terminal is the midpoint in a bipolar or symmetric monopole configuration. The midpoint can be grounded and/or have a metallic return.
negative		Negative pole. The converter terminal is intended to operate at a negative voltage relative the midpoint or positive terminal.

6.7.22 DCSeriesDevice

A series device within the DC system, typically a reactor used for filtering or smoothing. Needed for transient and short circuit studies.

Table 515 shows all attributes of DCSeriesDevice.

Table 515 – Attributes of DC::DCSeriesDevice

name	mult	type	description
inductance	0..1	Inductance	Inductance of the device.
resistance	0..1	Resistance	Resistance of the DC device.
ratedUdc	0..1	Voltage	inherited from: DCConductingEquipment
aggregate	0..1	Boolean	inherited from: Equipment
inService	0..1	Boolean	inherited from: Equipment
networkAnalysisEnabled	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject

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name	mult	type	description
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 516 shows all association ends of DCSeriesDevice with other classes.

Table 516 – Association ends of DC::DCSeriesDevice with other classes

mult from	name	mult to	type	description
1..1	DCTerminals	0..*	DCTerminal	inherited from: DCConductingEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	inherited from: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	inherited from: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment
0..1	Faults	0..*	Fault	inherited from: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	inherited from: Equipment
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.7.23 DCShunt

A shunt device within the DC system, typically used for filtering. Needed for transient and short circuit studies.

Table 517 shows all attributes of DCShunt.

Table 517 – Attributes of DC::DCShunt

name	mult	type	description
capacitance	0..1	Capacitance	Capacitance of the DC shunt.
resistance	0..1	Resistance	Resistance of the DC device.
ratedUdc	0..1	Voltage	inherited from: DCConductingEquipment
aggregate	0..1	Boolean	inherited from: Equipment
inService	0..1	Boolean	inherited from: Equipment
networkAnalysisEnabled	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

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Table 518 shows all association ends of DCShunt with other classes.

Table 518 – Association ends of DC::DCShunt with other classes

mult from	name	mult to	type	description
1..1	DCTerminals	0..*	DCTerminal	inherited from: DCConductingEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	inherited from: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	inherited from: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment
0..1	Faults	0..*	Fault	inherited from: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	inherited from: Equipment
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.7.24 DCSwitch

A switch within the DC system.

Table 519 shows all attributes of DCSwitch.

Table 519 – Attributes of DC::DCSwitch

name	mult	type	description
ratedUdc	0..1	Voltage	inherited from: DCConductingEquipment
aggregate	0..1	Boolean	inherited from: Equipment
inService	0..1	Boolean	inherited from: Equipment
networkAnalysisEnabled	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 520 shows all association ends of DCSwitch with other classes.

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Table 520 – Association ends of DC::DCSwitch with other classes

mult from	name	mult to	type	description
1..1	DCTerminals	0..*	DCTerminal	inherited from: DCConductingEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	inherited from: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	inherited from: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment
0..1	Faults	0..*	Fault	inherited from: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	inherited from: Equipment
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.7.25 DCTerminal

An electrical connection point to generic DC conducting equipment.

Table 521 shows all attributes of DCTerminal.

Table 521 – Attributes of DC::DCTerminal

name	mult	type	description
connected	0..1	Boolean	inherited from: ACDCTerminal
sequenceNumber	0..1	Integer	inherited from: ACDCTerminal
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 522 shows all association ends of DCTerminal with other classes.

Table 522 – Association ends of DC::DCTerminal with other classes

mult from	name	mult to	type	description
0..*	DCConductingEquipment	1..1	DCConductingEquipment	An DC terminal belong to a DC conducting equipment.
0..*	DCTopologicalNode	0..1	DCTopologicalNode	inherited from: DCBaseTerminal
0..*	DCNode	0..1	DCNode	inherited from: DCBaseTerminal
1..*	BusNameMarker	0..1	BusNameMarker	inherited from: ACDCTerminal
0..1	OperationalLimitSet	0..*	OperationalLimitSet	inherited from: ACDCTerminal
0..1	Measurements	0..*	Measurement	inherited from: ACDCTerminal
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

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6.7.26 DCTopologicalIsland

An electrically connected subset of the network. DC topological islands can change as the current network state changes, e.g. due to:

– disconnect switches or breakers changing state in a SCADA/EMS.
– manual creation, change or deletion of topological nodes in a planning tool.

Only energised TopologicalNode-s shall be part of the topological island.

Table 523 shows all attributes of DCTopologicalIsland.

Table 523 – Attributes of DC::DCTopologicalIsland

name	mult	type	description
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 524 shows all association ends of DCTopologicalIsland with other classes.

Table 524 – Association ends of DC::DCTopologicalIsland with other classes

mult from	name	mult to	type	description
0..1	DCTopologicalNodes	1..*	DCTopologicalNode	The DC topological nodes in a DC topological island.
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.7.27 PerLengthDCLineParameter

Common type for per-length electrical catalogues describing DC line parameters.

Table 525 shows all attributes of PerLengthDCLineParameter.

Table 525 – Attributes of DC::PerLengthDCLineParameter

name	mult	type	description
capacitance	0..1	CapacitancePerLength	Capacitance per unit of length of the DC line segment; significant for cables only.
inductance	0..1	InductancePerLength	Inductance per unit of length of the DC line segment.
resistance	0..1	ResistancePerLength	Resistance per length of the DC line segment.
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 526 shows all association ends of PerLengthDCLineParameter with other classes.

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Table 526 – Association ends of DC::PerLengthDCLineParameter with other classes

mult from	name	mult to	type	description
0..1	DCLineSegments	0..*	DCLineSegment	All line segments described by this set of per-length parameters.
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.7.28 VsCapabilityCurve

The P-Q capability curve for a voltage source converter, with P on X-axis and Qmin and Qmax on Y1-axis and Y2-axis.

Table 527 shows all attributes of VsCapabilityCurve.

Table 527 – Attributes of DC::VsCapabilityCurve

name	mult	type	description
curveStyle	0..1	CurveStyle	inherited from: Curve
xMultiplier	0..1	UnitMultiplier	inherited from: Curve
xUnit	0..1	UnitSymbol	inherited from: Curve
y1Multiplier	0..1	UnitMultiplier	inherited from: Curve
y1Unit	0..1	UnitSymbol	inherited from: Curve
y2Multiplier	0..1	UnitMultiplier	inherited from: Curve
y2Unit	0..1	UnitSymbol	inherited from: Curve
y3Multiplier	0..1	UnitMultiplier	inherited from: Curve
y3Unit	0..1	UnitSymbol	inherited from: Curve
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 528 shows all association ends of VsCapabilityCurve with other classes.

Table 528 – Association ends of DC::VsCapabilityCurve with other classes

mult from	name	mult to	type	description
0..1	VsConverterDCSides	0..*	VsConverter	All converters with this capability curve.
1..1	CurveDatas	0..*	CurveData	inherited from: Curve
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.7.29 VsConverter

DC side of the voltage source converter (VSC).

Table 529 shows all attributes of VsConverter.

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Table 529 – Attributes of DC::VsConverter

name	mult	type	description
delta	0..1	AngleDegrees	Angle between VsConverter.uv and ACDCConverter.uc. It is converter's state variable used in power flow. The attribute shall be a positive value or zero.
droop	0..1	PU	Droop constant. The pu value is obtained as D [kV/MW] x Sb / Ubdc. The attribute shall be a positive value.
droopCompensation	0..1	Resistance	Compensation constant. Used to compensate for voltage drop when controlling voltage at a distant bus. The attribute shall be a positive value.
maxModulationIndex	0..1	Float	The maximum quotient between the AC converter voltage (Uc) and DC voltage (Ud). A factor typically less than 1. It is converter's configuration data used in power flow.
maxValveCurrent	0..1	CurrentFlow	The maximum current through a valve. It is converter's configuration data.
pPccControl	0..1	VsPpccControlKind	Kind of control of real power and/or DC voltage.
qPccControl	0..1	VsQpccControlKind	Kind of reactive power control.
qShare	0..1	PerCent	Reactive power sharing factor among parallel converters on Uac control. The attribute shall be a positive value or zero.
targetQpcc	0..1	ReactivePower	Reactive power injection target in AC grid, at point of common coupling. Load sign convention is used, i.e. positive sign means flow out from a node.
targetUpcc	0..1	Voltage	Voltage target in AC grid, at point of common coupling. The attribute shall be a positive value.
uv	0..1	Voltage	Line-to-line voltage on the valve side of the converter transformer. It is converter's state variable, result from power flow. The attribute shall be a positive value.
targetPowerFactorPcc	0..1	Float	Power factor target at the AC side, at point of common coupling. The attribute shall be a positive value.
targetPhasePcc	0..1	AngleDegrees	Phase target at AC side, at point of common coupling. The attribute shall be a positive value.
targetPWMfactor	0..1	Float	Magnitude of pulse-modulation factor. The attribute shall be a positive value.
baseS	0..1	ApparentPower	inherited from: ACDCConverter
idc	0..1	CurrentFlow	inherited from: ACDCConverter
idleLoss	0..1	ActivePower	inherited from: ACDCConverter
maxUdc	0..1	Voltage	inherited from: ACDCConverter
minUdc	0..1	Voltage	inherited from: ACDCConverter
numberOfValves	0..1	Integer	inherited from: ACDCConverter
p	0..1	ActivePower	inherited from: ACDCConverter
poleLossP	0..1	ActivePower	inherited from: ACDCConverter
q	0..1	ReactivePower	inherited from: ACDCConverter
ratedUdc	0..1	Voltage	inherited from: ACDCConverter
resistiveLoss	0..1	Resistance	inherited from: ACDCConverter
switchingLoss	0..1	ActivePowerPerCurrentFlow	inherited from: ACDCConverter
targetPpcc	0..1	ActivePower	inherited from: ACDCConverter

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name	mult	type	description
targetUdc	0..1	Voltage	inherited from: ACDCConverter
uc	0..1	Voltage	inherited from: ACDCConverter
udc	0..1	Voltage	inherited from: ACDCConverter
valveU0	0..1	Voltage	inherited from: ACDCConverter
maxP	0..1	ActivePower	inherited from: ACDCConverter
minP	0..1	ActivePower	inherited from: ACDCConverter
aggregate	0..1	Boolean	inherited from: Equipment
inService	0..1	Boolean	inherited from: Equipment
networkAnalysisEnabled	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 530 shows all association ends of VsConverter with other classes.

Table 530 – Association ends of DC::VsConverter with other classes

mult from	name	mult to	type	description
0..*	CapabilityCurve	0..1	VsCapabilityCurve	Capability curve of this converter.
1..1	VSCDynamics	0..1	VSCDynamics	Voltage source converter dynamics model used to describe dynamic behaviour of this converter.
0..*	PccTerminal	0..1	Terminal	inherited from: ACDCConverter
1..1	DCTerminals	0..*	ACDCConverterDCTerminal	inherited from: ACDCConverter
0..*	BaseVoltage	0..1	BaseVoltage	inherited from: ConductingEquipment
1..1	SvStatus	0..*	SvStatus	inherited from: ConductingEquipment
0..*	ProtectionEquipments	0..*	ProtectionEquipment	inherited from: ConductingEquipment
1..1	Terminals	0..*	Terminal	inherited from: ConductingEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	inherited from: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	inherited from: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment
0..*	Faults	0..*	Fault	inherited from: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	inherited from: Equipment
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

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6.7.30 VsPpccControlKind enumeration

Types applicable to the control of real power and/or DC voltage by voltage source converter.

Table 531 shows all literals of VsPpccControlKind.

Table 531 – Literals of DC::VsPpccControlKind

literal	value	description
pPcc		Control is real power at point of common coupling. The target value is provided by ACDCConverter.targetPpcc.
udc		Control is DC voltage with target value provided by ACDCConverter.targetUdc.
pPccAndUdcDroop		Control is active power at point of common coupling and local DC voltage, with the droop. Target values are provided by ACDCConverter.targetPpcc, ACDCConverter.targetUdc and VsConverter.droop.
pPccAndUdcDroopWithCompensation		Control is active power at point of common coupling and compensated DC voltage, with the droop. Compensation factor is the resistance, as an approximation of the DC voltage of a common (real or virtual) node in the DC network. Targets are provided by ACDCConverter.targetPpcc, ACDCConverter.targetUdc, VsConverter.droop and VsConverter.droopCompensation.
pPccAndUdcDroopPilot		Control is active power at point of common coupling and the pilot DC voltage, with the droop. The mode is used for Multi Terminal High Voltage DC (MTDC) systems where multiple HVDC Substations are connected to the HVDC transmission lines. The pilot voltage is then used to coordinate the control the DC voltage across the HVDC substations. Targets are provided by ACDCConverter.targetPpcc, ACDCConverter.targetUdc and VsConverter.droop.
phasePcc		Control is phase at point of common coupling. Target is provided by VsConverter.targetPhasePcc.

6.7.31 VsQpccControlKind enumeration

Kind of reactive power control at point of common coupling for a voltage source converter.

Table 532 shows all literals of VsQpccControlKind.

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Table 532 – Literals of DC::VsQpccControlKind

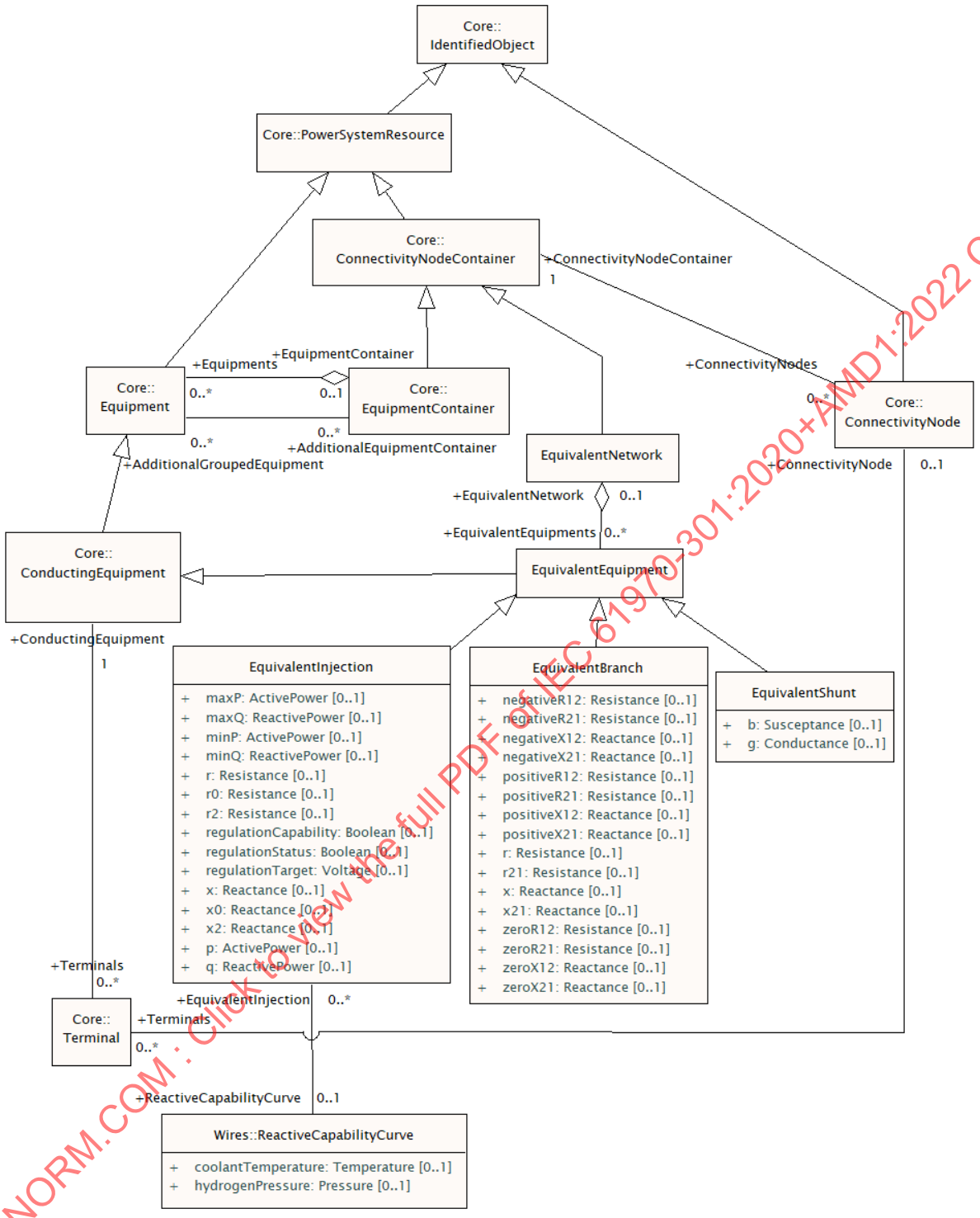
literal	value	description
reactivePcc		Control is reactive power at point of common coupling. Target is provided by VsConverter.targetQpcc.
voltagePcc		Control is voltage at point of common coupling. Target is provided by VsConverter.targetUpcc.
powerFactorPcc		Control is power factor at point of common coupling. Target is provided by VsConverter.targetPowerFactorPcc.
pulseWidthModulation		No explicit control. Pulse-modulation factor is directly set in magnitude (VsConverter.targetPWMfactor) and phase (VsConverter.targetPhasePcc).

6.8 Package Equivalents

6.8.1 General

The equivalents package models equivalent networks.

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Figure 117 – Class diagram Equivalents::Main

Figure 117: Shows model for equivalent networks.

6.8.2 EquivalentBranch

The class represents equivalent branches. In cases where a transformer phase shift is modelled and the EquivalentBranch is spanning the same nodes, the impedance quantities for the EquivalentBranch shall consider the needed phase shift.

Table 533 shows all attributes of EquivalentBranch.

Table 533 – Attributes of Equivalents::EquivalentBranch

name	mult	type	description
negativeR12	0..1	Resistance	Negative sequence series resistance from terminal sequence 1 to terminal sequence 2. Used for short circuit data exchange according to IEC 60909. EquivalentBranch is a result of network reduction prior to the data exchange.
negativeR21	0..1	Resistance	Negative sequence series resistance from terminal sequence 2 to terminal sequence 1. Used for short circuit data exchange according to IEC 60909. EquivalentBranch is a result of network reduction prior to the data exchange.
negativeX12	0..1	Reactance	Negative sequence series reactance from terminal sequence 1 to terminal sequence 2. Used for short circuit data exchange according to IEC 60909. Usage: EquivalentBranch is a result of network reduction prior to the data exchange.
negativeX21	0..1	Reactance	Negative sequence series reactance from terminal sequence 2 to terminal sequence 1. Used for short circuit data exchange according to IEC 60909. Usage: EquivalentBranch is a result of network reduction prior to the data exchange.
positiveR12	0..1	Resistance	Positive sequence series resistance from terminal sequence 1 to terminal sequence 2. Used for short circuit data exchange according to IEC 60909. EquivalentBranch is a result of network reduction prior to the data exchange.
positiveR21	0..1	Resistance	Positive sequence series resistance from terminal sequence 2 to terminal sequence 1. Used for short circuit data exchange according to IEC 60909. EquivalentBranch is a result of network reduction prior to the data exchange.
positiveX12	0..1	Reactance	Positive sequence series reactance from terminal sequence 1 to terminal sequence 2. Used for short circuit data exchange according to IEC 60909. Usage: EquivalentBranch is a result of network reduction prior to the data exchange.
positiveX21	0..1	Reactance	Positive sequence series reactance from terminal sequence 2 to terminal sequence 1. Used for short circuit data exchange according to IEC 60909. Usage: EquivalentBranch is a result of network reduction prior to the data exchange.
r	0..1	Resistance	Positive sequence series resistance of the reduced branch.

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name	mult	type	description
r21	0..1	Resistance	Resistance from terminal sequence 2 to terminal sequence 1. Used for steady state power flow. This attribute is optional and represent unbalanced network such as off-nominal phase shifter. If only EquivalentBranch.r is given, then EquivalentBranch.r21 is assumed equal to EquivalentBranch.r. Usage rule: EquivalentBranch is a result of network reduction prior to the data exchange.
x	0..1	Reactance	Positive sequence series reactance of the reduced branch.
x21	0..1	Reactance	Reactance from terminal sequence 2 to terminal sequence 1. Used for steady state power flow. This attribute is optional and represents an unbalanced network such as off-nominal phase shifter. If only EquivalentBranch.x is given, then EquivalentBranch.x21 is assumed equal to EquivalentBranch.x. Usage rule: EquivalentBranch is a result of network reduction prior to the data exchange.
zeroR12	0..1	Resistance	Zero sequence series resistance from terminal sequence 1 to terminal sequence 2. Used for short circuit data exchange according to IEC 60909. EquivalentBranch is a result of network reduction prior to the data exchange.
zeroR21	0..1	Resistance	Zero sequence series resistance from terminal sequence 2 to terminal sequence 1. Used for short circuit data exchange according to IEC 60909. Usage: EquivalentBranch is a result of network reduction prior to the data exchange.
zeroX12	0..1	Reactance	Zero sequence series reactance from terminal sequence 1 to terminal sequence 2. Used for short circuit data exchange according to IEC 60909. Usage: EquivalentBranch is a result of network reduction prior to the data exchange.
zeroX21	0..1	Reactance	Zero sequence series reactance from terminal sequence 2 to terminal sequence 1. Used for short circuit data exchange according to IEC 60909. Usage: EquivalentBranch is a result of network reduction prior to the data exchange.
aggregate	0..1	Boolean	inherited from: Equipment
inService	0..1	Boolean	inherited from: Equipment
networkAnalysisEnabled	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 534 shows all association ends of EquivalentBranch with other classes.

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Table 534 – Association ends of Equivalents::EquivalentBranch with other classes

mult from	name	mult to	type	description
0..*	EquivalentNetwork	0..1	EquivalentNetwork	inherited from: EquivalentEquipment
0..*	BaseVoltage	0..1	BaseVoltage	inherited from: ConductingEquipment
1..1	SvStatus	0..*	SvStatus	inherited from: ConductingEquipment
0..*	ProtectionEquipments	0..*	ProtectionEquipment	inherited from: ConductingEquipment
1..1	Terminals	0..*	Terminal	inherited from: ConductingEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	inherited from: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	inherited from: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment
0..1	Faults	0..*	Fault	inherited from: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	inherited from: Equipment
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.8.3 EquivalentEquipment

The class represents equivalent objects that are the result of a network reduction. The class is the base for equivalent objects of different types.

Table 535 shows all attributes of EquivalentEquipment.

Table 535 – Attributes of Equivalents::EquivalentEquipment

name	mult	type	description
aggregate	0..1	Boolean	inherited from: Equipment
inService	0..1	Boolean	inherited from: Equipment
networkAnalysisEnabled	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 536 shows all association ends of EquivalentEquipment with other classes.

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Table 536 – Association ends of Equivalents::EquivalentEquipment with other classes

mult from	name	mult to	type	description
0..*	EquivalentNetwork	0..1	EquivalentNetwork	The equivalent where the reduced model belongs.
0..*	BaseVoltage	0..1	BaseVoltage	inherited from: ConductingEquipment
1..1	SvStatus	0..*	SvStatus	inherited from: ConductingEquipment
0..*	ProtectionEquipments	0..*	ProtectionEquipment	inherited from: ConductingEquipment
1..1	Terminals	0..*	Terminal	inherited from: ConductingEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	inherited from: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	inherited from: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment
0..1	Faults	0..*	Fault	inherited from: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	inherited from: Equipment
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.8.4 EquivalentInjection

This class represents equivalent injections (generation or load). Voltage regulation is allowed only at the point of connection.

Table 537 shows all attributes of EquivalentInjection.

Table 537 – Attributes of Equivalents::EquivalentInjection

name	mult	type	description
maxP	0..1	ActivePower	Maximum active power of the injection.
maxQ	0..1	ReactivePower	Maximum reactive power of the injection. Used for modelling of infeed for load flow exchange. Not used for short circuit modelling. If maxQ and minQ are not used ReactiveCapabilityCurve can be used.
minP	0..1	ActivePower	Minimum active power of the injection.
minQ	0..1	ReactivePower	Minimum reactive power of the injection. Used for modelling of infeed for load flow exchange. Not used for short circuit modelling. If maxQ and minQ are not used ReactiveCapabilityCurve can be used.
r	0..1	Resistance	Positive sequence resistance. Used to represent Extended-Ward (IEC 60909). Usage: Extended-Ward is a result of network reduction prior to the data exchange.

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name	mult	type	description
r0	0..1	Resistance	Zero sequence resistance. Used to represent Extended-Ward (IEC 60909). Usage: Extended-Ward is a result of network reduction prior to the data exchange.
r2	0..1	Resistance	Negative sequence resistance. Used to represent Extended-Ward (IEC 60909). Usage: Extended-Ward is a result of network reduction prior to the data exchange.
regulationCapability	0..1	Boolean	Specifies whether or not the EquivalentInjection has the capability to regulate the local voltage. If true the EquivalentInjection can regulate. If false the EquivalentInjection cannot regulate. ReactiveCapabilityCurve can only be associated with EquivalentInjection if the flag is true.
regulationStatus	0..1	Boolean	Specifies the regulation status of the EquivalentInjection. True is regulating. False is not regulating.
regulationTarget	0..1	Voltage	The target voltage for voltage regulation. The attribute shall be a positive value.
x	0..1	Reactance	Positive sequence reactance. Used to represent Extended-Ward (IEC 60909). Usage: Extended-Ward is a result of network reduction prior to the data exchange.
x0	0..1	Reactance	Zero sequence reactance. Used to represent Extended-Ward (IEC 60909). Usage: Extended-Ward is a result of network reduction prior to the data exchange.
x2	0..1	Reactance	Negative sequence reactance. Used to represent Extended-Ward (IEC 60909). Usage: Extended-Ward is a result of network reduction prior to the data exchange.
p	0..1	ActivePower	Equivalent active power injection. Load sign convention is used, i.e. positive sign means flow out from a node. Starting value for steady state solutions.
q	0..1	ReactivePower	Equivalent reactive power injection. Load sign convention is used, i.e. positive sign means flow out from a node. Starting value for steady state solutions.
aggregate	0..1	Boolean	inherited from: Equipment
inService	0..1	Boolean	inherited from: Equipment
networkAnalysisEnabled	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 538 shows all association ends of EquivalentInjection with other classes.

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Table 538 – Association ends of Equivalents::EquivalentInjection with other classes

mult from	name	mult to	type	description
0..*	ReactiveCapabilityCurve	0..1	ReactiveCapabilityCurve	The reactive capability curve used by this equivalent injection.
0..*	EquivalentNetwork	0..1	EquivalentNetwork	inherited from: EquivalentEquipment
0..*	BaseVoltage	0..1	BaseVoltage	inherited from: ConductingEquipment
1..1	SvStatus	0..*	SvStatus	inherited from: ConductingEquipment
0..*	ProtectionEquipments	0..*	ProtectionEquipment	inherited from: ConductingEquipment
1..1	Terminals	0..*	Terminal	inherited from: ConductingEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	inherited from: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	inherited from: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment
0..1	Faults	0..*	Fault	inherited from: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	inherited from: Equipment
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.8.5 EquivalentNetwork

A class that groups electrical equivalents, including internal nodes, of a network that has been reduced. The ConnectivityNodes contained in the equivalent are intended to reflect internal nodes of the equivalent. The boundary Connectivity nodes where the equivalent connects outside itself are not contained by the equivalent.

Table 539 shows all attributes of EquivalentNetwork.

Table 539 – Attributes of Equivalents::EquivalentNetwork

name	mult	type	description
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 540 shows all association ends of EquivalentNetwork with other classes.

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Table 540 – Association ends of Equivalents::EquivalentNetwork with other classes

mult from	name	mult to	type	description
0..1	EquivalentEquipments	0..*	EquivalentEquipment	The associated reduced equivalents.
1..1	ConnectivityNodes	0..*	ConnectivityNode	inherited from: ConnectivityNodeContainer
0..1	TopologicalNode	0..*	TopologicalNode	inherited from: ConnectivityNodeContainer
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.8.6 EquivalentShunt

The class represents equivalent shunts.

Table 541 shows all attributes of EquivalentShunt.

Table 541 – Attributes of Equivalents::EquivalentShunt

name	mult	type	description
b	0..1	Susceptance	Positive sequence shunt susceptance.
g	0..1	Conductance	Positive sequence shunt conductance.
aggregate	0..1	Boolean	inherited from: Equipment
inService	0..1	Boolean	inherited from: Equipment
networkAnalysisEnabled	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 542 shows all association ends of EquivalentShunt with other classes.

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Table 542 – Association ends of Equivalents::EquivalentShunt with other classes

mult from	name	mult to	type	description
0..*	EquivalentNetwork	0..1	EquivalentNetwork	inherited from: EquivalentEquipment
0..*	BaseVoltage	0..1	BaseVoltage	inherited from: ConductingEquipment
1..1	SvStatus	0..*	SvStatus	inherited from: ConductingEquipment
0..*	ProtectionEquipments	0..*	ProtectionEquipment	inherited from: ConductingEquipment
1..1	Terminals	0..*	Terminal	inherited from: ConductingEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	inherited from: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	inherited from: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment
0..1	Faults	0..*	Fault	inherited from: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	inherited from: Equipment
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.9 Package AuxiliaryEquipment

6.9.1 General

Contains equipment which is not normal conducting equipment such as sensors, fault locators, and surge protectors. These devices do not define power carrying topological connections as conducting equipment, but are associated to terminals of other conducting equipment.

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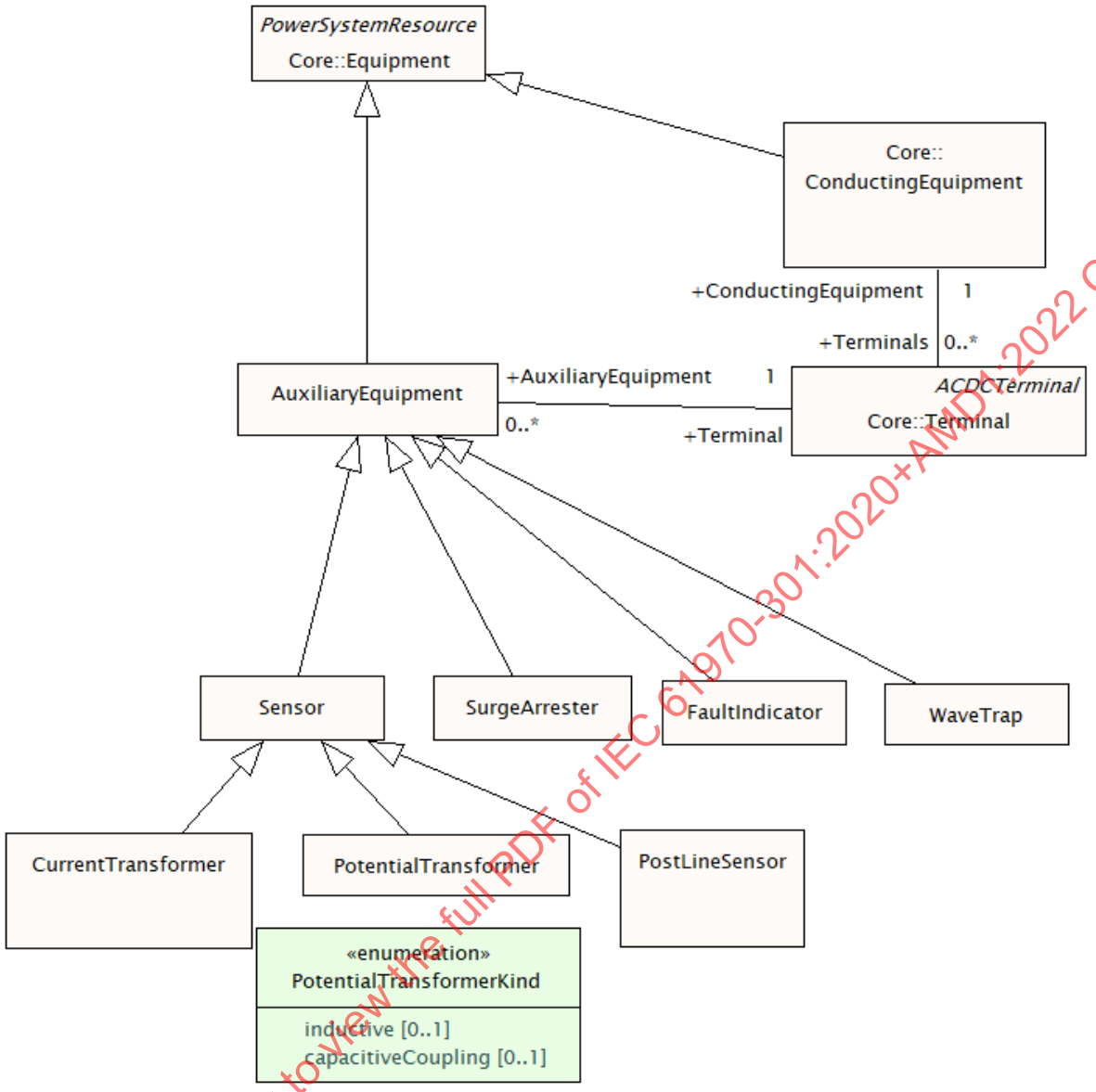


Figure 118 – Class diagram AuxiliaryEquipment::AuxiliaryEquipment

Figure 118: Inheritance and associations for auxiliary equipment.

6.9.2 AuxiliaryEquipment

AuxiliaryEquipment describe equipment that is not performing any primary functions but support for the equipment performing the primary function.

AuxiliaryEquipment is attached to primary equipment via an association with Terminal.

Table 543 shows all attributes of AuxiliaryEquipment.

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Table 543 – Attributes of AuxiliaryEquipment::AuxiliaryEquipment

name	mult	type	description
aggregate	0..1	Boolean	inherited from: Equipment
inService	0..1	Boolean	inherited from: Equipment
networkAnalysisEnabled	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 544 shows all association ends of AuxiliaryEquipment with other classes.

Table 544 – Association ends of AuxiliaryEquipment::AuxiliaryEquipment with other classes

mult from	name	mult to	type	description
0..*	Terminal	1..1	Terminal	The Terminal at the equipment where the AuxiliaryEquipment is attached.
0..1	OperationalLimitSet	0..*	OperationalLimitSet	inherited from: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	inherited from: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment
0..1	Faults	0..*	Fault	inherited from: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	inherited from: Equipment
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.9.3 CurrentTransformer

Instrument transformer used to measure electrical qualities of the circuit that is being protected and/or monitored. Typically used as current transducer for the purpose of metering or protection. A typical secondary current rating would be 5A.

Table 545 shows all attributes of CurrentTransformer.

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Table 545 – Attributes of AuxiliaryEquipment::CurrentTransformer

name	mult	type	description
accuracyClass	0..1	String	CT accuracy classification.
accuracyLimit	0..1	PerCent	Percent of rated current for which the CT remains accurate within specified limits.
ctClass	0..1	String	CT classification; i.e. class 10P.
usage	0..1	String	Intended usage of the CT; i.e. metering, protection.
coreBurden	0..1	ActivePower	Power burden of the CT core.
aggregate	0..1	Boolean	inherited from: Equipment
inService	0..1	Boolean	inherited from: Equipment
networkAnalysisEnabled	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 546 shows all association ends of CurrentTransformer with other classes.

Table 546 – Association ends of AuxiliaryEquipment::CurrentTransformer with other classes

mult from	name	mult to	type	description
0..*	Terminal	1..1	Terminal	inherited from: AuxiliaryEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	inherited from: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	inherited from: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment
0..1	Faults	0..*	Fault	inherited from: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	inherited from: Equipment
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

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6.9.4 FaultIndicator

A FaultIndicator is typically only an indicator (which may or may not be remotely monitored), and not a piece of equipment that actually initiates a protection event. It is used for FLISR (Fault Location, Isolation and Restoration) purposes, assisting with the dispatch of crews to "most likely" part of the network (i.e. assists with determining circuit section where the fault most likely happened).

Table 547 shows all attributes of FaultIndicator.

Table 547 – Attributes of AuxiliaryEquipment::FaultIndicator

name	mult	type	description
aggregate	0..1	Boolean	inherited from: Equipment
inService	0..1	Boolean	inherited from: Equipment
networkAnalysisEnabled	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 548 shows all association ends of FaultIndicator with other classes.

Table 548 – Association ends of AuxiliaryEquipment::FaultIndicator with other classes

mult from	name	mult to	type	description
0..*	Terminal	1..1	Terminal	inherited from: AuxiliaryEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	inherited from: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	inherited from: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment
0..1	Faults	0..*	Fault	inherited from: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	inherited from: Equipment
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.9.5 PostLineSensor

A sensor used mainly in overhead distribution networks as the source of both current and voltage measurements.

Table 549 shows all attributes of PostLineSensor.

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Table 549 – Attributes of AuxiliaryEquipment::PostLineSensor

name	mult	type	description
aggregate	0..1	Boolean	inherited from: Equipment
inService	0..1	Boolean	inherited from: Equipment
networkAnalysisEnabled	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 550 shows all association ends of PostLineSensor with other classes.

Table 550 – Association ends of AuxiliaryEquipment::PostLineSensor with other classes

mult from	name	mult to	type	description
0..*	Terminal	1..1	Terminal	inherited from: AuxiliaryEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	inherited from: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	inherited from: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment
0..1	Faults	0..*	Fault	inherited from: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	inherited from: Equipment
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.9.6 PotentialTransformer

Instrument transformer (also known as Voltage Transformer) used to measure electrical qualities of the circuit that is being protected and/or monitored. Typically used as voltage transducer for the purpose of metering, protection, or sometimes auxiliary substation supply. A typical secondary voltage rating would be 120V.

Table 551 shows all attributes of PotentialTransformer.

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Table 551 – Attributes of AuxiliaryEquipment::PotentialTransformer

name	mult	type	description
accuracyClass	0..1	String	PT accuracy classification.
nominalRatio	0..1	Float	Nominal ratio between the primary and secondary voltage.
ptClass	0..1	String	Potential transformer (PT) classification covering burden.
type	0..1	PotentialTransformerKind	Potential transformer construction type.
aggregate	0..1	Boolean	inherited from: Equipment
inService	0..1	Boolean	inherited from: Equipment
networkAnalysisEnabled	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 552 shows all association ends of PotentialTransformer with other classes.

Table 552 – Association ends of AuxiliaryEquipment::PotentialTransformer with other classes

mult from	name	mult to	type	description
0..*	Terminal	1..1	Terminal	inherited from: AuxiliaryEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	inherited from: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	inherited from: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment
0..1	Faults	0..*	Fault	inherited from: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	inherited from: Equipment
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

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6.9.7 PotentialTransformerKind enumeration

The construction kind of the potential transformer.

Table 553 shows all literals of PotentialTransformerKind.

Table 553 – Literals of AuxiliaryEquipment::PotentialTransformerKind

literal	value	description
inductive		The potential transformer is using induction coils to create secondary voltage.
capacitiveCoupling		The potential transformer is using capacitive coupling to create secondary voltage.

6.9.8 Sensor

This class describe devices that transform a measured quantity into signals that can be presented at displays, used in control or be recorded.

Table 554 shows all attributes of Sensor.

Table 554 – Attributes of AuxiliaryEquipment::Sensor

name	mult	type	description
aggregate	0..1	Boolean	inherited from: Equipment
inService	0..1	Boolean	inherited from: Equipment
networkAnalysisEnabled	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 555 shows all association ends of Sensor with other classes.

Table 555 – Association ends of AuxiliaryEquipment::Sensor with other classes

mult from	name	mult to	type	description
0..*	Terminal	1..1	Terminal	inherited from: AuxiliaryEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	inherited from: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	inherited from: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment
0..1	Faults	0..*	Fault	inherited from: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	inherited from: Equipment
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

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6.9.9 SurgeArrester

Shunt device, installed on the network, usually in the proximity of electrical equipment in order to protect the said equipment against transient voltage transients caused by lightning or switching activity.

Table 556 shows all attributes of SurgeArrester.

Table 556 – Attributes of AuxiliaryEquipment::SurgeArrester

name	mult	type	description
aggregate	0..1	Boolean	inherited from: Equipment
inService	0..1	Boolean	inherited from: Equipment
networkAnalysisEnabled	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 557 shows all association ends of SurgeArrester with other classes.

Table 557 – Association ends of AuxiliaryEquipment::SurgeArrester with other classes

mult from	name	mult to	type	description
0..*	Terminal	1..1	Terminal	inherited from: AuxiliaryEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	inherited from: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	inherited from: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment
0..1	Faults	0..*	Fault	inherited from: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	inherited from: Equipment
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

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6.9.10 WaveTrap

Line traps are devices that impede high frequency power line carrier signals yet present a negligible impedance at the main power frequency.

Table 558 shows all attributes of WaveTrap.

Table 558 – Attributes of AuxiliaryEquipment::WaveTrap

name	mult	type	description
aggregate	0..1	Boolean	inherited from: Equipment
inService	0..1	Boolean	inherited from: Equipment
networkAnalysisEnabled	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 559 shows all association ends of WaveTrap with other classes.

Table 559 – Association ends of AuxiliaryEquipment::WaveTrap with other classes

mult from	name	mult to	type	description
0..*	Terminal	1..1	Terminal	inherited from: AuxiliaryEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	inherited from: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	inherited from: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment
0..1	Faults	0..*	Fault	inherited from: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	inherited from: Equipment
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.10 Package Meas

6.10.1 General

Contains entities that describe dynamic measurement data exchanged between applications.

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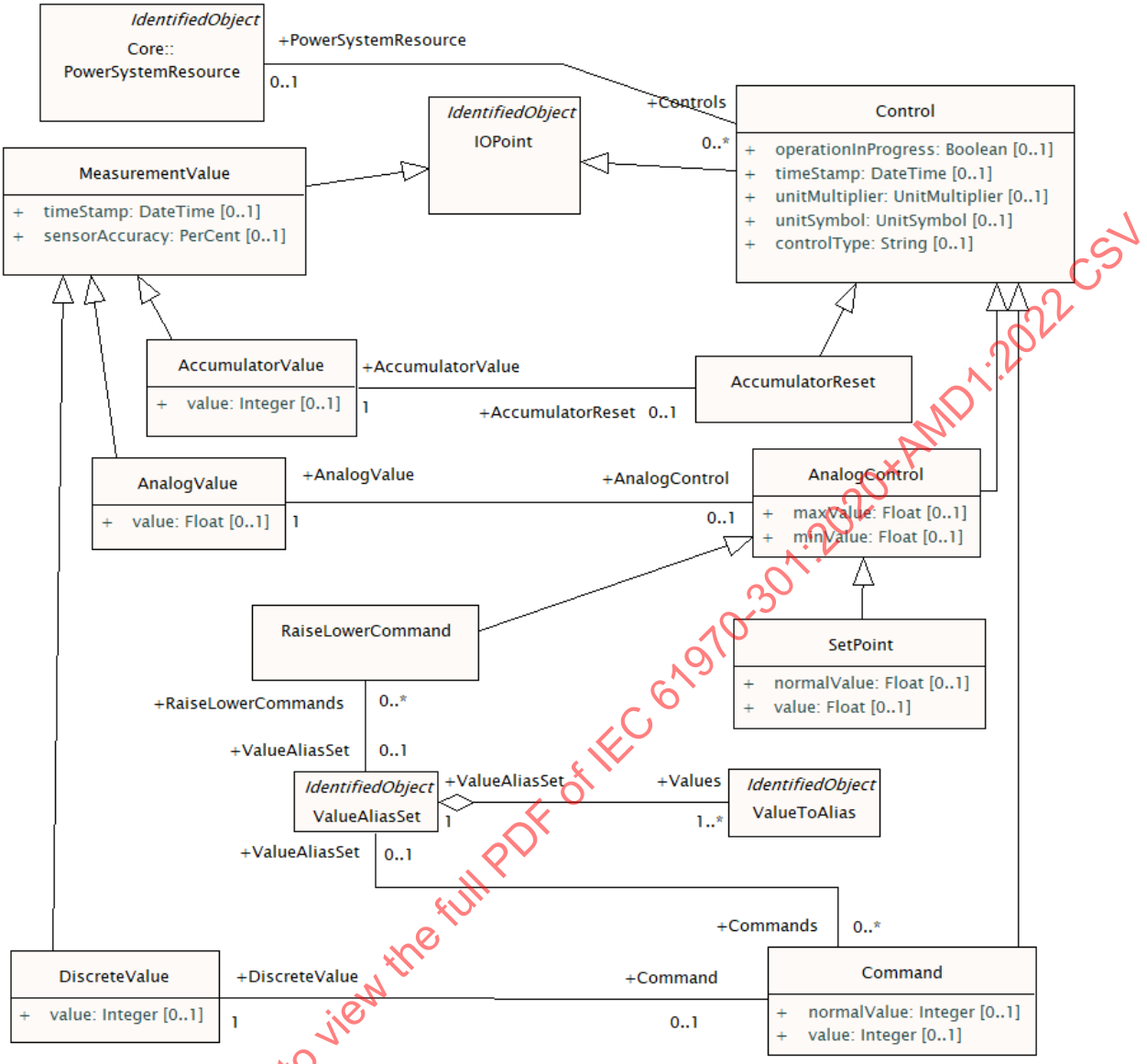


Figure 119 – Class diagram Meas::Control

Figure 119: This diagram shows all classes included in the Meas package.

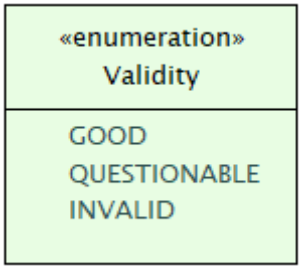
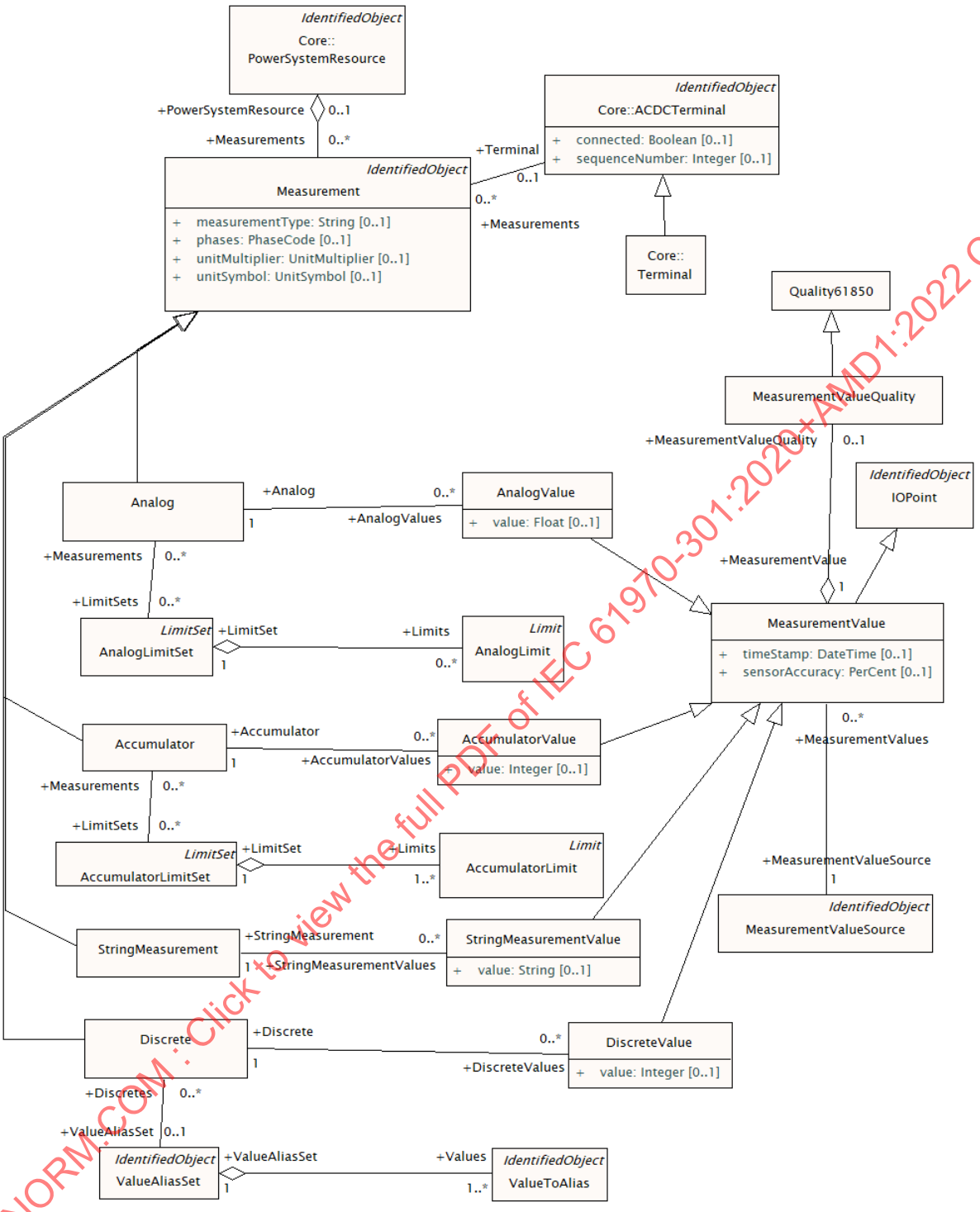


Figure 120 – Class diagram Meas::Datatypes

Figure 120: Shows datatypes for measurements.

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Figure 121 – Class diagram Meas::Measurement

Figure 121: This diagram shows classes central to the Measurement package and connections to some external classes.

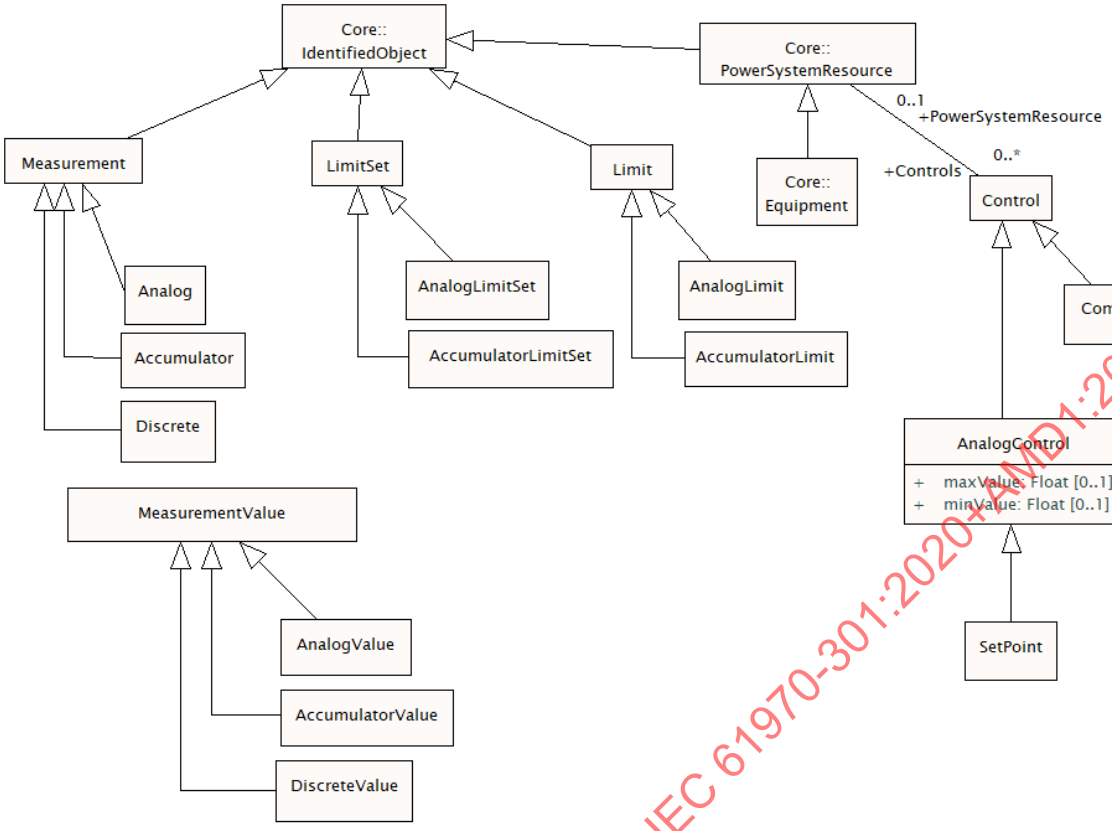


Figure 122 – Class diagram Meas::MeasurementInheritance

Figure 122: This diagram shows the measurement classes inheritance.

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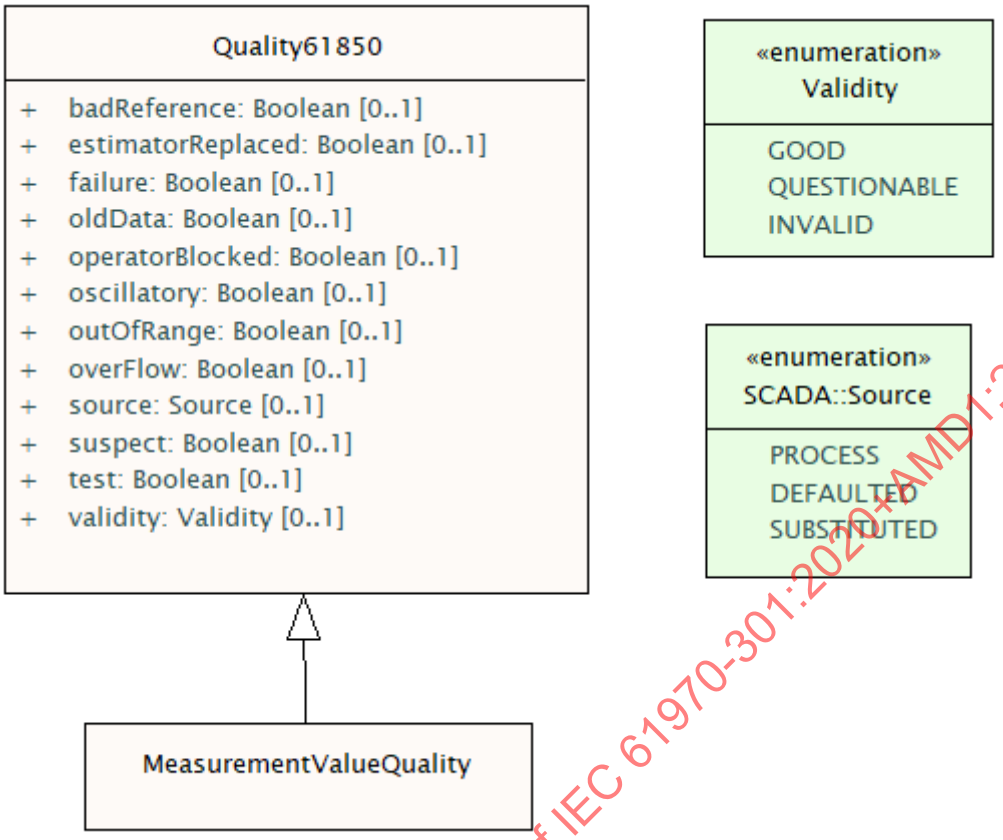


Figure 123 – Class diagram Meas::Quality

Figure 123: This diagram shows the details of the quality codes. The quality flags can be used also in other packages not only specific to MeasurementValues. A generalized Quality class is added and inherited into MeasurementValueQuality.

6.10.2 Accumulator

Accumulator represents an accumulated (counted) Measurement, e.g. an energy value.

Table 560 shows all attributes of Accumulator.

Table 560 – Attributes of Meas::Accumulator

name	mult	type	description
maxValue	0..1	Integer	Normal value range maximum for any of the MeasurementValue.values. Used for scaling, e.g. in bar graphs or of telemetered raw values.
measurementType	0..1	String	inherited from: Measurement
phases	0..1	PhaseCode	inherited from: Measurement
unitMultiplier	0..1	UnitMultiplier	inherited from: Measurement
unitSymbol	0..1	UnitSymbol	inherited from: Measurement
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

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Table 561 shows all association ends of Accumulator with other classes.

Table 561 – Association ends of Meas::Accumulator with other classes

mult from	name	mult to	type	description
1..1	AccumulatorValues	0..*	AccumulatorValue	The values connected to this measurement.
0..*	LimitSets	0..*	AccumulatorLimitSet	A measurement may have zero or more limit ranges defined for it.
0..*	Terminal	0..1	ACDCTerminal	inherited from: Measurement
0..*	PowerSystemResource	0..1	PowerSystemResource	inherited from: Measurement
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.10.3 AccumulatorLimit

Limit values for Accumulator measurements.

Table 562 shows all attributes of AccumulatorLimit.

Table 562 – Attributes of Meas::AccumulatorLimit

name	mult	type	description
value	0..1	Integer	The value to supervise against. The value is positive.
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 563 shows all association ends of AccumulatorLimit with other classes.

Table 563 – Association ends of Meas::AccumulatorLimit with other classes

mult from	name	mult to	type	description
1..*	LimitSet	1..1	AccumulatorLimitSet	The set of limits.
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.10.4 AccumulatorLimitSet

An AccumulatorLimitSet specifies a set of Limits that are associated with an Accumulator measurement.

Table 564 shows all attributes of AccumulatorLimitSet.

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Table 564 – Attributes of Meas::AccumulatorLimitSet

name	mult	type	description
isPercentageLimits	0..1	Boolean	inherited from: LimitSet
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 565 shows all association ends of AccumulatorLimitSet with other classes.

Table 565 – Association ends of Meas::AccumulatorLimitSet with other classes

mult from	name	mult to	type	description
1..1	Limits	1..*	AccumulatorLimit	The limit values used for supervision of Measurements.
0..*	Measurements	0..*	Accumulator	The Measurements using the LimitSet.
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.10.5 AccumulatorReset

This command resets the counter value to zero.

Table 566 shows all attributes of AccumulatorReset.

Table 566 – Attributes of Meas::AccumulatorReset

name	mult	type	description
operationInProgress	0..1	Boolean	inherited from: Control
timeStamp	0..1	DateTime	inherited from: Control
unitMultiplier	0..1	UnitMultiplier	inherited from: Control
unitSymbol	0..1	UnitSymbol	inherited from: Control
controlType	0..1	String	inherited from: Control
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 567 shows all association ends of AccumulatorReset with other classes.

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Table 567 – Association ends of Meas::AccumulatorReset with other classes

mult from	name	mult to	type	description
0..1	AccumulatorValue	1..1	AccumulatorValue	The accumulator value that is reset by the command.
0..*	PowerSystemResource	0..1	PowerSystemResource	inherited from: Control
1..1	RemoteControl	0..1	RemoteControl	inherited from: Control
0..1	BilateralToIOPoint	0..*	ProvidedBilateralPoint	inherited from: IOPoint
0..*	IOPointSource	0..1	IOPointSource	inherited from: IOPoint
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.10.6 AccumulatorValue

AccumulatorValue represents an accumulated (counted) MeasurementValue.

Table 568 shows all attributes of AccumulatorValue.

Table 568 – Attributes of Meas::AccumulatorValue

name	mult	type	description
value	0..1	Integer	The value to supervise. The value is positive.
timeStamp	0..1	DateTime	inherited from: MeasurementValue
sensorAccuracy	0..1	PerCent	inherited from: MeasurementValue
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 569 shows all association ends of AccumulatorValue with other classes.

Table 569 – Association ends of Meas::AccumulatorValue with other classes

mult from	name	mult to	type	description
0..*	Accumulator	1..1	Accumulator	Measurement to which this value is connected.
1..1	AccumulatorReset	0..1	AccumulatorReset	The command that resets the accumulator value.
1..1	RemoteSource	0..1	RemoteSource	inherited from: MeasurementValue
1..1	MeasurementValueQuality	0..1	MeasurementValueQuality	inherited from: MeasurementValue
0..*	MeasurementValueSource	1..1	MeasurementValueSource	inherited from: MeasurementValue
0..1	BilateralToIOPoint	0..*	ProvidedBilateralPoint	inherited from: IOPoint
0..*	IOPointSource	0..1	IOPointSource	inherited from: IOPoint
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

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6.10.7 Analog

Analog represents an analog Measurement.

Table 570 shows all attributes of Analog.

Table 570 – Attributes of Meas::Analog

name	mult	type	description
maxValue	0..1	Float	Normal value range maximum for any of the MeasurementValue.values. Used for scaling, e.g. in bar graphs or of telemetered raw values.
minValue	0..1	Float	Normal value range minimum for any of the MeasurementValue.values. Used for scaling, e.g. in bar graphs or of telemetered raw values.
normalValue	0..1	Float	Normal measurement value, e.g., used for percentage calculations.
positiveFlowIn	0..1	Boolean	If true then this measurement is an active power, reactive power or current with the convention that a positive value measured at the Terminal means power is flowing into the related PowerSystemResource.
measurementType	0..1	String	inherited from: Measurement
phases	0..1	PhaseCode	inherited from: Measurement
unitMultiplier	0..1	UnitMultiplier	inherited from: Measurement
unitSymbol	0..1	UnitSymbol	inherited from: Measurement
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 571 shows all association ends of Analog with other classes.

Table 571 – Association ends of Meas::Analog with other classes

mult from	name	mult to	type	description
1..1	AnalogValues	0..*	AnalogValue	The values connected to this measurement.
0..*	LimitSets	0..*	AnalogLimitSet	A measurement may have zero or more limit ranges defined for it.
0..*	Terminal	0..1	ACDCTerminal	inherited from: Measurement
0..*	PowerSystemResource	0..1	PowerSystemResource	inherited from: Measurement
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.10.8 AnalogControl

An analog control used for supervisory control.

Table 572 shows all attributes of AnalogControl.

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Table 572 – Attributes of Meas::AnalogControl

name	mult	type	description
maxValue	0..1	Float	Normal value range maximum for any of the Control.value. Used for scaling, e.g. in bar graphs.
minValue	0..1	Float	Normal value range minimum for any of the Control.value. Used for scaling, e.g. in bar graphs.
operationInProgress	0..1	Boolean	inherited from: Control
timeStamp	0..1	DateTime	inherited from: Control
unitMultiplier	0..1	UnitMultiplier	inherited from: Control
unitSymbol	0..1	UnitSymbol	inherited from: Control
controlType	0..1	String	inherited from: Control
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 573 shows all association ends of AnalogControl with other classes.

Table 573 – Association ends of Meas::AnalogControl with other classes

mult from	name	mult to	type	description
0..1	AnalogValue	1..1	AnalogValue	The MeasurementValue that is controlled.
0..*	PowerSystemResource	0..1	PowerSystemResource	inherited from: Control
1..1	RemoteControl	0..1	RemoteControl	inherited from: Control
0..1	BilateralToIOPoint	0..*	ProvidedBilateralPoint	inherited from: IOPoint
0..*	IOPointSource	0..1	IOPointSource	inherited from: IOPoint
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.10.9 AnalogLimit

Limit values for Analog measurements.

Table 574 shows all attributes of AnalogLimit.

Table 574 – Attributes of Meas::AnalogLimit

name	mult	type	description
value	0..1	Float	The value to supervise against.
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

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Table 575 shows all association ends of AnalogLimit with other classes.

Table 575 – Association ends of Meas::AnalogLimit with other classes

mult from	name	mult to	type	description
0..*	LimitSet	1..1	AnalogLimitSet	The set of limits.
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.10.10 AnalogLimitSet

An AnalogLimitSet specifies a set of Limits that are associated with an Analog measurement.

Table 576 shows all attributes of AnalogLimitSet.

Table 576 – Attributes of Meas::AnalogLimitSet

name	mult	type	description
isPercentageLimits	0..1	Boolean	inherited from: LimitSet
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 577 shows all association ends of AnalogLimitSet with other classes.

Table 577 – Association ends of Meas::AnalogLimitSet with other classes

mult from	name	mult to	type	description
1..1	Limits	0..*	AnalogLimit	The limit values used for supervision of Measurements.
0..*	Measurements	0..*	Analog	The Measurements using the LimitSet.
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.10.11 AnalogValue

AnalogValue represents an analog MeasurementValue.

Table 578 shows all attributes of AnalogValue.

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Table 578 – Attributes of Meas::AnalogValue

name	mult	type	description
value	0..1	Float	The value to supervise.
timeStamp	0..1	DateTime	inherited from: MeasurementValue
sensorAccuracy	0..1	PerCent	inherited from: MeasurementValue
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

n

Table 579 shows all association ends of AnalogValue with other classes.

Table 579 – Association ends of Meas::AnalogValue with other classes

mult from	name	mult to	type	description
1..1	AnalogControl	0..1	AnalogControl	The Control variable associated with the MeasurementValue.
0..*	Analog	1..1	Analog	Measurement to which this value is connected.
1..1	AltTieMeas	0..*	AltTieMeas	The usage of the measurement within the control area specification.
1..1	AltGeneratingUnit	0..*	AltGeneratingUnitMeas	The alternate generating unit for which this measurement value applies.
1..1	RemoteSource	0..1	RemoteSource	inherited from: MeasurementValue
1..1	MeasurementValueQuality	0..1	MeasurementValueQuality	inherited from: MeasurementValue
0..*	MeasurementValueSource	1..1	MeasurementValueSource	inherited from: MeasurementValue
0..1	BilateralToIOPoint	0..*	ProvidedBilateralPoint	inherited from: IOPoint
0..*	IOPointSource	0..1	IOPointSource	inherited from: IOPoint
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.10.12 Command

A Command is a discrete control used for supervisory control.

Table 580 shows all attributes of Command.

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Table 580 – Attributes of Meas::Command

name	mult	type	description
normalValue	0..1	Integer	Normal value for Control.value e.g. used for percentage scaling.
value	0..1	Integer	The value representing the actuator output.
operationInProgress	0..1	Boolean	inherited from: Control
timeStamp	0..1	DateTime	inherited from: Control
unitMultiplier	0..1	UnitMultiplier	inherited from: Control
unitSymbol	0..1	UnitSymbol	inherited from: Control
controlType	0..1	String	inherited from: Control
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 581 shows all association ends of Command with other classes.

Table 581 – Association ends of Meas::Command with other classes

mult from	name	mult to	type	description
0..*	ValueAliasSet	0..1	ValueAliasSet	The ValueAliasSet used for translation of a Control value to a name.
0..1	DiscreteValue	1..1	DiscreteValue	The MeasurementValue that is controlled.
0..*	PowerSystemResource	0..1	PowerSystemResource	inherited from: Control
1..1	RemoteControl	0..1	RemoteControl	inherited from: Control
0..1	BilateralToIOPoint	0..*	ProvidedBilateralPoint	inherited from: IOPoint
0..*	IOPointSource	0..1	IOPointSource	inherited from: IOPoint
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.10.13 Control

Control is used for supervisory/device control. It represents control outputs that are used to change the state in a process, e.g. close or open breaker, a set point value or a raise lower command.

Table 582 shows all attributes of Control.

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Table 582 – Attributes of Meas::Control

name	mult	type	description
operationInProgress	0..1	Boolean	Indicates that a client is currently sending control commands that has not completed.
timeStamp	0..1	DateTime	The last time a control output was sent.
unitMultiplier	0..1	UnitMultiplier	The unit multiplier of the controlled quantity.
unitSymbol	0..1	UnitSymbol	The unit of measure of the controlled quantity.
controlType	0..1	String	Specifies the type of Control. For example, this specifies if the Control represents BreakerOpen, BreakerClose, GeneratorVoltageSetPoint, GeneratorRaise, GeneratorLower, etc.
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 583 shows all association ends of Control with other classes.

Table 583 – Association ends of Meas::Control with other classes

mult from	name	mult to	type	description
0..*	PowerSystemResource	0..1	PowerSystemResource	Regulating device governed by this control output.
1..1	RemoteControl	0..1	RemoteControl	The remote point controlling the physical actuator.
0..1	BilateralToIOPoint	0..*	ProvidedBilateralPoint	inherited from: IOPoint
0..*	IOPointSource	0..1	IOPointSource	inherited from: IOPoint
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.10.14 Discrete

Discrete represents a discrete Measurement, i.e. a Measurement representing discrete values, e.g. a Breaker position.

Table 584 shows all attributes of Discrete.

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Table 584 – Attributes of Meas::Discrete

name	mult	type	description
maxValue	0..1	Integer	Normal value range maximum for any of the MeasurementValue.values. Used for scaling, e.g. in bar graphs or of telemetered raw values.
minValue	0..1	Integer	Normal value range minimum for any of the MeasurementValue.values. Used for scaling, e.g. in bar graphs or of telemetered raw values.
normalValue	0..1	Integer	Normal measurement value, e.g., used for percentage calculations.
measurementType	0..1	String	inherited from: Measurement
phases	0..1	PhaseCode	inherited from: Measurement
unitMultiplier	0..1	UnitMultiplier	inherited from: Measurement
unitSymbol	0..1	UnitSymbol	inherited from: Measurement
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 585 shows all association ends of Discrete with other classes.

Table 585 – Association ends of Meas::Discrete with other classes

mult from	name	mult to	type	description
1..1	DiscreteValues	0..*	DiscreteValue	The values connected to this measurement.
0..*	ValueAliasSet	0..1	ValueAliasSet	The ValueAliasSet used for translation of a MeasurementValue.value to a name.
0..*	Terminal	0..1	ACDCTerminal	inherited from: Measurement
0..*	PowerSystemResource	0..1	PowerSystemResource	inherited from: Measurement
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.10.15 DiscreteValue

DiscreteValue represents a discrete MeasurementValue.

Table 586 shows all attributes of DiscreteValue.

Table 586 – Attributes of Meas::DiscreteValue

name	mult	type	description
value	0..1	Integer	The value to supervise.
timeStamp	0..1	DateTime	inherited from: MeasurementValue
sensorAccuracy	0..1	PerCent	inherited from: MeasurementValue
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

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Table 587 shows all association ends of DiscreteValue with other classes.

Table 587 – Association ends of Meas::DiscreteValue with other classes

mult from	name	mult to	type	description
1..1	Command	0..1	Command	The Control variable associated with the MeasurementValue.
0..*	Discrete	1..1	Discrete	Measurement to which this value is connected.
1..1	RemoteSource	0..1	RemoteSource	inherited from: MeasurementValue
1..1	MeasurementValueQuality	0..1	MeasurementValueQuality	inherited from: MeasurementValue
0..*	MeasurementValueSource	1..1	MeasurementValueSource	inherited from: MeasurementValue
0..1	BilateralToIOPoint	0..*	ProvidedBilateralPoint	inherited from: IOPoint
0..*	IOPointSource	0..1	IOPointSource	inherited from: IOPoint
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.10.16 IOPoint

The class describe a measurement or control value. The purpose is to enable having attributes and associations common for measurement and control.

Table 588 shows all attributes of IOPoint.

Table 588 – Attributes of Meas::IOPoint

name	mult	type	description
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 589 shows all association ends of IOPoint with other classes.

Table 589 – Association ends of Meas::IOPoint with other classes

mult from	name	mult to	type	description
0..1	BilateralToIOPoint	0..*	ProvidedBilateralPoint	Bilateral ICCP point for the measurement or control.
0..*	IOPointSource	0..1	IOPointSource	Local merasurement value source for an ICCP point.
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

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6.10.17 Limit

Specifies one limit value for a Measurement. A Measurement typically has several limits that are kept together by the LimitSet class. The actual meaning and use of a Limit instance (i.e., if it is an alarm or warning limit or if it is a high or low limit) is not captured in the Limit class. However the name of a Limit instance may indicate both meaning and use.

Table 590 shows all attributes of Limit.

Table 590 – Attributes of Meas::Limit

name	mult	type	description
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 591 shows all association ends of Limit with other classes.

Table 591 – Association ends of Meas::Limit with other classes

mult from	name	mult to	type	description
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.10.18 LimitSet

Specifies a set of Limits that are associated with a Measurement. A Measurement may have several LimitSets corresponding to seasonal or other changing conditions. The condition is captured in the name and description attributes. The same LimitSet may be used for several Measurements. In particular percentage limits are used this way.

Table 592 shows all attributes of LimitSet.

Table 592 – Attributes of Meas::LimitSet

name	mult	type	description
isPercentageLimits	0..1	Boolean	Tells if the limit values are in percentage of normalValue or the specified Unit for Measurements and Controls.
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 593 shows all association ends of LimitSet with other classes.

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Table 593 – Association ends of Meas::LimitSet with other classes

mult from	name	mult to	type	description
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.10.19 Measurement

A Measurement represents any measured, calculated or non-measured non-calculated quantity. Any piece of equipment may contain Measurements, e.g. a substation may have temperature measurements and door open indications, a transformer may have oil temperature and tank pressure measurements, a bay may contain a number of power flow measurements and a Breaker may contain a switch status measurement.

The PSR – Measurement association is intended to capture this use of Measurement and is included in the naming hierarchy based on EquipmentContainer. The naming hierarchy typically has Measurements as leaves, e.g. Substation-VoltageLevel-Bay-Switch-Measurement.

Some Measurements represent quantities related to a particular sensor location in the network, e.g. a voltage transformer (VT) or potential transformer (PT) at a busbar or a current transformer (CT) at the bar between a breaker and an isolator. The sensing position is not captured in the PSR – Measurement association. Instead it is captured by the Measurement – Terminal association that is used to define the sensing location in the network topology. The location is defined by the connection of the Terminal to ConductingEquipment.

If both a Terminal and PSR are associated, and the PSR is of type ConductingEquipment, the associated Terminal should belong to that ConductingEquipment instance.

When the sensor location is needed both Measurement-PSR and Measurement-Terminal are used. The Measurement-Terminal association is never used alone.

Table 594 shows all attributes of Measurement.

Table 594 – Attributes of Meas::Measurement

name	mult	type	description
measurementType	0..1	String	Specifies the type of measurement. For example, this specifies if the measurement represents an indoor temperature, outdoor temperature, bus voltage, line flow, etc. When the measurementType is set to "Specialization", the type of Measurement is defined in more detail by the specialized class which inherits from Measurement.
phases	0..1	PhaseCode	Indicates to which phases the measurement applies and avoids the need to use 'measurementType' to also encode phase information (which would explode the types). The phase information in Measurement, along with 'measurementType' and 'phases' uniquely defines a Measurement for a device, based on normal network phase. Their meaning will not change when the computed energizing phasing is changed due to jumpers or other reasons. If the attribute is missing three phases (ABC) shall be assumed.
unitMultiplier	0..1	UnitMultiplier	The unit multiplier of the measured quantity.
unitSymbol	0..1	UnitSymbol	The unit of measure of the measured quantity.

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name	mult	type	description
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 595 shows all association ends of Measurement with other classes.

Table 595 – Association ends of Meas::Measurement with other classes

mult from	name	mult to	type	description
0..*	Terminal	0..1	ACDCTerminal	One or more measurements may be associated with a terminal in the network.
0..*	PowerSystemResource	0..1	PowerSystemResource	The power system resource that contains the measurement.
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.10.20 MeasurementValue

The current state for a measurement. A state value is an instance of a measurement from a specific source. Measurements can be associated with many state values, each representing a different source for the measurement.

Table 596 shows all attributes of MeasurementValue.

Table 596 – Attributes of Meas::MeasurementValue

name	mult	type	description
timeStamp	0..1	DateTime	The time when the value was last updated.
sensorAccuracy	0..1	PerCent	The limit, expressed as a percentage of the sensor maximum, that errors will not exceed when the sensor is used under reference conditions.
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 597 shows all association ends of MeasurementValue with other classes.

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Table 597 – Association ends of Meas::MeasurementValue with other classes

mult from	name	mult to	type	description
1..1	RemoteSource	0..1	RemoteSource	Link to the physical telemetered point associated with this measurement.
1..1	MeasurementValueQuality	0..1	MeasurementValueQuality	A MeasurementValue has a MeasurementValueQuality associated with it.
0..*	MeasurementValueSource	1..1	MeasurementValueSource	A reference to the type of source that updates the MeasurementValue, e.g. SCADA, CCLink, manual, etc. User conventions for the names of sources are contained in the introduction to IEC 61970-301.
0..1	BilateralToIOPoint	0..*	ProvidedBilateralPoint	inherited from: IOPoint
0..*	IOPointSource	0..1	IOPointSource	inherited from: IOPoint
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.10.21 MeasurementValueQuality

Measurement quality flags. Bits 0-10 are defined for substation automation in IEC 61850-7-3. Bits 11-15 are reserved for future expansion by that document. Bits 16-31 are reserved for EMS applications.

Table 598 shows all attributes of MeasurementValueQuality.

Table 598 – Attributes of Meas::MeasurementValueQuality

name	mult	type	description
badReference	0..1	Boolean	inherited from: Quality61850
estimatorReplaced	0..1	Boolean	inherited from: Quality61850
failure	0..1	Boolean	inherited from: Quality61850
oldData	0..1	Boolean	inherited from: Quality61850
operatorBlocked	0..1	Boolean	inherited from: Quality61850
oscillatory	0..1	Boolean	inherited from: Quality61850
outOfRange	0..1	Boolean	inherited from: Quality61850
overFlow	0..1	Boolean	inherited from: Quality61850
source	0..1	Source	inherited from: Quality61850
suspect	0..1	Boolean	inherited from: Quality61850
test	0..1	Boolean	inherited from: Quality61850
validity	0..1	Validity	inherited from: Quality61850

Table 599 shows all association ends of MeasurementValueQuality with other classes.

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Table 599 – Association ends of Meas::MeasurementValueQuality with other classes

mult from	name	mult to	type	description
0..1	MeasurementValue	1..1	MeasurementValue	A MeasurementValue has a MeasurementValueQuality associated with it.

6.10.22 MeasurementValueSource

MeasurementValueSource describes the alternative sources updating a MeasurementValue. User conventions for how to use the MeasurementValueSource attributes are defined in IEC 61970-301.

Table 600 shows all attributes of MeasurementValueSource.

Table 600 – Attributes of Meas::MeasurementValueSource

name	mult	type	description
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 601 shows all association ends of MeasurementValueSource with other classes.

Table 601 – Association ends of Meas::MeasurementValueSource with other classes

mult from	name	mult to	type	description
1..1	MeasurementValues	0..*	MeasurementValue	The MeasurementValues updated by the source.
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.10.23 Quality61850 root class

Quality flags in this class are as defined in IEC 61850, except for estimatorReplaced, which has been included in this class for convenience.

Table 602 shows all attributes of Quality61850.

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Table 602 – Attributes of Meas::Quality61850

name	mult	type	description
badReference	0..1	Boolean	Measurement value may be incorrect due to a reference being out of calibration.
estimatorReplaced	0..1	Boolean	Value has been replaced by State Estimator. estimatorReplaced is not an IEC61850 quality bit but has been put in this class for convenience.
failure	0..1	Boolean	This identifier indicates that a supervision function has detected an internal or external failure, e.g. communication failure.
oldData	0..1	Boolean	Measurement value is old and possibly invalid, as it has not been successfully updated during a specified time interval.
operatorBlocked	0..1	Boolean	Measurement value is blocked and hence unavailable for transmission.
oscillatory	0..1	Boolean	To prevent some overload of the communication it is sensible to detect and suppress oscillating (fast changing) binary inputs. If a signal changes in a defined time twice in the same direction (from 0 to 1 or from 1 to 0) then oscillation is detected and the detail quality identifier "oscillatory" is set. If it is detected a configured numbers of transient changes could be passed by. In this time the validity status "questionable" is set. If after this defined numbers of changes the signal is still in the oscillating state the value shall be set either to the opposite state of the previous stable value or to a defined default value. In this case the validity status "questionable" is reset and "invalid" is set as long as the signal is oscillating. If it is configured such that no transient changes should be passed by then the validity status "invalid" is set immediately in addition to the detail quality identifier "oscillatory" (used for status information only).
outOfRange	0..1	Boolean	Measurement value is beyond a predefined range of value.
overFlow	0..1	Boolean	Measurement value is beyond the capability of being represented properly. For example, a counter value overflows from maximum count back to a value of zero.
source	0..1	Source	Source gives information related to the origin of a value. The value may be acquired from the process, defaulted or substituted.
suspect	0..1	Boolean	A correlation function has detected that the value is not consistent with other values. Typically set by a network State Estimator.
test	0..1	Boolean	Measurement value is transmitted for test purposes.
validity	0..1	Validity	Validity of the measurement value.

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6.10.24 RaiseLowerCommand

An analog control that increases or decreases a set point value with pulses. Unless otherwise specified, one pulse moves the set point by one.

Table 603 shows all attributes of RaiseLowerCommand.

Table 603 – Attributes of Meas::RaiseLowerCommand

name	mult	type	description
maxValue	0..1	Float	inherited from: AnalogControl
minValue	0..1	Float	inherited from: AnalogControl
operationInProgress	0..1	Boolean	inherited from: Control
timeStamp	0..1	DateTime	inherited from: Control
unitMultiplier	0..1	UnitMultiplier	inherited from: Control
unitSymbol	0..1	UnitSymbol	inherited from: Control
controlType	0..1	String	inherited from: Control
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 604 shows all association ends of RaiseLowerCommand with other classes.

Table 604 – Association ends of Meas::RaiseLowerCommand with other classes

mult from	name	mult to	type	description
0..*	ValueAliasSet	0..1	ValueAliasSet	The ValueAliasSet used for translation of a Control value to a name.
0..1	AnalogValue	1..1	AnalogValue	inherited from: AnalogControl
0..*	PowerSystemResource	0..1	PowerSystemResource	inherited from: Control
1..1	RemoteControl	0..1	RemoteControl	inherited from: Control
0..1	BilateralToIOPoint	0..*	ProvidedBilateralPoint	inherited from: IOPoint
0..*	IOPointSource	0..1	IOPointSource	inherited from: IOPoint
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.10.25 SetPoint

An analog control that issues a set point value.

Table 605 shows all attributes of SetPoint.

Table 605 – Attributes of Meas::SetPoint

name	mult	type	description
normalValue	0..1	Float	Normal value for Control.value e.g. used for percentage scaling.
value	0..1	Float	The value representing the actuator output.
maxValue	0..1	Float	inherited from: AnalogControl
minValue	0..1	Float	inherited from: AnalogControl
operationInProgress	0..1	Boolean	inherited from: Control
timeStamp	0..1	DateTime	inherited from: Control
unitMultiplier	0..1	UnitMultiplier	inherited from: Control
unitSymbol	0..1	UnitSymbol	inherited from: Control

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name	mult	type	description
controlType	0..1	String	inherited from: Control
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 606 shows all association ends of SetPoint with other classes.

Table 606 – Association ends of Meas::SetPoint with other classes

mult from	name	mult to	type	description
0..1	AnalogValue	1..1	AnalogValue	inherited from: AnalogControl
0..*	PowerSystemResource	0..1	PowerSystemResource	inherited from: Control
1..1	RemoteControl	0..1	RemoteControl	inherited from: Control
0..1	BilateralToIOPoint	0..*	ProvidedBilateralPoint	inherited from: IOPoint
0..*	IOPointSource	0..1	IOPointSource	inherited from: IOPoint
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.10.26 StringMeasurement

StringMeasurement represents a measurement with values of type string.

Table 607 shows all attributes of StringMeasurement.

Table 607 – Attributes of Meas::StringMeasurement

name	mult	type	description
measurementType	0..1	String	inherited from: Measurement
phases	0..1	PhaseCode	inherited from: Measurement
unitMultiplier	0..1	UnitMultiplier	inherited from: Measurement
unitSymbol	0..1	UnitSymbol	inherited from: Measurement
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 608 shows all association ends of StringMeasurement with other classes.

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Table 608 – Association ends of Meas::StringMeasurement with other classes

mult from	name	mult to	type	description
1..1	StringMeasurementValues	0..*	StringMeasurementValue	The values connected to this measurement.
0..*	Terminal	0..1	ACDCTerminal	inherited from: Measurement
0..*	PowerSystemResource	0..1	PowerSystemResource	inherited from: Measurement
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.10.27 StringMeasurementValue

StringMeasurementValue represents a measurement value of type string.

Table 609 shows all attributes of StringMeasurementValue.

Table 609 – Attributes of Meas::StringMeasurementValue

name	mult	type	description
value	0..1	String	The value to supervise.
timeStamp	0..1	DateTime	inherited from: MeasurementValue
sensorAccuracy	0..1	PerCent	inherited from: MeasurementValue
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 610 shows all association ends of StringMeasurementValue with other classes.

Table 610 – Association ends of Meas::StringMeasurementValue with other classes

mult from	name	mult to	type	description
0..*	StringMeasurement	1..1	StringMeasurement	Measurement to which this value is connected.
1..1	RemoteSource	0..1	RemoteSource	inherited from: MeasurementValue
1..1	MeasurementValueQuality	0..1	MeasurementValueQuality	inherited from: MeasurementValue
0..*	MeasurementValueSource	1..1	MeasurementValueSource	inherited from: MeasurementValue
0..1	BilateralToIOPoint	0..*	ProvidedBilateralPoint	inherited from: IOPoint
0..*	IOPointSource	0..1	IOPointSource	inherited from: IOPoint
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.10.28 Validity enumeration

Validity for MeasurementValue.

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Table 611 shows all literals of Validity.

Table 611 – Literals of Meas::Validity

literal	value	description
GOOD		The value is marked good if no abnormal condition of the acquisition function or the information source is detected.
QUESTIONABLE		The value is marked questionable if a supervision function detects an abnormal behaviour, however the value could still be valid. The client is responsible for determining whether or not values marked "questionable" should be used.
INVALID		The value is marked invalid when a supervision function recognises abnormal conditions of the acquisition function or the information source (missing or non-operating updating devices). The value is not defined under this condition. The mark invalid is used to indicate to the client that the value may be incorrect and shall not be used.

6.10.29 ValueAliasSet

Describes the translation of a set of values into a name and is intendend to facilitate custom translations. Each ValueAliasSet has a name, description etc. A specific Measurement may represent a discrete state like Open, Closed, Intermediate etc. This requires a translation from the MeasurementValue.value number to a string, e.g. 0->"Invalid", 1->"Open", 2->"Closed", 3->"Intermediate". Each ValueToAlias member in ValueAliasSet.Value describe a mapping for one particular value to a name.

Table 612 shows all attributes of ValueAliasSet.

Table 612 – Attributes of Meas::ValueAliasSet

name	mult	type	description
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 613 shows all association ends of ValueAliasSet with other classes.

Table 613 – Association ends of Meas::ValueAliasSet with other classes

mult from	name	mult to	type	description
0..1	Discretes	0..*	Discrete	The Measurements using the set for translation.
1..1	Values	1..*	ValueToAlias	The ValueToAlias mappings included in the set.
0..1	Commands	0..*	Command	The Commands using the set for translation.
0..1	RaiseLowerCommands	0..*	RaiseLowerCommand	The Commands using the set for translation.
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject

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mult from	name	mult to	type	description
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.10.30 ValueToAlias

Describes the translation of one particular value into a name, e.g. 1 as "Open".

Table 614 shows all attributes of ValueToAlias.

Table 614 – Attributes of Meas::ValueToAlias

name	mult	type	description
value	0..1	Integer	The value that is mapped.
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 615 shows all association ends of ValueToAlias with other classes.

Table 615 – Association ends of Meas::ValueToAlias with other classes

mult from	name	mult to	type	description
1..*	ValueAliasSet	1..1	ValueAliasSet	The ValueAliasSet having the ValueToAlias mappings.
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.11 Package Topology

6.11.1 General

An extension to the Core Package that, in association with the Terminal class, models Connectivity, that is the physical definition of how equipment is connected together. In addition it models Topology, that is the logical definition of how equipment is connected via closed switches. The Topology definition is independent of the other electrical characteristics.

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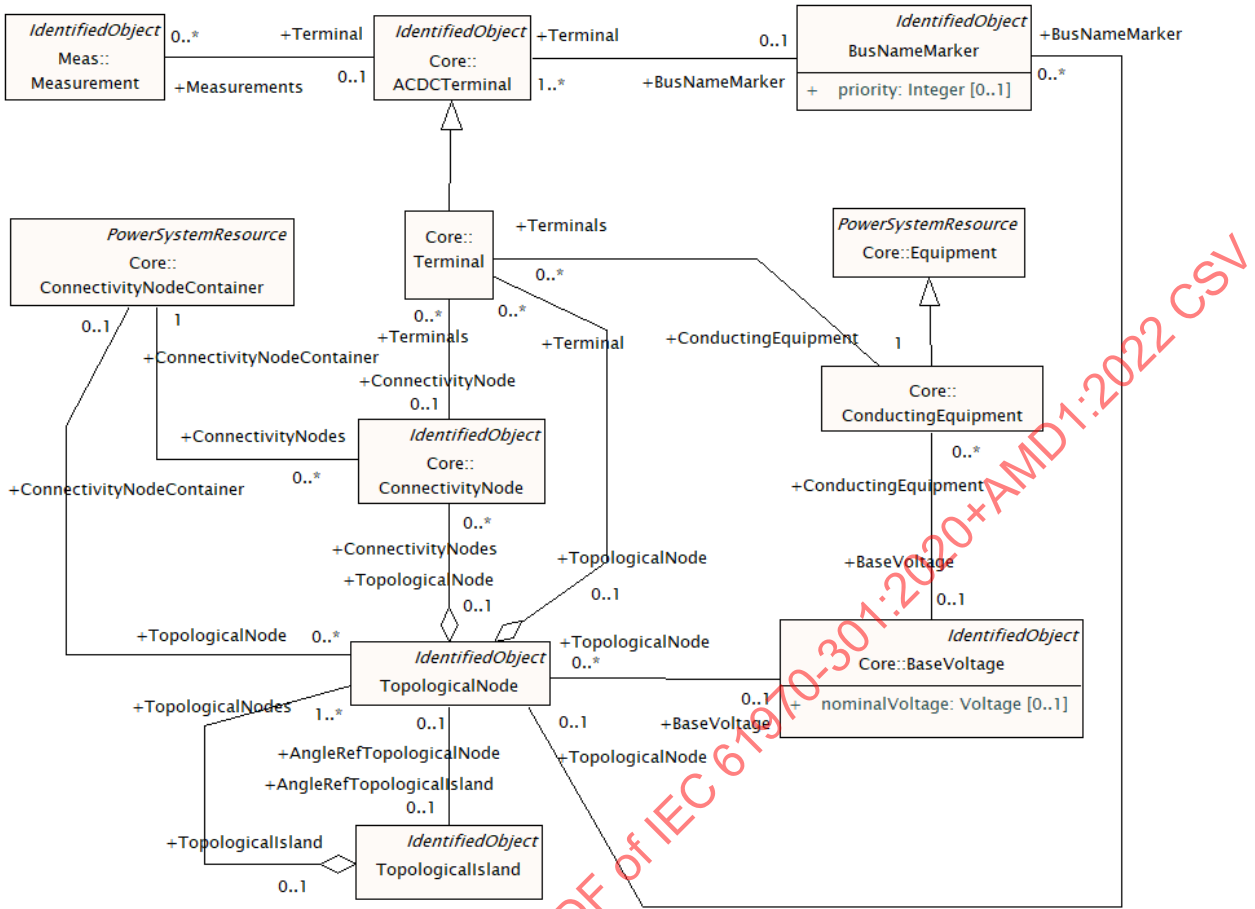


Figure 124 – Class diagram Topology::Main

Figure 124: This diagram shows all classes included in the Topology package as well as the key external classes that have associations with Topology classes.

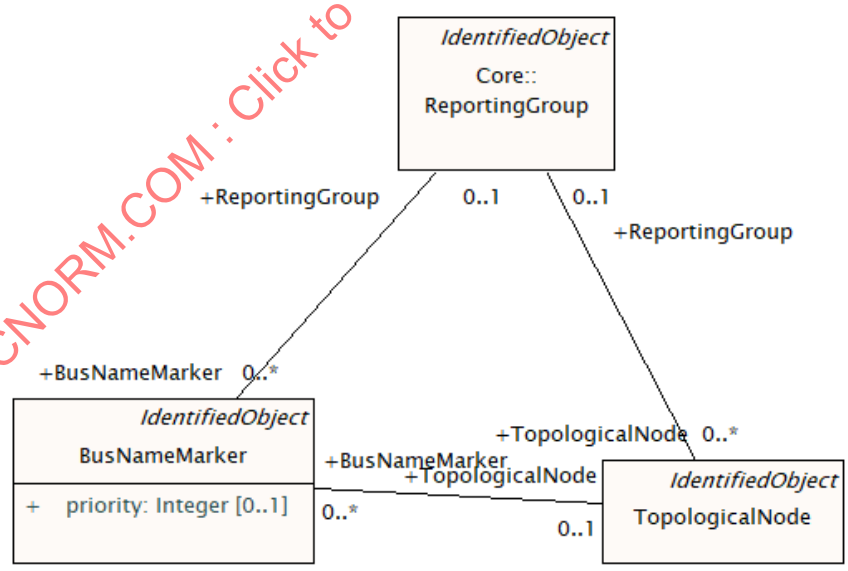


Figure 125 – Class diagram Topology::TopologyReporting

Figure 125: Shows topology reporting relationships.

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6.11.2 BusNameMarker

Used to apply user standard names to TopologicalNodes. Associated with one or more terminals that are normally connected with the bus name. The associated terminals are normally connected by non-retained switches. For a ring bus station configuration, all BusbarSection terminals in the ring are typically associated. For a breaker and a half scheme, both BusbarSections would normally be associated. For a ring bus, all BusbarSections would normally be associated. For a "straight" busbar configuration, normally only the main terminal at the BusbarSection would be associated.

Table 616 shows all attributes of BusNameMarker.

Table 616 – Attributes of Topology::BusNameMarker

name	mult	type	description
priority	0..1	Integer	Priority of bus name marker for use as topology bus name. Use 0 for do not care. Use 1 for highest priority. Use 2 as priority is less than 1 and so on.
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 617 shows all association ends of BusNameMarker with other classes.

Table 617 – Association ends of Topology::BusNameMarker with other classes

mult from	name	mult to	type	description
0..1	Terminal	1..*	ACDCTerminal	The terminals associated with this bus name marker.
0..*	ReportingGroup	0..1	ReportingGroup	The reporting group to which this bus name marker belongs.
0..*	TopologicalNode	0..1	TopologicalNode	A user defined topological node that was originally defined in a planning model not yet having topology described by ConnectivityNodes. Once ConnectivityNodes has been created they may linked to user defined ToplogicalNdes using BusNameMarkers.
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.11.3 TopologicalIsland

An electrically connected subset of the network. Topological islands can change as the current network state changes, e.g. due to:

– disconnect switches or breakers changing state in a SCADA/EMS.
– manual creation, change or deletion of topological nodes in a planning tool.

Only energised TopologicalNode-s shall be part of the topological island.

Table 618 shows all attributes of TopologicalIsland.

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Table 618 – Attributes of Topology::TopologicalIsland

name	mult	type	description
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 619 shows all association ends of TopologicalIsland with other classes.

Table 619 – Association ends of Topology::TopologicalIsland with other classes

mult from	name	mult to	type	description
0..1	AngleRefTopologicalNode	0..1	TopologicalNode	The angle reference for the island. Normally there is one TopologicalNode that is selected as the angle reference for each island. Other reference schemes exist, so the association is typically optional.
0..1	TopologicalNodes	1..*	TopologicalNode	A topological node belongs to a topological island.
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.11.4 TopologicalNode

For a detailed substation model a topological node is a set of connectivity nodes that, in the current network state, are connected together through any type of closed switches, including jumpers. Topological nodes change as the current network state changes (i.e., switches, breakers, etc. change state).

For a planning model, switch statuses are not used to form topological nodes. Instead they are manually created or deleted in a model builder tool. Topological nodes maintained this way are also called "busses".

Table 620 shows all attributes of TopologicalNode.

Table 620 – Attributes of Topology::TopologicalNode

name	mult	type	description
pInjection	0..1	ActivePower	The active power injected into the bus at this location in addition to injections from equipment. Positive sign means injection into the TopologicalNode (bus). Starting value for a steady state solution.
qInjection	0..1	ReactivePower	The reactive power injected into the bus at this location in addition to injections from equipment. Positive sign means injection into the TopologicalNode (bus). Starting value for a steady state solution.
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject

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name	mult	type	description
name	0..1	String	inherited from: IdentifiedObject

Table 621 shows all association ends of TopologicalNode with other classes.

Table 621 – Association ends of Topology::TopologicalNode with other classes

mult from	name	mult to	type	description
0..*	BaseVoltage	0..1	BaseVoltage	The base voltage of the topological node.
0..*	ConnectivityNodeContainer	0..1	ConnectivityNodeContainer	The connectivity node container to which the topological node belongs.
0..*	ReportingGroup	0..1	ReportingGroup	The reporting group to which the topological node belongs.
1..*	TopologicalIsland	0..1	TopologicalIsland	A topological node belongs to a topological island.
0..1	ConnectivityNodes	0..*	ConnectivityNode	The connectivity nodes combine together to form this topological node. May depend on the current state of switches in the network.
0..1	Terminal	0..*	Terminal	The terminals associated with the topological node. This can be used as an alternative to the connectivity node path to terminal, thus making it unnecessary to model connectivity nodes in some cases. Note that if connectivity nodes are in the model, this association would probably not be used as an input specification.
0..1	BusNameMarker	0..*	BusNameMarker	BusnameMarkers that may refer to a pre defined TopologicalNode.
0..1	AngleRefTopologicalIsland	0..1	TopologicalIsland	The island for which the node is an angle reference. Normally there is one angle reference node for each island.
1..1	SvInjection	0..*	SvInjection	The injection flows state variables associated with the topological node.
1..1	SvVoltage	0..*	SvVoltage	The state voltage associated with the topological node.
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.12 Package DiagramLayout

6.12.1 General

This package describes diagram layout. This describes how objects are arranged in a coordinate system rather than how they are rendered.

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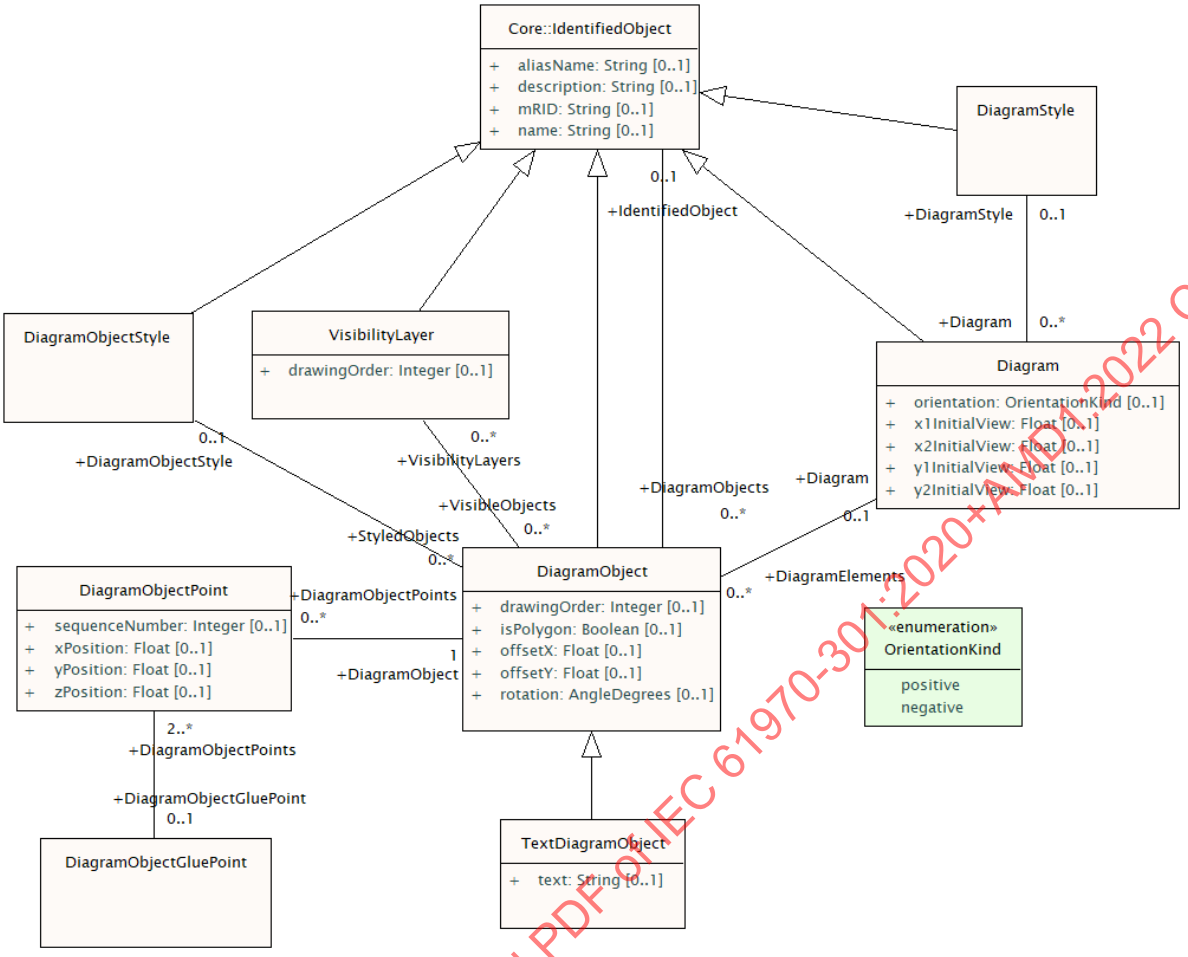


Figure 126 – Class diagram DiagramLayout::DiagramLayout

Figure 126: Shows model for diagram layout.

6.12.2 Diagram

The diagram being exchanged. The coordinate system is a standard Cartesian coordinate system and the orientation attribute defines the orientation. The initial view related attributes can be used to specify an initial view with the x,y coordinates of the diagonal points.

Table 622 shows all attributes of Diagram.

Table 622 – Attributes of DiagramLayout::Diagram

name	mult	type	description
orientation	0..1	OrientationKind	Coordinate system orientation of the diagram. A positive orientation gives standard “right-hand” orientation, with negative orientation indicating a “left-hand” orientation. For 2D diagrams, a positive orientation will result in X values increasing from left to right and Y values increasing from bottom to top. A negative orientation gives the “left-hand” orientation (favoured by computer graphics displays) with X values increasing from left to right and Y values increasing from top to bottom.
x1InitialView	0..1	Float	X coordinate of the first corner of the initial view.

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name	mult	type	description
x2InitialView	0..1	Float	X coordinate of the second corner of the initial view.
y1InitialView	0..1	Float	Y coordinate of the first corner of the initial view.
y2InitialView	0..1	Float	Y coordinate of the second corner of the initial view.
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 623 shows all association ends of Diagram with other classes.

Table 623 – Association ends of DiagramLayout::Diagram with other classes

mult from	name	mult to	type	description
0..1	DiagramElements	0..*	DiagramObject	A diagram is made up of multiple diagram objects.
0..*	DiagramStyle	0..1	DiagramStyle	A Diagram may have a DiagramStyle.
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.12.3 DiagramObject

An object that defines one or more points in a given space. This object can be associated with anything that specializes IdentifiedObject. For single line diagrams such objects typically include such items as analog values, breakers, disconnectors, power transformers, and transmission lines.

Table 624 shows all attributes of DiagramObject.

Table 624 – Attributes of DiagramLayout::DiagramObject

name	mult	type	description
drawingOrder	0..1	Integer	The drawing order of this element. The higher the number, the later the element is drawn in sequence. This is used to ensure that elements that overlap are rendered in the correct order.
isPolygon	0..1	Boolean	Defines whether or not the diagram objects points define the boundaries of a polygon or the routing of a polyline. If this value is true then a receiving application should consider the first and last points to be connected.
offsetX	0..1	Float	The offset in the X direction. This is used for defining the offset from centre for rendering an icon (the default is that a single point specifies the centre of the icon). The offset is in per-unit with 0 indicating there is no offset from the horizontal centre of the icon. -0.5 indicates it is offset by 50% to the left and 0.5 indicates an offset of 50% to the right.

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name	mult	type	description
offsetY	0..1	Float	The offset in the Y direction. This is used for defining the offset from centre for rendering an icon (the default is that a single point specifies the centre of the icon). The offset is in per-unit with 0 indicating there is no offset from the vertical centre of the icon. The offset direction is dependent on the orientation of the diagram, with -0.5 and 0.5 indicating an offset of +/- 50% on the vertical axis.
rotation	0..1	AngleDegrees	Sets the angle of rotation of the diagram object. Zero degrees is pointing to the top of the diagram. Rotation is clockwise. DiagramObject.rotation=0 has the following meaning: The connection point of an element which has one terminal is pointing to the top side of the diagram. The connection point "From side" of an element which has more than one terminal is pointing to the top side of the diagram. DiagramObject.rotation=90 has the following meaning: The connection point of an element which has one terminal is pointing to the right hand side of the diagram. The connection point "From side" of an element which has more than one terminal is pointing to the right hand side of the diagram.
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 625 shows all association ends of DiagramObject with other classes.

Table 625 – Association ends of DiagramLayout::DiagramObject with other classes

mult from	name	mult to	type	description
0..*	Diagram	0..1	Diagram	A diagram object is part of a diagram.
0..*	VisibilityLayers	0..*	VisibilityLayer	A diagram object can be part of multiple visibility layers.
1..1	DiagramObjectPoints	0..*	DiagramObjectPoint	A diagram object can have 0 or more points to reflect its layout position, routing (for polylines) or boundary (for polygons).
0..*	DiagramObjectStyle	0..1	DiagramObjectStyle	A diagram object has a style associated that provides a reference for the style used in the originating system.
0..*	IdentifiedObject	0..1	IdentifiedObject	The domain object to which this diagram object is associated.
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

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6.12.4 DiagramObjectGluePoint root class

This is used for grouping diagram object points from different diagram objects that are considered to be glued together in a diagram even if they are not at the exact same coordinates.

Table 626 shows all association ends of DiagramObjectGluePoint with other classes.

Table 626 – Association ends of DiagramLayout::DiagramObjectGluePoint with other classes

mult from	name	mult to	type	description
0..1	DiagramObjectPoints	2..*	DiagramObjectPoint	A diagram object glue point is associated with 2 or more object points that are considered to be 'glued' together.

6.12.5 DiagramObjectPoint root class

A point in a given space defined by 3 coordinates and associated to a diagram object. The coordinates may be positive or negative as the origin does not have to be in the corner of a diagram.

Table 627 shows all attributes of DiagramObjectPoint.

Table 627 – Attributes of DiagramLayout::DiagramObjectPoint

name	mult	type	description
sequenceNumber	0..1	Integer	The sequence position of the point, used for defining the order of points for diagram objects acting as a polyline or polygon with more than one point. The attribute shall be a positive value.
xPosition	0..1	Float	The X coordinate of this point.
yPosition	0..1	Float	The Y coordinate of this point.
zPosition	0..1	Float	The Z coordinate of this point.

Table 628 shows all association ends of DiagramObjectPoint with other classes.

Table 628 – Association ends of DiagramLayout::DiagramObjectPoint with other classes

mult from	name	mult to	type	description
2..*	DiagramObjectGluePoint	0..1	DiagramObjectGluePoint	The 'glue' point to which this point is associated.
0..*	DiagramObject	1..1	DiagramObject	The diagram object with which the points are associated.

6.12.6 DiagramObjectStyle

A reference to a style used by the originating system for a diagram object. A diagram object style describes information such as line thickness, shape such as circle or rectangle etc, and colour.

Table 629 shows all attributes of DiagramObjectStyle.

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Table 629 – Attributes of DiagramLayout::DiagramObjectStyle

name	mult	type	description
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 630 shows all association ends of DiagramObjectStyle with other classes.

Table 630 – Association ends of DiagramLayout::DiagramObjectStyle with other classes

mult from	name	mult to	type	description
0..1	StyledObjects	0..*	DiagramObject	A style can be assigned to multiple diagram objects.
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.12.7 DiagramStyle

The diagram style refers to a style used by the originating system for a diagram. A diagram style describes information such as schematic, geographic, etc.

Table 631 shows all attributes of DiagramStyle.

Table 631 – Attributes of DiagramLayout::DiagramStyle

name	mult	type	description
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 632 shows all association ends of DiagramStyle with other classes.

Table 632 – Association ends of DiagramLayout::DiagramStyle with other classes

mult from	name	mult to	type	description
0..1	Diagram	0..*	Diagram	A DiagramStyle can be used by many Diagrams.
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.12.8 OrientationKind enumeration

The orientation of the coordinate system with respect to top, left, and the coordinate number system.

Table 633 shows all literals of OrientationKind.

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Table 633 – Literals of DiagramLayout::OrientationKind

literal	value	description
positive		For 2D diagrams, a positive orientation will result in X values increasing from left to right and Y values increasing from bottom to top. This is also known as a right hand orientation.
negative		For 2D diagrams, a negative orientation gives the left-hand orientation (favoured by computer graphics displays) with X values increasing from left to right and Y values increasing from top to bottom. This is also known as a left hand orientation.

6.12.9 TextDiagramObject

A diagram object for placing free-text or text derived from an associated domain object.

Table 634 shows all attributes of TextDiagramObject.

Table 634 – Attributes of DiagramLayout::TextDiagramObject

name	mult	type	description
text	0..1	String	The text that is displayed by this text diagram object.
drawingOrder	0..1	Integer	inherited from: DiagramObject
isPolygon	0..1	Boolean	inherited from: DiagramObject
offsetX	0..1	Float	inherited from: DiagramObject
offsetY	0..1	Float	inherited from: DiagramObject
rotation	0..1	AngleDegrees	inherited from: DiagramObject
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 635 shows all association ends of TextDiagramObject with other classes.

Table 635 – Association ends of DiagramLayout::TextDiagramObject with other classes

mult from	name	mult to	type	description
0..*	Diagram	0..1	Diagram	inherited from: DiagramObject
0..*	VisibilityLayers	0..*	VisibilityLayer	inherited from: DiagramObject
1..1	DiagramObjectPoints	0..*	DiagramObjectPoint	inherited from: DiagramObject
0..*	DiagramObjectStyle	0..1	DiagramObjectStyle	inherited from: DiagramObject
0..*	IdentifiedObject	0..1	IdentifiedObject	inherited from: DiagramObject
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

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6.12.10 VisibilityLayer

Layers are typically used for grouping diagram objects according to themes and scales. Themes are used to display or hide certain information (e.g., lakes, borders), while scales are used for hiding or displaying information depending on the current zoom level (hide text when it is too small to be read, or when it exceeds the screen size). This is also called de-cluttering.

CIM based graphics exchange supports an m:n relationship between diagram objects and layers. The importing system shall convert an m:n case into an appropriate 1:n representation if the importing system does not support m:n.

Table 636 shows all attributes of VisibilityLayer.

Table 636 – Attributes of DiagramLayout::VisibilityLayer

name	mult	type	description
drawingOrder	0..1	Integer	The drawing order for this layer. The higher the number, the later the layer and the objects within it are rendered.
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 637 shows all association ends of VisibilityLayer with other classes.

Table 637 – Association ends of DiagramLayout::VisibilityLayer with other classes

mult from	name	mult to	type	description
0..*	VisibleObjects	0..*	DiagramObject	A visibility layer can contain one or more diagram objects.
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.13 Package OperationalLimits

6.13.1 General

This package models a specification of limits associated with equipment and other operational entities.

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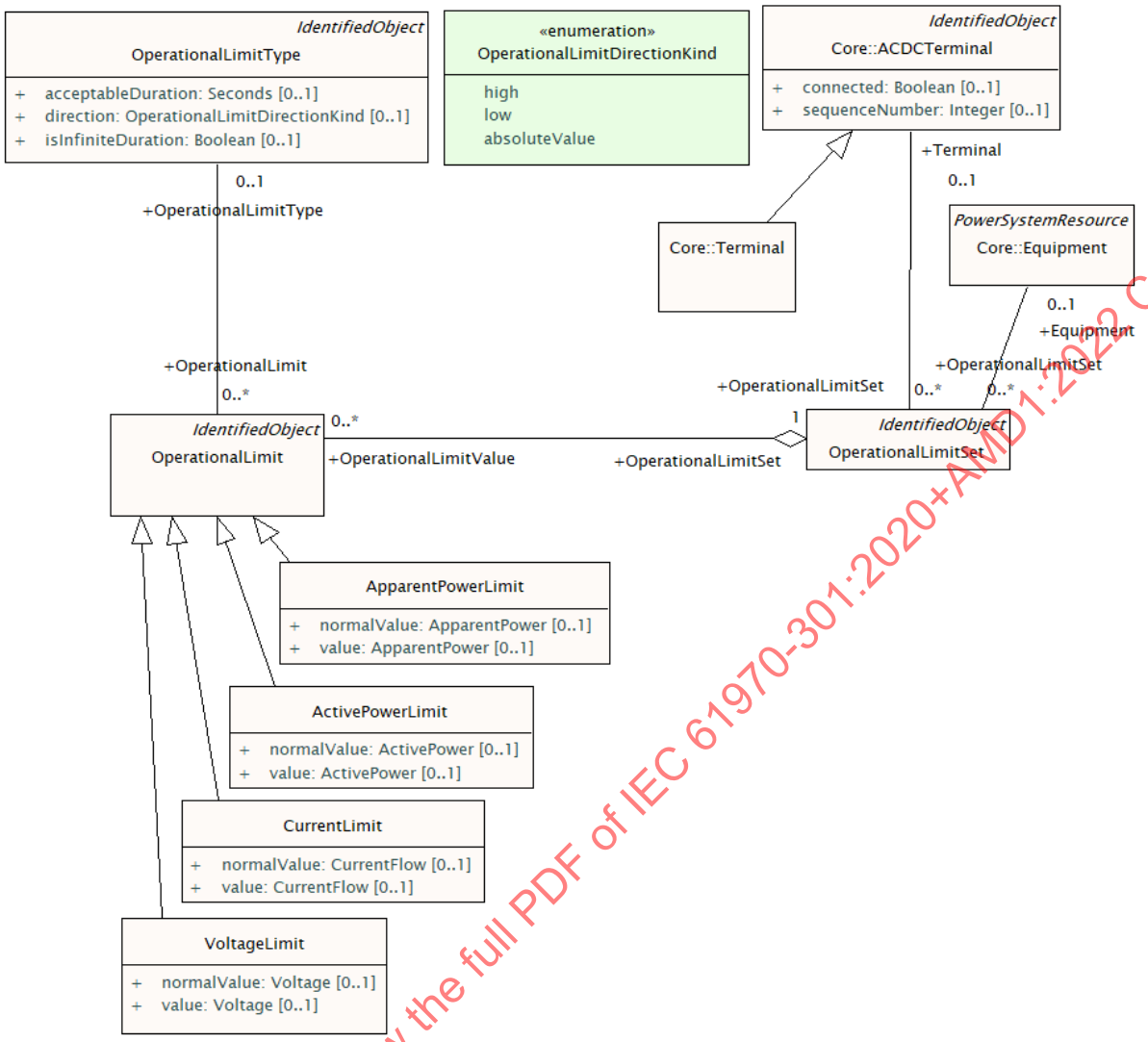


Figure 127 – Class diagram OperationalLimits::OperationalLimits

Figure 127: This diagram shows operational limits as they tie back into the core model.

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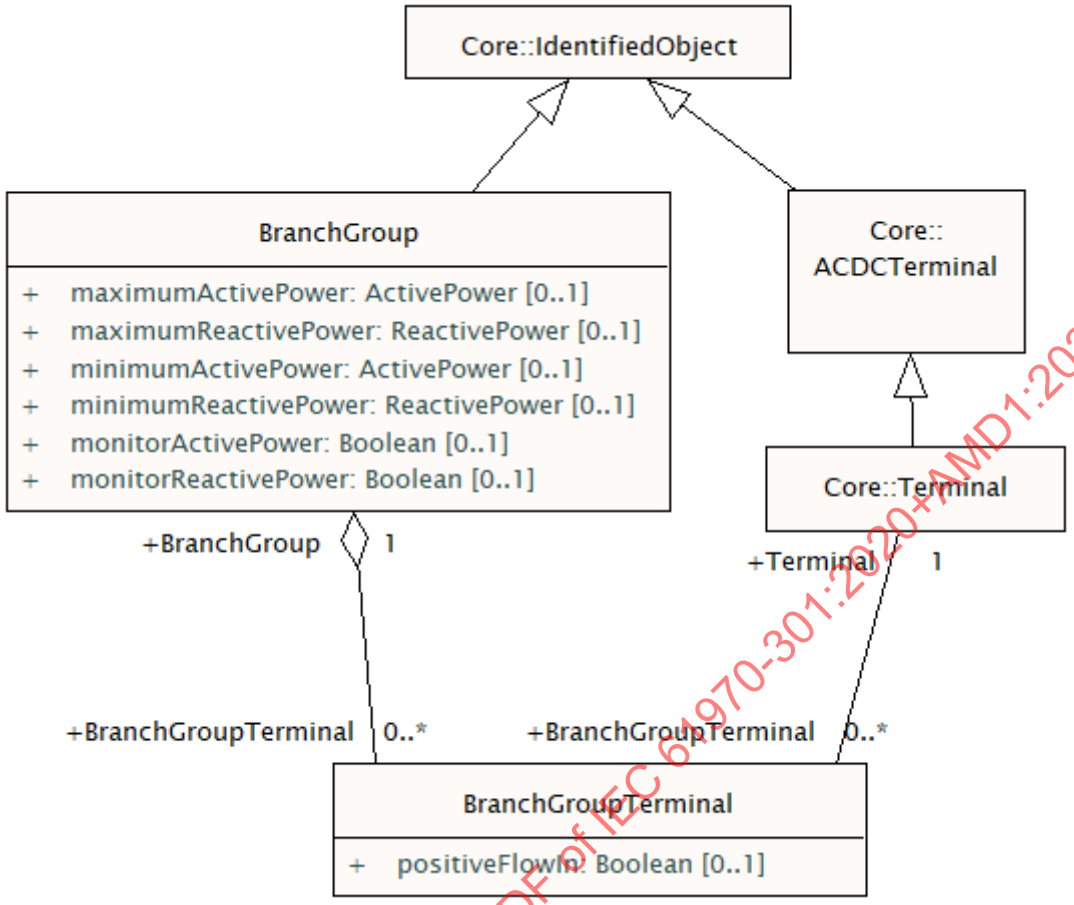


Figure 128 – Class diagram OperationalLimits::BranchGroup

Figure 128: This diagram shows the model for monitoring combined flows on groups of branches.

6.13.2 ActivePowerLimit

Limit on active power flow.

Table 638 shows all attributes of ActivePowerLimit.

Table 638 – Attributes of OperationalLimits::ActivePowerLimit

name	mult	type	description
normalValue	0..1	ActivePower	The normal value of active power limit. The attribute shall be a positive value or zero.
value	0..1	ActivePower	Value of active power limit. The attribute shall be a positive value or zero.
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 639 shows all association ends of ActivePowerLimit with other classes.

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Table 639 – Association ends of OperationalLimits::ActivePowerLimit with other classes

mult from	name	mult to	type	description
0..*	OperationalLimitSet	1..1	OperationalLimitSet	inherited from: OperationalLimit
0..*	OperationalLimitType	0..1	OperationalLimitType	inherited from: OperationalLimit
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.13.3 ApparentPowerLimit

Apparent power limit.

Table 640 shows all attributes of ApparentPowerLimit.

Table 640 – Attributes of OperationalLimits::ApparentPowerLimit

name	mult	type	description
normalValue	0..1	ApparentPower	The normal apparent power limit. The attribute shall be a positive value or zero.
value	0..1	ApparentPower	The apparent power limit. The attribute shall be a positive value or zero.
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 641 shows all association ends of ApparentPowerLimit with other classes.

Table 641 – Association ends of OperationalLimits::ApparentPowerLimit with other classes

mult from	name	mult to	type	description
0..*	OperationalLimitSet	1..1	OperationalLimitSet	inherited from: OperationalLimit
0..*	OperationalLimitType	0..1	OperationalLimitType	inherited from: OperationalLimit
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.13.4 BranchGroup

A group of branch terminals whose directed flow summation is to be monitored. A branch group need not form a cutset of the network.

Table 642 shows all attributes of BranchGroup.

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Table 642 – Attributes of OperationalLimits::BranchGroup

name	mult	type	description
maximumActivePower	0..1	ActivePower	The maximum active power flow.
maximumReactivePower	0..1	ReactivePower	The maximum reactive power flow.
minimumActivePower	0..1	ActivePower	The minimum active power flow.
minimumReactivePower	0..1	ReactivePower	The minimum reactive power flow.
monitorActivePower	0..1	Boolean	Monitor the active power flow.
monitorReactivePower	0..1	Boolean	Monitor the reactive power flow.
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 643 shows all association ends of BranchGroup with other classes.

Table 643 – Association ends of OperationalLimits::BranchGroup with other classes

mult from	name	mult to	type	description
1..1	BranchGroupTerminal	0..*	BranchGroupTerminal	The directed branch group terminals to be summed.
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.13.5 BranchGroupTerminal root class

A specific directed terminal flow for a branch group.

Table 644 shows all attributes of BranchGroupTerminal.

Table 644 – Attributes of OperationalLimits::BranchGroupTerminal

name	mult	type	description
positiveFlowIn	0..1	Boolean	The flow into the terminal is summed if set true. The flow out of the terminal is summed if set false.

Table 645 shows all association ends of BranchGroupTerminal with other classes.

Table 645 – Association ends of OperationalLimits::BranchGroupTerminal with other classes

mult from	name	mult to	type	description
0..*	Terminal	1..1	Terminal	The terminal to be summed.
0..*	BranchGroup	1..1	BranchGroup	The branch group to which the directed branch group terminals belong.

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6.13.6 CurrentLimit

Operational limit on current.

Table 646 shows all attributes of CurrentLimit.

Table 646 – Attributes of OperationalLimits::CurrentLimit

name	mult	type	description
normalValue	0..1	CurrentFlow	The normal value for limit on current flow. The attribute shall be a positive value or zero.
value	0..1	CurrentFlow	Limit on current flow. The attribute shall be a positive value or zero.
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 647 shows all association ends of CurrentLimit with other classes.

Table 647 – Association ends of OperationalLimits::CurrentLimit with other classes

mult from	name	mult to	type	description
0..*	OperationalLimitSet	1..1	OperationalLimitSet	inherited from: OperationalLimit
0..*	OperationalLimitType	0..1	OperationalLimitType	inherited from: OperationalLimit
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.13.7 OperationalLimit

A value and normal value associated with a specific kind of limit.

The sub class value and normalValue attributes vary inversely to the associated OperationalLimitType.acceptableDuration (acceptableDuration for short).

If a particular piece of equipment has multiple operational limits of the same kind (apparent power, current, etc.), the limit with the greatest acceptableDuration shall have the smallest limit value and the limit with the smallest acceptableDuration shall have the largest limit value. Note: A large current can only be allowed to flow through a piece of equipment for a short duration without causing damage, but a lesser current can be allowed to flow for a longer duration.

Table 648 shows all attributes of OperationalLimit.

Table 648 – Attributes of OperationalLimits::OperationalLimit

name	mult	type	description
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

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Table 649 shows all association ends of OperationalLimit with other classes.

Table 649 – Association ends of OperationalLimits::OperationalLimit with other classes

mult from	name	mult to	type	description
0..*	OperationalLimitSet	1..1	OperationalLimitSet	The limit set to which the limit values belong.
0..*	OperationalLimitType	0..1	OperationalLimitType	The limit type associated with this limit.
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.13.8 OperationalLimitDirectionKind enumeration

The direction attribute describes the side of a limit that is a violation.

Table 650 shows all literals of OperationalLimitDirectionKind.

Table 650 – Literals of OperationalLimits::OperationalLimitDirectionKind

literal	value	description
high		High means that a monitored value above the limit value is a violation. If applied to a terminal flow, the positive direction is into the terminal.
low		Low means a monitored value below the limit is a violation. If applied to a terminal flow, the positive direction is into the terminal.
absoluteValue		An absoluteValue limit means that a monitored absolute value above the limit value is a violation.

6.13.9 OperationalLimitSet

A set of limits associated with equipment. Sets of limits might apply to a specific temperature, or season for example. A set of limits may contain different severities of limit levels that would apply to the same equipment. The set may contain limits of different types such as apparent power and current limits or high and low voltage limits that are logically applied together as a set.

Table 651 shows all attributes of OperationalLimitSet.

Table 651 – Attributes of OperationalLimits::OperationalLimitSet

name	mult	type	description
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 652 shows all association ends of OperationalLimitSet with other classes.

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Table 652 – Association ends of OperationalLimits::OperationalLimitSet with other classes

mult from	name	mult to	type	description
0..*	Terminal	0..1	ACDCTerminal	The terminal where the operational limit set apply.
0..*	Equipment	0..1	Equipment	The equipment to which the limit set applies.
1..1	OperationalLimitValue	0..*	OperationalLimit	Values of equipment limits.
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.13.10 OperationalLimitType

The operational meaning of a category of limits.

Table 653 shows all attributes of OperationalLimitType.

Table 653 – Attributes of OperationalLimits::OperationalLimitType

name	mult	type	description
acceptableDuration	0..1	Seconds	The nominal acceptable duration of the limit. Limits are commonly expressed in terms of the time limit for which the limit is normally acceptable. The actual acceptable duration of a specific limit may depend on other local factors such as temperature or wind speed. The attribute has meaning only if the flag isInfiniteDuration is set to false, hence it shall not be exchanged when isInfiniteDuration is set to true.
direction	0..1	OperationalLimitDirectionKind	The direction of the limit.
isInfiniteDuration	0..1	Boolean	Defines if the operational limit type has infinite duration. If true, the limit has infinite duration. If false, the limit has definite duration which is defined by the attribute acceptableDuration.
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 654 shows all association ends of OperationalLimitType with other classes.

Table 654 – Association ends of OperationalLimits::OperationalLimitType with other classes

mult from	name	mult to	type	description
0..1	OperationalLimit	0..*	OperationalLimit	The operational limits associated with this type of limit.
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

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6.13.11 VoltageLimit

Operational limit applied to voltage.

The use of operational VoltageLimit is preferred instead of limits defined at VoltageLevel. The operational VoltageLimits are used, if present.

Table 655 shows all attributes of VoltageLimit.

Table 655 – Attributes of OperationalLimits::VoltageLimit

name	mult	type	description
normalValue	0..1	Voltage	The normal limit on voltage. High or low limit nature of the limit depends upon the properties of the operational limit type. The attribute shall be a positive value or zero.
value	0..1	Voltage	Limit on voltage. High or low limit nature of the limit depends upon the properties of the operational limit type. The attribute shall be a positive value or zero.
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 656 shows all association ends of VoltageLimit with other classes.

Table 656 – Association ends of OperationalLimits::VoltageLimit with other classes

mult from	name	mult to	type	description
0..*	OperationalLimitSet	1..1	OperationalLimitSet	inherited from: OperationalLimit
0..*	OperationalLimitType	0..1	OperationalLimitType	inherited from: OperationalLimit
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.14 Package ControlArea

6.14.1 General

The ControlArea package models area specifications which can be used for a variety of purposes. The package as a whole models potentially overlapping control area specifications for the purpose of actual generation control, load forecast area load capture, or powerflow based analysis.

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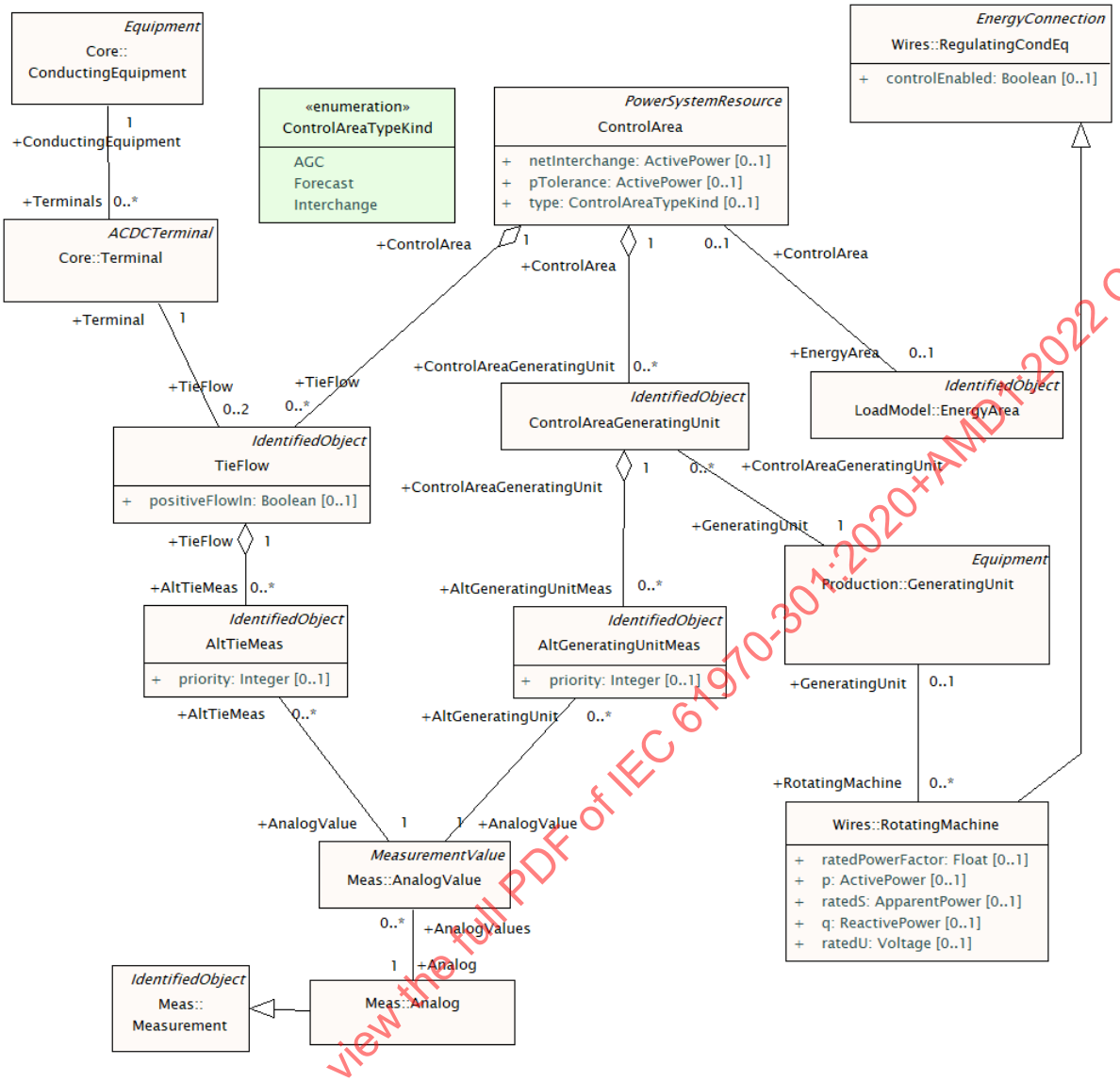


Figure 129 – Class diagram ControlArea::ControlArea

Figure 129: This diagram shows control area specification and some related classes. The Terminal to AnalogValue linkages are shown for clarity in understanding the control area specification. The GeneratingUnit to Terminal linkages are also shown to illustrate how generation flows are specifically tied to the network.

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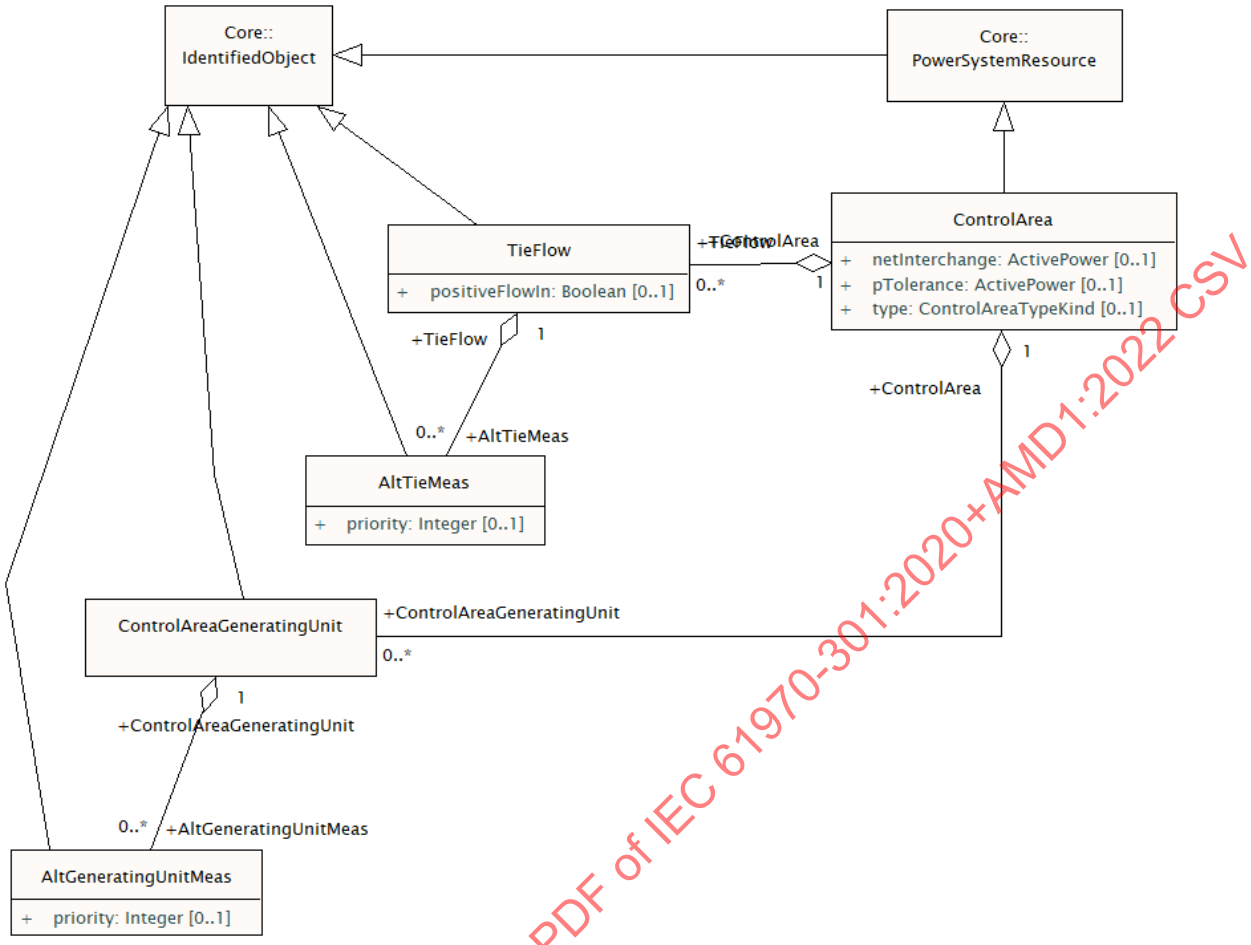


Figure 130 – Class diagram ControlArea::ControlAreaInheritance

Figure 130: Shows the inheritance of classes in this package.

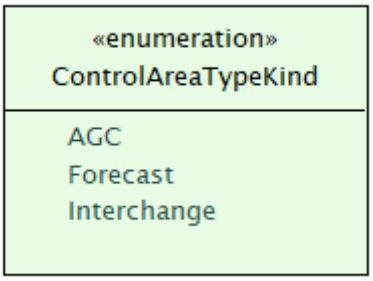


Figure 131 – Class diagram ControlArea::Datatypes

Figure 131: Shows datatypes for control areas.

6.14.2 AltGeneratingUnitMeas

A prioritized measurement to be used for the generating unit in the control area specification.

Table 657 shows all attributes of AltGeneratingUnitMeas.

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Table 657 – Attributes of ControlArea::AltGeneratingUnitMeas

name	mult	type	description
priority	0..1	Integer	Priority of a measurement usage. Lower numbers have first priority.
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 658 shows all association ends of AltGeneratingUnitMeas with other classes.

Table 658 – Association ends of ControlArea::AltGeneratingUnitMeas with other classes

mult from	name	mult to	type	description
0..*	AnalogValue	1..1	AnalogValue	The specific analog value used as a source.
0..*	ControlAreaGeneratingUnit	1..1	ControlAreaGeneratingUnit	The control area generating unit to which the prioritized measurement assignment is applied.
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.14.3 AltTieMeas

A prioritized measurement to be used for the tie flow as part of the control area specification.

Table 659 shows all attributes of AltTieMeas.

Table 659 – Attributes of ControlArea::AltTieMeas

name	mult	type	description
priority	0..1	Integer	Priority of a measurement usage. Lower numbers have first priority.
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 660 shows all association ends of AltTieMeas with other classes.

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Table 660 – Association ends of ControlArea::AltTieMeas with other classes

mult from	name	mult to	type	description
0..*	AnalogValue	1..1	AnalogValue	The specific analog value used as a source.
0..*	TieFlow	1..1	TieFlow	The tie flow of the alternate measurements.
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.14.4 ControlArea

A control area is a grouping of generating units and/or loads and a cutset of tie lines (as terminals) which may be used for a variety of purposes including automatic generation control, power flow solution area interchange control specification, and input to load forecasting. All generation and load within the area defined by the terminals on the border are considered in the area interchange control. Note that any number of overlapping control area specifications can be superimposed on the physical model. The following general principles apply to ControlArea:

1) The control area orientation for net interchange is positive for an import, negative for an export.
2) The control area net interchange is determined by summing flows in Terminals. The Terminals are identified by creating a set of TieFlow objects associated with a ControlArea object. Each TieFlow object identifies one Terminal.
3) In a single network model, a tie between two control areas must be modelled in both control area specifications, such that the two representations of the tie flow sum to zero.
4) The normal orientation of Terminal flow is positive for flow into the conducting equipment that owns the Terminal. (i.e. flow from a bus into a device is positive.) However, the orientation of each flow in the control area specification must align with the control area convention, i.e. import is positive. If the orientation of the Terminal flow referenced by a TieFlow is positive into the control area, then this is confirmed by setting TieFlow.positiveFlowIn flag TRUE. If not, the orientation must be reversed by setting the TieFlow.positiveFlowIn flag FALSE.

Table 661 shows all attributes of ControlArea.

Table 661 – Attributes of ControlArea::ControlArea

name	mult	type	description
netInterchange	0..1	ActivePower	The specified positive net interchange into the control area, i.e. positive sign means flow into the area.
pTolerance	0..1	ActivePower	Active power net interchange tolerance. The attribute shall be a positive value or zero.
type	0..1	ControlAreaTypeKind	The primary type of control area definition used to determine if this is used for automatic generation control, for planning interchange control, or other purposes. A control area specified with primary type of automatic generation control could still be forecast and used as an interchange area in power flow analysis.
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject

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name	mult	type	description
name	0..1	String	inherited from: IdentifiedObject

Table 662 shows all association ends of ControlArea with other classes.

Table 662 – Association ends of ControlArea::ControlArea with other classes

mult from	name	mult to	type	description
0..1	EnergyArea	0..1	EnergyArea	The energy area that is forecast from this control area specification.
1..1	ControlAreaGeneratingUnit	0..*	ControlAreaGeneratingUnit	The generating unit specifications for the control area.
1..1	TieFlow	0..*	TieFlow	The tie flows associated with the control area.
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.14.5 ControlAreaGeneratingUnit

A control area generating unit. This class is needed so that alternate control area definitions may include the same generating unit. It should be noted that only one instance within a control area should reference a specific generating unit.

Table 663 shows all attributes of ControlAreaGeneratingUnit.

Table 663 – Attributes of ControlArea::ControlAreaGeneratingUnit

name	mult	type	description
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 664 shows all association ends of ControlAreaGeneratingUnit with other classes.

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Table 664 – Association ends of ControlArea::ControlAreaGeneratingUnit with other classes

mult from	name	mult to	type	description
0..*	GeneratingUnit	1..1	GeneratingUnit	The generating unit specified for this control area. Note that a control area should include a GeneratingUnit only once.
0..*	ControlArea	1..1	ControlArea	The parent control area for the generating unit specifications.
1..1	AltGeneratingUnitMeas	0..*	AltGeneratingUnitMeas	The link to prioritized measurements for this GeneratingUnit.
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.14.6 ControlAreaTypeKind enumeration

The type of control area.

Table 665 shows all literals of ControlAreaTypeKind.

Table 665 – Literals of ControlArea::ControlAreaTypeKind

literal	value	description
AGC		Used for automatic generation control.
Forecast		Used for load forecast.
Interchange		Used for interchange specification or control.

6.14.7 TieFlow

Defines the structure (in terms of location and direction) of the net interchange constraint for a control area. This constraint may be used by either AGC or power flow.

Table 666 shows all attributes of TieFlow.

Table 666 – Attributes of ControlArea::TieFlow

name	mult	type	description
positiveFlowIn	0..1	Boolean	Specifies the sign of the tie flow associated with a control area. True if positive flow into the terminal (load convention) is also positive flow into the control area. See the description of ControlArea for further explanation of how TieFlow.positiveFlowIn is used.
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 667 shows all association ends of TieFlow with other classes.

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Table 667 – Association ends of ControlArea::TieFlow with other classes

mult from	name	mult to	type	description
0..2	Terminal	1..1	Terminal	The terminal to which this tie flow belongs.
0..*	ControlArea	1..1	ControlArea	The control area of the tie flows.
1..1	AltTieMeas	0..*	AltTieMeas	The primary and alternate tie flow measurements associated with the tie flow.
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.15 Package Contingency

6.15.1 General

Contingencies to be studied.

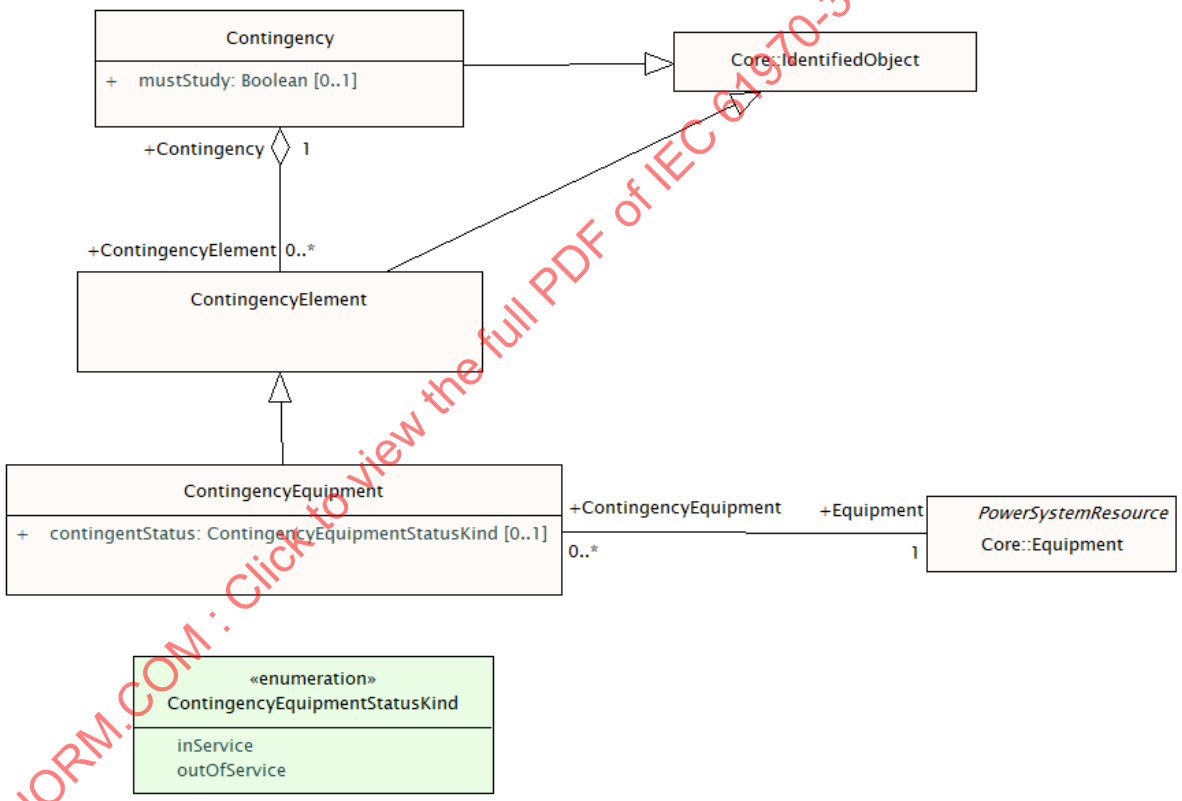


Figure 132 – Class diagram Contingency::Contingency

Figure 132: This diagram shows contingency model inheritance and associations.

6.15.2 Contingency

An event threatening system reliability, consisting of one or more contingency elements.

Table 668 shows all attributes of Contingency.

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Table 668 – Attributes of Contingency::Contingency

name	mult	type	description
mustStudy	0..1	Boolean	Set true if must study this contingency.
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 669 shows all association ends of Contingency with other classes.

Table 669 – Association ends of Contingency::Contingency with other classes

mult from	name	mult to	type	description
1..1	ContingencyElement	0..*	ContingencyElement	A contingency can have any number of contingency elements.
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.15.3 ContingencyElement

An element of a system event to be studied by contingency analysis, representing a change in status of a single piece of equipment.

Table 670 shows all attributes of ContingencyElement.

Table 670 – Attributes of Contingency::ContingencyElement

name	mult	type	description
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 671 shows all association ends of ContingencyElement with other classes.

Table 671 – Association ends of Contingency::ContingencyElement with other classes

mult from	name	mult to	type	description
0..*	Contingency	1..1	Contingency	A contingency element belongs to one contingency.
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.15.4 ContingencyEquipment

Equipment whose in service status is to change, such as a power transformer or AC line segment.

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Table 672 shows all attributes of ContingencyEquipment.

Table 672 – Attributes of Contingency::ContingencyEquipment

name	mult	type	description
contingentStatus	0..1	ContingencyEquipmentStatusKind	The status for the associated equipment when in the contingency state. This status is independent of the case to which the contingency is originally applied, but defines the equipment status when the contingency is applied.
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 673 shows all association ends of ContingencyEquipment with other classes.

Table 673 – Association ends of Contingency::ContingencyEquipment with other classes

mult from	name	mult to	type	description
0..*	Equipment	1..1	Equipment	The single piece of equipment to which to apply the contingency.
0..*	Contingency	1..1	Contingency	inherited from: ContingencyElement
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.15.5 ContingencyEquipmentStatusKind enumeration

Indicates the state which the contingency equipment is to be in when the contingency is applied.

Table 674 shows all literals of ContingencyEquipmentStatusKind.

Table 674 – Literals of Contingency::ContingencyEquipmentStatusKind

literal	value	description
inService		The equipment is to be put into service.
outOfService		The equipment is to be taken out of service.

6.16 Package StateVariables

6.16.1 General

State variables for analysis solutions such as powerflow.

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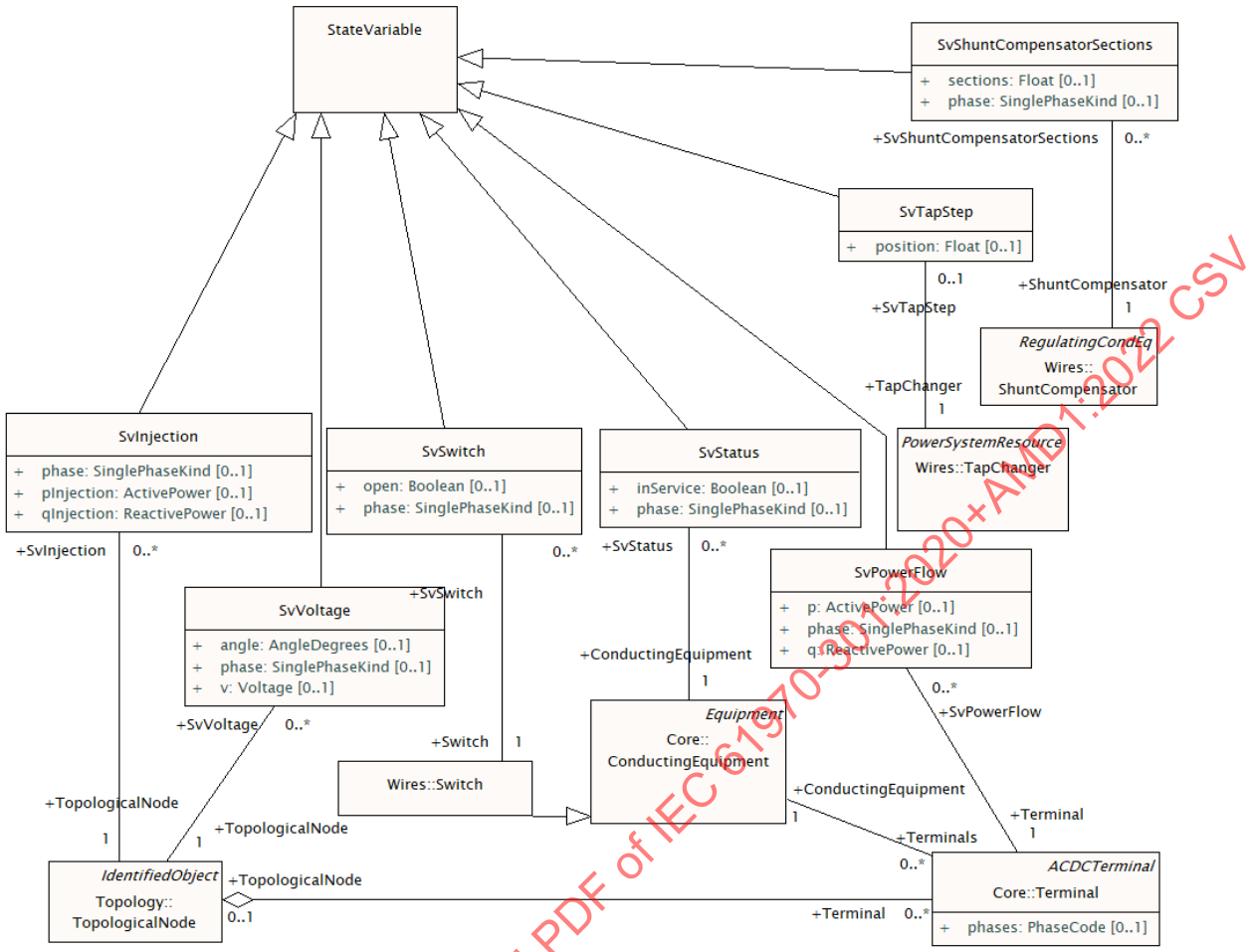


Figure 133 – Class diagram StateVariables::StateVariables

Figure 133: The state solution variables as derived from base StateVariable class. Note that specialized state variables are associated with objects derived from IdentifiedObject, but StateVariable does not derive from IdentifiedObject.

6.16.2 StateVariable root class

An abstract class for state variables.

6.16.3 SvInjection

The SvInjection reports the calculated bus injection minus the sum of the terminal flows. The terminal flow is positive out from the bus (load sign convention) and bus injection has positive flow into the bus. SvInjection may have the remainder after state estimation or slack after power flow calculation.

Table 675 shows all attributes of SvInjection.

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Table 675 – Attributes of StateVariables::SvInjection

name	mult	type	description
phase	0..1	SinglePhaseKind	The terminal phase at which the connection is applied. If missing, the injection is assumed to be balanced among non-neutral phases.
pInjection	0..1	ActivePower	The active power mismatch between calculated injection and initial injection. Positive sign means injection into the TopologicalNode (bus).
qInjection	0..1	ReactivePower	The reactive power mismatch between calculated injection and initial injection. Positive sign means injection into the TopologicalNode (bus).

Table 676 shows all association ends of SvInjection with other classes.

Table 676 – Association ends of StateVariables::SvInjection with other classes

mult from	name	mult to	type	description
0..*	TopologicalNode	1..1	TopologicalNode	The topological node associated with the flow injection state variable.

6.16.4 SvPowerFlow

State variable for power flow. Load convention is used for flow direction. This means flow out from the TopologicalNode into the equipment is positive.

Table 677 shows all attributes of SvPowerFlow.

Table 677 – Attributes of StateVariables::SvPowerFlow

name	mult	type	description
p	0..1	ActivePower	The active power flow. Load sign convention is used, i.e. positive sign means flow out from a TopologicalNode (bus) into the conducting equipment.
phase	0..1	SinglePhaseKind	The individual phase of the flow. If unspecified, then assumed to be balanced among phases.
q	0..1	ReactivePower	The reactive power flow. Load sign convention is used, i.e. positive sign means flow out from a TopologicalNode (bus) into the conducting equipment.

Table 678 shows all association ends of SvPowerFlow with other classes.

Table 678 – Association ends of StateVariables::SvPowerFlow with other classes

mult from	name	mult to	type	description
0..*	Terminal	1..1	Terminal	The terminal associated with the power flow state variable.

6.16.5 SvShuntCompensatorSections

State variable for the number of sections in service for a shunt compensator.

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Table 679 shows all attributes of SvShuntCompensatorSections.

Table 679 – Attributes of StateVariables::SvShuntCompensatorSections

name	mult	type	description
sections	0..1	Float	The number of sections in service as a continuous variable. The attribute shall be a positive value or zero. To get integer value scale with ShuntCompensator.bPerSection.
phase	0..1	SinglePhaseKind	The terminal phase at which the connection is applied. If missing, the injection is assumed to be balanced among non-neutral phases.

Table 680 shows all association ends of SvShuntCompensatorSections with other classes.

Table 680 – Association ends of StateVariables::SvShuntCompensatorSections with other classes

mult from	name	mult to	type	description
0..*	ShuntCompensator	1..1	ShuntCompensator	The shunt compensator for which the state applies.

6.16.6 SvStatus

State variable for status.

Table 681 shows all attributes of SvStatus.

Table 681 – Attributes of StateVariables::SvStatus

name	mult	type	description
inService	0..1	Boolean	The in service status as a result of topology processing. It indicates if the equipment is considered as energized by the power flow. It reflects if the equipment is connected within a solvable island. It does not necessarily reflect whether or not the island was solved by the power flow.
phase	0..1	SinglePhaseKind	The individual phase status. If the attribute is unspecified, then three phase model is assumed.

Table 682 shows all association ends of SvStatus with other classes.

Table 682 – Association ends of StateVariables::SvStatus with other classes

mult from	name	mult to	type	description
0..*	ConductingEquipment	1..1	ConductingEquipment	The conducting equipment associated with the status state variable.

6.16.7 SvSwitch

State variable for switch.

Table 683 shows all attributes of SvSwitch.

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Table 683 – Attributes of StateVariables::SvSwitch

name	mult	type	description
open	0..1	Boolean	The attribute tells if the computed state of the switch is considered open.
phase	0..1	SinglePhaseKind	The terminal phase at which the connection is applied. If missing, the injection is assumed to be balanced among non-neutral phases.

Table 684 shows all association ends of SvSwitch with other classes.

Table 684 – Association ends of StateVariables::SvSwitch with other classes

mult from	name	mult to	type	description
0..*	Switch	1..1	Switch	The switch associated with the switch state.

6.16.8 SvTapStep

State variable for transformer tap step.

Table 685 shows all attributes of SvTapStep.

Table 685 – Attributes of StateVariables::SvTapStep

name	mult	type	description
position	0..1	Float	The floating point tap position. This is not the tap ratio, but rather the tap step position as defined by the related tap changer model and normally is constrained to be within the range of minimum and maximum tap positions.

Table 686 shows all association ends of SvTapStep with other classes.

Table 686 – Association ends of StateVariables::SvTapStep with other classes

mult from	name	mult to	type	description
0..1	TapChanger	1..1	TapChanger	The tap changer associated with the tap step state.

6.16.9 SvVoltage

State variable for voltage.

Table 687 shows all attributes of SvVoltage.

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Table 687 – Attributes of StateVariables::SvVoltage

name	mult	type	description
angle	0..1	AngleDegrees	The voltage angle of the topological node complex voltage with respect to system reference.
phase	0..1	SinglePhaseKind	If specified the voltage is the line to ground voltage of the individual phase. If unspecified, then the voltage is assumed balanced.
v	0..1	Voltage	The voltage magnitude at the topological node. The attribute shall be a positive value.

Table 688 shows all association ends of SvVoltage with other classes.

Table 688 – Association ends of StateVariables::SvVoltage with other classes

mult from	name	mult to	type	description
0..*	TopologicalNode	1..1	TopologicalNode	The topological node associated with the voltage state.

6.17 Package Protection

6.17.1 General

An extension to the Core and Wires packages that models information for protection equipment such as relays. These entities are used within training simulators and distribution network fault location applications.

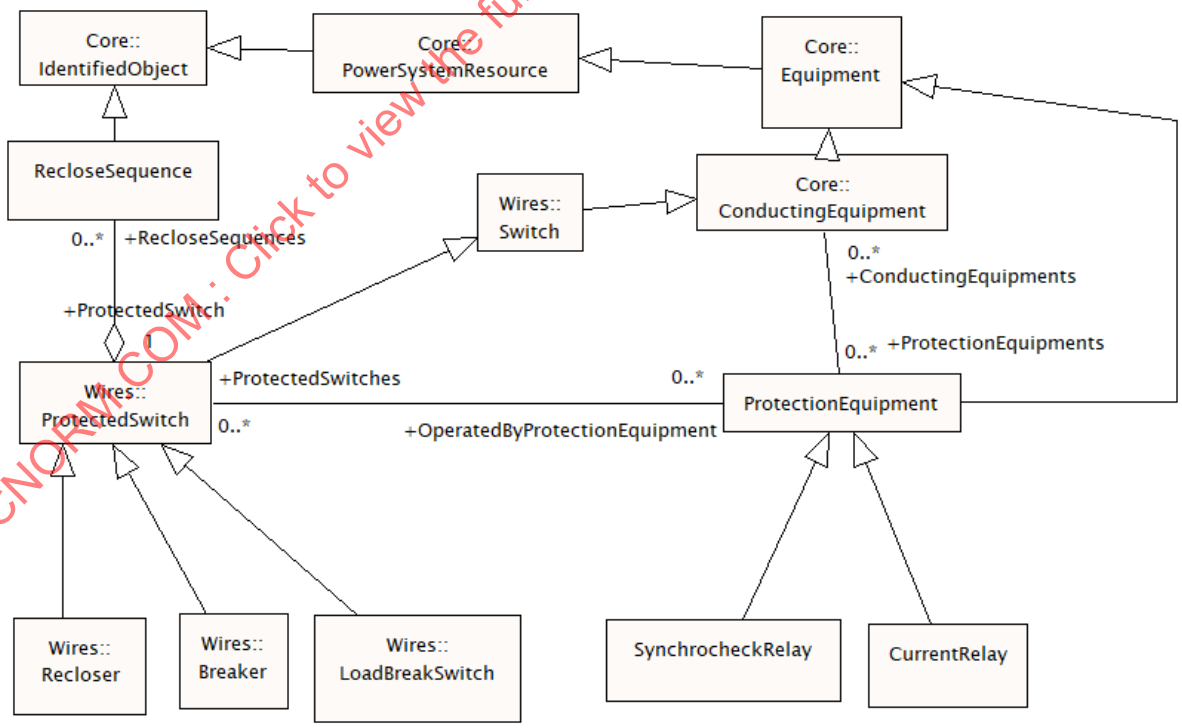


Figure 134 – Class diagram Protection::Main

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Figure 134: This diagram shows all classes included in the Protection package as well as the key external classes that have associations with Protection classes.

6.17.2 CurrentRelay

A device that checks current flow values in any direction or designated direction.

Table 689 shows all attributes of CurrentRelay.

Table 689 – Attributes of Protection::CurrentRelay

name	mult	type	description
currentLimit1	0..1	CurrentFlow	Current limit number one 1 for inverse time pickup.
currentLimit2	0..1	CurrentFlow	Current limit number 2 for inverse time pickup.
currentLimit3	0..1	CurrentFlow	Current limit number 3 for inverse time pickup.
inverseTimeFlag	0..1	Boolean	Set true if the current relay has inverse time characteristic.
timeDelay1	0..1	Seconds	Inverse time delay number 1 for current limit number 1.
timeDelay2	0..1	Seconds	Inverse time delay number 2 for current limit number 2.
timeDelay3	0..1	Seconds	Inverse time delay number 3 for current limit number 3.
relayDelayTime	0..1	Seconds	inherited from: ProtectionEquipment
highLimit	0..1	Float	inherited from: ProtectionEquipment
lowLimit	0..1	Float	inherited from: ProtectionEquipment
powerDirectionFlag	0..1	Boolean	inherited from: ProtectionEquipment
unitSymbol	0..1	UnitSymbol	inherited from: ProtectionEquipment
unitMultiplier	0..1	UnitMultiplier	inherited from: ProtectionEquipment
aggregate	0..1	Boolean	inherited from: Equipment
inService	0..1	Boolean	inherited from: Equipment
networkAnalysisEnabled	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 690 shows all association ends of CurrentRelay with other classes.

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Table 690 – Association ends of Protection::CurrentRelay with other classes

mult from	name	mult to	type	description
0..*	ConductingEquipments	0..*	ConductingEquipment	inherited from: ProtectionEquipment
0..*	ProtectedSwitches	0..*	ProtectedSwitch	inherited from: ProtectionEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	inherited from: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	inherited from: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment
0..1	Faults	0..*	Fault	inherited from: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	inherited from: Equipment
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.17.3 ProtectionEquipment

An electrical device designed to respond to input conditions in a prescribed manner and after specified conditions are met to cause contact operation or similar abrupt change in associated electric control circuits, or simply to display the detected condition. Protection equipment is associated with conducting equipment and usually operate circuit breakers.

Table 691 shows all attributes of ProtectionEquipment.

Table 691 – Attributes of Protection::ProtectionEquipment

name	mult	type	description
relayDelayTime	0..1	Seconds	The time delay from detection of abnormal conditions to relay operation.
highLimit	0..1	Float	The maximum allowable value.
lowLimit	0..1	Float	The minimum allowable value.
powerDirectionFlag	0..1	Boolean	Direction same as positive active power flow value.
unitSymbol	0..1	UnitSymbol	The unit of measure of the value.
unitMultiplier	0..1	UnitMultiplier	The unit multiplier of the value.
aggregate	0..1	Boolean	inherited from: Equipment
inService	0..1	Boolean	inherited from: Equipment
networkAnalysisEnabled	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

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Table 692 shows all association ends of ProtectionEquipment with other classes.

Table 692 – Association ends of Protection::ProtectionEquipment with other classes

mult from	name	mult to	type	description
0..*	ConductingEquipments	0..*	ConductingEquipment	Protection equipment may be used to protect specific conducting equipment.
0..*	ProtectedSwitches	0..*	ProtectedSwitch	Protected switches operated by this ProtectionEquipment.
0..1	OperationalLimitSet	0..*	OperationalLimitSet	inherited from: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	inherited from: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment
0..1	Faults	0..*	Fault	inherited from: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	inherited from: Equipment
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.17.4 RecloseSequence

A reclose sequence (open and close) is defined for each possible reclosure of a breaker.

Table 693 shows all attributes of RecloseSequence.

Table 693 – Attributes of Protection::RecloseSequence

name	mult	type	description
recloseDelay	0..1	Seconds	Indicates the time lapse before the reclose step will execute a reclose.
recloseStep	0..1	Integer	Indicates the ordinal position of the reclose step relative to other steps in the sequence.
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 694 shows all association ends of RecloseSequence with other classes.

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Table 694 – Association ends of Protection::RecloseSequence with other classes

mult from	name	mult to	type	description
0..*	ProtectedSwitch	1..1	ProtectedSwitch	A breaker may have zero or more automatic reclosures after a trip occurs.
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.17.5 SynchrocheckRelay

A device that operates when two AC circuits are within the desired limits of frequency, phase angle, and voltage, to permit or to cause the paralleling of these two circuits. Used to prevent the paralleling of non-synchronous topological islands.

Table 695 shows all attributes of SynchrocheckRelay.

Table 695 – Attributes of Protection::SynchrocheckRelay

name	mult	type	description
maxAngleDiff	0..1	AngleRadians	The maximum allowable voltage vector phase angle difference across the open device.
maxFreqDiff	0..1	Frequency	The maximum allowable frequency difference across the open device.
maxVoltDiff	0..1	Voltage	The maximum allowable difference voltage across the open device.
relayDelayTime	0..1	Seconds	inherited from: ProtectionEquipment
highLimit	0..1	Float	inherited from: ProtectionEquipment
lowLimit	0..1	Float	inherited from: ProtectionEquipment
powerDirectionFlag	0..1	Boolean	inherited from: ProtectionEquipment
unitSymbol	0..1	UnitSymbol	inherited from: ProtectionEquipment
unitMultiplier	0..1	UnitMultiplier	inherited from: ProtectionEquipment
aggregate	0..1	Boolean	inherited from: Equipment
inService	0..1	Boolean	inherited from: Equipment
networkAnalysisEnabled	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 696 shows all association ends of SynchrocheckRelay with other classes.

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Table 696 – Association ends of Protection::SynchrocheckRelay with other classes

mult from	name	mult to	type	description
0..*	ConductingEquipments	0..*	ConductingEquipment	inherited from: ProtectionEquipment
0..*	ProtectedSwitches	0..*	ProtectedSwitch	inherited from: ProtectionEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	inherited from: Equipment
1..1	ContingencyEquipment	0..*	ContingencyEquipment	inherited from: Equipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment
0..1	Faults	0..*	Fault	inherited from: Equipment
0..*	AdditionalEquipmentContainer	0..*	EquipmentContainer	inherited from: Equipment
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.18 Package Faults

6.18.1 General

The package describes faults that may happen to conducting equipment, e.g. tree falling on a power line.

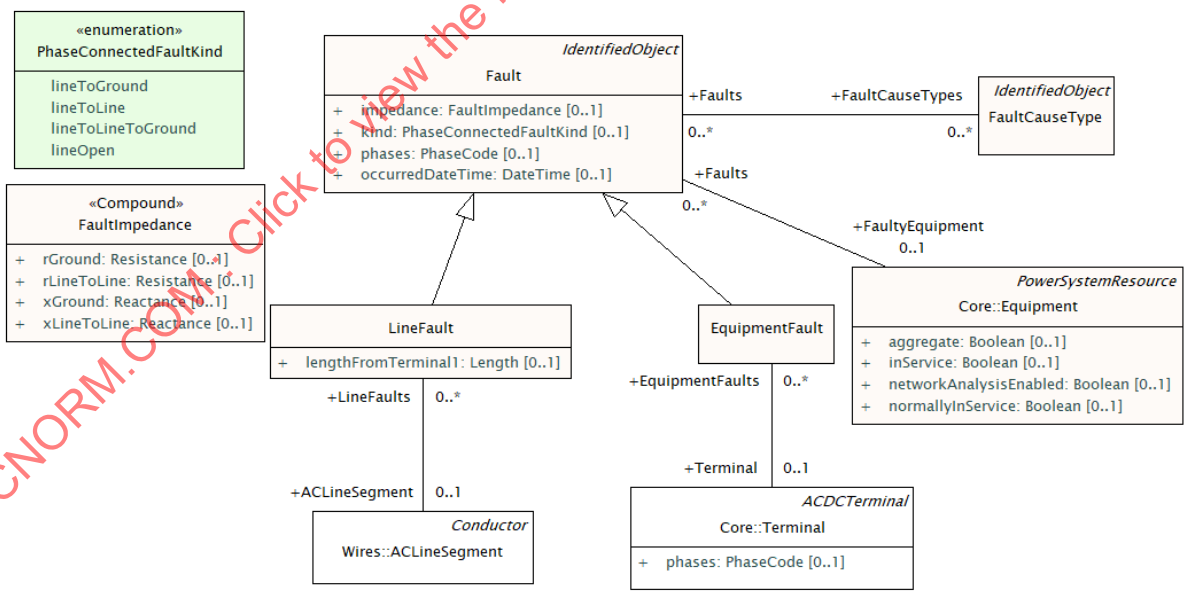


Figure 135 – Class diagram Faults::Faults

Figure 135: Classes used to model faults.

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6.18.2 EquipmentFault

A fault applied at the terminal, external to the equipment. This class is not used to specify faults internal to the equipment.

Table 697 shows all attributes of EquipmentFault.

Table 697 – Attributes of Faults::EquipmentFault

name	mult	type	description
impedance	0..1	FaultImpedance	inherited from: Fault
kind	0..1	PhaseConnectedFaultKind	inherited from: Fault
phases	0..1	PhaseCode	inherited from: Fault
occurredDateTime	0..1	DateTime	inherited from: Fault
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 698 shows all association ends of EquipmentFault with other classes.

Table 698 – Association ends of Faults::EquipmentFault with other classes

mult from	name	mult to	type	description
0..*	Terminal	0..1	Terminal	The terminal connecting to the bus to which the fault is applied.
0..*	FaultyEquipment	0..1	Equipment	inherited from: Fault
0..*	FaultCauseTypes	0..*	FaultCauseType	inherited from: Fault
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.18.3 Fault

Abnormal condition causing current flow through conducting equipment, such as caused by equipment failure or short circuits from objects not typically modelled (for example, a tree falling on a line).

Table 699 shows all attributes of Fault.

Table 699 – Attributes of Faults::Fault

name	mult	type	description
impedance	0..1	FaultImpedance	Fault impedance. Its usage is described by 'kind'.
kind	0..1	PhaseConnectedFaultKind	The kind of phase fault.
phases	0..1	PhaseCode	The phases participating in the fault. The fault connections into these phases are further specified by the type of fault.
occurredDateTime	0..1	DateTime	The date and time at which the fault occurred.

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name	mult	type	description
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 700 shows all association ends of Fault with other classes.

Table 700 – Association ends of Faults::Fault with other classes

mult from	name	mult to	type	description
0..*	FaultyEquipment	0..1	Equipment	Equipment carrying this fault.
0..*	FaultCauseTypes	0..*	FaultCauseType	All types of fault cause.
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.18.4 FaultCauseType

Type of cause of the fault.

Table 701 shows all attributes of FaultCauseType.

Table 701 – Attributes of Faults::FaultCauseType

name	mult	type	description
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 702 shows all association ends of FaultCauseType with other classes.

Table 702 – Association ends of Faults::FaultCauseType with other classes

mult from	name	mult to	type	description
0..*	Faults	0..*	Fault	All faults with this cause type.
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.18.5 FaultImpedance compound

Impedance description for the fault.

Table 703 shows all attributes of FaultImpedance.

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Table 703 – Attributes of Faults::FaultImpedance

name	mult	type	description
rGround	0..1	Resistance	The resistance of the fault between phases and ground.
rLineToLine	0..1	Resistance	The resistance of the fault between phases.
xGround	0..1	Reactance	The reactance of the fault between phases and ground.
xLineToLine	0..1	Reactance	The reactance of the fault between phases.

6.18.6 LineFault

A fault that occurs on an AC line segment at some point along the length.

Table 704 shows all attributes of LineFault.

Table 704 – Attributes of Faults::LineFault

name	mult	type	description
lengthFromTerminal1	0..1	Length	The length to the place where the fault is located starting from terminal with sequence number 1 of the faulted line segment.
impedance	0..1	FaultImpedance	inherited from: Fault
kind	0..1	PhaseConnectedFaultKind	inherited from: Fault
phases	0..1	PhaseCode	inherited from: Fault
occurredDateTime	0..1	DateTime	inherited from: Fault
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 705 shows all association ends of LineFault with other classes.

Table 705 – Association ends of Faults::LineFault with other classes

mult from	name	mult to	type	description
0..*	ACLineSegment	0..1	ACLineSegment	The line segment of this line fault.
0..*	FaultyEquipment	0..1	Equipment	inherited from: Fault
0..*	FaultCauseTypes	0..*	FaultCauseType	inherited from: Fault
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.18.7 PhaseConnectedFaultKind enumeration

The type of fault connection among phases.

Table 706 shows all literals of PhaseConnectedFaultKind.

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Table 706 – Literals of Faults::PhaseConnectedFaultKind

literal	value	description
lineToGround		The fault connects the indicated phases to ground. The line to line fault impedance is not used and assumed infinite. The full ground impedance is connected between each phase specified in the fault and ground, but not between the phases.
lineToLine		The fault connects the specified phases together without a connection to ground. The ground impedance of this fault is ignored. The line to line impedance is connected between each of the phases specified in the fault. For example three times for a three phase fault, one time for a two phase fault. A single phase fault should not be specified.
lineToLineToGround		The fault connects the indicated phases to ground and to each other. The line to line impedance is connected between each of the phases specified in the fault in a full mesh. For example three times for a three phase fault, one time for a two phase fault. A single phase fault should not be specified. The full ground impedance is connected between each phase specified in the fault and ground.
lineOpen		The fault is when the conductor path is broken between two terminals. Additional coexisting faults may be required if the broken conductor also causes connections to grounds or other lines or phases.

6.19 Package SCADA

6.19.1 General

Contains entities to model information used by Supervisory Control and Data Acquisition (SCADA) applications. Supervisory control supports operator control of equipment, such as opening or closing a breaker. Data acquisition gathers telemetered data from various sources. The subtypes of the Telemetry entity deliberately match the UCA and IEC 61850 definitions.

This package also supports alarm presentation but it is not expected to be used by other applications.

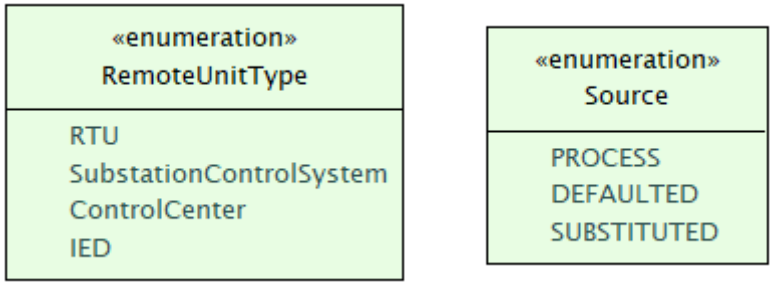


Figure 136 – Class diagram SCADA::Datatypes

Figure 136: Shows datatypes for SCADA model.

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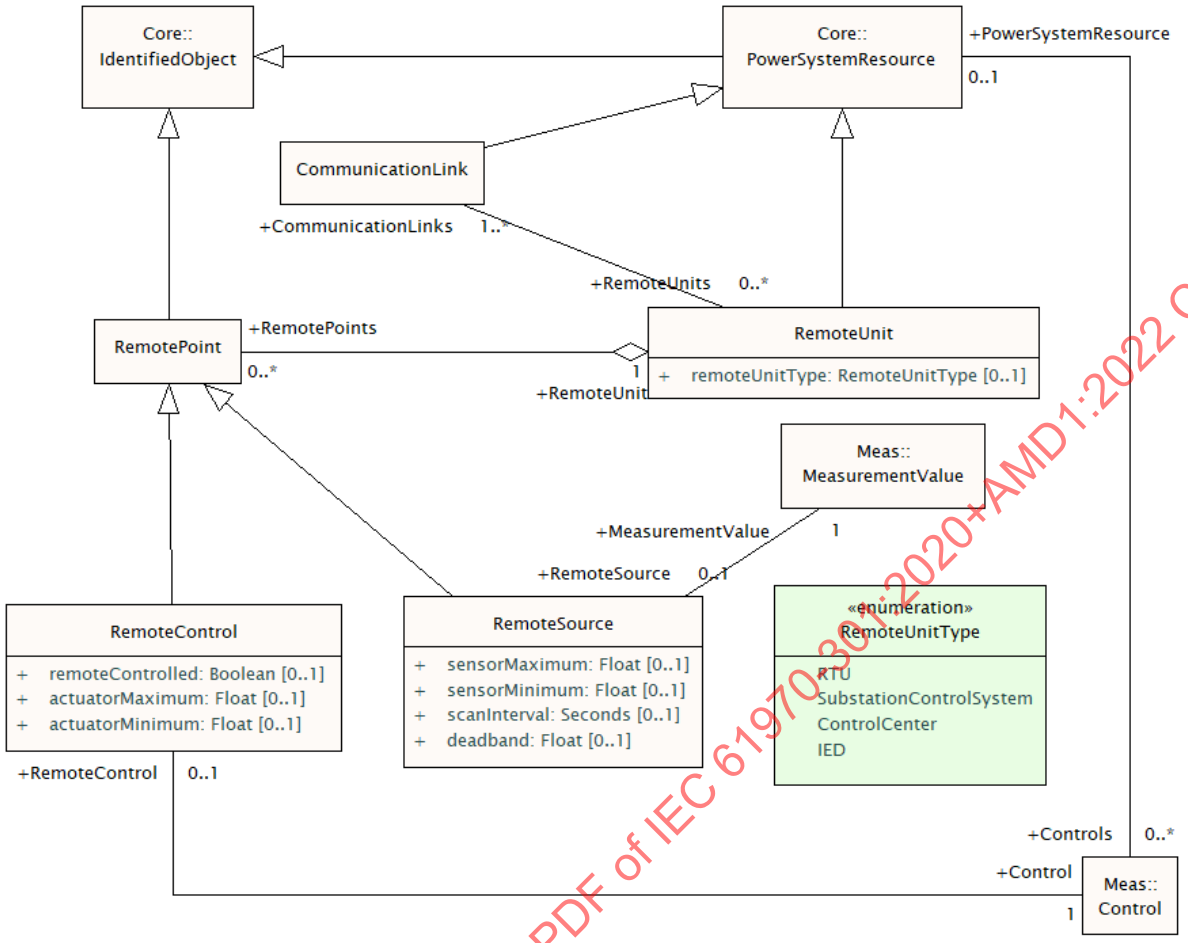


Figure 137 – Class diagram SCADA::Main

Figure 137: This diagram shows all classes included in the SCADA package as well as the key external classes that have associations with SCADA classes.

6.19.2 CommunicationLink

The connection to remote units is through one or more communication links. Reduntant links may exist. The CommunicationLink class inherits PowerSystemResource. The intention is to allow CommunicationLinks to have Measurements. These Measurements can be used to model link status as operational, out of service, unit failure etc.

Table 707 shows all attributes of CommunicationLink.

Table 707 – Attributes of SCADA::CommunicationLink

name	mult	type	description
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 708 shows all association ends of CommunicationLink with other classes.

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Table 708 – Association ends of SCADA::CommunicationLink with other classes

mult from	name	mult to	type	description
1..*	RemoteUnits	0..*	RemoteUnit	RTUs may be attached to communication links.
0..n	BilateralExchangeActor	0..1	BilateralExchangeActor	ICCP data provider or consumer using communication addressing for a Bilateral table.
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.19.3 RemoteControl

Remote controls are outputs that are sent by the remote unit to actuators in the process.

Table 709 shows all attributes of RemoteControl.

Table 709 – Attributes of SCADA::RemoteControl

name	mult	type	description
remoteControlled	0..1	Boolean	Set to true if the actuator is remotely controlled.
actuatorMaximum	0..1	Float	The maximum set point value accepted by the remote control point.
actuatorMinimum	0..1	Float	The minimum set point value accepted by the remote control point.
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 710 shows all association ends of RemoteControl with other classes.

Table 710 – Association ends of SCADA::RemoteControl with other classes

mult from	name	mult to	type	description
0..1	Control	1..1	Control	The Control for the RemoteControl point.
0..*	RemoteUnit	1..1	RemoteUnit	inherited from: RemotePoint
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.19.4 RemotePoint

For an RTU, remote points correspond to telemetered values or control outputs. Other units (e.g. control centres) usually also contain calculated values.

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Table 711 shows all attributes of RemotePoint.

Table 711 – Attributes of SCADA::RemotePoint

name	mult	type	description
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 712 shows all association ends of RemotePoint with other classes.

Table 712 – Association ends of SCADA::RemotePoint with other classes

mult from	name	mult to	type	description
0..*	RemoteUnit	1..1	RemoteUnit	Remote unit this point belongs to.
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.19.5 RemoteSource

Remote sources are state variables that are telemetered or calculated within the remote unit.

Table 713 shows all attributes of RemoteSource.

Table 713 – Attributes of SCADA::RemoteSource

name	mult	type	description
sensorMaximum	0..1	Float	The maximum value the telemetry item can return.
sensorMinimum	0..1	Float	The minimum value the telemetry item can return.
scanInterval	0..1	Seconds	The time interval between scans.
deadband	0..1	Float	The smallest change in value to be reported.
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 714 shows all association ends of RemoteSource with other classes.

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Table 714 – Association ends of SCADA::RemoteSource with other classes

mult from	name	mult to	type	description
0..1	MeasurementValue	1..1	MeasurementValue	Link to the physical telemetered point associated with this measurement.
0..*	RemoteUnit	1..1	RemoteUnit	inherited from: RemotePoint
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.19.6 RemoteUnit

A remote unit can be an RTU, IED, substation control system, control centre, etc. The communication with the remote unit can be through various standard protocols (e.g. IEC 61870, IEC 61850) or non standard protocols (e.g. DNP, RP570, etc.). A remote unit contains remote data points that might be telemetered, collected or calculated. The RemoteUnit class inherits PowerSystemResource. The intention is to allow RemoteUnits to have Measurements. These Measurements can be used to model unit status as operational, out of service, unit failure, etc.

Table 715 shows all attributes of RemoteUnit.

Table 715 – Attributes of SCADA::RemoteUnit

name	mult	type	description
remoteUnitType	0..1	RemoteUnitType	Type of remote unit.
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 716 shows all association ends of RemoteUnit with other classes.

Table 716 – Association ends of SCADA::RemoteUnit with other classes

mult from	name	mult to	type	description
0..*	CommunicationLinks	1..*	CommunicationLink	RTUs may be attached to communication links.
1..1	RemotePoints	0..*	RemotePoint	Remote points this Remote unit contains.
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.19.7 RemoteUnitType enumeration

Type of remote unit.

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Table 717 shows all literals of RemoteUnitType.

Table 717 – Literals of SCADA::RemoteUnitType

literal	value	description
RTU		Remote terminal unit.
SubstationControlSystem		Substation control system.
ControlCenter		Control centre.
IED		Intelligent electronic device (IED).

6.19.8 Source enumeration

Source gives information related to the origin of a value.

Table 718 shows all literals of Source.

Table 718 – Literals of SCADA::Source

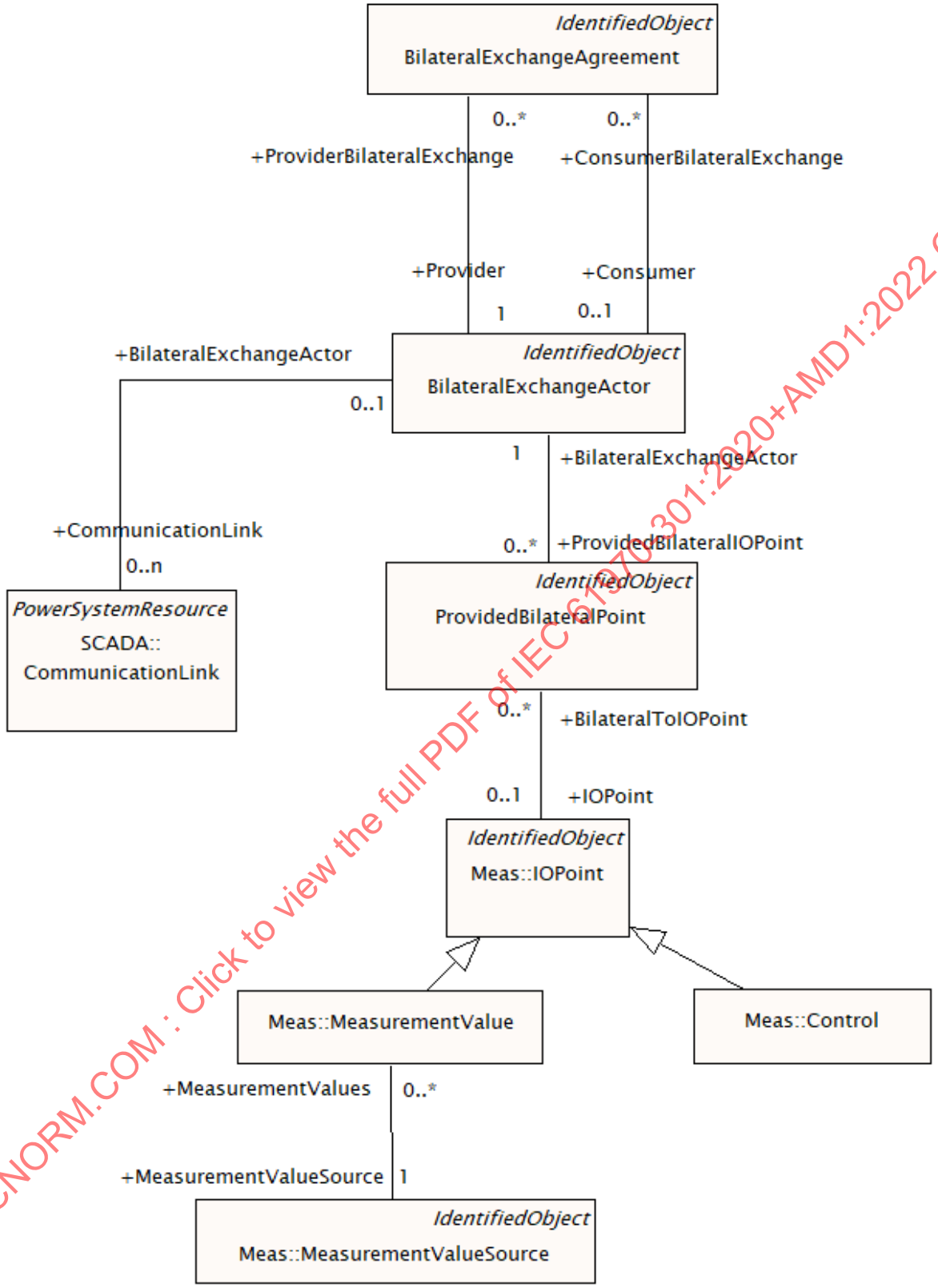
literal	value	description
PROCESS		The value is provided by input from the process I/O or being calculated from some function.
DEFAULTED		The value contains a default value.
SUBSTITUTED		The value is provided by input of an operator or by an automatic source.

6.20 Package ICCPConfiguration

6.20.1 General

This package models configuration of ICCP required for bilateral exchanges.

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Figure 138 – Class diagram ICCPConfiguration::GenericBilateralExchange

Figure 138: Classes used to model bilateral ICCP exchange.

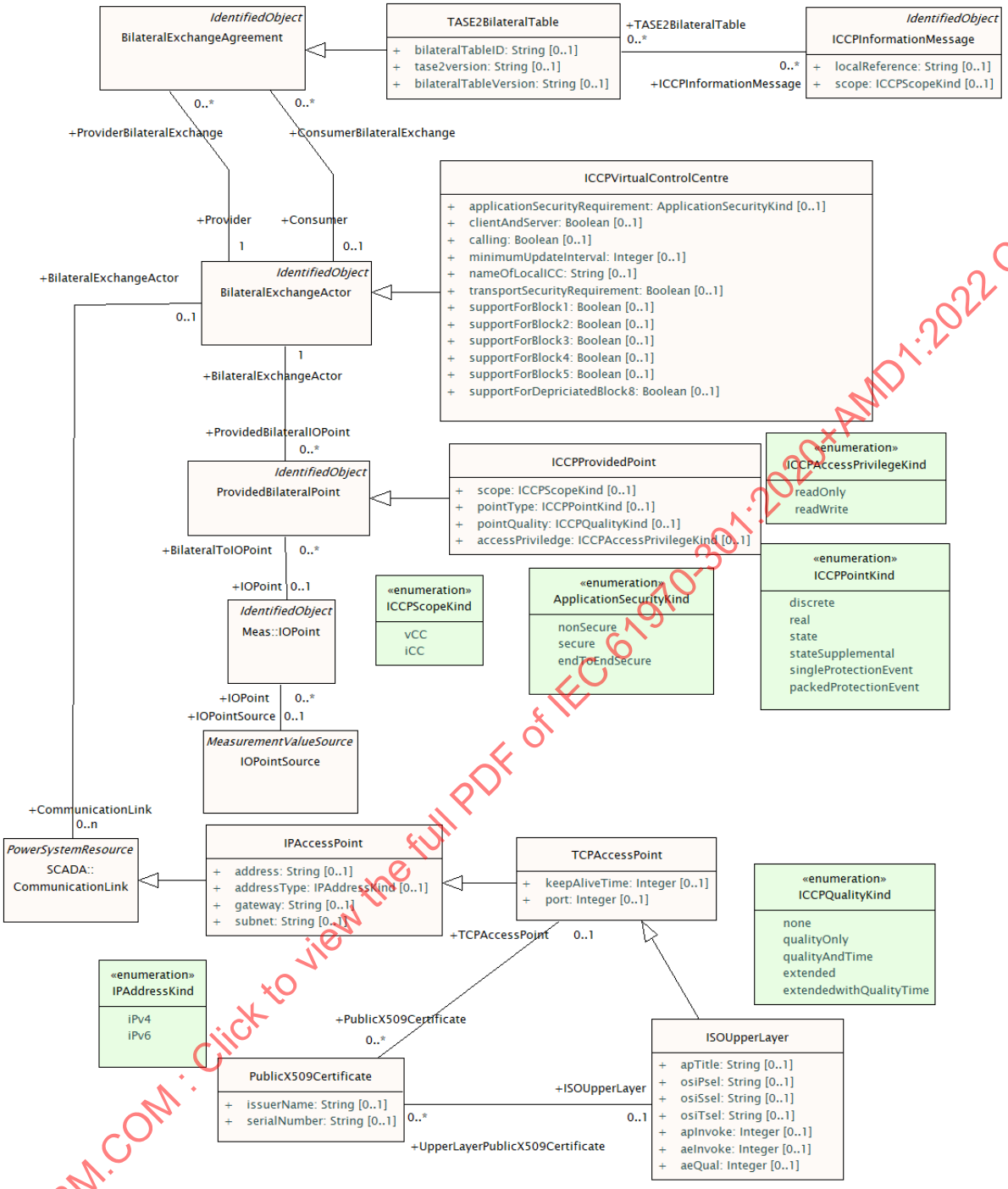


Figure 139 – Class diagram ICCPConfiguration::ICCP

Figure 139: Classes used to model ICCP configuration.

6.20.2 ApplicationSecurityKind enumeration

Specifies the expected security mechanism, per IEC 62351-4, to be utilized.

Table 719 shows all literals of ApplicationSecurityKind.

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Table 719 – Literals of ICCPConfiguration::ApplicationSecurityKind

literal	value	description
nonSecure		Indicates that an application security shall not be used in order to allow establishment of an MSS association.
secure		Indicates that the A-security-profile as specified in Clause 11 (or IEC TS 62351-4:2007) shall be used in order to allow establishment of an MMS association.
endToEndSecure		Indicates that E2E-security shall be used in order to allow establishment of an MMS association.

6.20.3 BilateralExchangeActor

BilateralExchangeActor describes an actor that provides ICCP data, consumes ICCP data or both. The ICCP data provider lists the data it makes available to an ICCP data consumer. This data is described by ProvidedBilateralPoints. The relation between an ICCP data provider and a consumer is established by a BilateralExchangeAgreement. It is up to the ICCP data consumer to select what ProvidedBilateralPoints to use. The selection made is not described in this information model.

Table 720 shows all attributes of BilateralExchangeActor.

Table 720 – Attributes of ICCPConfiguration::BilateralExchangeActor

name	mult	type	description
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 721 shows all association ends of BilateralExchangeActor with other classes.

Table 721 – Association ends of ICCPConfiguration::BilateralExchangeActor with other classes

mult from	name	mult to	type	description
1..1	ProviderBilateralExchange	0..*	BilateralExchangeAgreement	Agreement to information provider.
0..1	CommunicationLink	0..n	CommunicationLink	Communication addressing for a Bilateral Table used by a ICCP data provider or consumer.
0..1	ConsumerBilateralExchange	0..*	BilateralExchangeAgreement	Agreement to information subscriber.
1..1	ProvidedBilateralIOPoint	0..*	ProvidedBilateralPoint	ICCP information in a Bilateral table that will be exposed to a remote peer.
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.20.4 BilateralExchangeAgreement

This is the representation of the information exchange agreement between peers.

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Table 722 shows all attributes of BilateralExchangeAgreement.

Table 722 – Attributes of ICCPConfiguration::BilateralExchangeAgreement

name	mult	type	description
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 723 shows all association ends of BilateralExchangeAgreement with other classes.

Table 723 – Association ends of ICCPConfiguration::BilateralExchangeAgreement with other classes

mult from	name	mult to	type	description
0..*	Consumer	0..1	BilateralExchangeActor	Subscriber of information from a remote peer.
0..*	Provider	1..1	BilateralExchangeActor	Provider of information to a remote peer.
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.20.5 ICCPAccessPrivilegeKind enumeration

Provides access privilege information regarding an ICCP point.

Table 724 shows all literals of ICCPAccessPrivilegeKind.

Table 724 – Literals of ICCPConfiguration::ICCPAccessPrivilegeKind

literal	value	description
readOnly		Indicates that the remote is not allowed to change the value of the ICCPPoint.
readWrite		Indicates that the remote can not only get the value, but may also change the value of the ICCP Point.

6.20.6 ICCPInformationMessage

This class represents the TASE.2 Information Message Object. The IdentifiedObject.name attribute must be non-null. The value of the attribute shall be used as the TASE.2 Information Reference, as specified by 60870-6-503.

Table 725 shows all attributes of ICCPInformationMessage.

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Table 725 – Attributes of ICCPConfiguration::ICCPInformationMessage

name	mult	type	description
localReference	0..1	String	The Local Reference attribute specifies a value agreed upon between sender and receiver of the Information Message. It further identifies the Information Message.
scope	0..1	ICCPScopeKind	Indicates if the Point is global scoped (e.g. VCC) or accessible only to the Bilateral table peer (e.g. ICC).
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 726 shows all association ends of ICCPInformationMessage with other classes.

Table 726 – Association ends of ICCPConfiguration::ICCPInformationMessage with other classes

mult from	name	mult to	type	description
0..*	TASE2BilateralTable	0..*	TASE2BilateralTable	Bilateral table agreement that includes the informational message.
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.20.7 ICCPPointKind enumeration

The kind of ICCP point that is to be conveyed.

Table 727 shows all literals of ICCPPointKind.

Table 727 – Literals of ICCPConfiguration::ICCPPointKind

literal	value	description
discrete		Indicates that an ICCP discrete type is to be conveyed.
real		Indicates that an ICCP real type is to be conveyed.
state		Indicates that an ICCP state type is to be conveyed.
stateSupplemental		Indicates that an ICCP state supplemental type is to be conveyed.
singleProtectionEvent		Indicates that an ICCP single Protection Event type is to be conveyed.
packedProtectionEvent		Indicates that an ICCP packed Protection Event is to be conveyed.

6.20.8 ICCPProvidedPoint

The IdentifiedObject.name attribute must have a value. The name attribute shall be used as the DataValue name used for the exchange.

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Table 728 shows all attributes of ICCPProvidedPoint.

Table 728 – Attributes of ICCPConfiguration::ICCPProvidedPoint

name	mult	type	description
scope	0..1	ICCPScopeKind	Indicates if the Point is global scoped (e.g. VCC) or accessible only to the Bilateral table peer (e.g. ICC).
pointType	0..1	ICCPPointKind	Indicates the ICCP Point type that is to be conveyed. A CIM AccumlatorValue shall be mapped to an ICCP real. A CIM AnalogValue shall be mapped to an ICCP real. A CIM DiscreteValue shall be mapped to either an ICCP real, state, stateSupplemental, or either protection event type. A CIM StringMeasurementValue does not have a standardized mapping.
pointQuality	0..1	ICCPQualityKind	Specifies the type of ICCP quality that will be conveyed as part of the ICCP Point.
accessPriviledge	0..1	ICCPAccessPrivilegeKind	Provides information regarding the access privileges allowed to the ICCP Point.
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 729 shows all association ends of ICCPProvidedPoint with other classes.

Table 729 – Association ends of ICCPConfiguration::ICCPProvidedPoint with other classes

mult from	name	mult to	type	description
0..*	BilateralExchangeActor	1..1	BilateralExchangeActor	inherited from: ProvidedBilateralPoint
0..*	IOPoint	0..1	IOPoint	inherited from: ProvidedBilateralPoint
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.20.9 ICCPQualityKind enumeration

Indicates the type of quality information that is to be exchanged. For protection events the value shall be "none".

Table 730 shows all literals of ICCPQualityKind.

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Table 730 – Literals of ICCPConfiguration::ICCPQualityKind

literal	value	description
none		Indicates that no quality is conveyed with the ICCP point.
qualityOnly		Indicates that only quality is to be provided.
qualityAndTime		Indicates that quality and a timestamp are to be provided.
extended		Indicates that only extended information is to be provided.
extendedwithQualityTime		Provides quality, timestamp, and extended information.

6.20.10 ICCPScopeKind enumeration

Specifies the control centre scope.

Table 731 shows all literals of ICCPScopeKind.

Table 731 – Literals of ICCPConfiguration::ICCPScopeKind

literal	value	description
vCC		Virtual Control Centre Scope – globally available.
iCC		Inter-Control Centre scope – available for exchange between the control centres in the bilateral table.

6.20.11 ICCPVCC

Indicates that the ICCP information is global in nature and normally is available to all authorized peers.

Table 732 shows all attributes of ICCPVCC.

Table 732 – Attributes of ICCPConfiguration::ICCPVCC

name	mult	type	description
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 733 shows all association ends of ICCPVCC with other classes.

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Table 733 – Association ends of ICCPConfiguration::ICCPVCC with other classes

mult from	name	mult to	type	description
1..1	ProviderBilateralExchange	0..*	BilateralExchangeAgreement	inherited from: BilateralExchangeActor
0..1	CommunicationLink	0..n	CommunicationLink	inherited from: BilateralExchangeActor
0..1	ConsumerBilateralExchange	0..*	BilateralExchangeAgreement	inherited from: BilateralExchangeActor
1..1	ProvidedBilateralIOPoint	0..*	ProvidedBilateralPoint	inherited from: BilateralExchangeActor
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.20.12 ICCPVirtualControlCentre

This contains the information that a particular actor exposes for a particular agreed upon ICCP Bilateral Table.

Table 734 shows all attributes of ICCPVirtualControlCentre.

Table 734 – Attributes of ICCPConfiguration::ICCPVirtualControlCentre

name	mult	type	description
applicationSecurityRequirement	0..1	ApplicationSecurityKind	Specifies the expected security mechanism, per IEC 62351-4, to be utilized.
clientAndServer	0..1	Boolean	If True the value indicates that the entity represented by the bilateral table is capable of issuing requests and responding to request (e.g. bidirectional support of ICCP requests). If False, this indicates that a calling entity (e.g. calling = True) will not be able to respond to ICCP requests. If False, and calling=False, this indicates that the entity will only respond to ICCP requests and not issue ICCP requests.
calling	0..1	Boolean	Used to indicate if the Provider is responsible for initiating the TASE.2 connection. If the value is TRUE, the provider is responsible for establishing the association. If the value is FALSE, the peer provider of the Bilateral Table will need to establish the association.
minimumUpdateInterval	0..1	Integer	Specifies the fastest update interval that can be provided for integrity information and Transfer Set creation. The value is in seconds.
nameOfLocalICC	0..1	String	Specifies the ICC scope name that the remote can use to access the information in the Bilateral Table if the information is not VCC scoped. This value may not be null.
transportSecurityRequirement	0..1	Boolean	If true, then transport level security as specified by IEC 62351-6 is required.
supportForBlock1	0..1	Boolean	Per IEC 60870-6-702: If true indicates support for basic services. Must always be true.
supportForBlock2	0..1	Boolean	Per IEC 60870-6-702: If true indicates support for extended conditions.
supportForBlock3	0..1	Boolean	Per IEC 60870-6-702: If true indicates support for blocked transfers.
supportForBlock4	0..1	Boolean	Per IEC 60870-6-702: If true indicates support for information messages.

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name	mult	type	description
supportForBlock5	0..1	Boolean	Per IEC 60870-6-702: If true indicates support for device control.
supportForDepriciatedBlock8	0..1	Boolean	Per IEC 60870-6-702: If true indicates support for accounts. The use of this block was deprecated in Edition 3.
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 735 shows all association ends of ICCPVirtualControlCentre with other classes.

Table 735 – Association ends of ICCPConfiguration::ICCPVirtualControlCentre with other classes

mult from	name	mult to	type	description
1..1	ProviderBilateralExchange	0..*	BilateralExchangeAgreement	inherited from: BilateralExchangeActor
0..1	CommunicationLink	0..n	CommunicationLink	inherited from: BilateralExchangeActor
0..1	ConsumerBilateralExchange	0..*	BilateralExchangeAgreement	inherited from: BilateralExchangeActor
1..1	ProvidedBilateralIOPoint	0..*	ProvidedBilateralPoint	inherited from: BilateralExchangeActor
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.20.13 IOPointSource

Indicates the point source for an IO Point.

Table 736 shows all attributes of IOPointSource.

Table 736 – Attributes of ICCPConfiguration::IOPointSource

name	mult	type	description
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 737 shows all association ends of IOPointSource with other classes.

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Table 737 – Association ends of ICCPConfiguration::IOPointSource with other classes

mult from	name	mult to	type	description
0..1	IOPoint	0..*	IOPoint	ICCP point for a local measurement value source.
1..1	MeasurementValues	0..*	MeasurementValue	inherited from: MeasurementValueSource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.20.14 IPAccessPoint

Internet Protocol Access Point – used to represent an addressing structure is based upon an Internet Protocol (IP) address.

Table 738 shows all attributes of IPAccessPoint.

Table 738 – Attributes of ICCPConfiguration::IPAccessPoint

name	mult	type	description
address	0..1	String	Is the dotted decimal IP Address resolve the IP address. The format is controlled by the value of the addressType.
addressType	0..1	IPAddressKind	IP address type.
gateway	0..1	String	Is the dotted decimal IPAddress of the first hop router. Format is controlled by the addressType.
subnet	0..1	String	This is the IP subnet mask which controls the local vs non-local routing.
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 739 shows all association ends of IPAccessPoint with other classes.

Table 739 – Association ends of ICCPConfiguration::IPAccessPoint with other classes

mult from	name	mult to	type	description
1..*	RemoteUnits	0..*	RemoteUnit	inherited from: CommunicationLink
0..n	BilateralExchangeActor	0..1	BilateralExchangeActor	inherited from: CommunicationLink
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

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6.20.15 IPAddressKind enumeration

Indicates if the addressing of the IPAccessPoint, gateway, and subnet are per IPv4 or IPv6.

Table 740 shows all literals of IPAddressKind.

Table 740 – Literals of ICCPConfiguration::IPAddressKind

literal	value	description
iPv4		Indicates that IPv4 dotted decimal notation is in use.
iPv6		Indicates that an IPv6 dotted decimal is in use.

6.20.16 ISOUpperLayer

Is a set of configure addressing information that is required since ICCP utilizes addressing other than a TCP port.

Table 741 shows all attributes of ISOUpperLayer.

Table 741 – Attributes of ICCPConfiguration::ISOUpperLayer

name	mult	type	description
apTitle	0..1	String	Is a sequence of integer strings separated by ".". The value, in conjunction with other application addressing attributes (e.g. other APs) are used to select a specific application (e.g. the ICCP application entity) per the OSI reference model. The sequence, and its values, represent a namespace whose values are governed by ISO/IEC 7498-3.
osiPsel	0..1	String	Is the addressing selector for OSI presentation addressing.
osiSsel	0..1	String	Is the OSI session layer addressing information.
osiTsel	0..1	String	Is the OSI Transport Layer addressing information.
apInvoke	0..1	Integer	Is a further application level OSI addressing parameter.
aeInvoke	0..1	Integer	Is part of the Application Entity addressing as specified by ISO Addressing.
aeQual	0..1	Integer	Is the AE qualifier and represents further application level addressing information.
keepAliveTime	0..1	Integer	inherited from: TCPAccessPoint
port	0..1	Integer	inherited from: TCPAccessPoint
address	0..1	String	inherited from: IPAccessPoint
addressType	0..1	IPAddressKind	inherited from: IPAccessPoint
gateway	0..1	String	inherited from: IPAccessPoint
subnet	0..1	String	inherited from: IPAccessPoint
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 742 shows all association ends of ISOUpperLayer with other classes.

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Table 742 – Association ends of ICCPConfiguration::ISOUpperLayer with other classes

mult from	name	mult to	type	description
0..1	UpperLayerPublicX509Certificate	0..*	PublicX509Certificate	Certificate to be bound for use for Application layer mutual authentication.
0..1	PublicX509Certificate	0..*	PublicX509Certificate	inherited from: TCPAccessPoint
1..*	RemoteUnits	0..*	RemoteUnit	inherited from: CommunicationLink
0..n	BilateralExchangeActor	0..1	BilateralExchangeActor	inherited from: CommunicationLink
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.20.17 ProvidedBilateralPoint

Allows declaration of ICCP points to be provided through a Bilateral Table agreement.

Table 743 shows all attributes of ProvidedBilateralPoint.

Table 743 – Attributes of ICCPConfiguration::ProvidedBilateralPoint

name	mult	type	description
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 744 shows all association ends of ProvidedBilateralPoint with other classes.

Table 744 – Association ends of ICCPConfiguration::ProvidedBilateralPoint with other classes

mult from	name	mult to	type	description
0..*	BilateralExchangeActor	1..1	BilateralExchangeActor	Remote peer that will receive ICCP information in a Bilateral table.
0..*	IOPoint	0..1	IOPoint	Measurement or control for the bilateral ICCP point.
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.20.18 PublicX509Certificate root class

Used to convey information that will allow matching in order to determine which certificate to use. Actual certificates are exchanged externally to the CIM exchange.

Table 745 shows all attributes of PublicX509Certificate.

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Table 745 – Attributes of ICCPConfiguration::PublicX509Certificate

name	mult	type	description
issuerName	0..1	String	Represents the CA that issued the certificate. Defined to be per X.509.
serialNumber	0..1	String	Is the serial number of the certificate per X.509 definition.

Table 746 shows all association ends of PublicX509Certificate with other classes.

Table 746 – Association ends of ICCPConfiguration::PublicX509Certificate with other classes

mult from	name	mult to	type	description
0..*	ISOUpperLayer	0..1	ISOUpperLayer	Application layer used with the certificate for mutual authentication.
0..*	TCPAccessPoint	0..1	TCPAccessPoint	The association allows a certificate to be bound for use by TLS.

6.20.19 TASE2BilateralTable

This class describe the sending (providing) side in a bilateral ICCP data exchange. Hence the ICCP bilateral (table) descriptions are created by exchanging ICCP Provider data between the parties.

Table 747 shows all attributes of TASE2BilateralTable.

Table 747 – Attributes of ICCPConfiguration::TASE2BilateralTable

name	mult	type	description
bilateralTableID	0..1	String	Specifies the version of the Bilateral Table configuration that is being exchanged.
tase2version	0..1	String	Specifies the version of the TASE.2 that is needed to access the Bilateral Table information via TASE.2. In order for a link to be established, both sides must have the same value.
bilateralTableVersion	0..1	String	The Version attribute identifies a unique version of the Bilateral Table. If any changes are made to a Bilateral Table, then a new unique value for this attribute shall be generated.
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 748 shows all association ends of TASE2BilateralTable with other classes.

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Table 748 – Association ends of ICCPConfiguration::TASE2BilateralTable with other classes

mult from	name	mult to	type	description
0..*	ICCPInformationMessage	0..*	ICCPInformationMessage	Informational message to be included in a Bilateral Table agreement.
0..*	Consumer	0..1	BilateralExchangeActor	inherited from: BilateralExchangeAgreement
0..*	Provider	1..1	BilateralExchangeActor	inherited from: BilateralExchangeAgreement
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

6.20.20 TCPAccessPoint

Allows addressing and behavioural information regarding the use of TCP by ICCP links.

Table 749 shows all attributes of TCPAccessPoint.

Table 749 – Attributes of ICCPConfiguration::TCPAccessPoint

name	mult	type	description
keepAliveTime	0..1	Integer	Indicates the default interval at which TCP will check if the TCP connection is still valid.
port	0..1	Integer	This value is only needed to be specified for called nodes (e.g. those that respond to a TCP.Open request). This value specifies the TCP port to be used. Well known and "registered" ports are preferred and can be found at: http://www.iana.org/assignments/service-names-port-numbers/service-names-port-numbers.xhtml For IEC 60870-6 TASE.2 (e.g. ICCP) and IEC 61850, the value used shall be 102 for non-TLS protected exchanges. The value shall be 3782 for TLS transported ICCP and 61850 exchanges.
address	0..1	String	inherited from: IPAccessPoint
addressType	0..1	IPAddressKind	inherited from: IPAccessPoint
gateway	0..1	String	inherited from: IPAccessPoint
subnet	0..1	String	inherited from: IPAccessPoint
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 750 shows all association ends of TCPAccessPoint with other classes.

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Table 750 – Association ends of ICCPConfiguration::TCPAccessPoint with other classes

mult from	name	mult to	type	description
0..1	PublicX509Certificate	0..*	PublicX509Certificate	Is the Public Certificate used for mutual authentication between peers.
1..*	RemoteUnits	0..*	RemoteUnit	inherited from: CommunicationLink
0..n	BilateralExchangeActor	0..1	BilateralExchangeActor	inherited from: CommunicationLink
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

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Annex A
(normative)

Custom extensions

A.1 Overview

Annex A is normative and contains custom extensions with wide spread use that may be useful to more than the organizations that created them.

A.2 European extensions

A.2.1 General

[nsuri = http://iec.ch/TC57/CIM100-European#, nsprefix = eu]

This package contains the European extensions to Base package of the canonical CIM model.

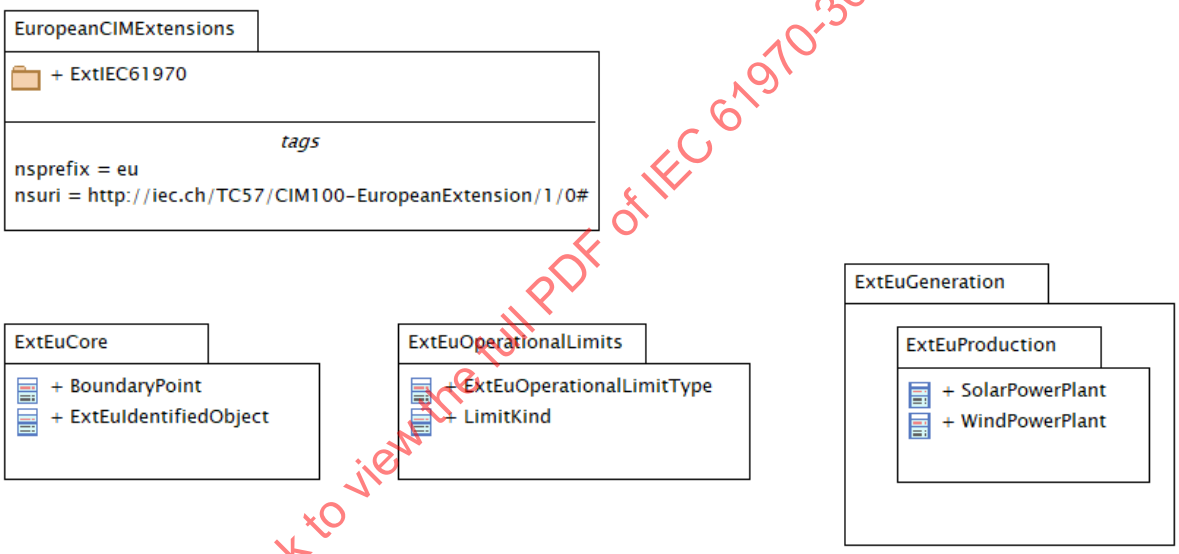


Figure A.1 – Class diagram ExtEuBase::ExtEuBase

Figure A.1: The diagram shows the overview of European extension packages.

A.2.2 Package ExtEuCore

A.2.2.1 General

European extensions to Core package.

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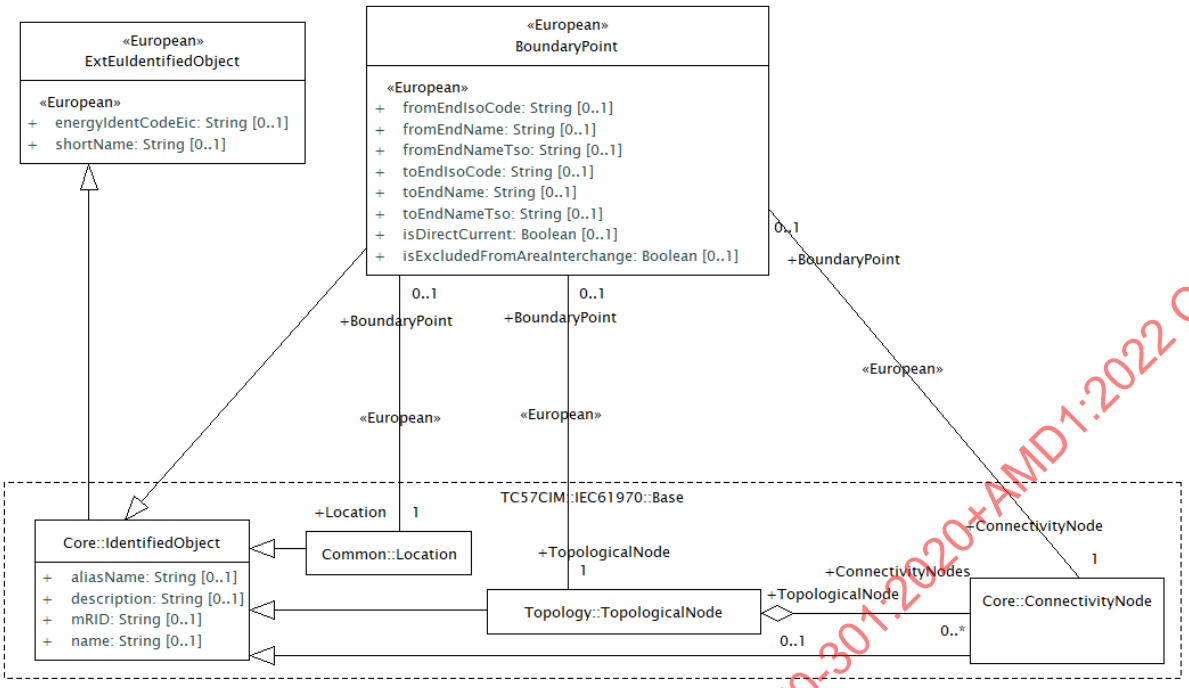


Figure A.2 – Class diagram ExtEuCore::ExtEuCore

Figure A.2: The diagram shows European extensions related to boundary definitions and naming.

A.2.2.2 (European) BoundaryPoint

Designates a connection point at which one or more model authority sets shall connect to. The location of the connection point as well as other properties are agreed between organisations responsible for the interconnection, hence all attributes of the class represent this agreement. It is primarily used in a boundary model authority set which can contain one or many BoundaryPoint-s among other Equipment-s and their connections.

Table A.1 shows all attributes of BoundaryPoint.

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Table A.1 – Attributes of ExtEuCore::BoundaryPoint

name	mult	type	description
fromEndIsoCode	0..1	String	(European) The ISO code of the region which the "From" side of the Boundary point belongs to or it is connected to. The ISO code is a two-character country code as defined by ISO 3166 (http://www.iso.org/iso/country_codes). The length of the string is 2 characters maximum.
fromEndName	0..1	String	(European) A human readable name with length of the string 64 characters maximum. It covers the following two cases: – if the Boundary point is placed on a tie-line, it is the name (IdentifiedObject.name) of the substation at which the "To"side of the tie-line is connected to. – if the Boundary point is placed in a substation, it is the name (IdentifiedObject.name) of the element (e.g. PowerTransformer, ACLineSegment, Switch, etc.) at which the "To" side of the Boundary point is connected to.
fromEndNameTso	0..1	String	(European) Identifies the name of the transmission system operator, distribution system operator or other entity at which the "From" side of the interconnection is connected to. The length of the string is 64 characters maximum.
toEndIsoCode	0..1	String	(European) The ISO code of the region which the "To" side of the Boundary point belongs to or is connected to. The ISO code is a two-character country code as defined by ISO 3166 (http://www.iso.org/iso/country_codes). The length of the string is 2 characters maximum.
toEndName	0..1	String	(European) A human readable name with length of the string 32 characters maximum. It covers the following two cases: – if the Boundary point is placed on a tie-line, it is the name (IdentifiedObject.name) of the substation at which the "To" side of the tie-line is connected to. – if the Boundary point is placed in a substation, it is the name (IdentifiedObject.name) of the element (e.g. PowerTransformer, ACLineSegment, Switch, etc.) at which the "To" side of the Boundary point is connected to.
toEndNameTso	0..1	String	(European) Identifies the name of the transmission system operator, distribution system operator or other entity at which the "To" side of the interconnection is connected to. The length of the string is 64 characters maximum.
isDirectCurrent	0..1	Boolean	(European) If true, this boundary point is a point of common coupling (PCC) of a direct current (DC) interconnection, otherwise the interconnection is AC (default).

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name	mult	type	description
isExcludedFromAreaInterchange	0..1	Boolean	(European) If true, this boundary point is on the interconnection that is excluded from control area interchange calculation and consequently has no related tie flows. Otherwise, the interconnection is included in control area interchange and a TieFlow is required at all sides of the boundary point (default).
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject
energyIdentCodeEic	0..1	String	(European) inherited from: ExtEuIdentifiedObject
shortName	0..1	String	(European) inherited from: ExtEuIdentifiedObject

Table A.2 shows all association ends of BoundaryPoint with other classes.

Table A.2 – Association ends of ExtEuCore::BoundaryPoint with other classes

mult from	name	mult to	type	description
0..1	ConnectivityNode	1..1	ConnectivityNode	(European) The connectivity node that is designated as a boundary point.
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource

A.2.2.3 (European) ExtEuIdentifiedObject root class

Contains attributes to allow for mappings between different European identification schemes.

Table A.3 shows all attributes of ExtEuIdentifiedObject.

Table A.3 – Attributes of ExtEuCore::ExtEuIdentifiedObject

name	mult	type	description
energyIdentCodeEic	0..1	String	(European) The attribute is used for an exchange of the EIC code (Energy identification Code). The length of the string is 16 characters as defined by the EIC code. For details on EIC scheme please refer to ENTSO-E web site.
shortName	0..1	String	(European) The attribute is used for an exchange of a human readable short name with length of the string 12 characters maximum.

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A.2.3 Package ExtEuOperationalLimits

A.2.3.1 General

European extensions to OperationalLimits package.

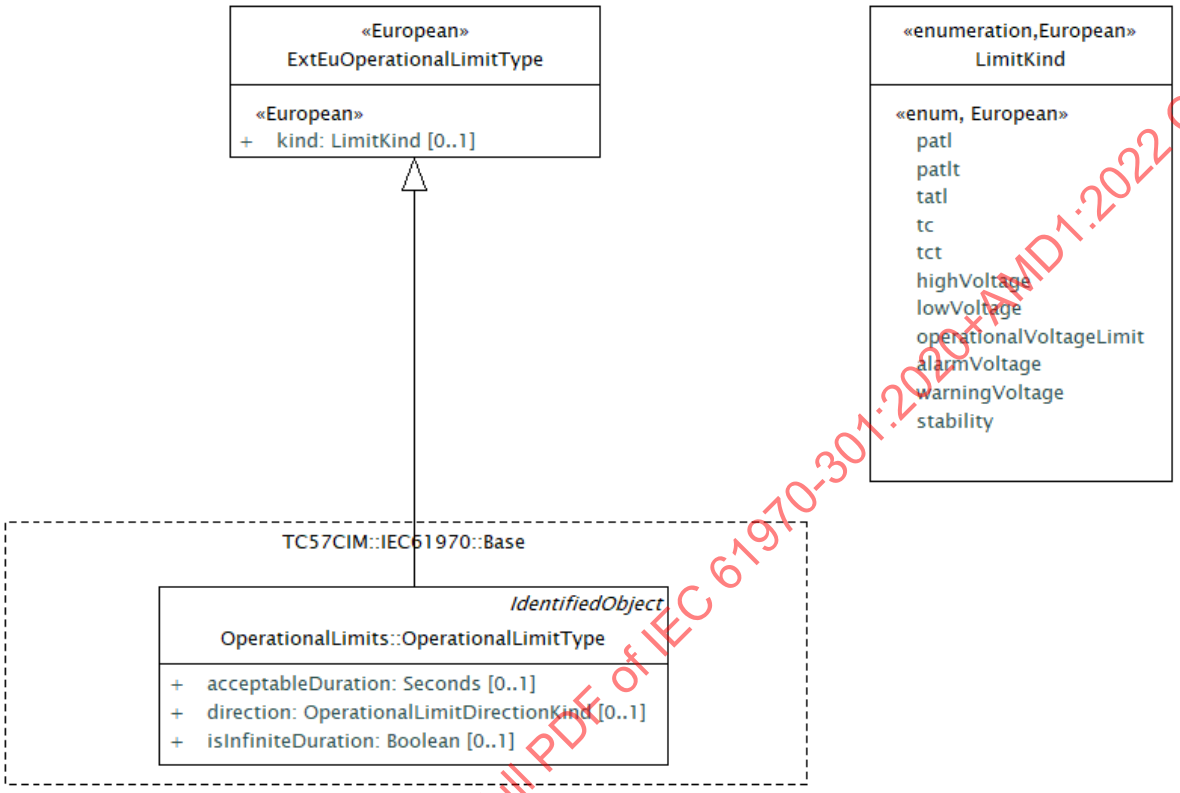


Figure A.3 – Class diagram ExtEuOperationalLimits::ExtEuOperationalLimits

Figure A.3: The diagram shows European extensions to OperationalLimits package.

A.2.3.2 (European) ExtEuOperationalLimitType root class

Contains an attribute that extends the OperationalLimit by assigning it a specific type.

Table A.4 shows all attributes of ExtEuOperationalLimitType.

Table A.4 – Attributes of ExtEuOperationalLimits::ExtEuOperationalLimitType

name	mult	type	description
kind	0..1	LimitKind	(European) Types of limits defined in the ENTSO-E Operational Handbook Policy 3.

A.2.3.3 (European) LimitKind enumeration

Limit kinds.

Table A.5 shows all literals of LimitKind.

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Table A.5 – Literals of ExtEuOperationalLimits::LimitKind

literal	value	description
patl		(European) The Permanent Admissible Transmission Loading (PATL) is the loading in amperes, MVA or MW that can be accepted by a network branch for an unlimited duration without any risk for the material. The OperationnalLimitType.isInfiniteDuration is set to true. There shall be only one OperationalLimitType of kind PATL per OperationalLimitSet if the PATL is ApparentPowerLimit, ActivePowerLimit, or CurrentLimit for a given Terminal or Equipment.
patlt		(European) Permanent Admissible Transmission Loading Threshold (PATLT) is a value in engineering units defined for PATL and calculated using a percentage less than 100 % of the PATL type intended to alert operators of an arising condition. The percentage should be given in the name of the OperationalLimitSet. The aceptableDuration is another way to express the severity of the limit.
tatl		(European) Temporarily Admissible Transmission Loading (TATL) which is the loading in amperes, MVA or MW that can be accepted by a branch for a certain limited duration. The TATL can be defined in different ways: – as a fixed percentage of the PATL for a given time (for example, 115% of the PATL that can be accepted during 15 minutes), – pairs of TATL type and Duration calculated for each line taking into account its particular configuration and conditions of functioning (for example, it can define a TATL acceptable during 20 minutes and another one acceptable during 10 minutes). Such a definition of TATL can depend on the initial operating conditions of the network element (sag situation of a line). The duration attribute can be used to define several TATL limit types. Hence multiple TATL limit values may exist having different durations.
tc		(European) Tripping Current (TC) is the ultimate intensity without any delay. It is defined as the threshold the line will trip without any possible remedial actions. The tripping of the network element is ordered by protections against short circuits or by overload protections, but in any case, the activation delay of these protections is not compatible with the reaction delay of an operator (less than one minute). The duration is always zero if the OperationalLimitType.acceptableDuration is exchanged. Only one limit value exists for the TC type.

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literal	value	description
tct		(European) Tripping Current Threshold (TCT) is a value in engineering units defined for TC and calculated using a percentage less than 100 % of the TC type intended to alert operators of an arising condition. The percentage should be given in the name of the OperationalLimitSet. The aceptableDuration is another way to express the severity of the limit.
highVoltage		(European) Referring to the rating of the equipments, a voltage too high can lead to accelerated ageing or the destruction of the equipment. This limit type may or may not have duration.
lowVoltage		(European) A too low voltage can disturb the normal operation of some protections and transformer equipped with on-load tap changers, electronic power devices or can affect the behaviour of the auxiliaries of generation units. This limit type may or may not have duration.
operationalVoltageLimit		(European) Operational voltage limit.
alarmVoltage		(European) Voltage alarm.
warningVoltage		(European) Voltage warning.
stability		(European) Stability.

A.2.4 Package ExtEuGeneration

A.2.4.1 General

European extensions to Generation package.

A.2.4.2 Package ExtEuProduction

A.2.4.2.1 General

European extensions to Production package.

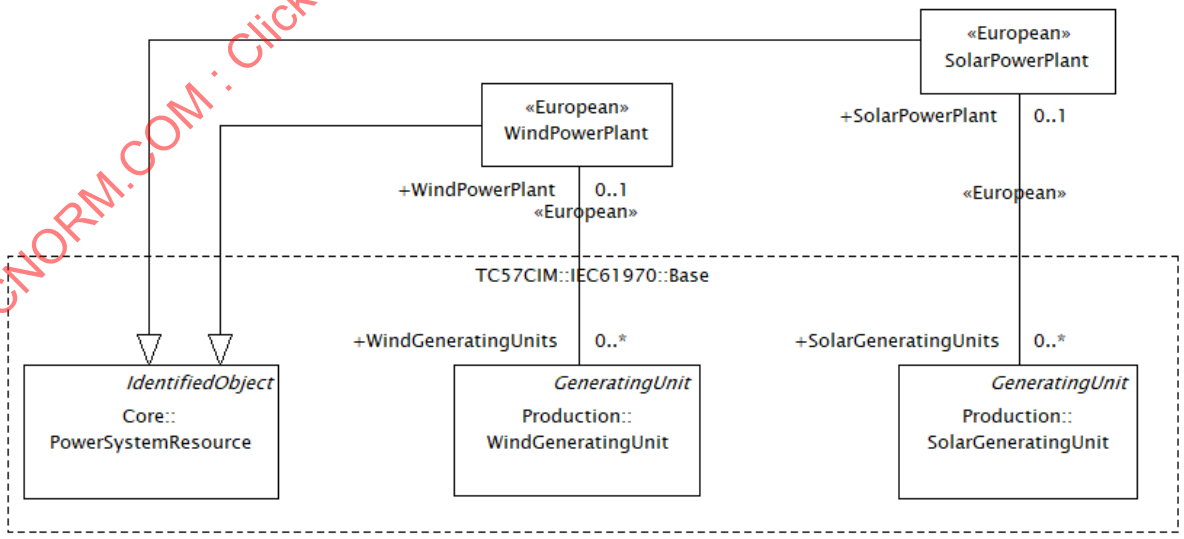


Figure A.4 – Class diagram ExtEuProduction::ExtEuProduction

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Figure A.4: The diagram shows European extensions to Production package.

A.2.4.2.2 (European) SolarPowerPlant

Solar power plant.

Table A.6 shows all attributes of SolarPowerPlant.

Table A.6 – Attributes of ExtEuProduction::SolarPowerPlant

name	mult	type	description
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject
energyIdentCodeEic	0..1	String	(European) inherited from: ExtEuIdentifiedObject
shortName	0..1	String	(European) inherited from: ExtEuIdentifiedObject

Table A.7 shows all association ends of SolarPowerPlant with other classes.

Table A.7 – Association ends of ExtEuProduction::SolarPowerPlant with other classes

mult from	name	mult to	type	description
0..1	SolarGeneratingUnits	0..*	SolarGeneratingUnit	(European) A solar generating unit or units may be a member of a solar power plant.
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

A.2.4.2.3 (European) WindPowerPlant

Wind power plant.

Table A.8 shows all attributes of WindPowerPlant.

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Table A.8 – Attributes of ExtEuProduction::WindPowerPlant

name	mult	type	description
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject
energyIdentCodeEic	0..1	String	(European) inherited from: ExtEuIdentifiedObject
shortName	0..1	String	(European) inherited from: ExtEuIdentifiedObject

Table A.9 shows all association ends of WindPowerPlant with other classes.

Table A.9 – Association ends of ExtEuProduction::WindPowerPlant with other classes

mult from	name	mult to	type	description
0..1	WindGeneratingUnits	0..*	WindGeneratingUnit	(European) A wind generating unit or units may be a member of a wind power plant.
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource
0..1	Controls	0..*	Control	inherited from: PowerSystemResource
0..1	Measurements	0..*	Measurement	inherited from: PowerSystemResource
1..1	OperatingShare	0..*	OperatingShare	inherited from: PowerSystemResource
0..*	ReportingGroup	0..*	ReportingGroup	inherited from: PowerSystemResource
0..1	DiagramObjects	0..*	DiagramObject	inherited from: IdentifiedObject
1..1	Names	0..*	Name	inherited from: IdentifiedObject

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Annex B
(Informative)

Examples of PST transformer modelling

B.1 General

This annex provides examples of Phase-Shifting Transformer (PST) modelling according to the type and technology of the equipment as described in 4.5.7.

B.2 Detailed calculations and examples

B.2.1 Symmetrical phase shifters with two cores

Figure B.1 shows symmetrical phase shifters with two cores.

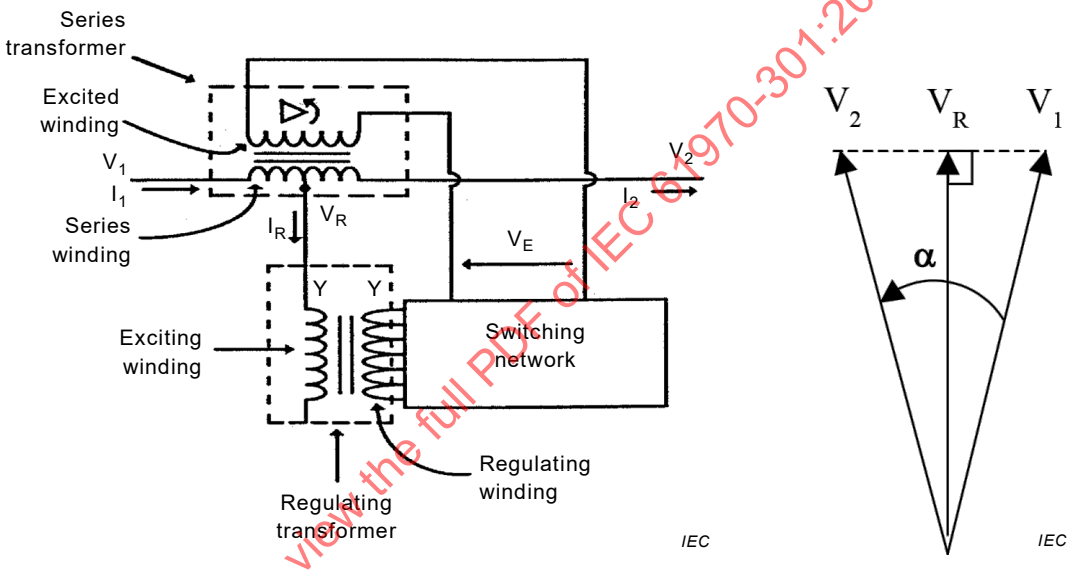


Figure B.1 – Symmetrical phase shifters with two cores

Figure B.2 shows a detailed three phase diagram.

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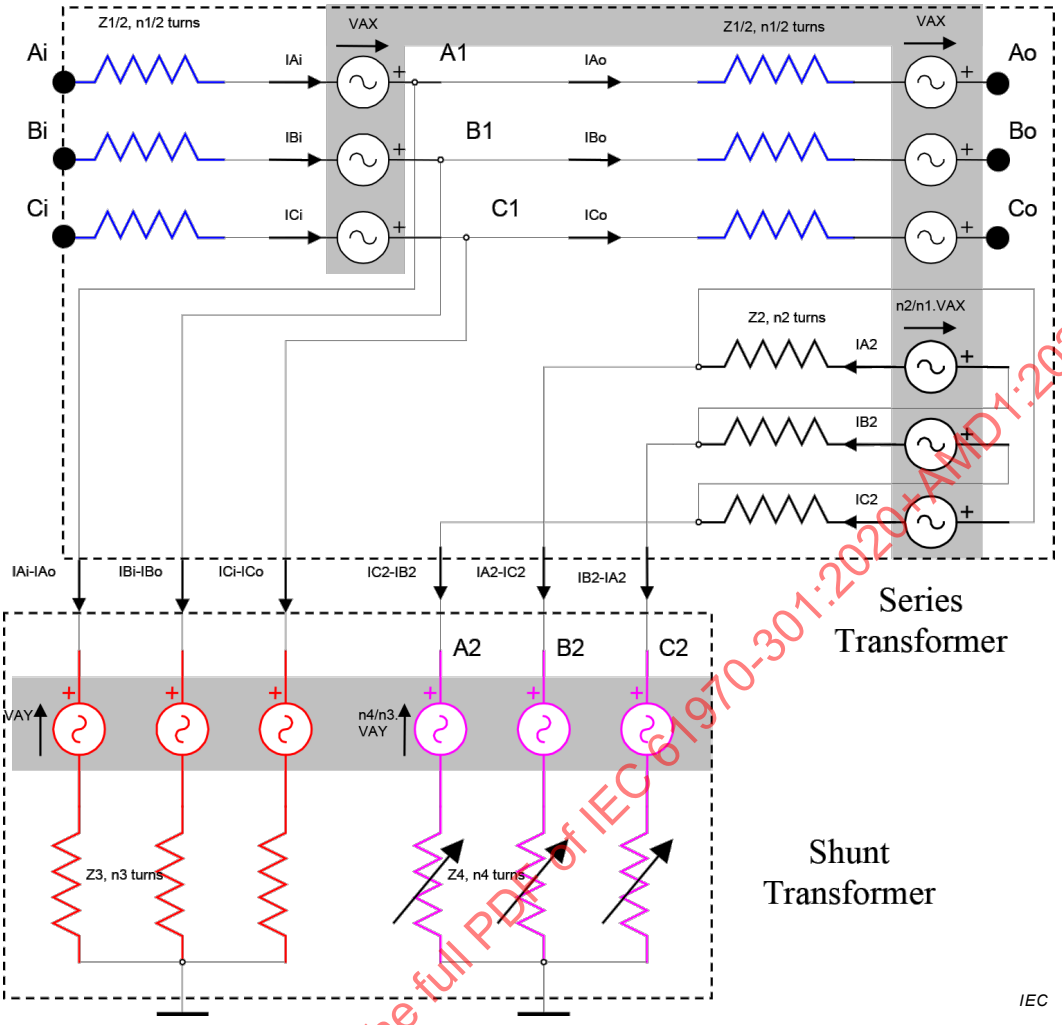


Figure B.2 – Detailed three phase diagram

Only n4 varies.

Example of numerical values:

n1 = 120

n2 = 318

n3 =680

$n4_{max}$ = 182

X1 = 1,23 Ω

X2 = 8,64 Ω

X3 = 101 Ω

Expression of the output current Io and the shunt current I3 = Ii-Io:

When considering an ideal phase shifter, the conservation of the electric power is written: $Si = 3ViIi^* = 3VoIo^*$

As the voltage angle is shifted by alpha: $Vo = e^{j\alpha}Vi$

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The current angle must also be shifted by alpha as well: $Io = e^{j\alpha} Ii$

Then, the shunt current $I3 = Ii - Io = (1 - e^{j\alpha})Ii$

Expression of the shunt equivalent reactance

The shunt reactance Xshunt(α) is defined as the equivalent reactance which crossed by the series input current (*Ii*) would produce the reactive losses of the shunt transformer:

$$Qshunt = 3.Xshunt(\alpha).|Ii|^2$$

with:

$$Qshunt = 3.X3.|I3|^2 + 3.X4.|I4|^2$$

$$|I3|^2 = |Ii|^2 |1 - e^{j\alpha}|^2 = 2(1 - \cos\alpha)|Ii|^2 = 4(\sin(\alpha/2))^2$$

$$|I4|^2 = \frac{n3^2}{n4^2}|I3|^2$$

$$Xshunt(\alpha) = 4(\sin(\alpha/2))^2 \left(X3 + X4 \left(\frac{n3}{n4} \right)^2 \right)$$

Hypothesis: $X4 = X4_{\max} \left(\frac{n4}{n4_{\max}} \right)^2$

Then $Xshunt(\alpha) = 4(\sin(\alpha/2))^2 \left(X3 + X4_{\max} \frac{n3^2}{n4^2_{\max}} \right)$

Expression of the equivalent series reactance

The series reactance Xseries(α) is defined as the equivalent reactance which crossed by the series input current (*Ii*) would produce the reactive losses of the series transformer:

$$Qseries = 3.Xseries(\alpha).|Ii|^2$$

with:

$$Qseries = 3.\frac{X1}{2}.|Ii|^2 + 3.\frac{X1}{2}.|Io|^2 + 3.X2.|I2|^2$$

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as seen previously: $Io = e^{j\alpha} Ii$

series transformer current relationship: $\frac{n1}{2}.Ii + \frac{n1}{2}.Io = +n2.I2$

then

$$I2 = \frac{n1}{2n2}\left(1 + e^{j\alpha}\right)Ii \text{ and } |I2|^2 = \left(\frac{n1}{2n2}\right)^2 |Ii|^2 \left|1 + e^{j\alpha}\right|^2 = \frac{1}{2}\frac{n1^2}{n2^2}(1+\cos\alpha)|Ii|^2$$

then

$$Xseries(\alpha) = X1 + \frac{1}{2}\left(\frac{n1}{n2}\right)^2 (1+\cos\alpha)X2 = X1 + \left(\frac{n1}{n2}\right)^2 (1-\sin(\alpha/2))X2$$

$$Xseries(\alpha) = \left(X1 + \left(\frac{n1}{n2}\right)^2 X2\right) - \left(\frac{n1}{n2}\right)^2 X2(\sin(\alpha/2))^2$$

Expression of the total equivalent reactance X

$$X(\alpha) = \left(X1 + \left(\frac{n1}{n2}\right)^2 X2\right) + 4(\sin(\alpha/2))^2 \left(X3 + X4_{\max}\frac{n3^2}{n4_{\max}^2} - \left(\frac{n1}{2n2}\right)^2 X2\right)$$

or

$$X(\alpha) = X(0) + \left(X(\alpha_{\max}) - X(0)\right)\left(\frac{\sin(\alpha/2)}{\sin(\alpha_{\max}/2)}\right)^2$$

with:

$$X(0) = \left(X1 + \left(\frac{n1}{n2}\right)^2 X2\right)$$

$$X(\alpha_{\max}) - X(0) = 4(\sin(\alpha_{\max}/2))^2 \left(X3 + X4_{\max}\frac{n3^2}{n4_{\max}^2} - \left(\frac{n1}{2n2}\right)^2 X2\right)$$

Remark: only α varies.

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B.2.2 Quadrature boosters

B.2.2.1 Quadrature booster with two cores

Figure B.3 shows a detailed three phase diagram. The single phase diagram is shown in Figure B.4.

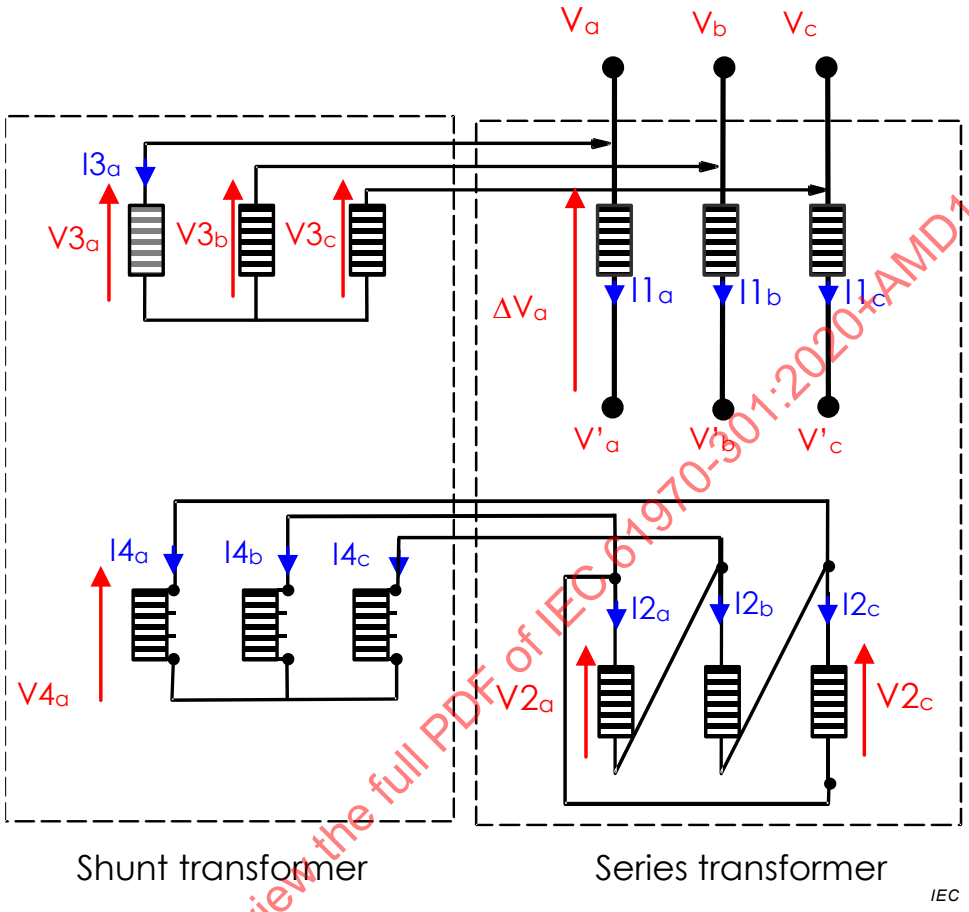


Figure B.3 – Detailed three phase diagram

For each physical value X (X = V or I) $X = X_a = aX_b = a^2X_c$ with $a = e^{j\frac{2\pi}{3}}$

shunt transformer with variable ratio n4/n3 with X3 reactance on the primary winding and X4 on the secondary winding:

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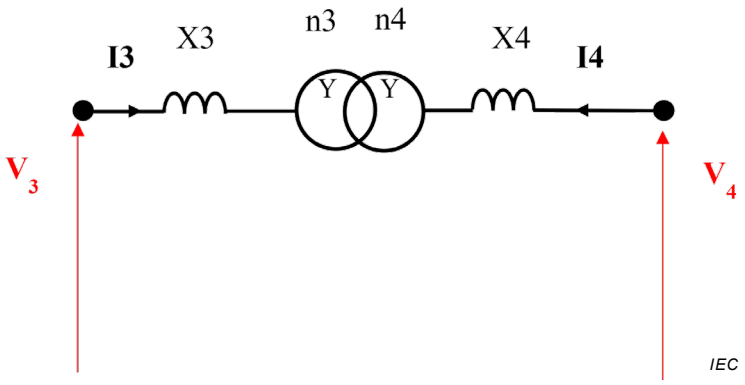


Figure B.4 – Single phase diagram

$$V4 - jX4.I4 = \frac{n4}{n3}(V3 - jX3.I3) \qquad I3 = -\frac{n4}{n3}I4$$

$$V4 = \frac{n4}{n3}V3 + j\left(X_4 + X_3\left(\frac{n4}{n3}\right)^2\right)I4$$

Hypothesis: the X4 reactance varies like the square of the number of turns n4:

$$X_4 = X_4^{\max}\left(\frac{n4}{n4_{\max}}\right)^2$$

Series transformer of fixed ratio n1/n2 with X1 reactance on the primary winding and X2 on the secondary winding:

$$\Delta V = \frac{n1}{n2}V2 + j\left(X1 + \left(\frac{n1}{n2}\right)^2 X2\right)I1$$

$$I2 = -\frac{n1}{n2}I1$$

Link between series and shunt transformers:

- Primary windings:

$$V3 = V$$

- Secondary windings:

$$I4 = I4_a = I2_b - I2_c = (a^2 - a)I2_a = -j\sqrt{3}I2$$

$$V2 = V2_a = V4_b - V4_c = (a^2 - a)V4 = -j\sqrt{3}V4$$

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Calculation:

$$\Delta V = -j\frac{n4.n1}{n3.n2}\sqrt{3}V + j\left(X1+\left(\frac{n1}{n2}\right)^2 X2 + 3\left(\frac{n1}{n2}\right)^2 n4^2\left(\frac{X4^{\max}}{n4^2_{\max}}+\frac{X3}{n3^2}\right)\right)I1$$

$$I3 = -j\frac{n4.n1}{n3.n2}\sqrt{3}I1$$

At no load conditions (I = 0):

$$\Delta V = -j\frac{n4.n1}{n3.n2}\sqrt{3}V$$

And geometrically, shown in Figure B.5:

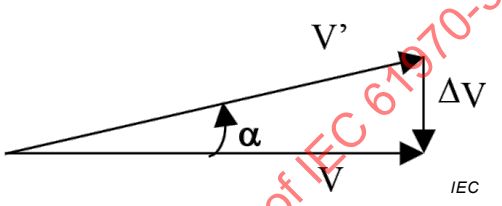


Figure B.5 – Phasor diagram

$$\Delta V = -jV\tan\alpha$$

Hence $\dfrac{n4}{n4^{\max}} = \dfrac{\tan\alpha}{\tan\alpha_{\max}}$

And $\Delta V = -j\dfrac{n4.n1}{n3.n2}\sqrt{3}V + j\left(X1+\left(\dfrac{n1}{n2}\right)^2 X2 + 3n4^2_{\max}\left(\dfrac{n1}{n2}\right)^2\left(\dfrac{X4^{\max}}{n4^2_{\max}}+\dfrac{X3}{n3^2}\right)\left(\dfrac{\tan\alpha}{\tan\alpha_{\max}}\right)^2\right)I1$

comes:

$$\Delta V = -j\frac{n4.n1}{n3.n2}\sqrt{3}V + jXI \text{ with } X(\alpha) = X(0) + \left(X(\alpha_{\max}) - X(0)\right)\left(\frac{\tan(\alpha)}{\tan(\alpha_{\max})}\right)^2$$

B.2.2.2 Quadrature booster with a single core

Figure B.6 shows a detailed three phase diagram.

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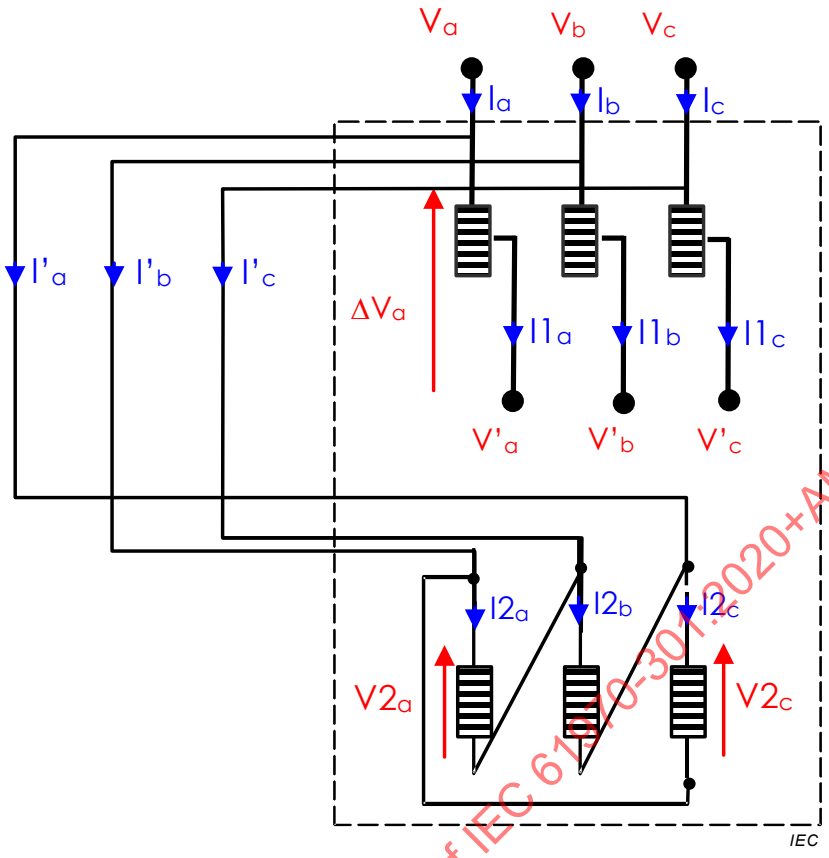


Figure B.6 – Detailed three phase diagram

n1 varies.

$$I' = j\sqrt{3}I2$$

$$V2 = -j\sqrt{3}V$$

$$\Delta V = \frac{n1}{n2}V2 + j\left(X1 + \left(\frac{n1}{n2}\right)^2 X2\right)I1$$

$$\Delta V = -j\sqrt{3}\frac{n1}{n2}V + j\left(X1 + \left(\frac{n1}{n2}\right)^2 X2\right)I1$$

Assuming $X1 = X1_{\max}\left(\frac{n1}{n1_{\max}}\right)^2$

$$\Delta V = -j\sqrt{3}\frac{n1}{n2}V + j\left(\frac{X1_{\max}}{n1_{\max}} + \frac{X2}{n2^2}\right)n1^2 I1$$

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At no-load: $\Delta V = -j\sqrt{3}\frac{n1}{n2}V$

And geometrically, shown in Figure B.7:

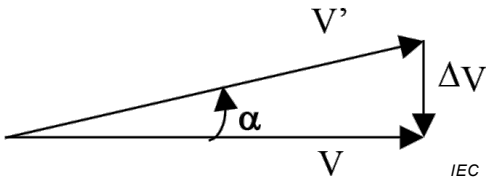


Figure B.7 – Phasor diagram

$$\Delta V = -jV\tan\alpha$$

hence $$\frac{n1}{n1^{\max}} = \frac{\tan\alpha}{\tan\alpha_{\max}}$$

$$X(\alpha) = \left(X1_{\max} + X2\frac{n1_{\max}^2}{n2^2}\right)\left(\frac{\tan\alpha}{\tan\alpha_{\max}}\right)^2$$

$$X(\alpha) = X(\alpha_{\max})\left(\frac{\tan\alpha}{\tan\alpha_{\max}}\right)^2$$

B.2.3 Asymmetrical phase shifter

B.2.3.1 Asymmetrical phase shifter with two cores

Figure B.8 shows an asymmetrical phase shifter with two cores.

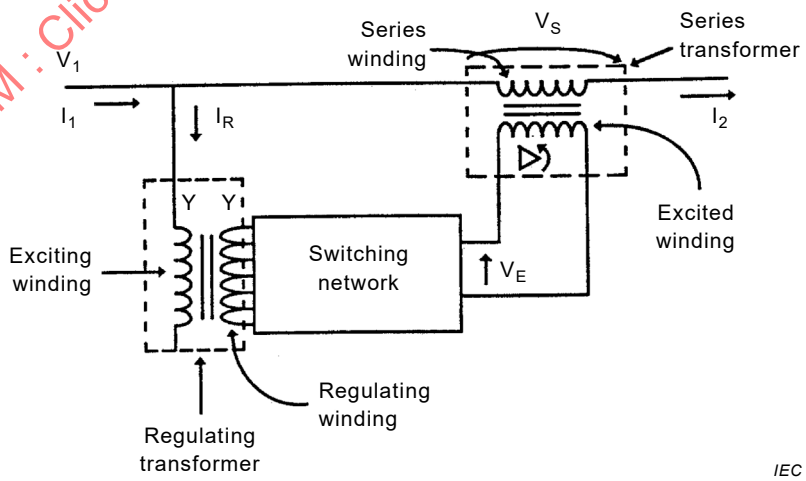


Figure B.8 – Asymmetrical phase shifter with two cores

Figure B.9 shows a detailed three phase diagram:

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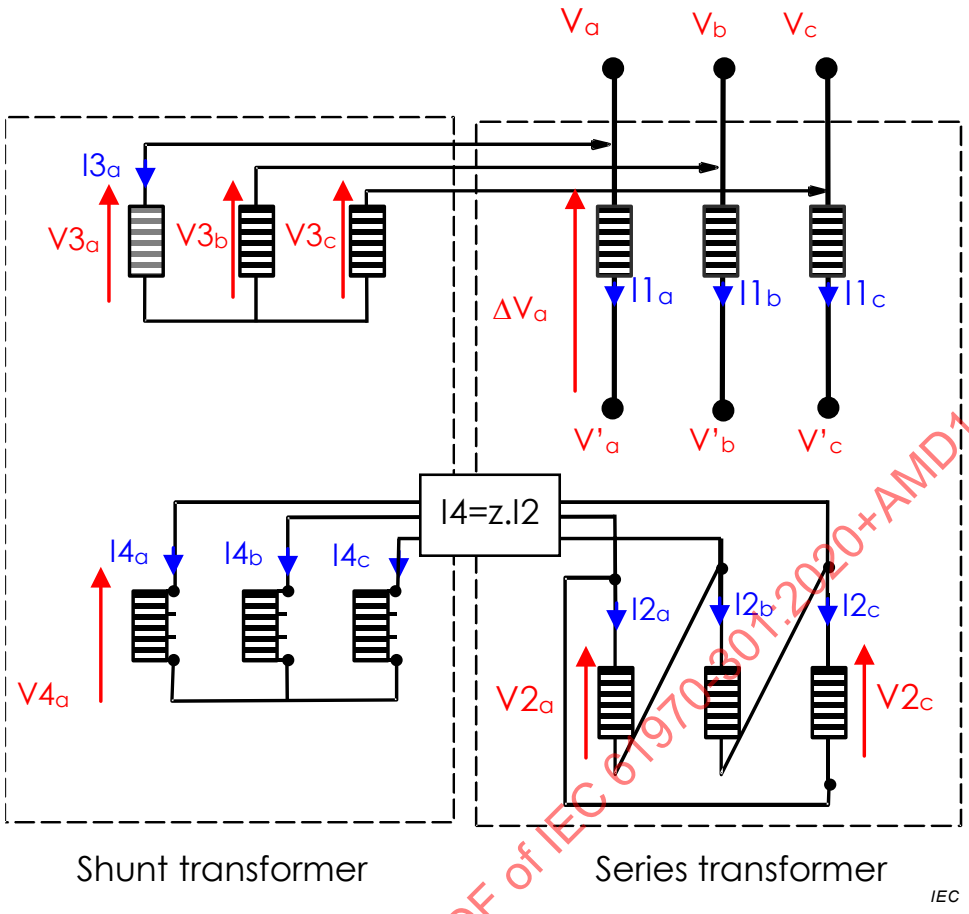


Figure B.9 – Detailed three phase diagram

For each physical value X (X = V or I) $X = X_a = aX_b = a^2X_c$ with $a = e^{j\frac{2\pi}{3}}$

shunt transformer equations:

$$V4 = \frac{n4}{n3}V3 + j\left(X_4 + X_3\left(\frac{n4}{n3}\right)^2\right)I4$$

$$I3 = -\frac{n4}{n3}I4$$

Hypothesis: the X2 reactance varies like the square of the k1 ratio:

$$X_4 = X_4^{\max}\left(\frac{n4}{n4_{\max}}\right)^2$$

Series transformer of fixed ratio k_2 with X_{series} reactance on the primary winding:

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$$\Delta V = \frac{n1}{n2} V2 + j\left(X1 + \left(\frac{n1}{n2} \right)^2 X2 \right) I1$$

$$I2 = -\frac{n1}{n2} I1$$

Link between series and shunt transformers:

- Primary windings:

  $V3 = V$

- "z", a complex number, determines the coupling between the series and shunt transformer secondary windings:

  $I4 = I4_a = z.I2$

  $V2 = z.V4$

  for a quadrature booster $z = -j\sqrt{3}$

Calculation:

$$\Delta V = \frac{n4.n1}{n3.n2}.z.V + j\left(X1 + \left(\frac{n1}{n2} \right)^2 X2 - z^2 \left(\frac{n1}{n2} \right)^2 n4^2 \left(\frac{X4^{\max}}{n4^2_{\max}} + \frac{X3}{n3^2} \right) \right) I1$$

$$I3 = \frac{n4.n1}{n3.n2}.z.I1$$

At no load conditions (I = 0):

$$\Delta V = \frac{n4.n1}{n3.n2}.z.V$$

And geometrically, shown in Figure B.10:

$$\Delta V = -e^{j\theta}.V \frac{\tan\alpha}{\sin\theta - \tan\alpha\cos\theta}$$

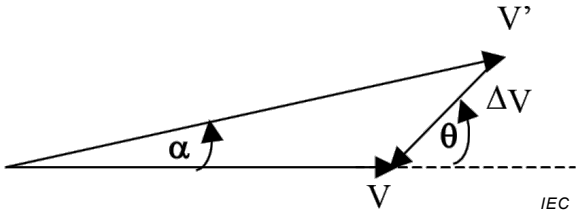


Figure B.10 – Phasor diagram

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hence $\frac{n4}{n4^{\max}} = \frac{\tan\alpha}{\tan\alpha_{\max}} \frac{\sin\theta - \tan\alpha_{\max}\cos\theta}{\sin\theta - \tan\alpha\cos\theta}$

And

$$\Delta V = -j\frac{n4.n1}{n3.n2}\sqrt{3}V + j\left(X1 + \left(\frac{n1}{n2}\right)^2 X2 - z^2 n4_{\max}^2 \left(\frac{n1}{n2}\right)^2 \left(\frac{X4^{\max}}{n4_{\max}^2} + \frac{X3}{n3^2}\right)\left(\frac{\tan\alpha}{\tan\alpha_{\max}} \frac{\sin\theta - \tan\alpha_{\max}\cos\theta}{\sin\theta - \tan\alpha\cos\theta}\right)^2\right) I1$$

comes:

$$\Delta V = z\frac{n4.n1}{n3.n2}V + jXI \text{ with } X(\alpha) = X(0) + \left(X(\alpha_{\max}) - X(0)\right)\left(\frac{\tan\alpha}{\tan\alpha_{\max}} \frac{\sin\theta - \tan\alpha_{\max}\cos\theta}{\sin\theta - \tan\alpha\cos\theta}\right)^2$$

B.2.3.2 Asymmetrical phase shifter with a single core

Figure B.11 shows an asymmetrical phase shifter with a single core.

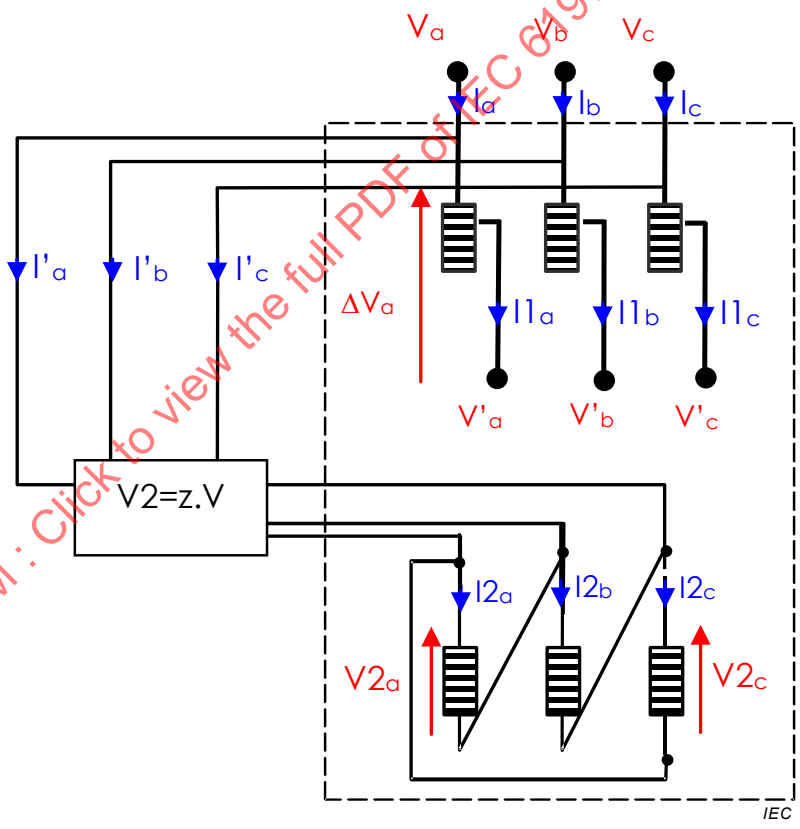


Figure B.11 – Asymmetrical phase shifter with a single core

Only n1 varies.

$$I' = -z.I2$$

$$V2 = z.V$$

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$$\Delta V = \frac{n1}{n2}V2 + j\left(X1 + \left(\frac{n1}{n2}\right)^2 X2\right)I1$$

$$\Delta V = z.\frac{n1}{n2}V + j\left(X1 + \left(\frac{n1}{n2}\right)^2 X2\right)I1$$

Assuming $X1 = X1_{max}\left(\frac{n1}{n1_{max}}\right)^2$

$$\Delta V = z.\frac{n1}{n2}V + j\left(\frac{X1_{max}}{n1_{max}} + \frac{X2}{n2^2}\right)n1^2 I1$$

At no-load: $\Delta V = z.\frac{n1}{n2}V$

And geometrically, shown in Figure B.12:

$$\Delta V = -e^{j\theta}.V\frac{\tan\alpha}{\sin\theta - \tan\alpha\cos\theta}$$

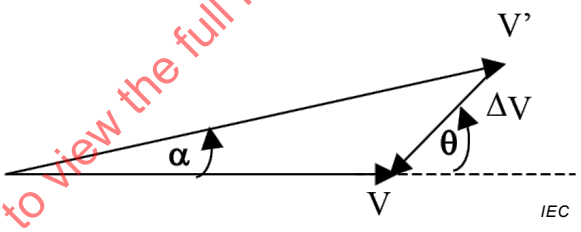


Figure B.12 – Phasor diagram

hence $\frac{n1}{n1_{max}} = \frac{\tan\alpha}{\tan\alpha_{max}}\frac{\sin\theta - \tan\alpha_{max}\cos\theta}{\sin\theta - \tan\alpha\cos\theta}$

$$X(\alpha) = \left(X1_{max} + X2\frac{n1_{max}^2}{n2^2}\right)\left(\frac{\tan\alpha}{\tan\alpha_{max}}\frac{\sin\theta - \tan\alpha_{max}\cos\theta}{\sin\theta - \tan\alpha\cos\theta}\right)^2$$

$$X(\alpha) = X(\alpha_{max})\left(\frac{\tan\alpha}{\tan\alpha_{max}}\frac{\sin\theta - \tan\alpha_{max}\cos\theta}{\sin\theta - \tan\alpha\cos\theta}\right)^2$$

B.2.3.3 In-phase transformer and asymmetrical phase shifter

Figure B.13 and Figure B.14 give examples of detailed three-phase diagrams of voltage regulating auto-transformer and quadrature booster.

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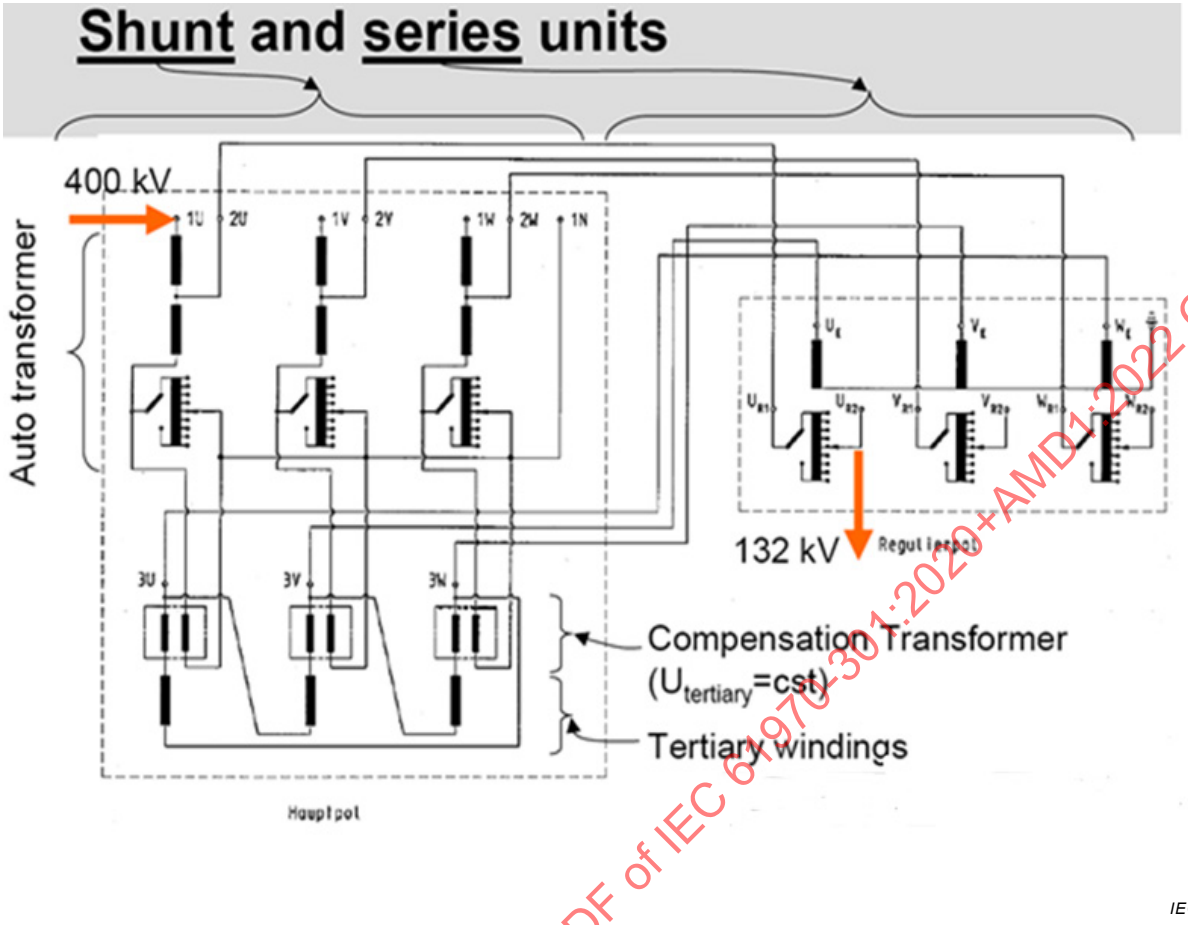
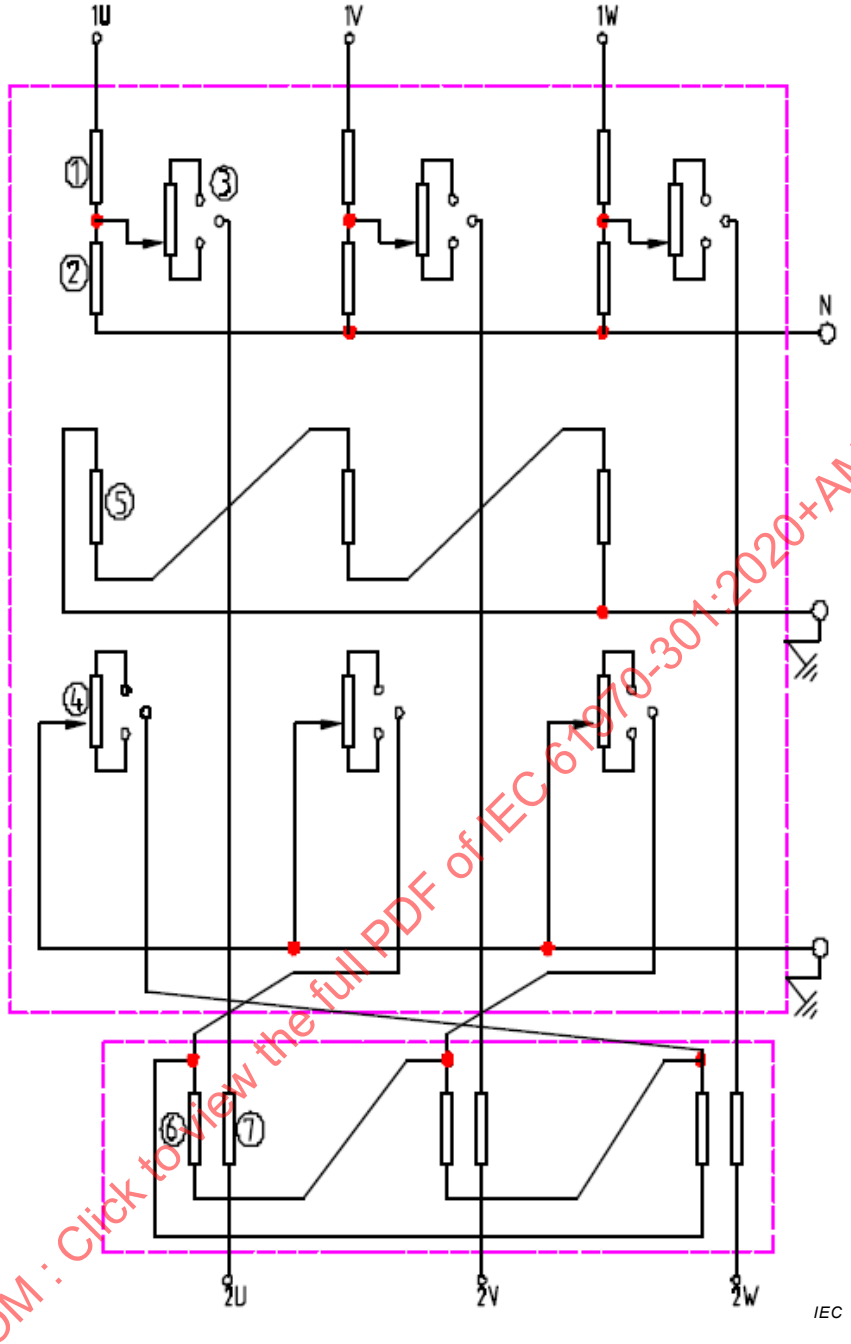


Figure B.13 – Example of detailed three-phase diagram of voltage regulating auto-transformer and quadrature booster

Voltage regulating auto-transformer and quadrature booster:

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1) EHV winding
2) HV winding
3) EV voltage regulating winding
4) Phase shift regulating winding
5) Tertiary winding
6) Primary winding of the series transformer
7) Secondary winding of the series transformer

Figure B.14 – Example of detailed winding diagram of voltage regulating auto-transformer and quadrature booster

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Annex C
(informative)

Use cases HVDC representation

C.1 Overview

Annex C is informative and contains information about the use cases related to the HVDC representation.

C.2 Back-to-back installations

The expression back-to-back indicates that the rectifier and inverter are located in the same station. Back-to-back converters are mainly used for power transmission between adjacent AC grids which cannot be synchronized. They can also be used within a meshed grid in order to achieve a defined power flow.

The DC filter and smoothing reactor is not modelled explicitly in this example, although they should when calculating special types of short circuit and/or dynamic response. The DC components are marked red, the candidates for boundary points are marked green. If the back-to-back installation is exchanged in a separate MAS, both boundary points are used.

The point of common coupling terminal associated with the boundary point also features as TieFlow.Terminal if the flow counts in the net position of the ControlArea. Figure C.1 represents a 12-p back-to-back installation.

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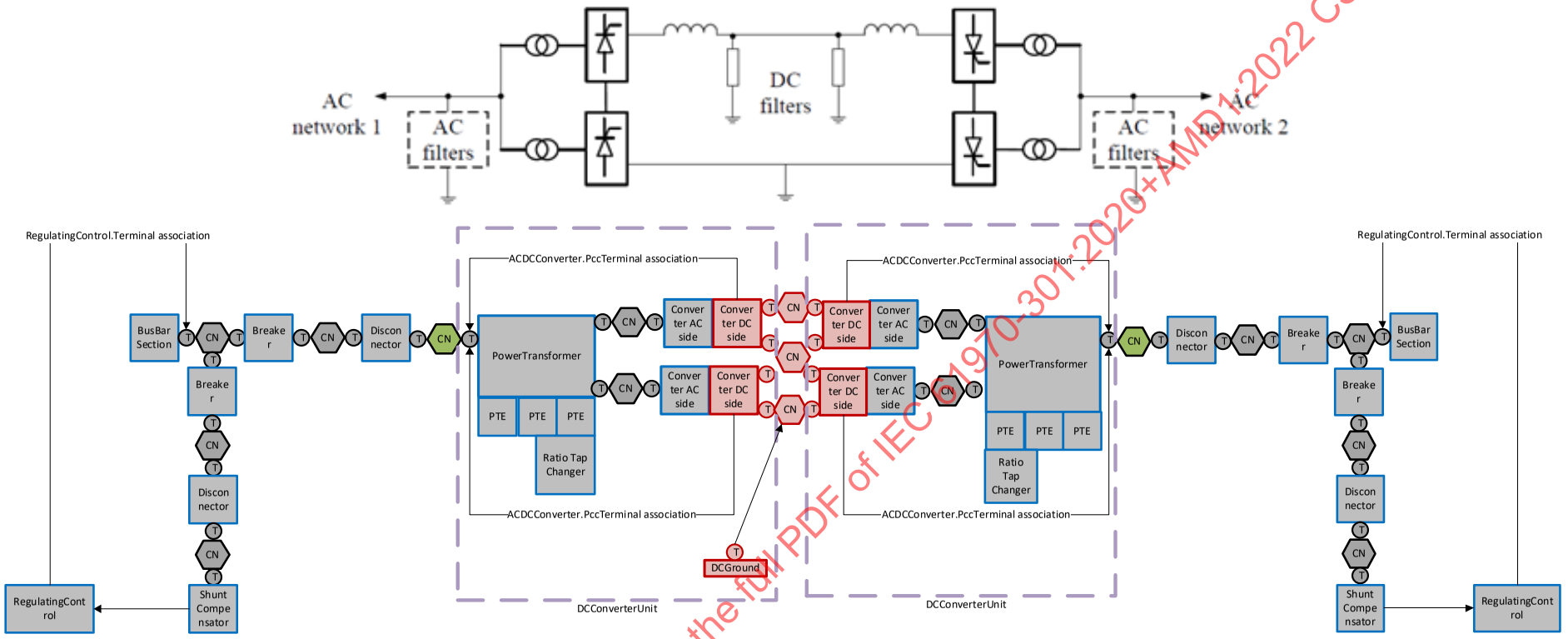


Figure C.1 – Representation of a 12-p back-to-back installation

C.3 Monopole with ground return

Figure C.2 shows an example for modelling and serializing a 12 pulse monopole installation with ground return.

The DC filter is not modelled explicitly in this example, although they should when calculating special types of short circuit and/or dynamic response. The DC components are marked red, the candidates for boundary points are marked green. If the installation is exchanged in a separate MAS, both boundary points are used.

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The point of Common Coupling terminal associated with the boundary point also features as TieFlow.Terminal if the flow counts in the net position of the ControlArea.

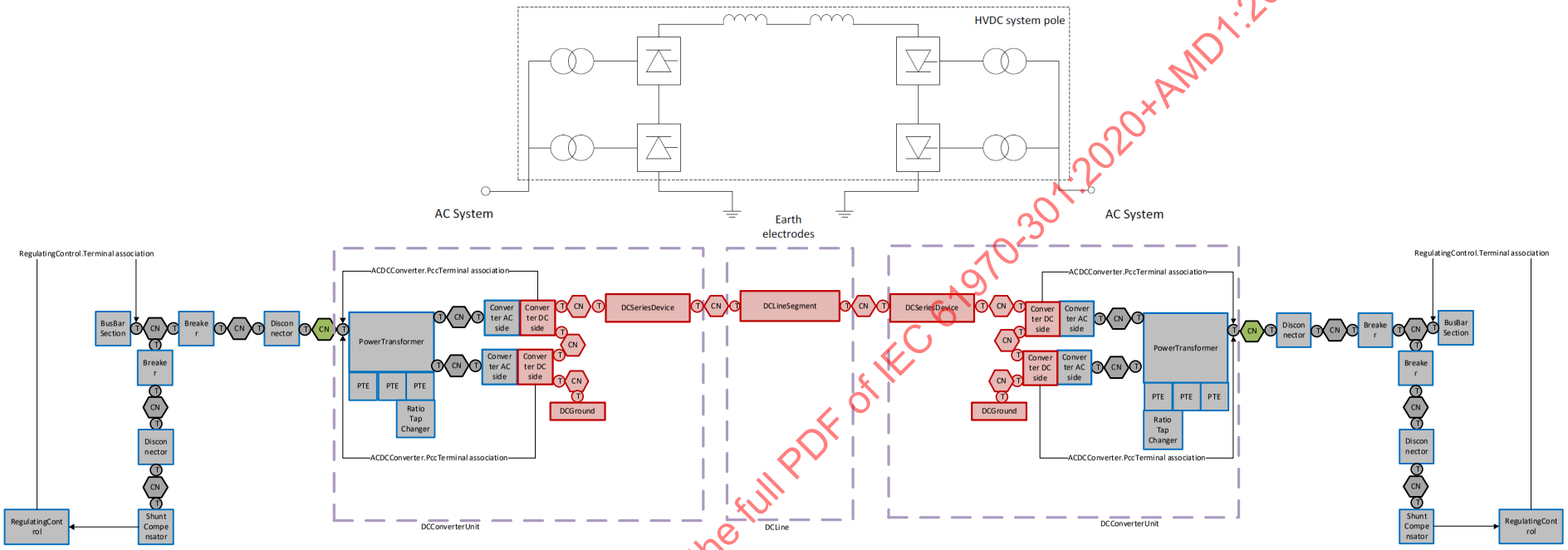


Figure C.2 – Representation of a 12-p monopole installation with ground return

C.4 Monopole with metallic return

Figure C.3 shows an example for modelling and serializing a 12 pulse monopole installation with metallic return.

The DC filter is not modelled explicitly in this example, although they should when calculating special types of short circuit and/or dynamic response. The DC components are marked red, the candidates for boundary points are marked green. If the installation is exchanged in a separate MAS, both boundary points are used.

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The point of Common Coupling terminal associated with the boundary point also features as TieFlow.Terminal if the flow counts in the net position of the ControlArea.

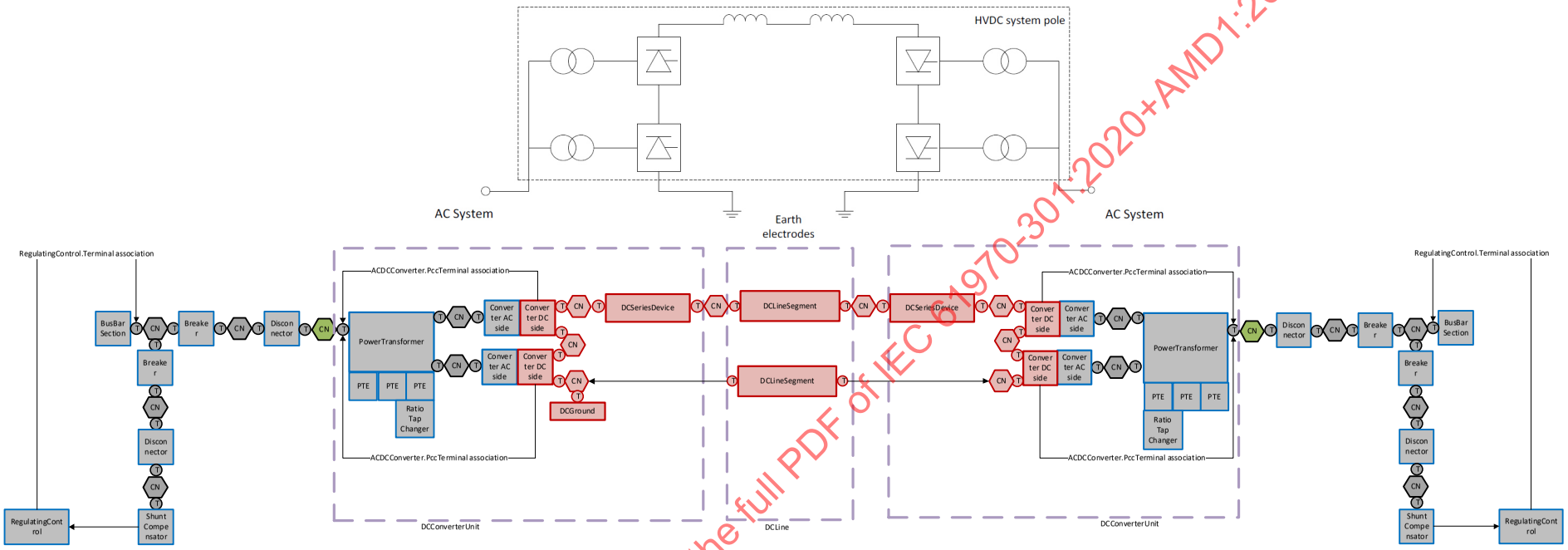


Figure C.3 – Representation of a 12-p monopole installation with metallic return

C.5 Voltage source converter

Figure C.4 shows an example for modelling and serializing a voltage source converter (VSC).

The DC filter is not modelled explicitly in this example, although they should when calculating special types of short circuit and/or dynamic response. The DC components are marked red, the candidates for boundary points are marked green. If the installation is exchanged in a separate MAS, both boundary points are used.

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The point of Common Coupling terminal associated with the boundary point also features as TieFlow.Terminal if the flow counts in the net position of the ControlArea.

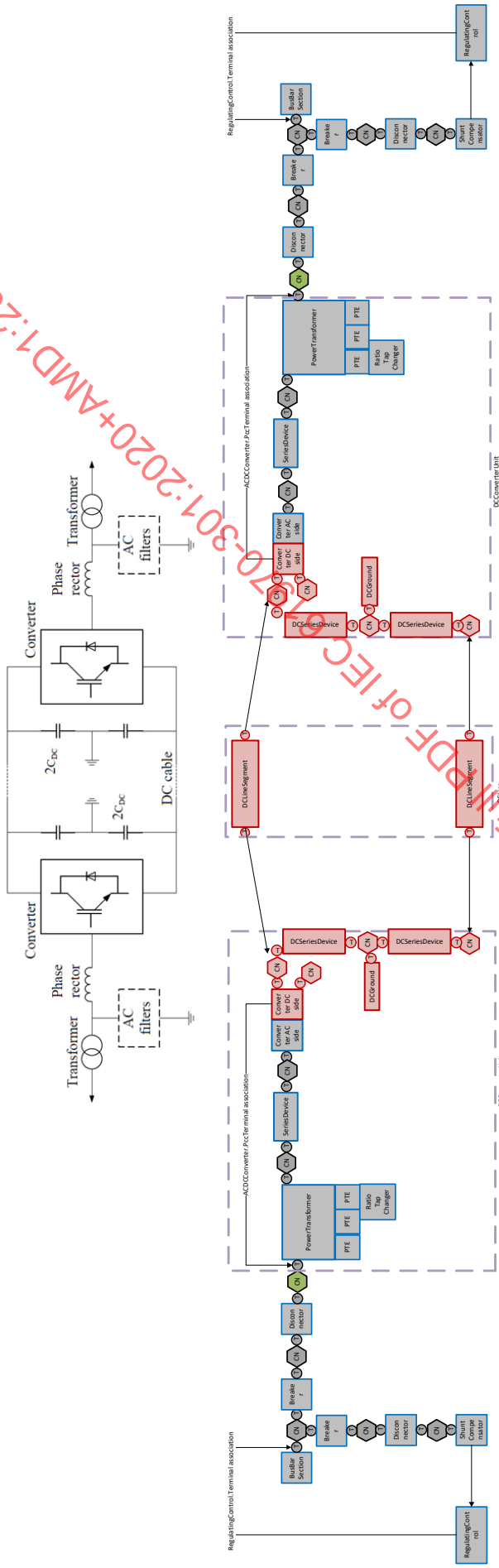


Figure C.4 – Representation of a voltage source converter

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SOMMAIRE

AVANT-PROPOS 592
INTRODUCTION 594
1 Domaine d'application 596
2 Références normatives 596
3 Termes et définitions 597
4 Spécification du CIM 598
4.1 Vue d'ensemble 598
4.2 Notation de modélisation du CIM 598
4.3 Paquetages CIM 598
4.4 Classes CIM et relations 600
4.4.1 Classes 600
4.4.2 Generalization 601
4.4.3 Simple association (Association simple) 602
4.4.4 Aggregation 603
4.5 Concepts et exemples de modèles CIM 604
4.5.1 Concepts 604
4.5.2 Hiérarchies d'emboîtement, d'équipements et dénomination 604
4.5.3 Modèle de Names 606
4.5.4 Modèle de connectivité 606
4.5.5 Hiérarchie des héritages 609
4.5.6 Modèle de Transformer 611
4.5.7 Modélisation de prise du transformateur 614
4.5.8 Modélisation des phases 629
4.5.9 Modélisation des appareils de mise à la terre 632
4.5.10 Modèle de cuts, de clamps (serre-fils) et de jumpers (cavaliers) 635
4.5.11 Mesures et commandes 639
4.5.12 Modèles de commande de régulation 644
4.5.13 Modèle en courant continu pour le CIM 645
4.5.14 Régulation de la tension du compensateur de Var statique 669
4.5.15 Modèle de configuration ICCP 671
4.5.16 Modèle Feeder 678
4.5.17 Modélisation de la zone de commande 679
4.6 Lignes directrices de modélisation 680
4.6.1 Modélisation pour modifications 680
4.6.2 Processus pour les amendements au CIM 681
4.6.3 Modifications apportées au modèle UML du CIM 681
4.6.4 Modifications apportées aux documents normatifs du CIM 681
4.6.5 Éléments déconseillés 682
4.6.6 Profils CIM 682
4.7 Outils de modélisation 682
4.8 Conventions de mise en œuvre pour les utilisateurs 683
4.8.1 Conventions au-delà de l'UML 683
4.8.2 Nombre de bornes pour les objets ConductingEquipment 683
4.8.3 Grandeurs nominales 683
4.8.4 Datatypes 683
4.9 Exemples de modélisation CIM 684

IECNORM.COM : Click to view the full PDF of IEC 61970-301:2020+AMD1:2022 CSV

5 Modèle détaillé 684
5.1 Vue d'ensemble 684
5.2 Contexte 684
6 Paquetage Base 686
6.1 Généralités 686
6.2 Paquetage Domain 687
6.2.1 Généralités 687
6.2.2 Type de données ActivePower 693
6.2.3 Type de données ActivePowerChangeRate 694
6.2.4 Type de données ActivePowerPerCurrentFlow 694
6.2.5 Type de données ActivePowerPerFrequency 694
6.2.6 Type de données Admittance 694
6.2.7 Type de données AngleDegrees 695
6.2.8 Type de données AngleRadians 695
6.2.9 Type de données ApparentPower 695
6.2.10 Type de données Area 695
6.2.11 Type primitif de données Boolean 696
6.2.12 Type de données Capacitance 696
6.2.13 Type de données CapacitancePerLength 696
6.2.14 Type de données Classification 696
6.2.15 Type de données Conductance 697
6.2.16 Type de données ConductancePerLength 697
6.2.17 Type de données CostPerEnergyUnit 697
6.2.18 Type de données CostPerHeatUnit 697
6.2.19 Type de données CostPerVolume 698
6.2.20 Type de données CostRate 698
6.2.21 Enumération Currency 698
6.2.22 Type de données CurrentFlow 702
6.2.23 Type de données Damping 702
6.2.24 Type primitif de données Date 703
6.2.25 Compound DateInterval 703
6.2.26 Type primitif de données DateTime 703
6.2.27 Compound DateTimeInterval 703
6.2.28 Type primitif de données Decimal 703
6.2.29 Compound DecimalQuantity 704
6.2.30 Type de données Displacement 704
6.2.31 Type primitif de données Duration 704
6.2.32 Type de données Emission 704
6.2.33 Type primitif de données Float 704
6.2.34 Compound FloatQuantity 705
6.2.35 Type de données Frequency 705
6.2.36 Type de données HeatRate 705
6.2.37 Type de données Hours 705
6.2.38 Type de données Impedance 706
6.2.39 Type de données Inductance 706
6.2.40 Type de données InductancePerLength 706
6.2.41 Type primitif de données Integer 706
6.2.42 Compound IntegerQuantity 707
6.2.43 Type de données KiloActivePower 707
IECNORM.COM : Click to view the full PDF of IEC 61970-301:2020+AMD1:2022 CSV

6.2.44 Type de données Length 707
6.2.45 Type de données Mass 707
6.2.46 Type de données Minutes 708
6.2.47 Type de données Money 708
6.2.48 Type primitif de données MonthDay 708
6.2.49 Compound MonthDayInterval 708
6.2.50 Type de données PU 708
6.2.51 Type de données PerCent 709
6.2.52 Type de données Pressure 709
6.2.53 Type de données Reactance 709
6.2.54 Type de données ReactancePerLength 709
6.2.55 Type de données ReactivePower 710
6.2.56 Type de données RealEnergy 710
6.2.57 Type de données Resistance 710
6.2.58 Type de données ResistancePerLength 711
6.2.59 Type de données RotationSpeed 711
6.2.60 Type de données Seconds 711
6.2.61 Type de données Speed 711
6.2.62 Type primitif de données String 712
6.2.63 Compound StringQuantity 712
6.2.64 Type de données Susceptance 712
6.2.65 Type de données SusceptancePerLength 712
6.2.66 Type de données Temperature 713
6.2.67 Type primitif de données Time 713
6.2.68 Compound TimeInterval 713
6.2.69 Enumération UnitMultiplier 713
6.2.70 Enumération UnitSymbol 714
6.2.71 Type de données Voltage 720
6.2.72 Type de données VoltagePerReactivePower 720
6.2.73 Type de données Volume 720
6.2.74 Type de données VolumeFlowRate 721
6.2.75 Type de données WaterLevel 721
6.3 Paquetage Core 721
6.3.1 Généralités 721
6.3.2 ACDCTerminal 726
6.3.3 BaseFrequency 727
6.3.4 BasePower 728
6.3.5 BaseVoltage 728
6.3.6 BasicIntervalSchedule 729
6.3.7 Bay 730
6.3.8 Enumération BreakerConfiguration 730
6.3.9 Enumération BusbarConfiguration 731
6.3.10 ConductingEquipment 731
6.3.11 ConnectivityNode 732
6.3.12 ConnectivityNodeContainer 733
6.3.13 Curve 734
6.3.14 Classe racine CurveData 734
6.3.15 Enumération CurveStyle 735
6.3.16 Equipment 735

IECNORM.COM : Click to view the full PDF of IEC 61970-301:2020+AMD1:2022 CSV

6.3.17 EquipmentContainer 737
6.3.18 Feeder 738
6.3.19 GeographicalRegion 739
6.3.20 Classe racine IdentifiedObject 739
6.3.21 IrregularIntervalSchedule 740
6.3.22 Classe racine IrregularTimePoint 741
6.3.23 Classe racine Name 741
6.3.24 Classe racine NameType 742
6.3.25 Classe racine NameTypeAuthority 742
6.3.26 OperatingParticipant 743
6.3.27 Classe racine OperatingShare 744
6.3.28 PSRType 744
6.3.29 Enumération PhaseCode 745
6.3.30 PowerSystemResource 746
6.3.31 RegularIntervalSchedule 747
6.3.32 Classe racine RegularTimePoint 747
6.3.33 ReportingGroup 748
6.3.34 ReportingSuperGroup 749
6.3.35 SubGeographicalRegion 749
6.3.36 Substation 750
6.3.37 Terminal 751
6.3.38 VoltageLevel 753
6.4 Paquetage Wires 754
6.4.1 Généralités 754
6.4.2 Enumération AsynchronousMachineKind 769
6.4.3 ACLineSegment 770
6.4.4 ACLineSegmentPhase 771
6.4.5 AsynchronousMachine 772
6.4.6 Breaker 775
6.4.7 BusbarSection 776
6.4.8 Clamp 777
6.4.9 CompositeSwitch 778
6.4.10 Conductor 779
6.4.11 Connector 780
6.4.12 Enumération CoolantType 781
6.4.13 Cut 782
6.4.14 Disconnector 783
6.4.15 DisconnectingCircuitBreaker 784
6.4.16 EarthFaultCompensator 786
6.4.17 EnergyConnection 787
6.4.18 EnergyConsumer 788
6.4.19 EnergyConsumerPhase 790
6.4.20 EnergySchedulingType 792
6.4.21 EnergySource 792
6.4.22 EnergySourcePhase 794
6.4.23 ExternalNetworkInjection 795
6.4.24 FrequencyConverter 797
6.4.25 Fuse 799
6.4.26 Ground 800

IECNORM.COM : Click to view the full PDF of IEC 61970-301:2020+AMD1:2022 CSV

6.4.27 GroundingImpedance 801
6.4.28 GroundDisconnector 802
6.4.29 Jumper 803
6.4.30 Junction 805
6.4.31 Line 805
6.4.32 LinearShuntCompensator 806
6.4.33 LinearShuntCompensatorPhase 808
6.4.34 LoadBreakSwitch 809
6.4.35 MutualCoupling 811
6.4.36 NonlinearShuntCompensator 812
6.4.37 NonlinearShuntCompensatorPhase 813
6.4.38 NonlinearShuntCompensatorPhasePoint root class 814
6.4.39 Classe racine NonlinearShuntCompensatorPoint 815
6.4.40 PerLengthImpedance 815
6.4.41 PerLengthLineParameter 816
6.4.42 PerLengthPhaseImpedance 816
6.4.43 PerLengthSequenceImpedance 817
6.4.44 PetersenCoil 818
6.4.45 Enumération PetersenCoilModeKind 819
6.4.46 Classe racine PhaseImpedanceData 820
6.4.47 Enumération PhaseShuntConnectionKind 821
6.4.48 PhaseTapChanger 821
6.4.49 PhaseTapChangerAsymmetrical 822
6.4.50 PhaseTapChangerLinear 823
6.4.51 PhaseTapChangerNonLinear 825
6.4.52 PhaseTapChangerSymmetrical 826
6.4.53 PhaseTapChangerTable 827
6.4.54 PhaseTapChangerTablePoint 828
6.4.55 PhaseTapChangerTabular 829
6.4.56 Plant 830
6.4.57 PowerElectronicsConnection 830
6.4.58 PowerElectronicsConnectionPhase 832
6.4.59 PowerTransformer 833
6.4.60 PowerTransformerEnd 836
6.4.61 ProtectedSwitch 838
6.4.62 RatioTapChanger 840
6.4.63 RatioTapChangerTable 841
6.4.64 RatioTapChangerTablePoint 842
6.4.65 ReactiveCapabilityCurve 842
6.4.66 Recloser 843
6.4.67 RegulatingCondEq 845
6.4.68 RegulatingControl 846
6.4.69 Enumération RegulatingControlModeKind 848
6.4.70 RegulationSchedule 848
6.4.71 RotatingMachine 849
6.4.72 Sectionaliser 851
6.4.73 SeriesCompensator 853
6.4.74 Enumération ShortCircuitRotorKind 854
6.4.75 ShuntCompensator 854

IECNORM.COM : Click to view the full PDF of IEC 61970-301:2020+AMD1:2022 CSV

6.4.76 ShuntCompensatorPhase 856
6.4.77 Enumération SinglePhaseKind 858
6.4.78 StaticVarCompensator 858
6.4.79 Enumération SVCControlMode 860
6.4.80 Switch 860
6.4.81 SwitchPhase 862
6.4.82 SwitchSchedule 863
6.4.83 SynchronousMachine 864
6.4.84 Enumération SynchronousMachineOperatingMode 867
6.4.85 Enumération SynchronousMachineKind 868
6.4.86 TapChanger 868
6.4.87 TapChangerControl 870
6.4.88 Classe racine TapChangerTablePoint 872
6.4.89 TapSchedule 873
6.4.90 Enumération TransformerControlMode 874
6.4.91 TransformerCoreAdmittance 874
6.4.92 TransformerEnd 875
6.4.93 TransformerMeshImpedance 876
6.4.94 TransformerStarImpedance 877
6.4.95 TransformerTank 878
6.4.96 TransformerTankEnd 879
6.4.97 VoltageControlZone 880
6.4.98 WireSegment 881
6.4.99 WireSegmentPhase 882
6.4.100 Enumération WindingConnection 883
6.5 Paquetage LoadModel 883
6.5.1 Généralités 883
6.5.2 ConformLoad 884
6.5.3 ConformLoadGroup 886
6.5.4 ConformLoadSchedule 886
6.5.5 DayType 887
6.5.6 EnergyArea 888
6.5.7 LoadArea 888
6.5.8 LoadGroup 889
6.5.9 LoadResponseCharacteristic 890
6.5.10 NonConformLoad 892
6.5.11 NonConformLoadGroup 893
6.5.12 NonConformLoadSchedule 894
6.5.13 PowerCutZone 895
6.5.14 Season 896
6.5.15 SeasonDayTypeSchedule 896
6.5.16 StationSupply 897
6.5.17 SubLoadArea 898
6.6 Paquetage Generation 899
6.6.1 Généralités 899
6.6.2 Paquetage GenerationTrainingSimulation 899
6.6.3 Paquetage Production 917
6.7 Paquetage DC 974
6.7.1 Généralités 974

IECNORM.COM : Click to view the full PDF of IEC 61970-301:2020+AMD1:2022 CSV

6.7.2 ACDCConverter 979
6.7.3 ACDCConverterDCTerminal 982
6.7.4 CsConverter 984
6.7.5 DCTopologicalNode 987
6.7.6 Enumération CsOperatingModeKind 987
6.7.7 Enumération CsPpccControlKind 988
6.7.8 DCBaseTerminal 988
6.7.9 DCBreaker 989
6.7.10 DCBusbar 990
6.7.11 DCChopper 991
6.7.12 DCConductingEquipment 992
6.7.13 Enumération DCConverterOperatingModeKind 993
6.7.14 DCConverterUnit 993
6.7.15 DCDisconnector 994
6.7.16 DCEquipmentContainer 995
6.7.17 DCGround 996
6.7.18 DCLine 997
6.7.19 DCLineSegment 998
6.7.20 DCNode 1000
6.7.21 Enumération DCPolarityKind 1000
6.7.22 DCSeriesDevice 1001
6.7.23 DCShunt 1002
6.7.24 DCSwitch 1002
6.7.25 DCTerminal 1003
6.7.26 DCTopologicalIsland 1004
6.7.27 PerLengthDCLineParameter 1005
6.7.28 VsCapabilityCurve 1006
6.7.29 VsConverter 1006
6.7.30 Enumération VsPpccControlKind 1009
6.7.31 Enumération VsQpccControlKind 1010
6.8 Paquetage Equivalents 1010
6.8.1 Généralités 1010
6.8.2 EquivalentBranch 1011
6.8.3 EquivalentEquipment 1014
6.8.4 EquivalentInjection 1015
6.8.5 EquivalentNetwork 1017
6.8.6 EquivalentShunt 1018
6.9 Paquetage AuxiliaryEquipment 1019
6.9.1 Généralités 1019
6.9.2 AuxiliaryEquipment 1020
6.9.3 CurrentTransformer 1021
6.9.4 FaultIndicator 1023
6.9.5 PostLineSensor 1024
6.9.6 PotentialTransformer 1024
6.9.7 Enumération PotentialTransformerKind 1025
6.9.8 Sensor 1026
6.9.9 SurgeArrester 1027
6.9.10 WaveTrap 1028
6.10 Paquetage Meas 1029

IECNORM.COM : Click to view the full PDF of IEC 61970-301:2020+AMD1:2022 CSV

6.10.1 Généralités 1029
6.10.2 Accumulator 1033
6.10.3 AccumulatorLimit 1034
6.10.4 AccumulatorLimitSet 1035
6.10.5 AccumulatorReset 1035
6.10.6 AccumulatorValue 1036
6.10.7 Analog 1037
6.10.8 AnalogControl 1038
6.10.9 AnalogLimit 1039
6.10.10 AnalogLimitSet 1039
6.10.11 AnalogValue 1040
6.10.12 Command 1041
6.10.13 Control 1042
6.10.14 Discrete 1043
6.10.15 DiscreteValue 1044
6.10.16 IOPoint 1045
6.10.17 Limit 1045
6.10.18 LimitSet 1046
6.10.19 Measurement 1047
6.10.20 MeasurementValue 1048
6.10.21 MeasurementValueQuality 1049
6.10.22 MeasurementValueSource 1050
6.10.23 Classe racine Quality61850 1050
6.10.24 RaiseLowerCommand 1051
6.10.25 SetPoint 1052
6.10.26 StringMeasurement 1053
6.10.27 StringMeasurementValue 1054
6.10.28 Enumération Validity 1055
6.10.29 ValueAliasSet 1055
6.10.30 ValueToAlias 1056
6.11 Paquetage Topology 1057
6.11.1 Généralités 1057
6.11.2 BusNameMarker 1058
6.11.3 TopologicalIsland 1059
6.11.4 TopologicalNode 1060
6.12 Package DiagramLayout 1061
6.12.1 Généralités 1061
6.12.2 Diagram 1062
6.12.3 DiagramObject 1063
6.12.4 Classe racine DiagramObjectGluePoint 1065
6.12.5 Classe racine DiagramObjectPoint 1065
6.12.6 DiagramObjectStyle 1066
6.12.7 DiagramStyle 1067
6.12.8 Enumération OrientationKind 1067
6.12.9 TextDiagramObject 1068
6.12.10 VisibilityLayer 1069
6.13 Paquetage OperationalLimits 1070
6.13.1 Généralités 1070
6.13.2 ActivePowerLimit 1071

IECNORM.COM: Click to view the full PDF of IEC 61970-301:2020+AMD1:2022 CSV

6.13.3 ApparentPowerLimit 1072
6.13.4 BranchGroup 1072
6.13.5 Classe racine BranchGroupTerminal 1073
6.13.6 CurrentLimit 1074
6.13.7 OperationalLimit 1074
6.13.8 Enumération OperationalLimitDirectionKind 1075
6.13.9 OperationalLimitSet 1076
6.13.10 OperationalLimitType 1076
6.13.11 VoltageLimit 1077
6.14 Paquetage ControlArea 1078
6.14.1 Généralités 1078
6.14.2 AltGeneratingUnitMeas 1080
6.14.3 AltTieMeas 1081
6.14.4 ControlArea 1082
6.14.5 ControlAreaGeneratingUnit 1083
6.14.6 Enumération ControlAreaTypeKind 1084
6.14.7 TieFlow 1084
6.15 Paquetage Contingency 1085
6.15.1 Généralités 1085
6.15.2 Contingency 1086
6.15.3 ContingencyElement 1087
6.15.4 ContingencyEquipment 1087
6.15.5 Enumération ContingencyEquipmentStatusKind 1088
6.16 Paquetage StateVariables 1088
6.16.1 Généralités 1088
6.16.2 Classe racine StateVariable 1089
6.16.3 SvInjection 1089
6.16.4 SvPowerFlow 1090
6.16.5 SvShuntCompensatorSections 1091
6.16.6 SvStatus 1091
6.16.7 SvSwitch 1092
6.16.8 SvTapStep 1092
6.16.9 SvVoltage 1093
6.17 Paquetage Protection 1093
6.17.1 Généralités 1093
6.17.2 CurrentRelay 1094
6.17.3 ProtectionEquipment 1095
6.17.4 RecloseSequence 1097
6.17.5 SynchrocheckRelay 1097
6.18 Paquetage Faults 1099
6.18.1 Généralités 1099
6.18.2 EquipmentFault 1099
6.18.3 Fault 1100
6.18.4 FaultCauseType 1101
6.18.5 Compound FaultImpedance 1101
6.18.6 LineFault 1101
6.18.7 Enumération PhaseConnectedFaultKind 1102
6.19 Paquetage SCADA 1103
6.19.1 Généralités 1103

IECNORM.COM : Click to view the full PDF of IEC 61970-301:2020+AMD1:2022 CSV

6.19.2 CommunicationLink 1104
6.19.3 RemoteControl 1105
6.19.4 RemotePoint 1106
6.19.5 RemoteSource 1106
6.19.6 RemoteUnit 1107
6.19.7 Enumération RemoteUnitType 1108
6.19.8 Enumération Source 1108
6.20 Paquetage ICCPConfiguration 1109
6.20.1 Généralités 1109
6.20.2 Enumération ApplicationSecurityKind 1110
6.20.3 BilateralExchangeActor 1111
6.20.4 BilateralExchangeAgreement 1112
6.20.5 Enumération ICCPAccessPrivilegeKind 1112
6.20.6 ICCPInformationMessage 1112
6.20.7 Enumération ICCPPointKind 1113
6.20.8 ICCPProvidedPoint 1114
6.20.9 Enumération ICCPQualityKind 1114
6.20.10 Enumération ICCPScopeKind 1115
6.20.11 ICCPVCC 1115
6.20.12 ICCPVirtualControlCentre 1116
6.20.13 IOPointSource 1117
6.20.14 IPAccessPoint 1118
6.20.15 Enumération IPAddressKind 1119
6.20.16 ISOUpperLayer 1119
6.20.17 ProvidedBilateralPoint 1120
6.20.18 Classe racine PublicX509Certificate 1121
6.20.19 TASE2BilateralTable 1121
6.20.20 TCPAccessPoint 1122
Annexe A (normative) Extensions personnalisées 1124
A.1 Vue d'ensemble 1124
A.2 Extensions européennes 1124
A.2.1 Généralités 1124
A.2.2 Paquetage ExtEuCore 1124
A.2.3 Paquetage ExtEuOperationalLimits 1127
A.2.4 Paquetage ExtEuGeneration 1130
Annexe B (informative) Exemples de modélisation de transformateur PST 1134
B.1 Généralités 1134
B.2 Calculs et exemples détaillés 1134
B.2.1 Déphaseurs symétriques avec deux noyaux 1134
B.2.2 Transformateurs déphaseurs en quadrature 1138
B.2.3 Déphaseur asymétrique 1142
Annexe C (informative) Représentation des cas d'utilisation CCHT 1150
C.1 Aperçu 1150
C.2 Installations dos à dos 1150
C.3 Monopole avec retour par la terre 1152
C.4 Monopole avec retour métallique 1154
C.5 Convertisseur de source de tension 1156
Bibliographie 1158

IECNORM.COM : Click to view the full PDF of IEC 61970-301:2020+AMD1:2022 CSV

Figure 1 – Dépendances définies entre les paquetages du CIM et les informations de versions de paquetages 599
Figure 2 – Diagramme du paquetage CIM IEC 61970-301 600
Figure 3 – Exemple de généralisation 602
Figure 4 – Exemple d'association simple 603
Figure 5 – Exemple d'agrégation 603
Figure 6 – EquipmentContainers 605
Figure 7 – Names 606
Figure 8 – Modèle de connectivité 607
Figure 9 – Exemple de réseau simple 608
Figure 10 – Connectivité d'un réseau simple modélisé avec la topologie du CIM 609
Figure 11 – Hiérarchie des héritages de Equipment 610
Figure 12 – Modèle de Transformer et Tank 611
Figure 13 – Modèle de Transformer 613
Figure 14 – Modèle de prise de transformateur 615
Figure 15 – Schéma et équations du phaseur 619
Figure 16 – Variation d'impédance de déphaseur symétrique 620
Figure 17 – Organisation du noyau 621
Figure 18 – Schéma et équations du phaseur 621
Figure 19 – Organisation du noyau 623
Figure 20 – Schéma et équations du phaseur 624
Figure 21 – Organisation du noyau 625
Figure 22 – Schéma et équations du phaseur 625
Figure 23 – Schémas et équations du phaseur 627
Figure 24 – Organisation du noyau 628
Figure 25 – Modèle de données des phases 630
Figure 26 – Connectivité de phase 631
Figure 27 – Modèle de données de l'appareil de mise à la terre 633
Figure 28 – Exemple de représentation de poste comprenant des bobines Petersen 634
Figure 29 – Objets de diagramme d'instance avec une bobine à bornes 635
Figure 30 – Modèle UML de cuts, de clamps (serre-fils) et de jumpers (cavaliers) 636
Figure 31 – Exemple avant application des cuts et des jumpers (cavaliers) 637
Figure 32 – Exemple après application des cuts et des jumpers (cavaliers) 638
Figure 33 – Exemple de cavalier sans cut ni serre-fil 639
Figure 34 – Navigation de PSR à MeasurementValue 641
Figure 35 – Placement de Measurement 644
Figure 36 – Modèles de commande de régulation 645
Figure 37 – Exemple simplifié de représentation d'un modèle CCHT 647
Figure 38 – Exemple détaillé de représentation de modèle CCHT avec postes CCHT fictifs 648
Figure 39 – Exemple détaillé de représentation de modèle CCHT sans postes CCHT fictifs 649
Figure 40 – Liaison CCHT bipolaire issue de l'IEC 60633 650
Figure 41 – Schéma de transport point à point par un VSC 650

IECNORM.COM : Click to view the full PDF of IEC 61970-301:2020+AMD1:2022 CSV

Figure 42 – Modèle de flux de puissance CCHT 651
Figure 43 – Modèle détaillé de flux de puissance CCHT 652
Figure 44 – Flux de puissance d'un convertisseur de source de courant 653
Figure 45 – Flux de puissance d'un convertisseur de source de tension 654
Figure 46 – Cas de flux de puissance 655
Figure 47 – Transport par VSC à monopole symétrique représenté avec mise à la terre capacitive côté courant continu (IEC 62747) 656
Figure 48 – Courbe de capacité P-Q du VSC 656
Figure 49 – Transport par VSC bipolaire avec retour par la terre (IEC 62747) 657
Figure 50 – Instances d'objets d'une ligne CCHT de source bipolaire de courant 658
Figure 51 – Instances d'objets d'un modèle de données CCHT d'un VSC à monopole symétrique 659
Figure 52 – Structure d'emboîtement d'une ligne CCHT bipolaire 661
Figure 53 – Structure d'emboîtement d'un poste CCHT bipolaire dos à dos 662
Figure 54 – Topologie de base (Basic) dans le paquetage Core 663
Figure 55 – Topologie en courant continu et en courant alternatif 664
Figure 56 – Modèle d'Equipment 665
Figure 57 – Modèle de ligne CCHT 666
Figure 58 – Légende 667
Figure 59 – Monopole simple et mesures 668
Figure 60 – Bipolaire simple 668
Figure 61 – Côté de monopole avec modèle détaillé 669
Figure 62 – Caractéristique V-I du SVC 670
Figure 63 – Mesures ICCP et modèles de réseau 672
Figure 64 – Configuration et démarrage d'ICCP 673
Figure 65 – Exemple de fournisseur et d'utilisateur de valeur de mesure 674
Figure 66 – Modèle de données d'échange bilatéral généralisé 675
Figure 67 – Modèle de données d'échange bilatéral ICCP 677
Figure 68 – Modèle de données Feeder 678
Figure 69 – Orientation du flux de la Terminal 679
Figure 70 – Différentes manières de décrire les interconnexions de la zone de commande 680
Figure 71 – Paquetages de haut niveau du CIM 685
Figure 72 – Diagramme de classe Domain::CombinedElectricalDatatypes 687
Figure 73 – Diagramme de classe Domain::BasicDatatypes 687
Figure 74 – Diagramme de classe Domain::ElectricityDatatypes 689
Figure 75 – Diagramme de classe Domain::EnumeratedUnitDatatypes 690
Figure 76 – Diagramme de classe Domain::GeneralDatatypes 691
Figure 77 – Diagramme de classe Domain::MonetaryDatatypes 692
Figure 78 – Diagramme de classe Domain::TimeDatatypes 693
Figure 79 – Diagramme de classe Core::Main 722
Figure 80 – Diagramme de classe Core::Names 723
Figure 81 – Diagramme de classe Core::CurveSchedule 723
Figure 82 – Diagramme de classe Core::Datatypes 724
IECNORM.COM : Click to view the full PDF of IEC 61970-301:2020+AMD1:2022 CSV

Figure 83 – Diagramme de classe Core::FeederContainment 725
Figure 84 – Diagramme de classe Core::Reporting 725
Figure 85 – Diagramme de classe Core::OperatingShare 726
Figure 86 – Diagramme de classe Wires::CutsAndJumpers 755
Figure 87 – Diagramme de classe Wires::Datatypes 756
Figure 88 – Diagramme de classe Wires::EarthFaultCompensator 757
Figure 89 – Diagramme de classe Wires::InheritanceHierarchy 758
Figure 90 – Diagramme de classe Wires::LineModel 759
Figure 91 – Diagramme de classe Wires::MutualCoupling 760
Figure 92 – Diagramme de classe Wires::NamingHierarchyPart1 761
Figure 93 – Diagramme de classe Wires::NamingHierarchyPart2 762
Figure 94 – Diagramme de classe Wires::RegulatingEquipment 763
Figure 95 – Diagramme de classe Wires::Schedules 764
Figure 96 – Diagramme de classe Wires::ShuntCompensator 764
Figure 97 – Diagramme de classe Wires::SwitchingEquipment 765
Figure 98 – Diagramme de classe Wires::TapChanger 766
Figure 99 – Diagramme de classe Wires::VoltageControl 767
Figure 100 – Diagramme de classe Wires::WiresPhaseModel 768
Figure 101 – Diagramme de classe Wires::Transformer 769
Figure 102 – Diagramme de classe LoadModel::Main 884
Figure 103 – Diagramme de classe Generation::Main 899
Figure 104 – Diagramme de classe GenerationTrainingSimulation::Main 900
Figure 105 – Diagramme de classe GenerationTrainingSimulation::Datatypes 900
Figure 106 – Diagramme de classe Production::PowerElectronics 917
Figure 107 – Diagramme de classe Production::Nuclear 918
Figure 108 – Diagramme de classe Production::Main 919
Figure 109 – Diagramme de classe Production::Datatypes 920
Figure 110 – Diagramme de classe Production::Hydro 921
Figure 111 – Diagramme de classe Production::Thermal 922
Figure 112 – Diagramme de classe DC::DCContainment 975
Figure 113 – Diagramme de classe DC::DCEquipment 976
Figure 114 – Diagramme de classe DC::DCLineModel 977
Figure 115 – Diagramme de classe DC::ACDCConverter 978
Figure 116 – Diagramme de classe DC::ACDCConnectivityModel 979
Figure 117 – Diagramme de classe Equivalents::Main 1011
Figure 118 – Diagramme de classe AuxiliaryEquipment::AuxiliaryEquipment 1020
Figure 119 – Diagramme de classe Meas::Control 1029
Figure 120 – Diagramme de classe Meas::Datatypes 1030
Figure 121 – Diagramme de classe Meas::Measurement 1031
Figure 122 – Diagramme de classe Meas::MeasurementInheritance 1032
Figure 123 – Diagramme de classe Meas::Quality 1033
Figure 124 – Diagramme de classe Topology::Main 1057
Figure 125 – Diagramme de classe Topology::TopologyReporting 1058
IECNORM.COM : Click to view the full PDF of IEC 61970-301:2020+AMD1:2022 CSV

Figure 126 – Diagramme de classe DiagramLayout::DiagramLayout 1062
Figure 127 – Diagramme de classe OperationalLimits::OperationalLimits 1070
Figure 128 – Diagramme de classe OperationalLimits::BranchGroup 1071
Figure 129 – Diagramme de classe ControlArea::ControlArea 1079
Figure 130 – Diagramme de classe ControlArea::ControlAreaInheritance 1080
Figure 131 – Diagramme de classe ControlArea::Datatypes 1080
Figure 132 – Diagramme de classe Contingency::Contingency 1086
Figure 133 – Diagramme de classe StateVariables::StateVariables 1089
Figure 134 – Diagramme de classe Protection::Main 1094
Figure 135 – Diagramme de classe Faults::Faults 1099
Figure 136 – Diagramme de classe SCADA::Datatypes 1103
Figure 137 – Diagramme de classe SCADA::Main 1104
Figure 138 – Diagramme de classe ICCPConfiguration::GenericBilateralExchange 1109
Figure 139 – Diagramme de classe ICCPConfiguration::ICCP 1110
Figure A.1 – Diagramme de classe ExtEuBase::ExtEuBase 1124
Figure A.2 – Diagramme de classe ExtEuCore::ExtEuCore 1125
Figure A.3 – Diagramme de classe ExtEuOperationalLimits::ExtEuOperationalLimits 1128
Figure A.4 – Diagramme de classe ExtEuProduction::ExtEuProduction 1131
Figure B.1 – Déphaseurs symétriques avec deux noyaux 1134
Figure B.2 – Schéma triphasé détaillé 1135
Figure B.3 – Schéma triphasé détaillé 1138
Figure B.4 – Schéma monophasé 1139
Figure B.5 – Schéma du phaseur 1140
Figure B.6 – Schéma triphasé détaillé 1141
Figure B.7 – Schéma du phaseur 1142
Figure B.8 – Déphaseur asymétrique avec deux noyaux 1142
Figure B.9 – Schéma triphasé détaillé 1143
Figure B.10 – Schéma du phaseur 1145
Figure B.11 – Déphaseur asymétrique avec un seul noyau 1146
Figure B.12 – Schéma du phaseur 1147
Figure B.13 – Exemple de schéma triphasé détaillé d'un autotransformateur et d'un transformateur déphaseur en quadrature à régulation de tension 1148
Figure B.14 – Exemple de schéma d'enroulement détaillé d'un autotransformateur et d'un transformateur déphaseur en quadrature à régulation de tension 1149
Figure C.1 – Représentation d'une installation à 12 impulsions dos à dos 1151
Figure C.2 – Représentation d'une installation monopolaire à 12 impulsions avec retour par la terre 1153
Figure C.3 – Représentation d'une installation monopolaire à 12 impulsions avec retour métallique 1155
Figure C.4 – Représentation d'un convertisseur de source de courant 1157

Tableau 1 – Mise en correspondance des transformateurs déphaseurs avec les classes CIM 617
Tableau 2 – Mise en correspondance des symboles utilisés dans les formules avec les attributs CIM 617

IECNORM.COM : Click to view the full PDF of IEC 61970-301:2020+AMD1:2022 CSV

Tableau 3 – Variations d'impédance dans un transformateur déphaseur 618
Tableau 4 – Description des variables 618
Tableau 5 – Options de commande du changeur de prises 629
Tableau 6 – Conventions de dénomination de measurementType 642
Tableau 7 – Conventions de dénomination de MeasurementValueSource (source de valeur de mesure) 643
Tableau 8 – Attributs de Package1::Class1 685
Tableau 9 – Extrémités d'association de Package1::Class1 avec d'autres classes 686
Tableau 10 – Libellés de Package1::Enumeration1 686
Tableau 11 – Attributs de Domain::ActivePower 693
Tableau 12 – Attributs de Domain::ActivePowerChangeRate 694
Tableau 13 – Attributs de Domain::ActivePowerPerCurrentFlow 694
Tableau 14 – Attributs de Domain::ActivePowerPerFrequency 694
Tableau 15 – Attributs de Domain::Admittance 694
Tableau 16 – Attributs de Domain::AngleDegrees 695
Tableau 17 – Attributs de Domain::AngleRadians 695
Tableau 18 – Attributs de Domain::ApparentPower 695
Tableau 19 – Attributs de Domain::Area 696
Tableau 20 – Attributs de Domain::Capacitance 696
Tableau 21 – Attributs de Domain::CapacitancePerLength 696
Tableau 22 – Attributs de Domain::Classification 696
Tableau 23 – Attributs de Domain::Conductance 697
Tableau 24 – Attributs de Domain::ConductancePerLength 697
Tableau 25 – Attributs de Domain::CostPerEnergyUnit 697
Tableau 26 – Attributs de Domain::CostPerHeatUnit 698
Tableau 27 – Attributs de Domain::CostPerVolume 698
Tableau 28 – Attributs de Domain::CostRate 698
Tableau 29 – Libellés de Domain::Currency 698
Tableau 30 – Attributs de Domain::CurrentFlow 702
Tableau 31 – Attributs de Domain::Damping 703
Tableau 32 – Attributs de Domain::DateInterval 703
Tableau 33 – Attributs de Domain::DateTimeInterval 703
Tableau 34 – Attributs de Domain::DecimalQuantity 704
Tableau 35 – Attributs de Domain::Displacement 704
Tableau 36 – Attributs de Domain::Emission 704
Tableau 37 – Attributs de Domain::FloatQuantity 705
Tableau 38 – Attributs de Domain::Frequency 705
Tableau 39 – Attributs de Domain::HeatRate 705
Tableau 40 – Attributs de Domain::Hours 706
Tableau 41 – Attributs de Domain::Impedance 706
Tableau 42 – Attributs de Domain::Inductance 706
Tableau 43 – Attributs de Domain::InductancePerLength 706
Tableau 44 – Attributs de Domain::IntegerQuantity 707

IECNORM.COM : Click to view the full PDF of IEC 61970-301:2020+AMD1:2022 CSV

Tableau 45 – Attributs de Domain::KiloActivePower 707
Tableau 46 – Attributs de Domain::Length 707
Tableau 47 – Attributs de Domain::Mass 707
Tableau 48 – Attributs de Domain::Minutes 708
Tableau 49 – Attributs de Domain::Money 708
Tableau 50 – Attributs de Domain::MonthDayInterval 708
Tableau 51 – Attributs de Domain::PU 709
Tableau 52 – Attributs de Domain::PerCent 709
Tableau 53 – Attributs de Domain::Pressure 709
Tableau 54 – Attributs de Domain::Reactance 709
Tableau 55 – Attributs de Domain::ReactancePerLength 710
Tableau 56 – Attributs de Domain::ReactivePower 710
Tableau 57 – Attributs de Domain::RealEnergy 710
Tableau 58 – Attributs de Domain::Resistance 710
Tableau 59 – Attributs de Domain::ResistancePerLength 711
Tableau 60 – Attributs de Domain::RotationSpeed 711
Tableau 61 – Attributs de Domain::Seconds 711
Tableau 62 – Attributs de Domain::Speed 712
Tableau 63 – Attributs de Domain::StringQuantity 712
Tableau 64 – Attributs de Domain::Susceptance 712
Tableau 65 – Attributs de Domain::SusceptancePerLength 712
Tableau 66 – Attributs de Domain::Temperature 713
Tableau 67 – Attributs de Domain::TimeInterval 713
Tableau 68 – Libellés de Domain::UnitMultiplier 714
Tableau 69 – Libellés de Domain::UnitSymbol 715
Tableau 70 – Attributs de Domain::Voltage 720
Tableau 71 – Attributs de Domain::VoltagePerReactivePower 720
Tableau 72 – Attributs de Domain::Volume 721
Tableau 73 – Attributs de Domain::VolumeFlowRate 721
Tableau 74 – Attributs de Domain::WaterLevel 721
Tableau 75 – Attributs de Core::ACDCTerminal 726
Tableau 76 – Extrémités d'association de Core::ACDCTerminal avec d'autres classes 727
Tableau 77 – Attributs de Core::BaseFrequency 727
Tableau 78 – Extrémités d'association de Core::BaseFrequency avec d'autres classes 728
Tableau 79 – Attributs de Core::BasePower 728
Tableau 80 – Extrémités d'association de Core::BasePower avec d'autres classes 728
Tableau 81 – Attributs de Core::BaseVoltage 728
Tableau 82 – Extrémités d'association de Core::BaseVoltage avec d'autres classes 729
Tableau 83 – Attributs de Core::BasicIntervalSchedule 729
Tableau 84 – Extrémités d'association de Core::BasicIntervalSchedule avec d'autres classes 729
Tableau 85 – Attributs de Core::Bay 730
Tableau 86 – Extrémités d'association de Core::Bay avec d'autres classes 730
IECNORM.COM : Click to view the full PDF of IEC 61970-301:2020+AMD1:2022 CSV

Tableau 87 – Libellés de Core::BreakerConfiguration 731
Tableau 88 – Libellés de Core::BusbarConfiguration 731
Tableau 89 – Attributs de Core::ConductingEquipment 731
Tableau 90 – Extrémités d'association de Core::ConductingEquipment avec d'autres classes 732
Tableau 91 – Attributs de Core::ConnectivityNode 732
Tableau 92 – Extrémités d'association de Core::ConnectivityNode avec d'autres classes 733
Tableau 93 – Attributs de Core::ConnectivityNodeContainer 733
Tableau 94 – Extrémités d'association de Core::ConnectivityNodeContainer avec d'autres classes 733
Tableau 95 – Attributs de Core::Curve 734
Tableau 96 – Extrémités d'association de Core::Curve avec d'autres classes 734
Tableau 97 – Attributs de Core::CurveData 735
Tableau 98 – Extrémités d'association de Core::CurveData avec d'autres classes 735
Tableau 99 – Libellés de Core::CurveStyle 735
Tableau 100 – Attributs de Core::Equipment 736
Tableau 101 – Extrémités d'association de Core::Equipment avec d'autres classes 736
Tableau 102 – Attributs de Core::EquipmentContainer 737
Tableau 103 – Extrémités d'association de Core::EquipmentContainer avec d'autres classes 737
Tableau 104 – Attributs de Core::Feeder 738
Tableau 105 – Extrémités d'association de Core::Feeder avec d'autres classes 738
Tableau 106 – Attributs de Core::GeographicalRegion 739
Tableau 107 – Extrémités d'association de Core::GeographicalRegion avec d'autres classes 739
Tableau 108 – Attributs de Core::IdentifiedObject 740
Tableau 109 – Extrémités d'association de Core::IdentifiedObject avec d'autres classes 740
Tableau 110 – Attributs de Core::IrregularIntervalSchedule 740
Tableau 111 – Extrémités d'association de Core::IrregularIntervalSchedule avec d'autres classes 741
Tableau 112 – Attributs de Core::IrregularTimePoint 741
Tableau 113 – Extrémités d'association de Core::IrregularTimePoint avec d'autres classes 741
Tableau 114 – Attributs de Core::Name 742
Tableau 115 – Extrémités d'association de Core::Name avec d'autres classes 742
Tableau 116 – Attributs de Core::NameType 742
Tableau 117 – Extrémités d'association de Core::NameType avec d'autres classes 742
Tableau 118 – Attributs de Core::NameTypeAuthority 743
Tableau 119 – Extrémités d'association de Core::NameTypeAuthority avec d'autres classes 743
Tableau 120 – Attributs de Core::OperatingParticipant 743
Tableau 121 – Extrémités d'association de Core::OperatingParticipant avec d'autres classes 743
Tableau 122 – Attributs de Core::OperatingShare 744

IECNORM.COM : Click to view the full PDF of IEC 61970-301:2020+AMD1:2022 CSV

Tableau 123 – Extrémités d'association de Core::OperatingShare avec d'autres classes 744
Tableau 124 – Attributs de Core::PSRType 744
Tableau 125 – Extrémités d'association de Core::PSRType avec d'autres classes 745
Tableau 126 – Libellés de Core::PhaseCode 745
Tableau 127 – Attributs de Core::PowerSystemResource 746
Tableau 128 – Extrémités d'association de Core::PowerSystemResource avec d'autres classes 746
Tableau 129 – Attributs de Core::RegularIntervalSchedule 747
Tableau 130 – Extrémités d'association de Core::RegularIntervalSchedule avec d'autres classes 747
Tableau 131 – Attributs de Core::RegularTimePoint 748
Tableau 132 – Extrémités d'association de Core::RegularTimePoint avec d'autres classes 748
Tableau 133 – Attributs de Core::ReportingGroup 748
Tableau 134 – Extrémités d'association de Core::ReportingGroup avec d'autres classes 749
Tableau 135 – Attributs de Core::ReportingSuperGroup 749
Tableau 136 – Extrémités d'association de Core::ReportingSuperGroup avec d'autres classes 749
Tableau 137 – Attributs de Core::SubGeographicalRegion 750
Tableau 138 – Extrémités d'association de Core::SubGeographicalRegion avec d'autres classes 750
Tableau 139 – Attributs de Core::Substation 750
Tableau 140 – Extrémités d'association de Core::Substation avec d'autres classes 751
Tableau 141 – Attributs de Core::Terminal 752
Tableau 142 – Extrémités d'association de Core::Terminal avec d'autres classes 752
Tableau 143 – Attributs de Core::VoltageLevel 753
Tableau 144 – Extrémités d'association de Core::VoltageLevel avec d'autres classes 754
Tableau 145 – Libellés de Wires::AsynchronousMachineKind 770
Tableau 146 – Attributs de Wires::ACLineSegment 770
Tableau 147 – Extrémités d'association de Wires::ACLineSegment avec d'autres classes 771
Tableau 148 – Attributs de Wires::ACLineSegmentPhase 772
Tableau 149 – Extrémités d'association de Wires::ACLineSegmentPhase avec d'autres classes 772
Tableau 150 – Attributs de Wires::AsynchronousMachine 773
Tableau 151 – Extrémités d'association de Wires::AsynchronousMachine avec d'autres classes 774
Tableau 152 – Attributs de Wires::Breaker 775
Tableau 153 – Extrémités d'association de Wires::Breaker avec d'autres classes 775
Tableau 154 – Attributs de Wires::BusbarSection 776
Tableau 155 – Extrémités d'association de Wires::BusbarSection avec d'autres classes 777
Tableau 156 – Attributs de Wires::Clamp 777
Tableau 157 – Extrémités d'association de Wires::Clamp avec d'autres classes 778
Tableau 158 – Attributs de Wires::CompositeSwitch 779
IECNORM.COM : Click to view the full PDF of IEC 61970-301:2020+AMD1:2022 CSV

Tableau 159 – Extrémités d'association de Wires::CompositeSwitch avec d'autres classes 779
Tableau 160 – Attributs de Wires::Conductor 780
Tableau 161 – Extrémités d'association de Wires::Conductor avec d'autres classes 780
Tableau 162 – Attributs de Wires::Connector 781
Tableau 163 – Extrémités d'association de Wires::Connector avec d'autres classes 781
Tableau 164 – Libellés de Wires::CoolantType 782
Tableau 165 – Attributs de Wires::Cut 782
Tableau 166 – Extrémités d'association de Wires::Cut avec d'autres classes 783
Tableau 167 – Attributs de Wires::Disconnector 783
Tableau 168 – Extrémités d'association de Wires::Disconnector avec d'autres classes 784
Tableau 169 – Attributs de Wires::DisconnectingCircuitBreaker 785
Tableau 170 – Extrémités d'association de ExtEuWires::DisconnectingCircuitBreaker avec d'autres classes 785
Tableau 171 – Attributs de Wires::EarthFaultCompensator 786
Tableau 172 – Extrémités d'association de Wires::EarthFaultCompensator avec d'autres classes 787
Tableau 173 – Attributs de Wires::EnergyConnection 787
Tableau 174 – Extrémités d'association de Wires::EnergyConnection avec d'autres classes 788
Tableau 175 – Attributs de Wires::EnergyConsumer 789
Tableau 176 – Extrémités d'association de Wires::EnergyConsumer avec d'autres classes 790
Tableau 177 – Attributs de Wires::EnergyConsumerPhase 791
Tableau 178 – Extrémités d'association de Wires::EnergyConsumerPhase avec d'autres classes 792
Tableau 179 – Attributs de Wires::EnergySchedulingType 792
Tableau 180 – Extrémités d'association de Wires::EnergySchedulingType avec d'autres classes 792
Tableau 181 – Attributs de Wires::EnergySource 793
Tableau 182 – Extrémités d'association de Wires::EnergySource avec d'autres classes 794
Tableau 183 – Attributs de Wires::EnergySourcePhase 794
Tableau 184 – Extrémités d'association de Wires::EnergySourcePhase avec d'autres classes 795
Tableau 185 – Attributs de Wires::ExternalNetworkInjection 795
Tableau 186 – Extrémités d'association de Wires::ExternalNetworkInjection avec d'autres classes 797
Tableau 187 – Attributs de Wires::FrequencyConverter 798
Tableau 188 – Extrémités d'association de Wires::FrequencyConverter avec d'autres classes 798
Tableau 189 – Attributs de Wires::Fuse 799
Tableau 190 – Extrémités d'association de Wires::Fuse avec d'autres classes 799
Tableau 191 – Attributs de Wires::Ground 800
Tableau 192 – Extrémités d'association de Wires::Ground avec d'autres classes 801
Tableau 193 – Attributs de Wires::GroundingImpedance 801

IECNORM.COM : Click to view the full PDF of IEC 61970-301:2020+AMD1:2022 CSV

Tableau 194 – Extrémités d'association de Wires::GroundingImpedance avec d'autres classes 802
Tableau 195 – Attributs de Wires::GroundDisconnector 802
Tableau 196 – Extrémités d'association de Wires::GroundDisconnector avec d'autres classes 803
Tableau 197 – Attributs de Wires::Jumper 804
Tableau 198 – Extrémités d'association de Wires::Jumper avec d'autres classes 804
Tableau 199 – Attributs de Wires::Junction 805
Tableau 200 – Extrémités d'association de Wires::Junction avec d'autres classes 805
Tableau 201 – Attributs de Wires::Line 806
Tableau 202 – Extrémités d'association de Wires::Line avec d'autres classes 806
Tableau 203 – Attributs de Wires::LinearShuntCompensator 807
Tableau 204 – Extrémités d'association de Wires::LinearShuntCompensator avec d'autres classes 808
Tableau 205 – Attributs de Wires::LinearShuntCompensatorPhase 809
Tableau 206 – Extrémités d'association de Wires::LinearShuntCompensatorPhase avec d'autres classes 809
Tableau 207 – Attributs de Wires::LoadBreakSwitch 810
Tableau 208 – Extrémités d'association de Wires::LoadBreakSwitch avec d'autres classes 810
Tableau 209 – Attributs de Wires::MutualCoupling 811
Tableau 210 – Extrémités d'association de Wires::MutualCoupling avec d'autres classes 812
Tableau 211 – Attributs de Wires::NonlinearShuntCompensator 812
Tableau 212 – Extrémités d'association de Wires::NonlinearShuntCompensator avec d'autres classes 813
Tableau 213 – Attributs de Wires::NonlinearShuntCompensatorPhase 814
Tableau 214 – Extrémités d'association de Wires::NonlinearShuntCompensatorPhase avec d'autres classes 814
Tableau 215 – Attributs de Wires::NonlinearShuntCompensatorPhasePoint 814
Tableau 216 – Extrémités d'association de Wires::NonlinearShuntCompensatorPhasePoint avec d'autres classes 815
Tableau 217 – Attributs de Wires::NonlinearShuntCompensatorPoint 815
Tableau 218 – Extrémités d'association de Wires::NonlinearShuntCompensatorPoint avec d'autres classes 815
Tableau 219 – Attributs de Wires::PerLengthImpedance 816
Tableau 220 – Extrémités d'association de Wires::PerLengthImpedance avec d'autres classes 816
Tableau 221 – Attributs de Wires::PerLengthLineParameter 816
Tableau 222 – Extrémités d'association de Wires::PerLengthLineParameter avec d'autres classes 816
Tableau 223 – Attributs de Wires::PerLengthPhaseImpedance 817
Tableau 224 – Extrémités d'association de Wires::PerLengthPhaseImpedance avec d'autres classes 817
Tableau 225 – Attributs de Wires::PerLengthSequenceImpedance 817
Tableau 226 – Extrémités d'association de Wires::PerLengthSequenceImpedance avec d'autres classes 818
IECNORM.COM : Click to view the full PDF of IEC 61970-301:2020+AMD1:2022 CSV

Tableau 227 – Attributs de Wires::PetersenCoil 818
Tableau 228 – Extrémités d'association de Wires::PetersenCoil avec d'autres classes 819
Tableau 229 – Libellés de Wires::PetersenCoilModeKind 820
Tableau 230 – Attributs de Wires::PhaseImpedanceData 820
Tableau 231 – Extrémités d'association de Wires::PhaseImpedanceData avec d'autres classes 820
Tableau 232 – Libellés de Wires::PhaseShuntConnectionKind 821
Tableau 233 – Attributs de Wires::PhaseTapChanger 821
Tableau 234 – Extrémités d'association de Wires::PhaseTapChanger avec d'autres classes 822
Tableau 235 – Attributs de Wires::PhaseTapChangerAsymmetrical 822
Tableau 236 – Extrémités d'association de Wires::PhaseTapChangerAsymmetrical avec d'autres classes 823
Tableau 237 – Attributs de Wires::PhaseTapChangerLinear 824
Tableau 238 – Extrémités d'association de Wires::PhaseTapChangerLinear avec d'autres classes 825
Tableau 239 – Attributs de Wires::PhaseTapChangerNonLinear 825
Tableau 240 – Extrémités d'association de Wires::PhaseTapChangerNonLinear avec d'autres classes 826
Tableau 241 – Attributs de Wires::PhaseTapChangerSymmetrical 827
Tableau 242 – Extrémités d'association de Wires::PhaseTapChangerSymmetrical avec d'autres classes 827
Tableau 243 – Attributs de Wires::PhaseTapChangerTable 828
Tableau 244 – Extrémités d'association de Wires::PhaseTapChangerTable avec d'autres classes 828
Tableau 245 – Attributs de Wires::PhaseTapChangerTablePoint 828
Tableau 246 – Extrémités d'association de Wires::PhaseTapChangerTablePoint avec d'autres classes 829
Tableau 247 – Attributs de Wires::PhaseTapChangerTabular 829
Tableau 248 – Extrémités d'association de Wires::PhaseTapChangerTabular avec d'autres classes 829
Tableau 249 – Attributs de Wires::Plant 830
Tableau 250 – Extrémités d'association de Wires::Plant avec d'autres classes 830
Tableau 251 – Attributs de Wires::PowerElectronicsConnection 831
Tableau 252 – Extrémités d'association de Wires::PowerElectronicsConnection avec d'autres classes 832
Tableau 253 – Attributs de Wires::PowerElectronicsConnectionPhase 833
Tableau 254 – Extrémités d'association de Wires::PowerElectronicsConnectionPhase avec d'autres classes 833
Tableau 255 – Attributs de Wires::PowerTransformer 834
Tableau 256 – Extrémités d'association de Wires::PowerTransformer avec d'autres classes 836
Tableau 257 – Attributs de Wires::PowerTransformerEnd 837
Tableau 258 – Extrémités d'association de Wires::PowerTransformerEnd avec d'autres classes 838
Tableau 259 – Attributs de Wires::ProtectedSwitch 839

IECNORM.COM : Click to view the full PDF of IEC 61970-301:2020+AMD1:2022 CSV

Tableau 260 – Extrémités d'association de Wires::ProtectedSwitch avec d'autres classes 839
Tableau 261 – Attributs de Wires::RatioTapChanger 840
Tableau 262 – Extrémités d'association de Wires::RatioTapChanger avec d'autres classes 841
Tableau 263 – Attributs de Wires::RatioTapChangerTable 841
Tableau 264 – Extrémités d'association de Wires::RatioTapChangerTable avec d'autres classes 842
Tableau 265 – Attributs de Wires::RatioTapChangerTablePoint 842
Tableau 266 – Extrémités d'association de Wires::RatioTapChangerTablePoint avec d'autres classes 842
Tableau 267 – Attributs de Wires::ReactiveCapabilityCurve 843
Tableau 268 – Extrémités d'association de Wires::ReactiveCapabilityCurve avec d'autres classes 843
Tableau 269 – Attributs de Wires::Recloser 844
Tableau 270 – Extrémités d'association de Wires::Recloser avec d'autres classes 844
Tableau 271 – Attributs de Wires::RegulatingCondEq 845
Tableau 272 – Extrémités d'association de Wires::RegulatingCondEq avec d'autres classes 845
Tableau 273 – Attributs de Wires::RegulatingControl 847
Tableau 274 – Extrémités d'association de Wires::RegulatingControl avec d'autres classes 848
Tableau 275 – Libellés de Wires::RegulatingControlModeKind 848
Tableau 276 – Attributs de Wires::RegulationSchedule 849
Tableau 277 – Extrémités d'association de Wires::RegulationSchedule avec d'autres classes 849
Tableau 278 – Attributs de Wires::RotatingMachine 850
Tableau 279 – Extrémités d'association de Wires::RotatingMachine avec d'autres classes 851
Tableau 280 – Attributs de Wires::Sectionaliser 852
Tableau 281 – Extrémités d'association de Wires::Sectionaliser avec d'autres classes 852
Tableau 282 – Attributs de Wires::SeriesCompensator 853
Tableau 283 – Extrémités d'association de Wires::SeriesCompensator avec d'autres classes 854
Tableau 284 – Libellés de Wires::ShortCircuitRotorKind 854
Tableau 285 – Attributs de Wires::ShuntCompensator 855
Tableau 286 – Extrémités d'association de Wires::ShuntCompensator avec d'autres classes 856
Tableau 287 – Attributs de Wires::ShuntCompensatorPhase 857
Tableau 288 – Extrémités d'association de Wires::ShuntCompensatorPhase avec d'autres classes 858
Tableau 289 – Libellés de Wires::SinglePhaseKind 858
Tableau 290 – Attributs de Wires::StaticVarCompensator 859
Tableau 291 – Extrémités d'association de Wires::StaticVarCompensator avec d'autres classes 860
Tableau 292 – Libellés de Wires::SVCControlMode 860
Tableau 293 – Attributs de Wires::Switch 861
IECNORM.COM : Click to view the full PDF of IEC 61970-301:2020+AMD1:2022 CSV

Tableau 294 – Extrémités d'association de Wires::Switch avec d'autres classes 862
Tableau 295 – Attributs de Wires::SwitchPhase 863
Tableau 296 – Extrémités d'association de Wires::SwitchPhase avec d'autres classes 863
Tableau 297 – Attributs de Wires::SwitchSchedule 864
Tableau 298 – Extrémités d'association de Wires::SwitchSchedule avec d'autres classes 864
Tableau 299 – Attributs de Wires::SynchronousMachine 865
Tableau 300 – Extrémités d'association de Wires::SynchronousMachine avec d'autres classes 867
Tableau 301 – Libellés de Wires::SynchronousMachineOperatingMode 868
Tableau 302 – Libellés de Wires::SynchronousMachineKind 868
Tableau 303 – Attributs de Wires::TapChanger 869
Tableau 304 – Extrémités d'association de Wires::TapChanger avec d'autres classes 870
Tableau 305 – Attributs de Wires::TapChangerControl 871
Tableau 306 – Extrémités d'association de Wires::TapChangerControl avec d'autres classes 872
Tableau 307 – Attributs de Wires::TapChangerTablePoint 872
Tableau 308 – Attributs de Wires::TapSchedule 873
Tableau 309 – Extrémités d'association de Wires::TapSchedule avec d'autres classes 874
Tableau 310 – Libellés de Wires::TransformerControlMode 874
Tableau 311 – Attributs de Wires::TransformerCoreAdmittance 874
Tableau 312 – Extrémités d'association de Wires::TransformerCoreAdmittance avec d'autres classes 875
Tableau 313 – Attributs de Wires::TransformerEnd 875
Tableau 314 – Extrémités d'association de Wires::TransformerEnd avec d'autres classes 876
Tableau 315 – Attributs de Wires::TransformerMeshImpedance 877
Tableau 316 – Extrémités d'association de Wires::TransformerMeshImpedance avec d'autres classes 877
Tableau 317 – Attributs de Wires::TransformerStarImpedance 878
Tableau 318 – Extrémités d'association de Wires::TransformerStarImpedance avec d'autres classes 878
Tableau 319 – Attributs de Wires::TransformerTank 878
Tableau 320 – Extrémités d'association de Wires::TransformerTank avec d'autres classes 879
Tableau 321 – Attributs de Wires::TransformerTankEnd 879
Tableau 322 – Extrémités d'association de Wires::TransformerTankEnd avec d'autres classes 880
Tableau 323 – Attributs de Wires::VoltageControlZone 880
Tableau 324 – Extrémités d'association de Wires::VoltageControlZone avec d'autres classes 881
Tableau 325 – Attributs de Wires::WireSegment 881
Tableau 326 – Extrémités d'association de Wires::WireSegment avec d'autres classes 882
Tableau 327 – Attributs de Wires::WireSegmentPhase 882
Tableau 328 – Extrémités d'association de Wires::WireSegmentPhase avec d'autres classes 883

IECNORM.COM : Click to view the full PDF of IEC 61970-301:2020+AMD1:2022 CSV

Tableau 329 – Libellés de Wires::WindingConnection 883
Tableau 330 – Attributs de LoadModel::ConformLoad 885
Tableau 331 – Extrémités d'association de LoadModel::ConformLoad avec d'autres classes 885
Tableau 332 – Attributs de LoadModel::ConformLoadGroup 886
Tableau 333 – Extrémités d'association de LoadModel::ConformLoadGroup avec d'autres classes 886
Tableau 334 – Attributs de LoadModel::ConformLoadSchedule 887
Tableau 335 – Extrémités d'association de LoadModel::ConformLoadSchedule avec d'autres classes 887
Tableau 336 – Attributs de LoadModel::DayType 887
Tableau 337 – Extrémités d'association de LoadModel::DayType avec d'autres classes 888
Tableau 338 – Attributs de LoadModel::EnergyArea 888
Tableau 339 – Extrémités d'association de LoadModel::EnergyArea avec d'autres classes 888
Tableau 340 – Attributs de LoadModel::LoadArea 889
Tableau 341 – Extrémités d'association de LoadModel::LoadArea avec d'autres classes 889
Tableau 342 – Attributs de LoadModel::LoadGroup 889
Tableau 343 – Extrémités d'association de LoadModel::LoadGroup avec d'autres classes 889
Tableau 344 – Attributs de LoadModel::LoadResponseCharacteristic 891
Tableau 345 – Extrémités d'association de LoadModel::LoadResponseCharacteristic avec d'autres classes 892
Tableau 346 – Attributs de LoadModel::NonConformLoad 892
Tableau 347 – Extrémités d'association de LoadModel::NonConformLoad avec d'autres classes 893
Tableau 348 – Attributs de LoadModel::NonConformLoadGroup 893
Tableau 349 – Extrémités d'association de LoadModel::NonConformLoadGroup avec d'autres classes 894
Tableau 350 – Attributs de LoadModel::NonConformLoadSchedule 894
Tableau 351 – Extrémités d'association de LoadModel::NonConformLoadSchedule avec d'autres classes 895
Tableau 352 – Attributs de LoadModel::PowerCutZone 895
Tableau 353 – Extrémités d'association de LoadModel::PowerCutZone avec d'autres classes 895
Tableau 354 – Attributs de LoadModel::Season 896
Tableau 355 – Extrémités d'association de LoadModel::Season avec d'autres classes 896
Tableau 356 – Attributs de LoadModel::SeasonDayTypeSchedule 896
Tableau 357 – Extrémités d'association de LoadModel::SeasonDayTypeSchedule avec d'autres classes 897
Tableau 358 – Attributs de LoadModel::StationSupply 897
Tableau 359 – Extrémités d'association de LoadModel::StationSupply avec d'autres classes 898
Tableau 360 – Attributs de LoadModel::SubLoadArea 898
Tableau 361 – Extrémités d'association de LoadModel::SubLoadArea avec d'autres classes 899
IECNORM.COM : Click to view the full PDF of IEC 61970-301:2020+AMD1:2022 CSV

Tableau 362 – Attributs de GenerationTrainingSimulation::BWRSteamSupply 901
Tableau 363 – Extrémités d'association de GenerationTrainingSimulation::BWRSteamSupply avec d'autres classes 902
Tableau 364 – Libellés de GenerationTrainingSimulation::BoilerControlMode 902
Tableau 365 – Attributs de GenerationTrainingSimulation::CTTempActivePowerCurve 902
Tableau 366 – Extrémités d'association de GenerationTrainingSimulation::CTTempActivePowerCurve avec d'autres classes 903
Tableau 367 – Attributs de GenerationTrainingSimulation::CombustionTurbine 903
Tableau 368 – Extrémités d'association de GenerationTrainingSimulation::CombustionTurbine avec d'autres classes 904
Tableau 369 – Attributs de GenerationTrainingSimulation::DrumBoiler 905
Tableau 370 – Extrémités d'association de GenerationTrainingSimulation::DrumBoiler avec d'autres classes 906
Tableau 371 – Attributs de GenerationTrainingSimulation::FossilSteamSupply 906
Tableau 372 – Extrémités d'association de GenerationTrainingSimulation::FossilSteamSupply avec d'autres classes 907
Tableau 373 – Attributs de GenerationTrainingSimulation::HeatRecoveryBoiler 908
Tableau 374 – Extrémités d'association de GenerationTrainingSimulation::HeatRecoveryBoiler avec d'autres classes 909
Tableau 375 – Attributs de GenerationTrainingSimulation::HydroTurbine 909
Tableau 376 – Extrémités d'association de GenerationTrainingSimulation::HydroTurbine avec d'autres classes 910
Tableau 377 – Attributs de GenerationTrainingSimulation::PWRSteamSupply 910
Tableau 378 – Extrémités d'association de GenerationTrainingSimulation:: PWRSteamSupply avec d'autres classes 911
Tableau 379 – Attributs de GenerationTrainingSimulation::PrimeMover 911
Tableau 380 – Extrémités d'association de GenerationTrainingSimulation::PrimeMover avec d'autres classes 912
Tableau 381 – Attributs de GenerationTrainingSimulation::SteamSupply 912
Tableau 382 – Extrémités d'association de GenerationTrainingSimulation::SteamSupply avec d'autres classes 912
Tableau 383 – Attributs de GenerationTrainingSimulation::SteamTurbine 913
Tableau 384 – Extrémités d'association de GenerationTrainingSimulation::SteamTurbine avec d'autres classes 914
Tableau 385 – Attributs de GenerationTrainingSimulation::Subcritical 914
Tableau 386 – Extrémités d'association de GenerationTrainingSimulation::Subcritical avec d'autres classes 915
Tableau 387 – Attributs de GenerationTrainingSimulation::Supercritical 915
Tableau 388 – Extrémités d'association de GenerationTrainingSimulation:: Supercritical avec d'autres classes 916
Tableau 389 – Libellés de GenerationTrainingSimulation::HydroTurbineKind 917
Tableau 390 – Attributs de Production::AirCompressor 922
Tableau 391 – Extrémités d'association de Production::AirCompressor avec d'autres classes 923
Tableau 392 – Libellés de Production::BatteryStateKind 923
Tableau 393 – Attributs de Production::BatteryUnit 923
Tableau 394 – Extrémités d'association de Production:: BatteryUnit avec d'autres classes 924

IECNORM.COM : Click to view the full PDF of IEC 61970-301:2020+AMD1:2022 CSV

Tableau 395 – Attributs de Production::CAESPlant 925
Tableau 396 – Extrémités d'association de Production::CAESPlant avec d'autres classes 925
Tableau 397 – Attributs de Production::CogenerationPlant 926
Tableau 398 – Extrémités d'association de Production::CogenerationPlant avec d'autres classes 926
Tableau 399 – Attributs de Production::CombinedCyclePlant 927
Tableau 400 – Extrémités d'association de Production::CombinedCyclePlant avec d'autres classes 927
Tableau 401 – Attributs de Production::EmissionAccount 927
Tableau 402 – Extrémités d'association de Production::EmissionAccount avec d'autres classes 928
Tableau 403 – Attributs de Production::EmissionCurve 928
Tableau 404 – Extrémités d'association de Production::EmissionCurve avec d'autres classes 929
Tableau 405 – Libellés de Production::EmissionType 929
Tableau 406 – Libellés de Production::WindGenUnitKind 930
Tableau 407 – Libellés de Production::EmissionValueSource 930
Tableau 408 – Attributs de Production::FossilFuel 930
Tableau 409 – Extrémités d'association de Production::FossilFuel avec d'autres classes 931
Tableau 410 – Attributs de Production::FuelAllocationSchedule 931
Tableau 411 – Extrémités d'association de Production::FuelAllocationSchedule avec d'autres classes 932
Tableau 412 – Libellés de Production::FuelType 932
Tableau 413 – Attributs de Production::GenUnitOpCostCurve 933
Tableau 414 – Extrémités d'association de Production::GenUnitOpCostCurve avec d'autres classes 933
Tableau 415 – Attributs de Production::GenUnitOpSchedule 934
Tableau 416 – Extrémités d'association de Production::GenUnitOpSchedule avec d'autres classes 934
Tableau 417 – Attributs de Production::GeneratingUnit 935
Tableau 418 – Extrémités d'association de Production::GeneratingUnit avec d'autres classes 938
Tableau 419 – Libellés de Production::GeneratorControlMode 938
Tableau 420 – Libellés de Production::GeneratorControlSource 939
Tableau 421 – Attributs de Production::GrossToNetActivePowerCurve 939
Tableau 422 – Extrémités d'association de Production::GrossToNetActivePowerCurve avec d'autres classes 940
Tableau 423 – Attributs de Production::HeatInputCurve 940
Tableau 424 – Extrémités d'association de Production::HeatInputCurve avec d'autres classes 941
Tableau 425 – Attributs de Production::HeatRateCurve 941
Tableau 426 – Extrémités d'association de Production::HeatRateCurve avec d'autres classes 942
Tableau 427 – Libellés de Production::HydroEnergyConversionKind 942
Tableau 428 – Attributs de Production::HydroGeneratingEfficiencyCurve 943
IECNORM.COM : Click to view the full PDF of IEC 61970-301:2020+AMD1:2022 CSV

Tableau 429 – Extrémités d'association de Production::HydroGeneratingEfficiencyCurve avec d'autres classes 943
Tableau 430 – Attributs de Production::HydroGeneratingUnit 944
Tableau 431 – Extrémités d'association de Production::HydroGeneratingUnit avec d'autres classes 945
Tableau 432 – Libellés de Production::HydroPlantStorageKind 946
Tableau 433 – Attributs de Production::HydroPowerPlant 946
Tableau 434 – Extrémités d'association de Production::HydroPowerPlant avec d'autres classes 947
Tableau 435 – Attributs de Production::HydroPump 947
Tableau 436 – Extrémités d'association de Production::HydroPump avec d'autres classes 948
Tableau 437 – Attributs de Production::HydroPumpOpSchedule 949
Tableau 438 – Extrémités d'association de Production::HydroPumpOpSchedule avec d'autres classes 949
Tableau 439 – Attributs de Production::IncrementalHeatRateCurve 950
Tableau 440 – Extrémités d'association de Production::IncrementalHeatRateCurve avec d'autres classes 950
Tableau 441 – Attributs de Production::InflowForecast 951
Tableau 442 – Extrémités d'association de Production::InflowForecast avec d'autres classes 951
Tableau 443 – Attributs de Production::LevelVsVolumeCurve 951
Tableau 444 – Extrémités d'association de Production::LevelVsVolumeCurve avec d'autres classes 952
Tableau 445 – Attributs de Production::NuclearGeneratingUnit 952
Tableau 446 – Extrémités d'association de Production::NuclearGeneratingUnit avec d'autres classes 954
Tableau 447 – Attributs de Production::PenstockLossCurve 954
Tableau 448 – Extrémités d'association de Production::PenstockLossCurve avec d'autres classes 955
Tableau 449 – Attributs de Production::PhotoVoltaicUnit 955
Tableau 450 – Extrémités d'association de Production::PhotoVoltaicUnit avec d'autres noms 956
Tableau 451 – Attributs de Production::PowerElectronicsUnit 956
Tableau 452 – Extrémités d'association de Production::PowerElectronicsUnit avec d'autres classes 957
Tableau 453 – Attributs de Production::PowerElectronicsWindUnit 957
Tableau 454 – Extrémités d'association de Production::PowerElectronicsWindUnit avec d'autres classes 958
Tableau 455 – Attributs de Production::Reservoir 958
Tableau 456 – Extrémités d'association de Production::Reservoir avec d'autres classes 959
Tableau 457 – Attributs de Production::ShutdownCurve 960
Tableau 458 – Extrémités d'association de Production::ShutdownCurve avec d'autres classes 960
Tableau 459 – Attributs de Production::SolarGeneratingUnit 961
Tableau 460 – Extrémités d'association de Production::SolarGeneratingUnit avec d'autres classes 962
Tableau 461 – Attributs de Production::StartIgnFuelCurve 963

IECNORM.COM : Click to view the full PDF of IEC 61970-301:2020+AMD1:2022 CSV

Tableau 462 – Extrémités d'association de Production::StartIgnFuelCurve avec d'autres classes 963
Tableau 463 – Attributs de Production::StartMainFuelCurve 964
Tableau 464 – Extrémités d'association de Production::StartMainFuelCurve avec d'autres classes 964
Tableau 465 – Attributs de Production::StartRampCurve 965
Tableau 466 – Extrémités d'association de Production::StartRampCurve avec d'autres classes 965
Tableau 467 – Attributs de Production::StartupModel 966
Tableau 468 – Extrémités d'association de Production::StartupModel avec d'autres classes 966
Tableau 469 – Attributs de Production::SteamSendoutSchedule 967
Tableau 470 – Extrémités d'association de Production::SteamSendoutSchedule avec d'autres classes 967
Tableau 471 – Attributs de Production::TailbayLossCurve 968
Tableau 472 – Extrémités d'association de Production::TailbayLossCurve avec d'autres classes 968
Tableau 473 – Attributs de Production::TargetLevelSchedule 969
Tableau 474 – Extrémités d'association de Production::TargetLevelSchedule avec d'autres classes 969
Tableau 475 – Attributs de Production::ThermalGeneratingUnit 970
Tableau 476 – Extrémités d'association de Production::ThermalGeneratingUnit avec d'autres classes 971
Tableau 477 – Attributs de Production::WindGeneratingUnit 972
Tableau 478 – Extrémités d'association de Production::WindGeneratingUnit avec d'autres classes 974
Tableau 479 – Attributs de DC::ACDCConverter 980
Tableau 480 – Extrémités d'association de DC::ACDCConverter avec d'autres classes 982
Tableau 481 – Attributs de DC::ACDCConverterDCTerminal 983
Tableau 482 – Extrémités d'association de DC::ACDCConverterDCTerminal avec d'autres classes 983
Tableau 483 – Attributs de DC::CsConverter 984
Tableau 484 – Extrémités d'association de DC::CsConverter avec d'autres classes 986
Tableau 485 – Attributs de DC::DCTopologicalNode 987
Tableau 486 – Extrémités d'association de DC::DCTopologicalNode avec d'autres classes 987
Tableau 487 – Libellés de DC::CsOperatingModeKind 987
Tableau 488 – Libellés de DC::CsPpccControlKind 988
Tableau 489 – Attributs de DC::DCBaseTerminal 988
Tableau 490 – Extrémités d'association de DC::DCBaseTerminal avec d'autres classes 989
Tableau 491 – Attributs de DC::DCBreaker 989
Tableau 492 – Extrémités d'association de DC::DCBreaker avec d'autres classes 990
Tableau 493 – Attributs de DC::DCBusbar 990
Tableau 494 – Extrémités d'association de DC::DCBusbar avec d'autres classes 991
Tableau 495 – Attributs de DC::DCChopper 991
Tableau 496 – Extrémités d'association de DC::DCChopper avec d'autres classes 992

IECNORM.COM : Click to view the full PDF of IEC 61970-301:2020+AMD1:2022 CSV

Tableau 497 – Attributs de DC::DCConductingEquipment 992
Tableau 498 – Extrémités d'association de DC::DCConductingEquipment avec d'autres classes 993
Tableau 499 – Libellés de DC::DCConverterOperatingModeKind 993
Tableau 500 – Attributs de DC::DCConverterUnit 994
Tableau 501 – Extrémités d'association de DC::DCConverterUnit avec d'autres classes 994
Tableau 502 – Attributs de DC::DCDisconnector 995
Tableau 503 – Extrémités d'association de DC::DCDisconnector avec d'autres classes 995
Tableau 504 – Attributs de DC::DCEquipmentContainer 996
Tableau 505 – Extrémités d'association de DC::DCEquipmentContainer avec d'autres classes 996
Tableau 506 – Attributs de DC::DCGround 997
Tableau 507 – Extrémités d'association de DC::DCGround avec d'autres classes 997
Tableau 508 – Attributs de DC::DCLine 998
Tableau 509 – Extrémités d'association de DC::DCLine avec d'autres classes 998
Tableau 510 – Attributs de DC::DCLineSegment 999
Tableau 511 – Extrémités d'association de DC::DCLineSegment avec d'autres classes 999
Tableau 512 – Attributs de DC::DCNode 1000
Tableau 513 – Extrémités d'association de DC::DCNode avec d'autres classes 1000
Tableau 514 – Libellés de DC::DCPolarityKind 1000
Tableau 515 – Attributs de DC::DCSeriesDevice 1001
Tableau 516 – Extrémités d'association de DC::DCSeriesDevice avec d'autres classes 1001
Tableau 517 – Attributs de DC::DCShunt 1002
Tableau 518 – Extrémités d'association de DC::DCShunt avec d'autres classes 1002
Tableau 519 – Attributs de DC::DCSwitch 1003
Tableau 520 – Extrémités d'association de DC::DCSwitch avec d'autres classes 1003
Tableau 521 – Attributs de DC::DCTerminal 1004
Tableau 522 – Extrémités d'association de DC::DCTerminal avec d'autres classes 1004
Tableau 523 – Attributs de DC::DCTopologicalIsland 1004
Tableau 524 – Extrémités d'association de DC::DCTopologicalIsland avec d'autres classes 1005
Tableau 525 – Attributs de DC::PerLengthDCLineParameter 1005
Tableau 526 – Extrémités d'association de DC::PerLengthDCLineParameter avec d'autres classes 1005
Tableau 527 – Attributs de DC::VsCapabilityCurve 1006
Tableau 528 – Extrémités d'association de DC::VsCapabilityCurve avec d'autres classes 1006
Tableau 529 – Attributs de DC::VsConverter 1007
Tableau 530 – Extrémités d'association de DC::VsConverter avec d'autres classes 1008
Tableau 531 – Libellés de DC::VsPpccControlKind 1009
Tableau 532 – Libellés de DC::VsQpccControlKind 1010
Tableau 533 – Attributs de Equivalents::EquivalentBranch 1012
Tableau 534 – Extrémités d'association de Equivalents::EquivalentBranch avec d'autres classes 1014
Tableau 535 – Attributs de Equivalents::EquivalentEquipment 1014

IECNORM.COM : Click to view the full PDF of IEC 61970-301:2020+AMD1:2022 CSV

Tableau 536 – Extrémités d'association de Equivalents::EquivalentEquipment avec d'autres classes 1015
Tableau 537 – Attributs de Equivalents::EquivalentInjection 1015
Tableau 538 – Extrémités d'association de Equivalents::EquivalentInjection avec d'autres classes 1017
Tableau 539 – Attributs de Equivalents::EquivalentNetwork 1017
Tableau 540 – Extrémités d'association de Equivalents::EquivalentNetwork avec d'autres classes 1018
Tableau 541 – Attributs de Equivalents::EquivalentShunt 1018
Tableau 542 – Extrémités d'association de Equivalents::EquivalentShunt avec d'autres classes 1019
Tableau 543 – Attributs de AuxiliaryEquipment::AuxiliaryEquipment 1021
Tableau 544 – Extrémités d'association de AuxiliaryEquipment::AuxiliaryEquipment avec d'autres classes 1021
Tableau 545 – Attributs de AuxiliaryEquipment::CurrentTransformer 1022
Tableau 546 – Extrémités d'association de AuxiliaryEquipment::CurrentTransformer avec d'autres classes 1022
Tableau 547 – Attributs de AuxiliaryEquipment::FaultIndicator 1023
Tableau 548 – Extrémités d'association de AuxiliaryEquipment::FaultIndicator avec d'autres classes 1023
Tableau 549 – Attributs de AuxiliaryEquipment::PostLineSensor 1024
Tableau 550 – Extrémités d'association de AuxiliaryEquipment::PostLineSensor avec d'autres classes 1024
Tableau 551 – Attributs de AuxiliaryEquipment::PotentialTransformer 1025
Tableau 552 – Extrémités d'association de AuxiliaryEquipment::PotentialTransformer avec d'autres classes 1025
Tableau 553 – Libellés de AuxiliaryEquipment::PotentialTransformerKind 1026
Tableau 554 – Attributs de AuxiliaryEquipment::Sensor 1026
Tableau 555 – Extrémités d'association de AuxiliaryEquipment::Sensor avec d'autres classes 1026
Tableau 556 – Attributs de AuxiliaryEquipment::SurgeArrester 1027
Tableau 557 – Extrémités d'association de AuxiliaryEquipment::SurgeArrester avec d'autres classes 1027
Tableau 558 – Attributs de AuxiliaryEquipment::WaveTrap 1028
Tableau 559 – Extrémités d'association de AuxiliaryEquipment::WaveTrap avec d'autres classes 1028
Tableau 560 – Attributs de Meas::Accumulator 1033
Tableau 561 – Extrémités d'association de Meas::Accumulator avec d'autres classes 1034
Tableau 562 – Attributs de Meas::AccumulatorLimit 1034
Tableau 563 – Extrémités d'association de Meas::AccumulatorLimit avec d'autres classes 1034
Tableau 564 – Attributs de Meas::AccumulatorLimitSet 1035
Tableau 565 – Extrémités d'association de Meas::AccumulatorLimitSet avec d'autres classes 1035
Tableau 566 – Attributs de Meas::AccumulatorReset 1035
Tableau 567 – Extrémités d'association de Meas::AccumulatorReset avec d'autres classes 1036
Tableau 568 – Attributs de Meas::AccumulatorValue 1036
IECNORM.COM : Click to view the full PDF of IEC 61970-301:2020+AMD1:2022 CSV

Tableau 569 – Extrémités d'association de Meas::AccumulatorValue avec d'autres classes 1037
Tableau 570 – Attributs de Meas::Analog 1037
Tableau 571 – Extrémités d'association de Meas::Analog avec d'autres classes 1038
Tableau 572 – Attributs de Meas::AnalogControl 1038
Tableau 573 – Extrémités d'association de Meas::AnalogControl avec d'autres classes 1039
Tableau 574 – Attributs de Meas::AnalogLimit 1039
Tableau 575 – Extrémités d'association de Meas::AnalogLimit avec d'autres classes 1039
Tableau 576 – Attributs de Meas::AnalogLimitSet 1040
Tableau 577 – Extrémités d'association de Meas::AnalogLimitSet avec d'autres classes 1040
Tableau 578 – Attributs de Meas::AnalogValue 1040
Tableau 579 – Extrémités d'association de Meas::AnalogValue avec d'autres classes 1041
Tableau 580 – Attributs de Meas::Command 1041
Tableau 581 – Extrémités d'association de Meas::Command avec d'autres classes 1042
Tableau 582 – Attributs de Meas::Control 1042
Tableau 583 – Extrémités d'association de Meas::Control avec d'autres classes 1042
Tableau 584 – Attributs de Meas::Discrete 1043
Tableau 585 – Extrémités d'association de Meas::Discrete avec d'autres classes 1044
Tableau 586 – Attributs de Meas::DiscreteValue 1044
Tableau 587 – Extrémités d'association de Meas::DiscreteValue avec d'autres classes 1044
Tableau 588 – Attributs de Meas::IOPoint 1045
Tableau 589 – Extrémités d'association de Meas::IOPoint avec d'autres classes 1045
Tableau 590 – Attributs de Meas::Limit 1046
Tableau 591 – Extrémités d'association de Meas::Limit avec d'autres classes 1046
Tableau 592 – Attributs de Meas::LimitSet 1046
Tableau 593 – Extrémités d'association de Meas::LimitSet avec d'autres classes 1046
Tableau 594 – Attributs de Meas::Measurement 1047
Tableau 595 – Extrémités d'association de Meas::Measurement avec d'autres classes 1048
Tableau 596 – Attributs de Meas::MeasurementValue 1048
Tableau 597 – Extrémités d'association de Meas::MeasurementValue avec d'autres classes 1049
Tableau 598 – Attributs de Meas::MeasurementValueQuality 1049
Tableau 599 – Extrémités d'association de Meas::MeasurementValueQuality avec d'autres classes 1050
Tableau 600 – Attributs de Meas::MeasurementValueSource 1050
Tableau 601 – Extrémités d'association de Meas::MeasurementValueSource avec d'autres classes 1050
Tableau 602 – Attributs de Meas::Quality61850 1051
Tableau 603 – Attributs de Meas::RaiseLowerCommand 1052
Tableau 604 – Extrémités d'association de Meas::RaiseLowerCommand avec d'autres classes 1052
Tableau 605 – Attributs de Meas::SetPoint 1053
Tableau 606 – Extrémités d'association de Meas::SetPoint avec d'autres classes 1053
Tableau 607 – Attributs de Meas::StringMeasurement 1054

IECNORM.COM : Click to view the full PDF of IEC 61970-301:2020+AMD1:2022 CSV

Tableau 608 – Extrémités d'association de Meas::StringMeasurement avec d'autres classes 1054
Tableau 609 – Attributs de Meas::StringMeasurementValue 1054
Tableau 610 – Extrémités d'association de Meas::StringMeasurementValue avec d'autres classes 1055
Tableau 611 – Libellés de Meas::Validity 1055
Tableau 612 – Attributs de Meas::ValueAliasSet 1056
Tableau 613 – Extrémités d'association de Meas::ValueAliasSet avec d'autres classes 1056
Tableau 614 – Attributs de Meas::ValueToAlias 1056
Tableau 615 – Extrémités d'association de Meas::ValueToAlias avec d'autres classes 1057
Tableau 616 – Attributs de Topology::BusNameMarker 1058
Tableau 617 – Extrémités d'association de Topology::BusNameMarker avec d'autres classes 1059
Tableau 618 – Attributs de Topology::TopologicalIsland 1059
Tableau 619 – Extrémités d'association de Topology::TopologicalIsland avec d'autres classes 1060
Tableau 620 – Attributs de Topology::TopologicalNode 1060
Tableau 621 – Extrémités d'association de Topology::TopologicalNode avec d'autres classes 1061
Tableau 622 – Attributs de DiagramLayout::Diagram 1063
Tableau 623 – Extrémités d'association de DiagramLayout::Diagram avec d'autres classes 1063
Tableau 624 – Attributs de DiagramLayout::DiagramObject 1064
Tableau 625 – Extrémités d'association de DiagramLayout::DiagramObject avec d'autres classes 1065
Tableau 626 – Extrémités d'association de DiagramLayout::DiagramObjectGluePoint avec d'autres classes 1065
Tableau 627 – Attributs de DiagramLayout::DiagramObjectPoint 1066
Tableau 628 – Extrémités d'association de DiagramLayout::DiagramObjectPoint avec d'autres classes 1066
Tableau 629 – Attributs de DiagramLayout::DiagramObjectStyle 1066
Tableau 630 – Extrémités d'association de DiagramLayout::DiagramObjectStyle avec d'autres classes 1067
Tableau 631 – Attributs de DiagramLayout::DiagramStyle 1067
Tableau 632 – Extrémités d'association de DiagramLayout::DiagramStyle avec d'autres classes 1067
Tableau 633 – Libellés de DiagramLayout::OrientationKind 1068
Tableau 634 – Attributs de DiagramLayout::TextDiagramObject 1068
Tableau 635 – Extrémités d'association de DiagramLayout::TextDiagramObject avec d'autres classes 1069
Tableau 636 – Attributs de DiagramLayout::VisibilityLayer 1069
Tableau 637 – Extrémités d'association de DiagramLayout::VisibilityLayer avec d'autres classes 1070
Tableau 638 – Attributs de OperationalLimits::ActivePowerLimit 1071
Tableau 639 – Extrémités d'association de OperationalLimits::ActivePowerLimit avec d'autres classes 1072
Tableau 640 – Attributs de OperationalLimits::ApparentPowerLimit 1072
IECNORM.COM : Click to view the full PDF of IEC 61970-301:2020+AMD1:2022 CSV

Tableau 641 – Extrémités d'association de OperationalLimits::ApparentPowerLimit avec d'autres classes 1072
Tableau 642 – Attributs de OperationalLimits::BranchGroup 1073
Tableau 643 – Extrémités d'association de OperationalLimits::BranchGroup avec d'autres classes 1073
Tableau 644 – Attributs de OperationalLimits::BranchGroupTerminal 1073
Tableau 645 – Extrémités d'association de OperationalLimits::BranchGroupTerminal avec d'autres classes 1074
Tableau 646 – Attributs de OperationalLimits::CurrentLimit 1074
Tableau 647 – Extrémités d'association de OperationalLimits::CurrentLimit avec d'autres classes 1074
Tableau 648 – Attributs de OperationalLimits::OperationalLimit 1075
Tableau 649 – Extrémités d'association de OperationalLimits::OperationalLimit avec d'autres classes 1075
Tableau 650 – Libellés de OperationalLimits::OperationalLimitDirectionKind 1075
Tableau 651 – Attributs de OperationalLimits::OperationalLimitSet 1076
Tableau 652 – Extrémités d'association de OperationalLimits::OperationalLimitSet avec d'autres classes 1076
Tableau 653 – Attributs de OperationalLimits::OperationalLimitType 1077
Tableau 654 – Extrémités d'association de OperationalLimits::OperationalLimitType avec d'autres classes 1077
Tableau 655 – Attributs de OperationalLimits::VoltageLimit 1078
Tableau 656 – Extrémités d'association de OperationalLimits::VoltageLimit avec d'autres classes 1078
Tableau 657 – Attributs de ControlArea::AltGeneratingUnitMeas 1081
Tableau 658 – Extrémités d'association de ControlArea::AltGeneratingUnitMeas avec d'autres classes 1081
Tableau 659 – Attributs de ControlArea::AltTieMeas 1081
Tableau 660 – Extrémités d'association de ControlArea::AltTieMeas avec d'autres classes 1082
Tableau 661 – Attributs de ControlArea::ControlArea 1083
Tableau 662 – Extrémités d'association de ControlArea::ControlArea avec d'autres classes 1083
Tableau 663 – Attributs de ControlArea::ControlAreaGeneratingUnit 1084
Tableau 664 – Extrémités d'association de ControlArea::ControlAreaGeneratingUnit avec d'autres classes 1084
Tableau 665 – Libellés de ControlArea::ControlAreaTypeKind 1084
Tableau 666 – Attributs de ControlArea::TieFlow 1085
Tableau 667 – Extrémités d'association de ControlArea::TieFlow avec d'autres classes 1085
Tableau 668 – Attributs de Contingency::Contingency 1086
Tableau 669 – Extrémités d'association de Contingency::Contingency avec d'autres classes 1087
Tableau 670 – Attributs de Contingency::ContingencyElement 1087
Tableau 671 – Extrémités d'association de Contingency::ContingencyElement avec d'autres classes 1087
Tableau 672 – Attributs de Contingency::ContingencyEquipment 1088
Tableau 673 – Extrémités d'association de Contingency::ContingencyEquipment avec d'autres classes 1088

IECNORM.COM : Click to view the full PDF of IEC 61970-301:2020+AMD1:2022 CSV

Tableau 674 – Libellés de Contingency::ContingencyEquipmentStatusKind 1088
Tableau 675 – Attributs de StateVariables::SvInjection 1090
Tableau 676 – Extrémités d'association de StateVariables::SvInjection avec d'autres classes 1090
Tableau 677 – Attributs de StateVariables::SvPowerFlow 1090
Tableau 678 – Extrémités d'association de StateVariables::SvPowerFlow avec d'autres classes 1091
Tableau 679 – Attributs de StateVariables::SvShuntCompensatorSections 1091
Tableau 680 – Extrémités d'association de StateVariables::SvShuntCompensatorSections avec d'autres classes 1091
Tableau 681 – Attributs de StateVariables::SvStatus 1091
Tableau 682 – Extrémités d'association de StateVariables::SvStatus avec d'autres classes 1092
Tableau 683 – Attributs de StateVariables::SvSwitch 1092
Tableau 684 – Extrémités d'association de StateVariables::SvSwitch avec d'autres classes 1092
Tableau 685 – Attributs de StateVariables::SvTapStep 1092
Tableau 686 – Extrémités d'association de StateVariables::SvTapStep avec d'autres classes 1093
Tableau 687 – Attributs de StateVariables::SvVoltage 1093
Tableau 688 – Extrémités d'association de StateVariables::SvVoltage avec d'autres classes 1093
Tableau 689 – Attributs de Protection::CurrentRelay 1094
Tableau 690 – Extrémités d'association de Protection::CurrentRelay avec d'autres classes 1095
Tableau 691 – Attributs de Protection::ProtectionEquipment 1096
Tableau 692 – Extrémités d'association de Protection::ProtectionEquipment avec d'autres classes 1096
Tableau 693 – Attributs de Protection::RecloseSequence 1097
Tableau 694 – Extrémités d'association de Protection::RecloseSequence avec d'autres classes 1097
Tableau 695 – Attributs de Protection::SynchrocheckRelay 1098
Tableau 696 – Extrémités d'association de Protection::SynchrocheckRelay avec d'autres classes 1098
Tableau 697 – Attributs de Faults::EquipmentFault 1099
Tableau 698 – Extrémités d'association de Faults::EquipmentFault avec d'autres classes 1100
Tableau 699 – Attributs de Faults::Fault 1100
Tableau 700 – Extrémités d'association de Faults::Fault avec d'autres classes 1100
Tableau 701 – Attributs de Faults::FaultCauseType 1101
Tableau 702 – Extrémités d'association de Faults::FaultCauseType avec d'autres classes 1101
Tableau 703 – Attributs de Faults::FaultImpedance 1101
Tableau 704 – Attributs de Faults::LineFault 1102
Tableau 705 – Extrémités d'association de Faults::LineFault avec d'autres classes 1102
Tableau 706 – Libellés de Faults::PhaseConnectedFaultKind 1102
Tableau 707 – Attributs de SCADA::CommunicationLink 1104

IECNORM.COM : Click to view the full PDF of IEC 61970-301:2020+AMD1:2022 CSV

Tableau 708 – Extrémités d'association de SCADA::CommunicationLink avec d'autres classes 1105
Tableau 709 – Attributs de SCADA::RemoteControl 1105
Tableau 710 – Extrémités d'association de SCADA::RemoteControl avec d'autres classes 1106
Tableau 711 – Attributs de SCADA::RemotePoint 1106
Tableau 712 – Extrémités d'association de SCADA::RemotePoint avec d'autres classes 1106
Tableau 713 – Attributs de SCADA::RemoteSource 1107
Tableau 714 – Extrémités d'association de SCADA::RemoteSource avec d'autres classes 1107
Tableau 715 – Attributs de SCADA::RemoteUnit 1107
Tableau 716 – Extrémités d'association de SCADA::RemoteUnit avec d'autres classes 1108
Tableau 717 – Libellés de SCADA::RemoteUnitType 1108
Tableau 718 – Libellés de SCADA::Source 1108
Tableau 719 – Libellés de ICCPConfiguration::ApplicationSecurityKind 1111
Tableau 720 – Attributs de ICCPConfiguration::BilateralExchangeActor 1111
Tableau 721 – Extrémités d'association de ICCPConfiguration::BilateralExchangeActor avec d'autres classes 1111
Tableau 722 – Attributs de ICCPConfiguration::BilateralExchangeAgreement 1112
Tableau 723 – Extrémités d'association de ICCPConfiguration::BilateralExchangeAgreement avec d'autres classes 1112
Tableau 724 – Libellés de ICCPConfiguration::ICCPAccessPrivilegeKind 1112
Tableau 725 – Attributs de ICCPConfiguration::ICCPInformationMessage 1113
Tableau 726 – Extrémités d'association de ICCPConfiguration::ICCPInformationMessage avec d'autres classes 1113
Tableau 727 – Libellés de ICCPConfiguration::ICCPPointKind 1113
Tableau 728 – Attributs de ICCPConfiguration::ICCPProvidedPoint 1114
Tableau 729 – Extrémités d'association de ICCPConfiguration::ICCPProvidedPoint avec d'autres classes 1114
Tableau 730 – Libellés de ICCPConfiguration::ICCPQualityKind 1115
Tableau 731 – Libellés de ICCPConfiguration::ICCPScopeKind 1115
Tableau 732 – Attributs de ICCPConfiguration::ICCPVCC 1115
Tableau 733 – Extrémités d'association de ICCPConfiguration::ICCPVCC avec d'autres classes 1116
Tableau 734 – Attributs de ICCPConfiguration::ICCPVirtualControlCentre 1116
Tableau 735 – Extrémités d'association de ICCPConfiguration::ICCPVirtualControlCentre avec d'autres classes 1117
Tableau 736 – Attributs de ICCPConfiguration::IOPointSource 1117
Tableau 737 – Extrémités d'association de ICCPConfiguration::IOPointSource avec d'autres classes 1118
Tableau 738 – Attributs de ICCPConfiguration::IPAccessPoint 1118
Tableau 739 – Extrémités d'association de ICCPConfiguration::IPAccessPoint avec d'autres classes 1118
Tableau 740 – Libellés de ICCPConfiguration::IPAddressKind 1119
Tableau 741 – Attributs de ICCPConfiguration::ISOUpperLayer 1119
Tableau 742 – Extrémités d'association de ICCPConfiguration::ISOUpperLayer avec d'autres classes 1120

IECNORM.COM : Click to view the full PDF of IEC 61970-301:2020+AMD1:2022 CSV

Tableau 743 – Attributs de ICCPConfiguration::ProvidedBilateralPoint 1120
Tableau 744 – Extrémités d'association de ICCPConfiguration::ProvidedBilateralPoint avec d'autres classes 1121
Tableau 745 – Attributs de ICCPConfiguration::PublicX509Certificate 1121
Tableau 746 – Extrémités d'association de ICCPConfiguration::PublicX509Certificate avec d'autres classes 1121
Tableau 747 – Attributs de ICCPConfiguration::TASE2BilateralTable 1122
Tableau 748 – Extrémités d'association de ICCPConfiguration::TASE2BilateralTable avec d'autres classes 1122
Tableau 749 – Attributs de ICCPConfiguration::TCPAccessPoint 1123
Tableau 750 – Extrémités d'association de ICCPConfiguration::TCPAccessPoint avec d'autres classes 1123
Tableau A.1 – Attributs de ExtEuCore::BoundaryPoint 1126
Tableau A.2 – Extrémités d'association de ExtEuCore::BoundaryPoint avec d'autres classes 1127
Tableau A.3 – Attributs de ExtEuCore::ExtEuIdentifiedObject 1127
Tableau A.4 – Attributs de ExtEuOperationalLimits::ExtEuOperationalLimitType 1128
Tableau A.5 – Libellés de ExtEuOperationalLimits::LimitKind 1129
Tableau A.6 – Attributs de ExtEuProduction::SolarPowerPlant 1131
Tableau A.7 – Extrémités d'association de ExtEuProduction::SolarPowerPlant avec d'autres classes 1132
Tableau A.8 – Attributs de ExtEuProduction::WindPowerPlant 1132
Tableau A.9 – Extrémités d'association de ExtEuProduction::WindPowerPlant avec d'autres classes 1133

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COMMISSION ÉLECTROTECHNIQUE INTERNATIONALE

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INTERFACE DE PROGRAMMATION D'APPLICATION POUR SYSTÈME DE GESTION D'ÉNERGIE (EMS-API) –

Partie 301: Base de modèle d'information commun (CIM)

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Cette version consolidée de la Norme IEC officielle et de son amendement a été préparée pour la commodité de l'utilisateur.

L'IEC 61970-301 édition 7.1 contient la septième édition (2020-06) [documents 57/2210/FDIS and 57/2224/RVD] et son amendement 1 (2022-02) [documents 57/2439/FDIS et 57/2450/RVD].

Cette version Finale ne montre pas les modifications apportées au contenu technique par l'amendement 1. Une version Redline montrant toutes les modifications est disponible dans cette publication.

La Norme internationale IEC 61970-301 a été établie par le comité d'études 57 de l'IEC: Gestion des systèmes de puissance et échanges d'informations associés

Cette septième édition constitue une révision technique.

Cette édition reflète la version du contenu du modèle "IEC61970CIM17v38", datée de "2020-01-21", et inclut les modifications techniques majeures suivantes par rapport à l'édition précédente:

a) modélisation Feeder ajoutée;
b) modélisation de la configuration ICCP ajoutée;
c) correction de problèmes détectés dans les essais d'interopérabilité ou l'utilisation de la norme;
d) documentation améliorée;
e) Annexe A mise à jour avec des extensions personnalisées;
f) Annexe B ajoutée Exemples de modélisation de transformateur PST;
g) Annexe C ajoutée Cas d'utilisation CCHT.

Cette publication a été rédigée selon les Directives ISO/IEC, Partie 2

Une liste de toutes les parties de la série IEC 61970, sous le titre général: *Interface de programme d'application de système de gestion d'énergie (EMS-API)*, peut être consultée sur le site Web de l'IEC.

Le comité a décidé que le contenu de la publication de base et de son amendement ne sera pas modifié avant la date de stabilité indiquée sur le site web de l'IEC sous webstore.iec.ch dans les données relatives à la publication recherchée. A cette date, la publication sera

- reconduite,
- supprimée,
- remplacée par une édition révisée, ou
- amendée.

IMPORTANT – Le logo *"colour inside"* qui se trouve sur la page de couverture de cette publication indique qu'elle contient des couleurs qui sont considérées comme utiles à une bonne compréhension de son contenu. Les utilisateurs devraient, par conséquent, imprimer cette publication en utilisant une imprimante couleur.

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INTRODUCTION

Le présent document fait partie de la série IEC 61970 qui définit une interface de programmation d'application (API – *Application program interface*) pour un système de gestion d'énergie (EMS – *Energy management system*). L'IEC 61970 a été initialement fondée sur les travaux réalisés dans le cadre du projet de recherche (RP-3654-1) sur les API de centres de conduite (CCAPI) de l'EPRI. Le projet CCAPI de l'EPRI avait principalement pour objet de:

- réduire les coûts et le temps nécessaires à l'ajout de nouvelles applications à un EMS;
- protéger l'investissement dans les applications ou systèmes existant(e)s qui fonctionnent efficacement dans un EMS.

Le principal objet de la série IEC 61970 est de produire des documents destinés à faciliter l'intégration d'applications EMS développées de façon indépendante par différents fournisseurs, entre des systèmes EMS complets développés de façon indépendante ou entre un système EMS et d'autres systèmes concernés par différents aspects de l'exploitation d'un système de puissance, tels que les systèmes de gestion de la distribution (DMS – *Distribution management systems*) ou de la production. Cela est réalisé en définissant des API pour permettre à ces applications ou systèmes d'accéder aux données publiques et d'échanger des informations indépendamment de la représentation interne de ces informations.

Le modèle d'information commun (CIM – *Common Information Model*) spécifie la sémantique de cette API. Les spécifications des composants d'interface (CIS – *Component Interface Specifications*), qui sont contenues dans d'autres parties de la série de normes IEC 61970, précisent le contenu des messages échangés.

Le CIM est un modèle abstrait contenant tous les objets principaux d'une entreprise de service public d'électricité habituellement nécessaires pour représenter les opérations d'une entreprise de service public d'électricité. Ce modèle inclut les classes et les attributs publics de ces objets, ainsi que les relations entre eux.

Le présent document définit la base du CIM constituée d'un ensemble de paquetages qui offrent une vue logique des aspects fonctionnels d'un EMS incluant SCADA (*Supervisory control and data acquisition* – système de supervision, contrôle et acquisition de données). D'autres domaines fonctionnels sont normalisés dans des documents IEC distincts qui complètent et référencent le présent document. Par exemple, l'IEC 61968-11 traite des modèles de distribution et référence le présent document. Alors qu'il existe plusieurs normes de l'IEC qui traitent des différentes parties du CIM, un seul modèle d'information unifié comprenant le CIM est sous-jacent à tous ces documents normatifs individuels.

La commission électrotechnique internationale (IEC) attire l'attention sur le fait qu'il est déclaré que la conformité au présent document peut impliquer l'utilisation d'un brevet intéressant une mise en œuvre gérée par ordinateur d'un modèle de système de puissance orienté objet dans une base de données relationnelle. À ce titre, elle n'est en conflit avec aucun développement de modèle logique de système de puissance incluant le CIM, lorsque la mise en œuvre du modèle n'est pas définie.

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INTERFACE DE PROGRAMMATION D'APPLICATION POUR SYSTÈME DE GESTION D'ÉNERGIE (EMS-API) –

Partie 301: Base de modèle d'information commun (CIM)

1 Domaine d'application

Le modèle d'information commun (CIM – common information model) est un modèle abstrait qui représente tous les objets principaux d'une entreprise de service public d'électricité habituellement nécessaires aux opérations d'une entreprise de service public d'électricité. La représentation normalisée des ressources de systèmes de puissance comme classes et attributs d'objets ainsi que leurs relations que fournit le CIM facilite l'intégration et l'interopérabilité des applications réseau développées de façon indépendante par différents fournisseurs, entre des systèmes complets exploitant des applications réseau développés de façon indépendante ou entre un système exploitant des applications réseau et d'autres systèmes concernés par différents aspects des opérations d'un système de puissance tels que la gestion de la production ou de la distribution. Le système SCADA (système de supervision, contrôle et acquisition de données – *supervisory control and data acquisition*) est modélisé dans toute la mesure nécessaire pour prendre en charge la simulation des systèmes de puissance et la communication entre des centres de conduite. Le CIM facilite l'intégration en définissant un langage commun (c'est-à-dire une sémantique) fondé sur le modèle CIM pour permettre à ces applications ou systèmes d'accéder aux données publiques et d'échanger des informations indépendamment de la représentation interne de ces informations.

Les classes d'objets représentées dans le CIM sont de nature abstraite et peuvent être utilisées dans une large gamme d'applications. L'utilisation du CIM n'est pas limitée à son application dans un EMS. Il convient de considérer le présent document comme un outil permettant l'intégration dans tout domaine nécessitant d'appliquer un modèle commun de système de puissance pour faciliter l'interopérabilité et la compatibilité de connexion entre des applications et des systèmes indépendants de toute mise en œuvre particulière.

En raison de la taille du CIM complet, les classes d'objets qui le composent sont regroupées en plusieurs Paquetages logiques, qui représentent chacun une certaine partie du système de puissance global modélisé. Les ensembles de ces Paquetages sont fournis progressivement sous forme de Normes internationales distinctes. Le présent document spécifie un ensemble de Base de paquetages qui offrent une vue logique sur les aspects fonctionnels des informations relatives à un EMS et à la modélisation du système de puissance d'une entreprise de service public d'électricité qui sont partagées par toutes les applications. D'autres normes spécifient des aspects plus spécifiques du modèle qui ne sont nécessaires qu'à certaines applications. Le Paragraphe 4.3 du présent document définit le découpage actuel des paquetages dans les documents normatifs.

2 Références normatives

Les documents suivants sont cités dans le texte de sorte qu'ils constituent, pour tout ou partie de leur contenu, des exigences du présent document. Pour les références datées, seule l'édition citée s'applique. Pour les références non datées, la dernière édition du document de référence s'applique (y compris les éventuels amendements).

IEC 61850 (toutes les parties), *Réseaux et systèmes de communication pour l'automatisation des systèmes électriques*

IEC 61850-7-4:2010, *Réseaux et systèmes de communication pour l'automatisation des systèmes électriques – Partie 7-4: Structure de communication de base – Classes de nœud logique et classes de donnée objet compatibles*

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IEC 61968 (toutes les parties), *Intégration d'applications pour les services électriques – Interfaces système pour la gestion de distribution*

IEC TS 61970-2, *Energy management system application program interface (EMS-API) – Part 2: Glossary* (disponible en anglais seulement)

Object Management Group: UML 2.0 Specification – http://www.omg.org

3 Termes et définitions

Pour les besoins du présent document, les termes et les définitions de l'IEC TS 61970-2 ainsi que les suivants, s'appliquent.

L'ISO et l'IEC tiennent à jour des bases de données terminologiques destinées à être utilisées en normalisation, consultables aux adresses suivantes:

- IEC Electropedia: disponible à l'adresse http://www.electropedia.org/
- ISO Online browsing platform: disponible à l'adresse http://www.iso.org/obp

3.1
système de gestion d'énergie
EMS
système informatique comprenant une plate-forme logicielle offrant les services de support de base et un ensemble d'applications offrant les fonctionnalités requises pour le bon fonctionnement des installations de production et de transport d'électricité afin d'assurer la sécurité adéquate d'approvisionnement énergétique à un coût minimal

Note 1 à l'article: L'abréviation "EMS" est dérivée du terme anglais développé correspondant "energy management system".

3.2
interface de programmation d'application
API
ensemble des fonctions publiques qu'offre un composant exécutable d'application pour être utilisées par d'autres composants exécutables d'application

Note 1 à l'article: L'abréviation "API" est dérivée du terme anglais développé correspondant "application program interface".

3.3
langage de modélisation unifié
UML
langage descriptif formel et complet avec des techniques de présentation de diagrammes utilisées pour représenter des systèmes logiciels, depuis l'analyse des exigences, en passant par la conception et la mise en œuvre, jusqu'à la documentation

Note 1 à l'article: Le langage UML a évolué pour devenir une Norme internationale (ISO/IEC 19505, publiée en 2012) en passant d'un ensemble de méthodes apportées par différents pratiquants. Le CIM se réfère à l'UML pour définir le modèle, des outils automatiques génèrent directement à partir de l'UML la documentation, les schémas ainsi que d'autres artéfacts. Il est nécessaire d'avoir des notions d'UML pour comprendre le CIM.

Note 2 à l'article: L'abréviation "UML" est dérivée du terme anglais développé correspondant "unified modeling language".

3.4
profil
sous-ensemble des classes, associations et attributs du CIM nécessaires pour accomplir un type spécifique d'interface

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Note 1 à l'article: Cela peut être exprimé dans des fichiers XSD, RDF et/ou OWL. Un profil peut être soumis à l'essai entre des applications. Un profil est nécessaire pour "utiliser" le CIM. Plusieurs profils sont définis dans d'autres parties des séries IEC 61968 et IEC 62325.

4 Spécification du CIM

4.1 Vue d'ensemble

Le modèle CIM est décrit dans le langage de modélisation unifié (UML) qui est conservé comme un fichier UML géré par un outil d'édition UML. Le fichier UML existe dans deux différents formats:

- un format propriétaire d'outil;
- un format xmi normalisé.

Le modèle CIM est décrit à l'Article 6, qui présente un rapport généré à partir du fichier UML. Le nom du fichier UML utilisé pour la génération de l'Article 6 est:

- iec61970cim17v40_iec61968cim13v13a_iec62325cim03v17a.eap

Ce fichier peut être obtenu auprès du groupe des utilisateurs du CIM.

4.2 Notation de modélisation du CIM

Le CIM est défini en utilisant des techniques de modélisation orientées objet. Plus précisément, la spécification du CIM utilise la notation UML qui définit le CIM comme un groupe de paquetages.

Chaque paquetage du CIM contient un ou plusieurs diagrammes de classe représentant sous forme graphique toutes les classes de ce paquetage et leurs relations. Chaque classe est ensuite définie de façon textuelle en mettant l'accent sur ses attributs et ses relations avec d'autres classes.

La notation UML est décrite dans les documents de l'Object Management Group (OMG) et dans plusieurs autres manuels.

4.3 Paquetages CIM

Un paquetage est un moyen général permettant de grouper des éléments liés à un modèle. Les paquetages ont été choisis pour simplifier la conception, la compréhension et la révision du modèle. Des entités peuvent avoir des associations dépassant les limites de plusieurs paquetages. Chaque application utilise des informations représentées dans plusieurs paquetages.

Différents groupes de paquetages sont attribués à différents groupes dans l'IEC afin de mieux les gérer et maintenir.

Les paquetages WG13 sont inclus dans le présent document et contenus dans le paquetage de l'IEC 61970. Les paquetages de l'IEC 61970 ne dépendent pas d'autres paquetages externes. Comme le représente la Figure 1, le paquetage de l'IEC 61970 et ses sous-paquetages servent de modèle central ou de modèle de base à d'autres paquetages du CIM. Les lignes tiretées indiquent des relations de dépendance, la flèche allant du paquetage dépendant vers le paquetage dont il dépend. Les paquetages WG14 de la série IEC 61968 décrivent des parties supplémentaires du CIM qui traitent d'autres vues logiques des opérations d'une entreprise de service public, y compris la gestion du patrimoine, des emplacements, des activités, des clients, de la documentation et des travaux et des comptages. Les paquetages WG16 de la série IEC 62325 décrivent les marchés de l'énergie électrique.

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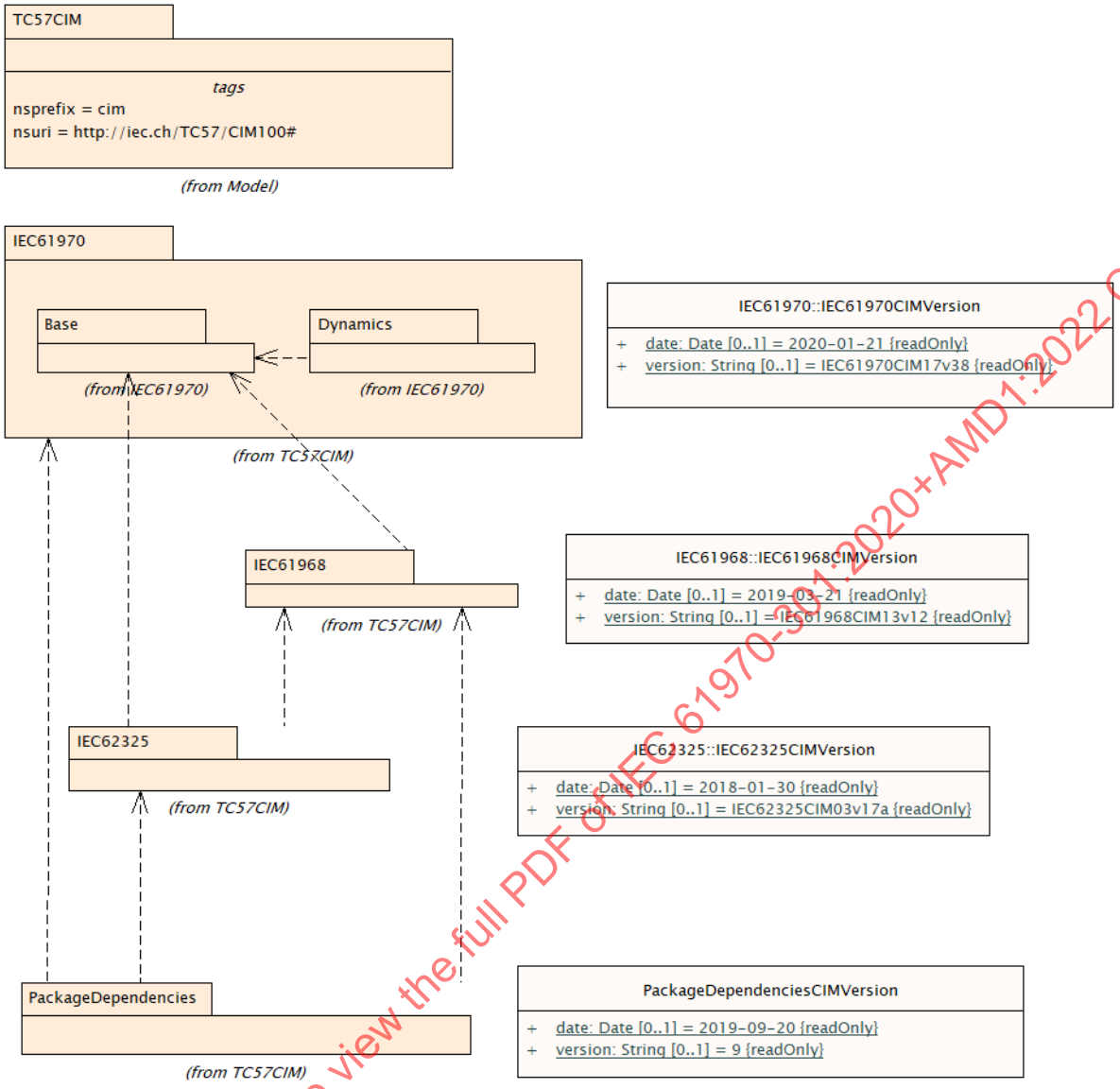


Figure 1 – Dépendances définies entre les paquetages du CIM et les informations de versions de paquetages

Noter que les limites du paquetage n'impliquent pas de limites pour une application. Une application peut utiliser des entités CIM provenant de différents paquetages. Il est également prévu que des paquetages du CIM en dehors de ceux décrits dans le présent document auront des dépendances avec certains des paquetages décrits dans le présent document, notamment les paquetages Domain et Core, même si d'autres dépendances existent aussi.

La Figure 2 représente les paquetages définis pour la Base de CIM de l'IEC 61970-301 et leurs relations de dépendance.

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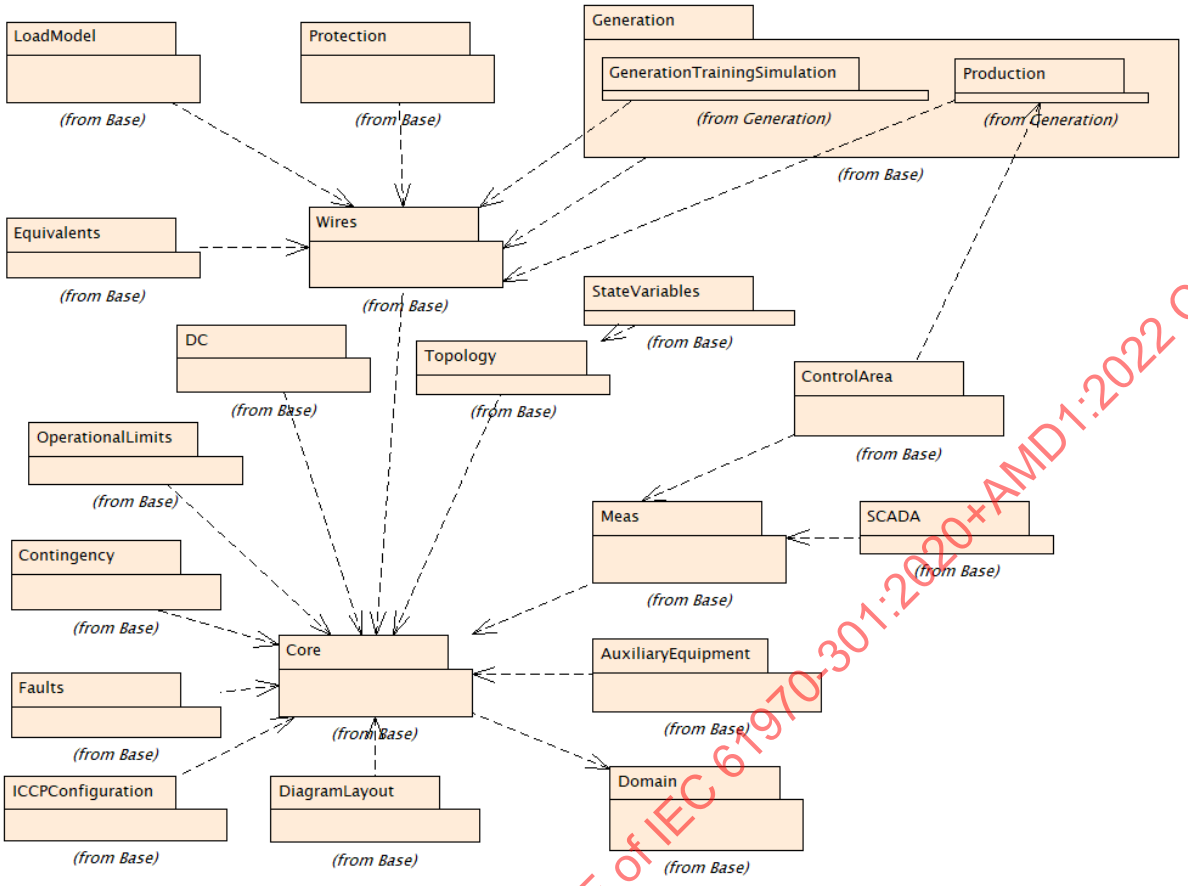


Figure 2 – Diagramme du paquetage CIM IEC 61970-301

4.4 Classes CIM et relations

4.4.1 Classes

Le ou les diagrammes de classe de chaque paquetage CIM représentent toutes les classes du paquetage et leurs relations. Lorsque des relations existent avec des classes dans d'autres paquetages, ces classes peuvent être également représentées.

Les classes et les objets modélisent ce qui se trouve dans un système de puissance et qu'il y a lieu de représenter de la même façon pour des applications de système de puissance. Une classe est une description d'un objet réel, tel qu'un transformateur électrique, un générateur ou une charge, qu'il y a lieu de représenter comme faisant partie du modèle global de système de puissance dans un EMS, par exemple. Parmi les autres types d'objets figurent des éléments tels que les programmes et les mesures qui nécessitent également d'être traités, analysés et enregistrés par des applications EMS. De tels objets nécessitent une représentation commune pour atteindre les objectifs de compatibilité de connexion et d'interopérabilité de la norme EMS-API. Un objet particulier dans un système de puissance ayant une identité unique est modélisé comme une instance de la classe à laquelle il appartient.

Il convient également de noter que le CIM est défini pour faciliter l'échange de données. Comme indiqué dans le présent document, les propriétés des entités CIM sont modélisées, mais pas leur comportement. Pour une interface spécifique, un profil est défini et comprend des sous-ensembles de classes, attributs et associations du CIM. Un profil définit la charge utile de message pour une interface.

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Les classes comportent des attributs qui décrivent les caractéristiques des objets. Chaque classe du CIM contient les attributs décrivant et identifiant une instance spécifique de la classe. Seuls les attributs importants pour l'intégration et l'interopérabilité des applications de système de puissance sont inclus dans les descriptions de classe.

Chaque attribut a un type qui identifie le type d'attribut dont il s'agit. Les attributs typiques sont de type Integer (entier), Float (valeur flottante), Boolean (valeur booléenne), String (chaîne de caractères), Date et Decimal (valeur décimale), qui sont appelés types primitifs. Cependant, de nombreux types supplémentaires sont définis comme partie intégrante de la spécification du CIM. Par exemple, ShuntCompensator a un attribut "maxU" du type Voltage. La définition de nombreux types partagés est contenue dans le paquetage Domain. Les stéréotypes Primitive, enumeration, CIMDatatype et Compound de l'UML sont ajoutés aux classes utilisées comme types. Le stéréotype CIMDatatype est utilisé avec une sémantique spécifique du CIM pour une valeur simple avec des attributs supplémentaires, qui décrit l'unité et le multiplicateur de la valeur, par exemple, unit, multiplier. Cela implique une mise en correspondance personnalisée avec des artéfacts de sérialisation tels que RDFS, OWL et XSD. Les classes ayant ces stéréotypes ne participent pas à des relations de généralisation ou d'association et sont simplement utilisées comme types pour des attributs. Le stéréotype enumeration est utilisé pour décrire un attribut avec une liste énumérée de choix. Le stéréotype Compound est utilisé pour décrire des ensembles d'attributs liés qui sont couramment réutilisés. Les classes Compound peuvent se composer de Primitive, enumeration, CIMDatatype ou d'autres classes Compound à condition qu'elles ne participent pas à une récursion.

Tous les attributs du CIM sont facultatifs en ce sens que les profils utilisant le CIM peuvent les éliminer tous.

Les relations entre les classes révèlent la façon dont elles sont structurées l'une par rapport à l'autre. Les classes CIM sont reliées de différentes façons, comme décrit de 4.4.2 à 4.4.4.

4.4.2 Generalization

Une generalization (généralisation) est une relation entre une classe générale et une classe plus spécifique. La classe plus spécifique ne peut contenir que des informations supplémentaires. L'association de type Generalization permet à une classe spécifique d'hériter d'attributs et de relations de toutes les classes plus générales situées au-dessus d'elle.

La Figure 3 est un exemple de generalization (généralisation). Dans cet exemple issu du paquetage Wires (fils), un Breaker (disjoncteur) est un type plus spécifique de ProtectedSwitch (commutateur protégé), qui à son tour est un type plus spécifique de Switch (commutateur), qui est un type plus spécifique de ConductingEquipment (équipement conducteur), etc. Un PowerTransformer (transformateur de puissance) est un autre type plus spécifique de ConductingEquipment. Noter que PowerSystemResource (ressource de système de puissance) hérite de la classe IdentifiedObject (objet identifié) qui ne figure pas dans le diagramme. IdentifiedObject est donc représenté en italique dans l'angle supérieur droit de la classe PowerSystemResource.

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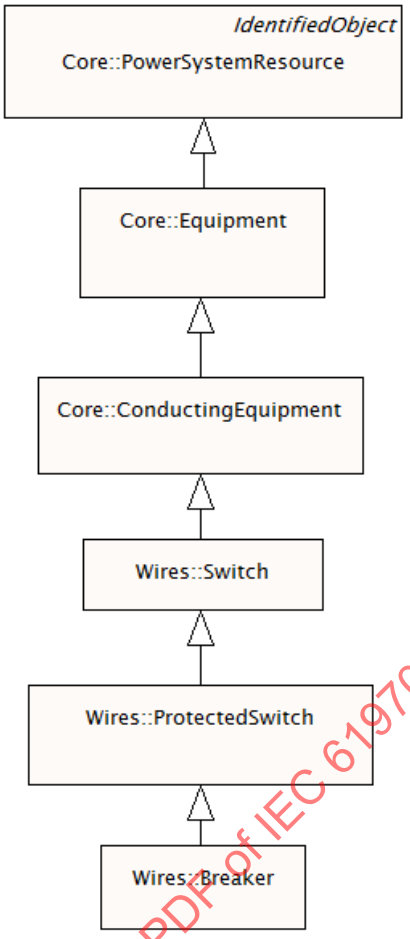
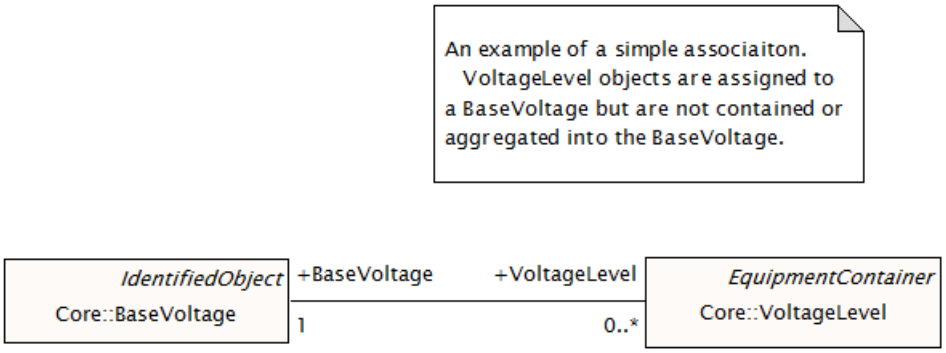


Figure 3 – Exemple de généralisation

4.4.3 Simple association (Association simple)

Une association est une connexion conceptuelle entre des classes. Chaque association a deux "extrémités d'association". Les "extrémités d'association" étaient appelées "rôles" avant la spécification UML 2.0. Chaque extrémité d'association décrit le rôle que la classe cible (c'est-à-dire, la classe *vers* laquelle l'extrémité d'association part) a en relation avec la classe source (c'est-à-dire, la classe *à partir de* laquelle l'extrémité d'association part). La coutume est d'attribuer aux extrémités d'association le nom de la classe cible avec ou sans expression verbale. Chaque extrémité d'association possède aussi une cardinalité/multiplicité, qui est une indication du nombre d'objets qui peuvent prendre part à la relation décrite. Dans le CIM, les associations ne sont pas nommées, seules les extrémités d'association sont nommées. Par exemple, comme représenté à la Figure 4, il y a dans le CIM une association entre une classe BaseVoltage (tension de base) et une classe VoltageLevel (niveau de tension). La multiplicité est représentée aux deux extrémités de l'association. Dans cet exemple, un objet VoltageLevel peut faire référence à 1 BaseVoltage, et une BaseVoltage peut être référencée par 0 ou plus d'objets VoltageLevel.

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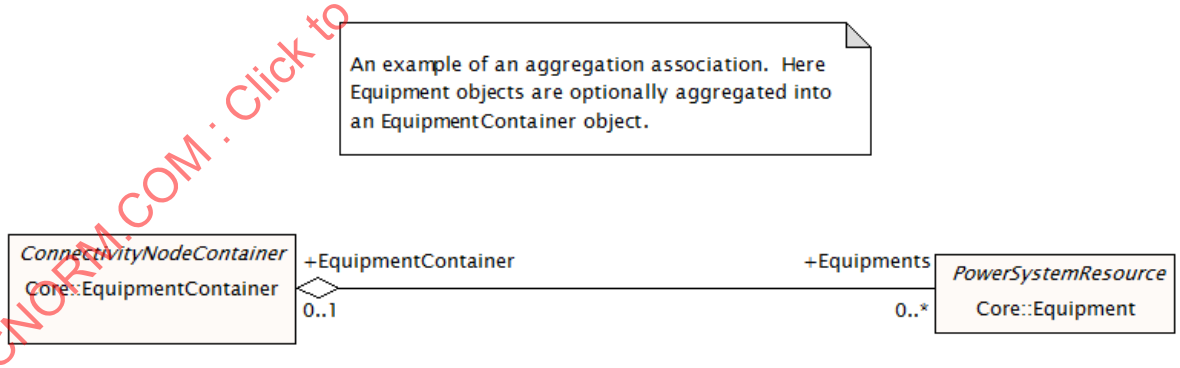


Anglais	Français
An example of a simple association. VoltageLevel objects are assigned to a BaseVoltage but are not contained or aggregated into the BaseVoltage.	Exemple d'association simple. Des objets VoltageLevel sont affectés à une BaseVoltage, mais ne sont ni contenus ni agrégés dans la BaseVoltage.

Figure 4 – Exemple d'association simple

4.4.4 Aggregation

Aggregation (agrégation) est un cas spécial d'association. L'agrégation indique que la relation entre les classes est une sorte de relation classe entière/classe partielle où la classe entière "consists of" (se compose de) ou "contains" (contient) la classe partielle, et cette classe partielle est une "part of" (partie de) la classe entière. La classe partielle n'hérite pas de la classe entière comme dans la généralisation. La Figure 5 représente une agrégation entre la classe EquipmentContainer (Conteneur d'équipements) et la classe Equipment, qui provient du paquetage Core. Comme représenté à la figure, un Equipment peut être un élément de un ou zéro objet EquipmentContainer mais l'objet EquipmentContainer peut contenir un nombre quelconque d'objets Equipment. Dans le cadre de l'utilisation du CIM comme modèle d'information, l'agrégation n'a pas d'interprétation précise ou formelle au-delà d'une association simple, et permet d'aider à représenter visuellement une utilisation normale.



Anglais	Français
An example of an aggregation association. Here Equipment objects are optionally aggregated into an EquipmentContainer object.	Exemple d'association d'agrégation. Ici, des objets Equipment sont facultativement agrégés en un objet EquipmentContainer.

Figure 5 – Exemple d'agrégation

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4.5 Concepts et exemples de modèles CIM

4.5.1 Concepts

Afin d'aider à comprendre comment interpréter le CIM, certains concepts-clés de modèles utilisés dans le CIM sont présentés et décrits de 4.5.2 à 4.5.16.

4.5.2 Hiérarchies d'emboîtement, d'équipements et dénomination

4.5.2.1 Structure de l'emboîtement

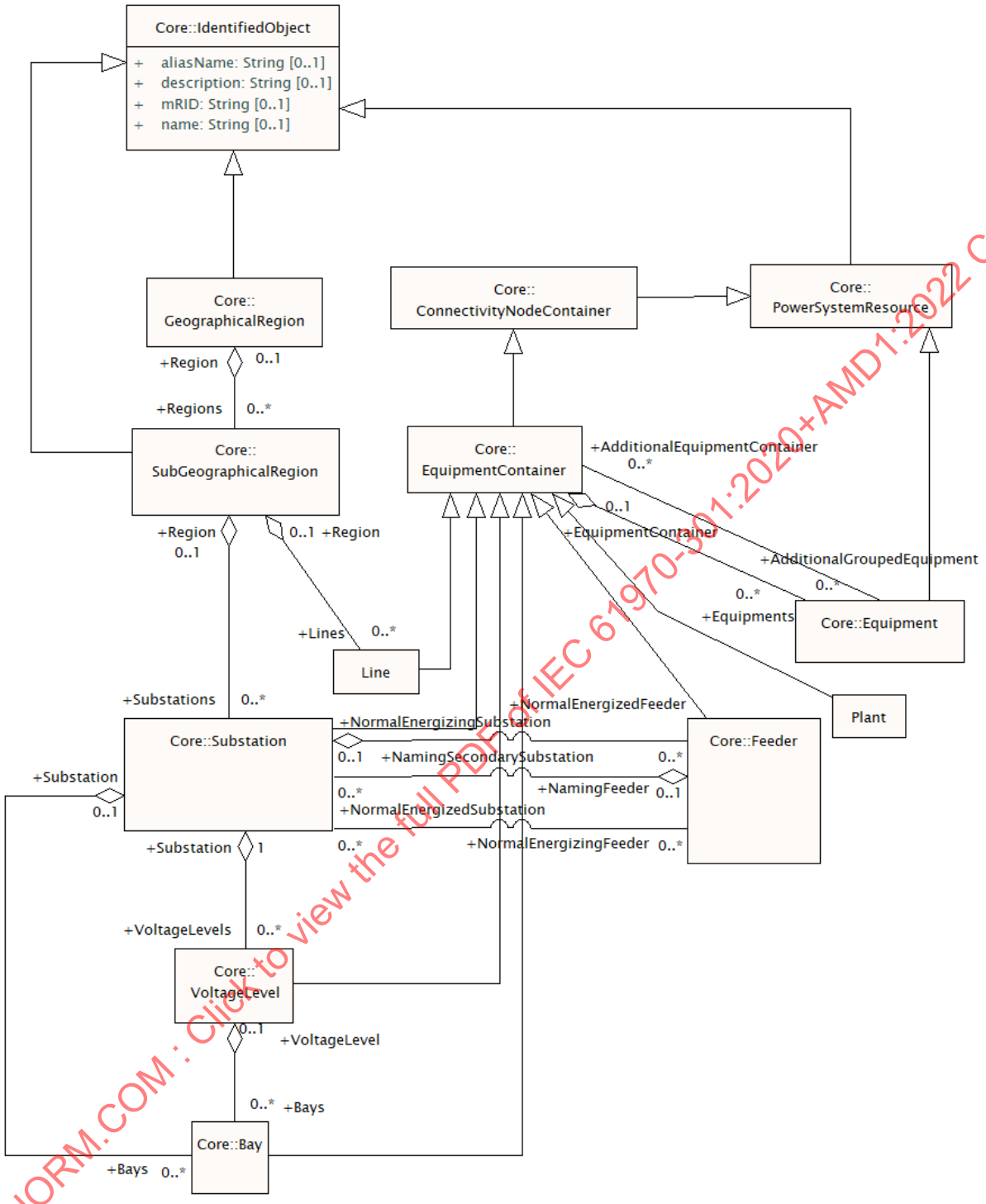
La Figure 6 représente le concept de conteneurs d'équipements (EquipmentContainer) pour former des hiérarchies dans le CIM. Les conteneurs d'équipements sont un moyen de regrouper et de nommer des équipements se trouvant généralement dans un poste (substation). Comme il peut être constaté de visu, les conteneurs offrent une certaine souplesse d'utilisation pour s'adapter aux différents usages internationaux, ainsi qu'aux différences observées habituellement entre les postes de transport et de distribution. Bay (cellule), VoltageLevel (niveau de tension), Substation (poste), Line (ligne) et Plant (centrale) sont tous des types de EquipmentContainer(s). En général, une Bay est contenue dans un VoltageLevel spécifique, qui à son tour est contenu dans un Substation. Les Substation(s) et les Line(s) peuvent être contenus dans des SubGeographicalRegion(s) (sous-régions géographiques) et GeographicalRegion(s) (régions géographiques).

Une hiérarchie d'emboîtement est utilisée avec la classe IdentifiedObject pour créer une désignation hiérarchique lisible par l'homme. Cette hiérarchie est utilisée spécifiquement pour nommer les équipements selon leur fonction dans le système de puissance. Il s'agit de la hiérarchie de dénomination fonctionnelle. Outre les noms fonctionnels, d'autres identifications communes sont les numéros de série des biens. Le nom fonctionnel diffère d'un numéro de série en ce qu'il renvoie à la fonction d'une position ou localisation particulière d'un équipement dans le système de puissance. Quel que soit l'élément spécifique d'équipement physique qui est placé en un endroit, le nom fonctionnel est le même, mais le numéro de série varie en fonction de l'équipement physique actuellement utilisé.

4.5.2.2 Classe IdentifiedObject

La classe IdentifiedObject (objet identifié) contenue dans le paquetage Core est héritée par tous les objets PowerSystemResource (ressource du système de puissance) et de nombreuses autres classes. Cette classe comporte les attributs et les associations à utiliser pour nommer tous les objets du CIM. Des noms supplémentaires peuvent être définis à l'aide des classes de noms de 4.5.3 ou en définissant des extensions. L'attribut mRID de la classe IdentifiedObject est un moyen direct et rigoureux pour l'identité des objets du CIM.

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Figure 6 – EquipmentContainers

Les diagrammes NamingHierarchyPart1 et NamingHierarchyPart2 du paquetage Wires représentent la hiérarchie fonctionnelle de dénomination.

4.5.3 Modèle de Names

Un modèle de dénomination souple et extensible est fourni pour spécifier des noms différents pour les objets. Plusieurs applications ou systèmes ayant différents noms pour le même objet constituent un cas d'utilisation dans lequel le modèle de Names est utile. Le modèle de Names permet alors l'échange de ces noms.

La Figure 7 représente le diagramme de classe pour des noms de remplacement et la manière dont ils peuvent être associés à un type de nom défini par un utilisateur spécifique. Ce modèle permet de définir spécifiquement les noms dans un domaine particulier et ne fait pas intervenir de règles spécifiques de dénomination. Les concepts de noms de remplacement, de noms de chemin et de noms locaux peuvent tous être utilisés avec ce modèle. Les modèles du CIM n'utilisent ni ne favorisent des conventions spécifiques de dénomination mais permettent d'échanger ces conventions de dénomination dans un contexte clair.

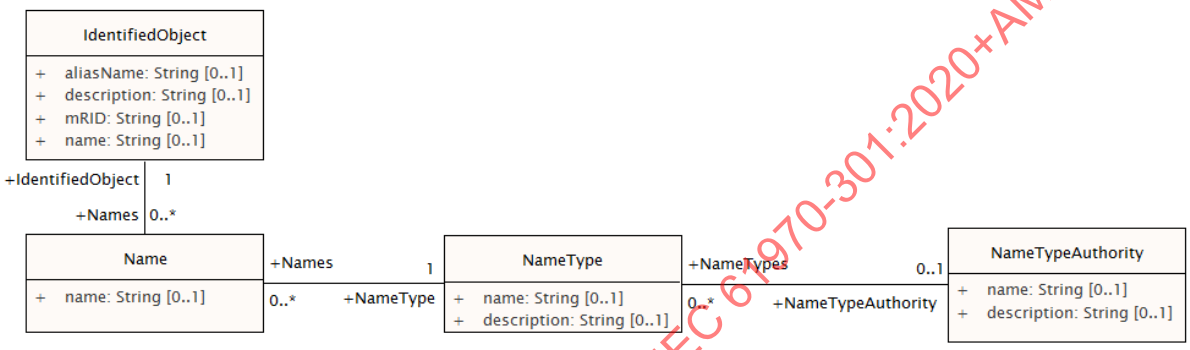


Figure 7 – Names

4.5.4 Modèle de connectivité

4.5.4.1 Description de la connectivité

La Figure 8 représente le diagramme de classe Topology qui modélise la connectivité entre différents types de ConductingEquipment. Elle inclut également une partie du diagramme de classe du paquetage Meas traitant des mesures pour représenter la façon dont les mesures sont associées aux équipements conducteurs.

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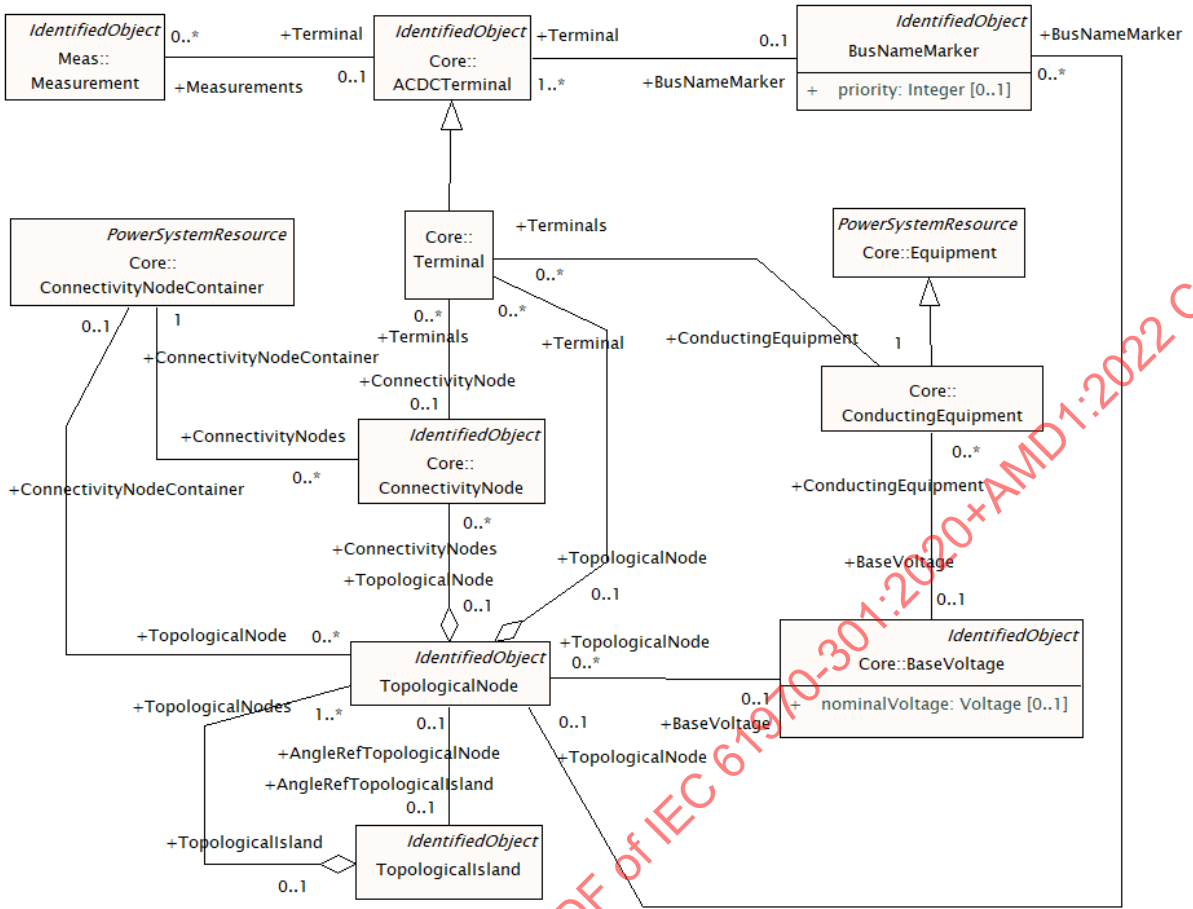


Figure 8 – Modèle de connectivité

Pour modéliser la connectivité, les classes Terminal (borne) et ConnectivityNode (nœud de connectivité) ont été définies. Une Terminal appartient à un ConductingEquipment, mais un ConductingEquipment peut avoir un nombre quelconque de Terminals (bornes). Chaque Terminal peut être connectée à un ConnectivityNode qui est un point auquel les bornes des équipements conducteurs sont connectées ensemble avec une impédance nulle. Un ConnectivityNode peut avoir un nombre quelconque de bornes connectées et peut être membre d'un TopologicalNode (nœud topologique) (c'est-à-dire, un bus) qui est membre d'un TopologicalIsland (îlot topologique). Les TopologicalNode-s et TopologicalIsland-s sont créés comme résultat d'un processeur topologique qui prend en compte la connectivité prédéfinie et les positions réelles des Switchs (commutateurs).

Il est possible d'échanger des documents impliquant directement TopologicalNode et contournant les détails de ConnectivityNode en utilisant l'association TopologicalNode à Terminal. Cela est souvent utile pour les échanges impliquant des modèles qui ne contiennent pas de détails relatifs aux commutateurs. Quand le modèle TopologicalNode est échangé, il est utile d'échanger aussi l'attribut "connected" (connecté) dans la classe Terminal. Cela permet de retenir la structure topologique du modèle, mais indique qu'une borne n'est pas entièrement connectée. Cette déconnexion résulte normalement de ce qu'un ou plusieurs commutateurs s'ouvrent dans le modèle détaillé qui n'est pas représenté dans un échange de modèle sans détail de commutateur.

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Les EquipmentContainer-s, qui sont une spécialisation d'un ConnectivityNodeContainer (Conteneur de nœuds de connectivité), peuvent avoir zéro à plusieurs de ConnectivityNode-s. Les associations ConductingEquipment–Terminal et Terminal–ConnectivityNode permettent de représenter la connectivité prédéfinie d'un système de puissance réel. Pour chaque Terminal connectée à un ConnectivityNode, les associations des autres Terminal(s) connectées au même ConnectivityNode identifient l'objet ou les objets ConductingEquipment qui sont connectés électriquement. Une connectivité similaire, au niveau de détail "topologie nodale", peut être exprimée à l'aide de TopologicalNode au lieu du ConnectivityNode. La classe BusNameMarker, qui a une association à ConnectivityNode, est utilisée pour contenir les noms de bus utilisateur devant être appliqués aux TopologicalNode-s. Les TopologicalNode-s sont créés à partir de ConnectivityNode-s et résultent du traitement de la topologie, il est possible d'appliquer de nombreux noms en fonction des instances de ConnectivityNode en présence.

Pour modéliser les valeurs analogiques telles que la tension et la puissance, chaque Terminal a une association avec une classe Measurement du paquetage Meas. Bien qu'il ne soit pas représenté à la Figure 8, un objet Measurement est associé à au moins un objet MeasurementValue (valeur de mesure). Chaque objet MeasurementValue est une instance de mesure d'une source spécifique, par exemple, une télémesure.

4.5.4.2 Exemple de connectivité et d'emboîtement

Pour représenter comment le modèle de connectivité et le modèle d'emboîtement peuvent être représentés comme des objets, un petit exemple est présenté à la Figure 9. L'exemple représente une ligne de transport avec une jonction en T entre deux postes et un poste avec deux niveaux de tension et un transformateur entre eux. La ligne de transport contient deux câbles différents. Un des niveaux de tension est représenté avec un tronçon de jeux de barres contenant un seul jeu de barres et deux baies de commutation très simples connectées au jeu de barres.

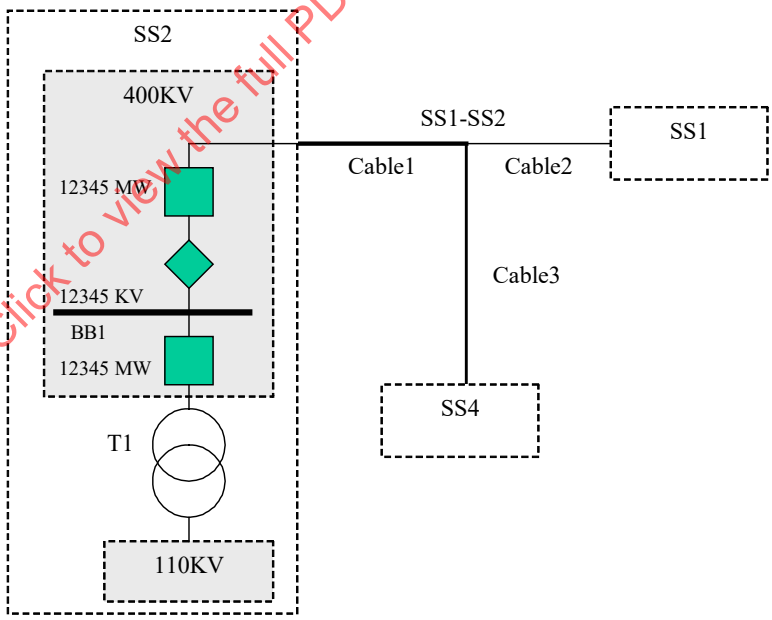


Figure 9 – Exemple de réseau simple

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La Figure 10 représente comment la connectivité est modélisée dans le CIM ainsi qu'une façon (mais pas nécessairement la seule) dont l'emboîtement est modélisé pour le diagramme de la Figure 9. Les carrés ombrés représentent les EquipmentContainer-s, et les carrés blancs les ConductingEquipments. Un ombrage plus sombre indique que l'EquipmentContainer est plus haut dans la hiérarchie d'emboîtement (c'est-à-dire que Substation est le plus haut, VoltageLevel vient ensuite, etc.). Les cercles blancs représentent les ConnectivityNode-s, et les petits cercles noirs les Terminals. Une Terminal appartient à un ConductingEquipment, et un ConnectivityNode appartient à un EquipmentContainer. Cela signifie que les frontières (ou points de contact) entre ConductingEquipments sont leurs Terminals interconnectées via les ConnectivityNode-s.

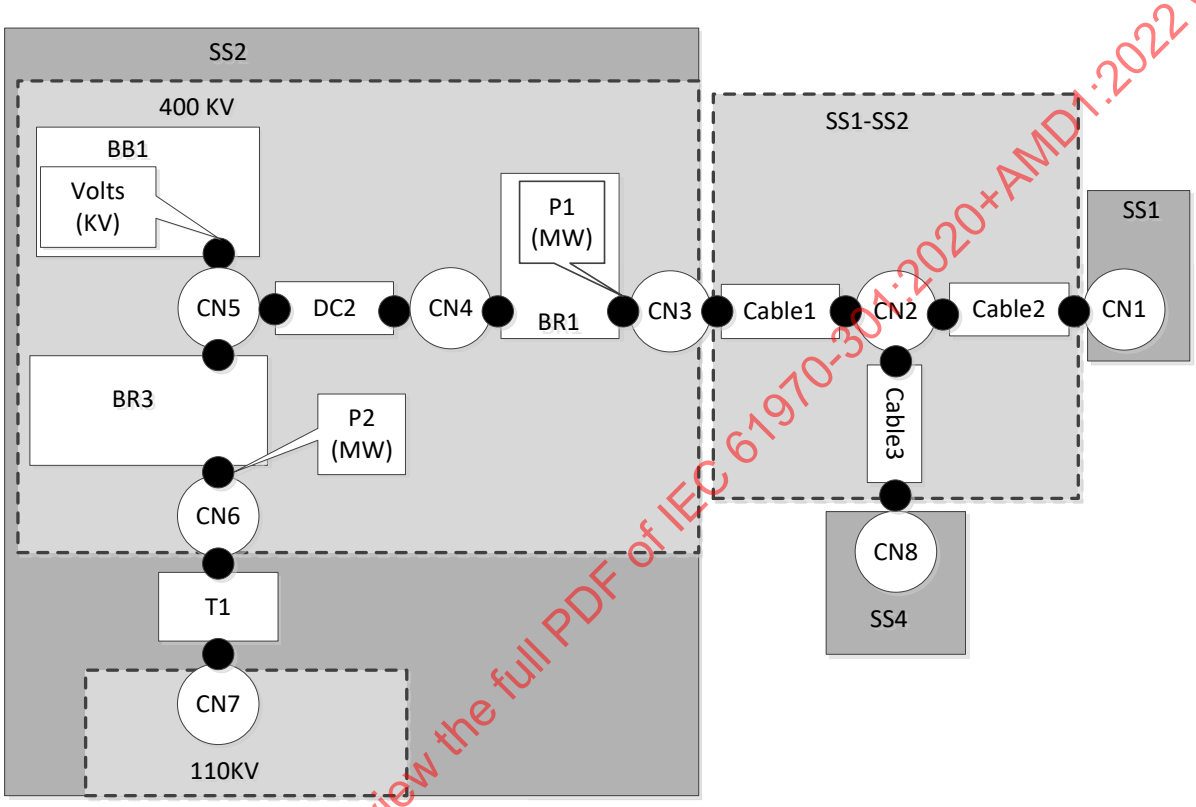


Figure 10 – Connectivité d'un réseau simple modélisé avec la topologie du CIM

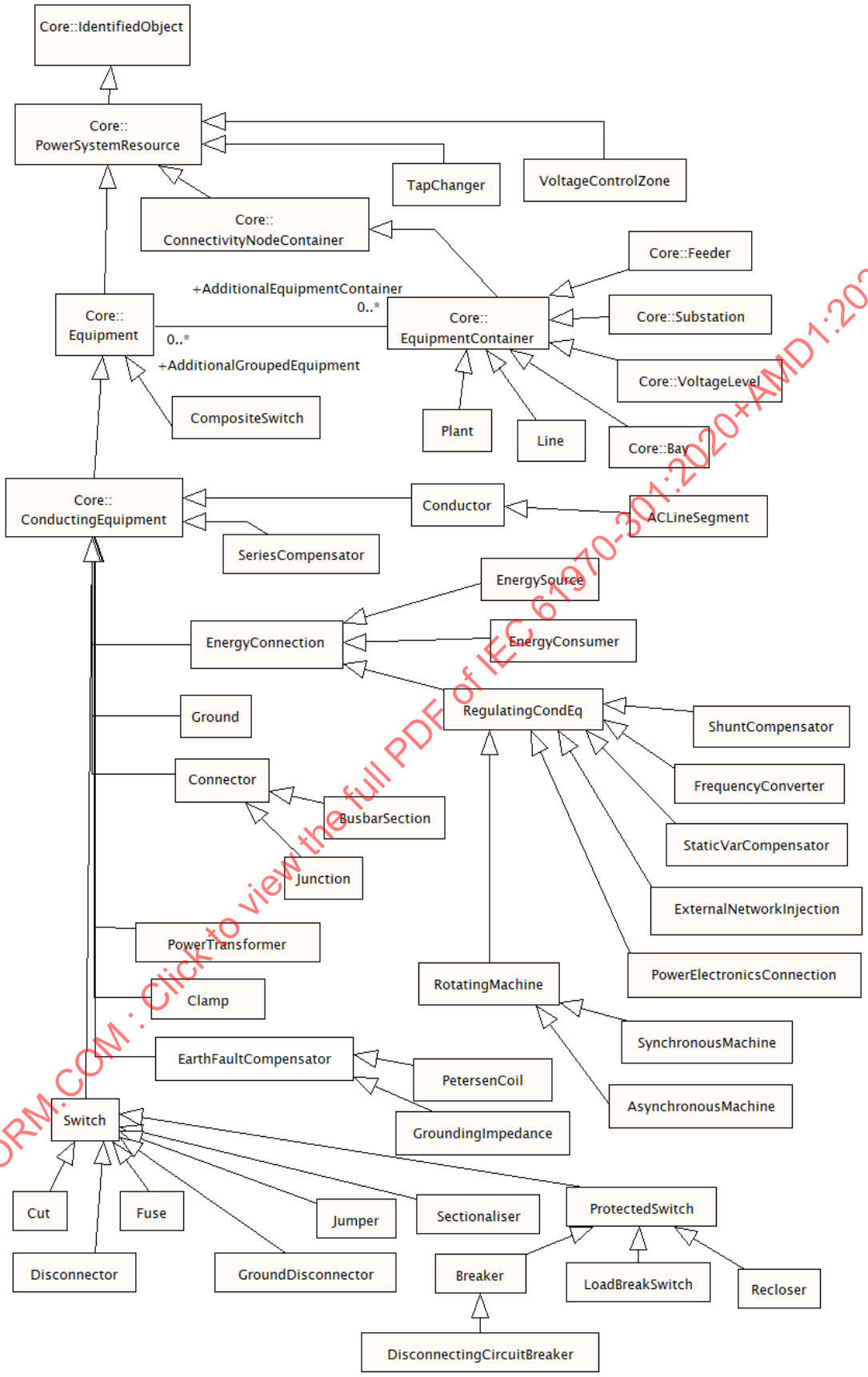
La Line (ligne) SS1-SS2 contient trois ACLineSegment-s (Cable1, Cable2, et Cable3) et le ConnectivityNode (CN2) associé pour modéliser une jonction en T, qui assure une connexion à SS4. Cela n'est qu'une façon dont cette configuration pourrait être modélisée. Chaque ACLineSegment a deux Terminals. Cable1 est connecté à CN3 et CN2 via ces Terminals. CN3 est contenu par le VoltageLevel 400KV. Le disjoncteur ("Breaker") BR1 a deux bornes dont l'une est connectée à CN3.

Les Measurements sont représentés par des bulles carrées dont les flèches pointent vers une Terminal. P1 est connecté à la Terminal de droite appartenant au Breaker BR1. Noter que P1 est tracé dans la boîte représentant BR1. C'est parce qu'un Measurement peut appartenir à une PowerSystemResource (PSR), comme c'est le cas avec BR1. P2 est tracé dans le VoltageLevel 400 KV, ce qui signifie qu'il appartient au VoltageLevel 400 KV et non à BR3.

4.5.5 Hiérarchie des héritages

La Figure 11 représente une vue d'ensemble de la hiérarchie des héritages modélisée dans le CIM. Cette vue d'ensemble qui est incluse comme l'un des diagrammes du paquetage Wires couvre plusieurs paquetages du CIM.

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Figure 11 – Hiérarchie des héritages de Equipment

4.5.6 Modèle de Transformer

La Figure 13 représente une partie du paquetage Wires dans un diagramme de classe qui modélise un appareil PowerTransformer (Transformateur de puissance).

Le modèle de transformateur s'applique pour les modèles équilibrés et déséquilibrés. Le PowerTransformer est en outre désormais en soi un ConductingEquipment qui a potentiellement plusieurs bornes pour modéliser plus directement des transformateurs qui comportent une, deux, trois bornes ou davantage.

Comme représenté à la Figure 12, le PowerTransformer est aussi éventuellement en mesure de modéliser des détails de cuve (Tank), qui peuvent être utilisés pour décrire en détail les déséquilibres et les connexions des phases de l'enroulement intérieur du transformateur. Dans tous les cas, un PowerTransformer modélise un groupe d'appareils physiques qui agissent conjointement pour transformer la puissance sur les bornes et en un emplacement physique. Pour des systèmes de transport, une instance de PowerTransformer représente souvent trois appareils physiques monophasés. Il convient de modéliser en outre les objets TransformerTank s'il est exigé d'obtenir des détails sur chaque appareil monophasé.

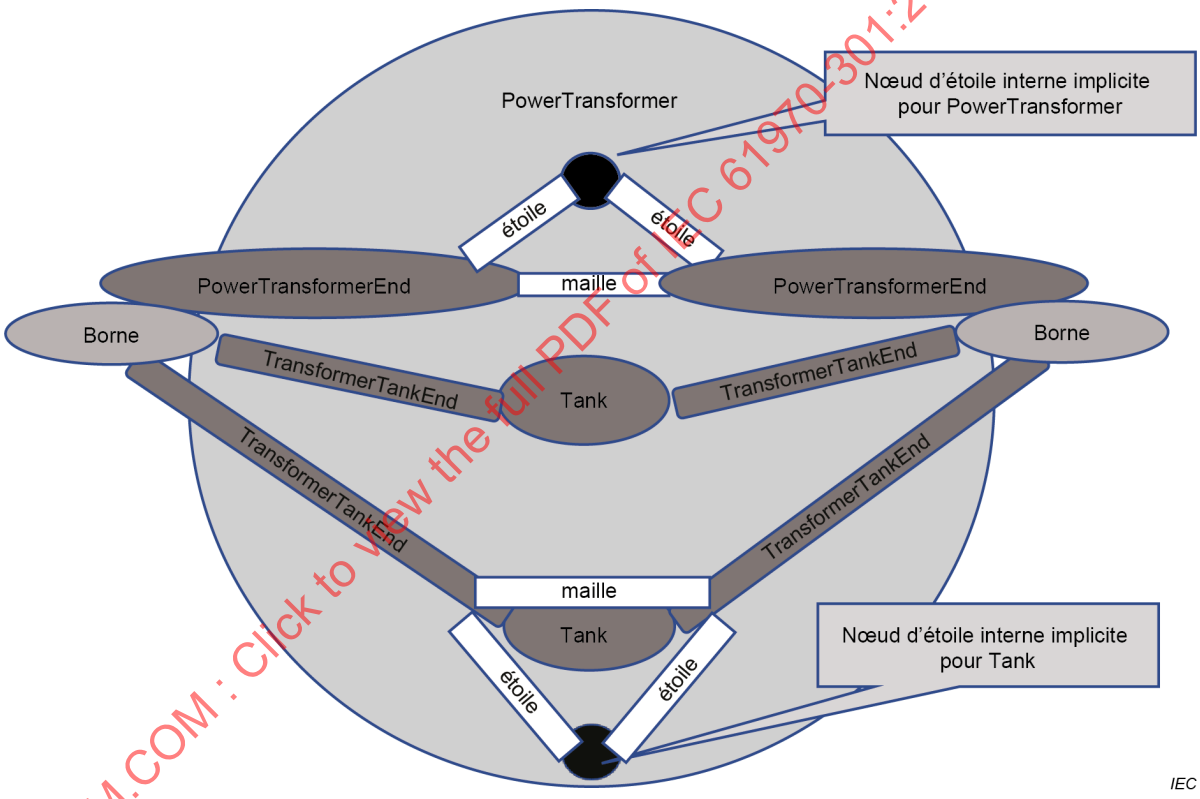


Figure 12 – Modèle de Transformer et Tank

Un PowerTransformer et un TransformerTank peuvent tous deux avoir l'impédance décrite soit dans une connexion étoile hypothétique avec la connexion centrale implicite soit sous forme d'impédance de maille en utilisant la classe facultative TransformerMeshImpedance. La forme en maille de l'impédance est exigée pour modéliser correctement des transformateurs qui ont plus de trois bornes. Si la forme d'impédance en maille est utilisée, il faudrait spécifier la classe TransformerMeshImpedance pour chaque connexion possible borne à borne, donc une instance pour deux bornes, trois pour trois bornes, six pour quatre bornes et ainsi de suite. Si une connexion étoile est utilisée, les paramètres d'impédance peuvent être spécifiés directement dans la classe PowerTransformerEnd; une autre solution consiste à les répartir entre les transformateurs en utilisant la classe TransformerStarImpedance.

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Comme représenté à la Figure 11, un PowerTransformer est une classe spécialisée de ConductingEquipment, elle-même classe spécialisée de Equipment. Ceci est représenté par l'utilisation du type généralisation de la relation qui utilise une flèche pour pointer vers la classe générale. L'héritage permet à PowerTransformer d'hériter des attributs de ConductingEquipment, de Equipment et de toutes les généralisations de Equipment que la Figure 11 ne représente pas.

Un PowerTransformer a aussi des relations avec PowerTransformerEnd et TransformerTank qui sont modélisés avec des relations de type association. Comme représenté dans la figure, un PowerTransformer peut être associé à zéro PowerTransformerEnd-s ou davantage, mais un PowerTransformerEnd ne peut être associé qu'à zéro ou un PowerTransformer. De façon similaire, le PowerTransformer peut être associé à zéro objet TransformerTank ou davantage, mais un TransformerTank ne peut être associé qu'à zéro ou un PowerTransformer.

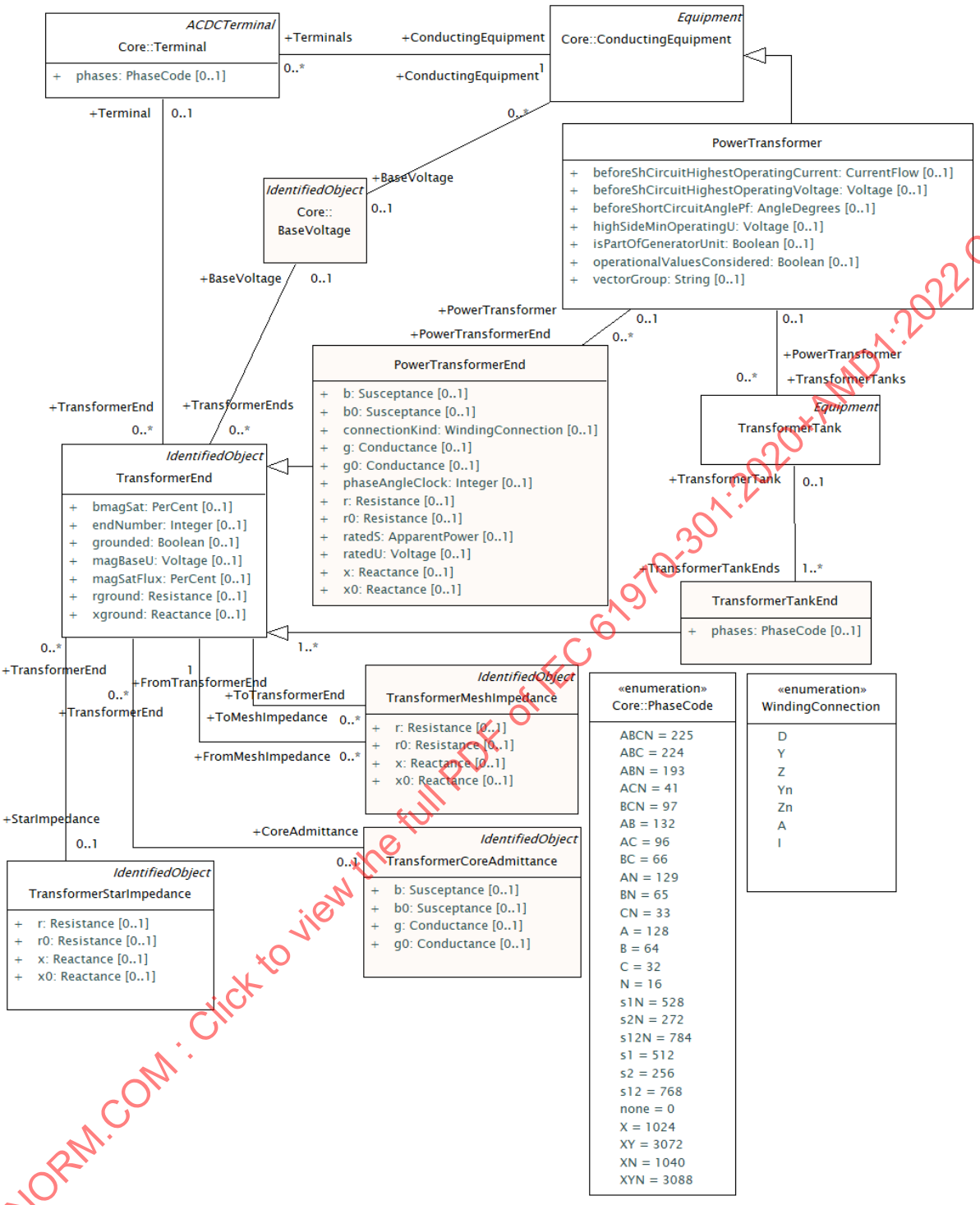
Le PowerTransformerEnd spécialise la classe TransformerEnd qui a aussi d'autres relations:

- une relation de généralisation avec IdentifiedObject;
- deux relations d'association avec la classe TransformerMeshImpedance, de sorte qu'un objet TransformerEnd peut être de (From) 0, 1 ou plusieurs objets TransformerMeshImpedance et vers (To) 0, 1 ou plusieurs objets TransformerMeshImpedance;
- des relations d'agrégation avec les classes PhaseTapChanger et RatioTapChanger, de sorte qu'un objet TransformerWinding peut avoir 0 ou 1 objet PhaseTapChanger et 0 ou 1 objet RatioTapChanger qui lui sont associés.

Pour un PowerTransfomer de réseau de transport ayant deux ou trois extrémités, les impédances équivalentes du modèle Pi apparaissent dans les attributs r, r0, x, x0, g, g0, b et b0 de la PowerTransformerEnd. La PowerTransformerEnd et sa Terminal connectée ont toutes les deux des numéros d'ordre TransformerEnd.endNumber et ACDCTerminal.sequenceNumber. Ces numéros peuvent ou peuvent ne pas être synchronisés.

La Figure 13 représente UML pour le modèle de Transformer.

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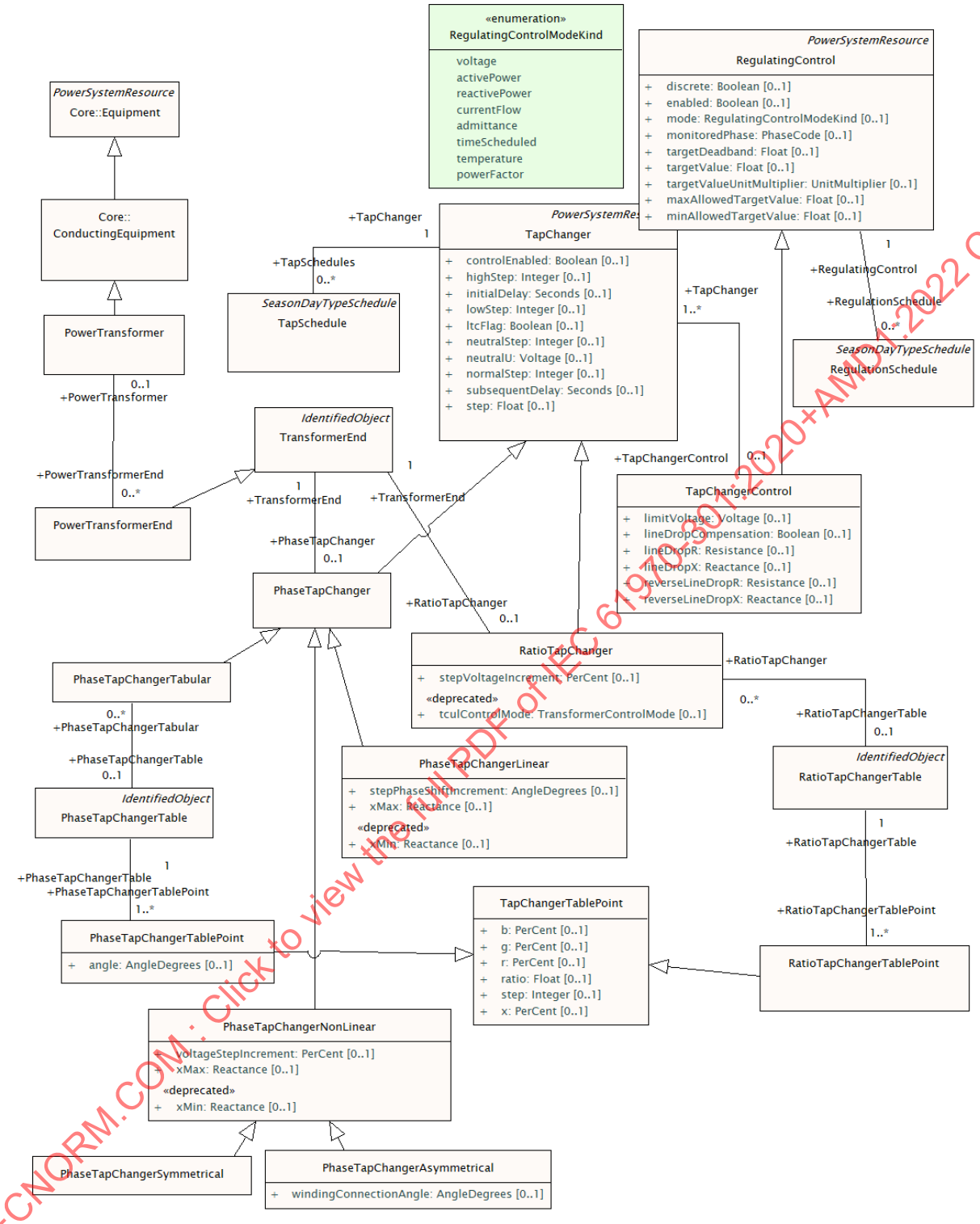
Figure 13 – Modèle de Transformer

4.5.7 Modélisation de prise du transformateur

4.5.7.1 Modélisation généralisée de prise

Plusieurs types de modèles de prise de transformateur sont pris en charge par le modèle CIM. En fonction de la structure physique, les effets du mouvement de prise doivent être définis en utilisant la classe RatioTapChanger ou la classe PhaseTapChanger et ses différentes spécialisations. Le PhaseTapChanger peut être spécialisé dans plusieurs types qui représentent la structure physique et donc le comportement. Les attributs de TapChanger sont applicables à toutes les spécialisations de RatioTapChanger. La Figure 14 représente le modèle UML pour les prises de transformateur.

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Figure 14 – Modèle de prise de transformateur

Plusieurs changeurs de prises peuvent être combinés à l'intérieur d'un transformateur de puissance, mais pour éviter les problèmes d'interprétation, un seul changeur de prises déphaseur et un seul changeur de prises qui modifie le rapport doivent être modélisés sur une borne donnée. Le changeur déphaseur et le changeur qui modifie le rapport sont documentés par rapport à l'autre ou aux autres bornes en partant de l'hypothèse que ces bornes ont le rapport nominal (1 PU) et le déphasage angulaire nominal (zéro). Des représentations tabulaires sont exigées lorsqu'il est nécessaire de combiner le changeur de prises déphaseur et le changeur de prises qui modifie le rapport sur une borne, car elles donnent les valeurs explicites des phases et des angles subséquents.

Des représentations tabulaires peuvent être utilisées à la fois pour des transformateurs déphaseurs et des transformateurs de rapport quand les modèles disponibles du CIM ne reflètent pas le comportement physique de manière appropriée. Les modèles tabulaires sont facultatifs pour les autres modèles de prises du CIM. Les modèles tabulaires peuvent être utilisés pour décrire la variation d'impédance dans la plage de prise.

Les différents modèles de changeurs de prises sont décrits plus en détail de 4.5.7.2 à 4.5.7.7.

4.5.7.2 Modélisation de transformateur de tension

La classe RatioTapChanger est utilisée pour définir une prise de transformateur qui change le rapport de la valeur de tension sans changer l'angle de phase à travers le transformateur. Un RatioTapChanger peut être utilisé dans des cas où le transformateur introduit intrinsèquement un déphasage fixe, comme à partir d'une connexion d'enroulement en étoile-triangle.

4.5.7.3 Modélisation tabulaire d'un transformateur de tension

Un RatioTapChangerTabular peut être facultativement associé à n'importe quel RatioTapChanger et représenter une relation non linéaire entre le nombre de prises, le rapport de prises et les impédances. S'il est associé, le modèle tabulaire de rapport a la priorité.

4.5.7.4 Modélisation d'un transformateur déphaseur linéaire

Un transformateur déphaseur est linéaire si l'incrément (accroissement) de déphasage par échelon de prise est uniforme et si la valeur de la tension est constante sur toute la plage du changeur de prises. Un déphaseur linéaire est modélisé en utilisant la classe PhaseTapChangerLinear.

4.5.7.5 Modélisation d'un déphaseur symétrique et asymétrique

4.5.7.5.1 Informations communes

Le paragraphe 4.5.7.5 décrit la modélisation de transformateurs déphaseurs (PST – Phase-Shifting Transformer) en fonction du type et de la technologie des équipements, et de manière plus spécifique, la réactance série équivalente des déphaseurs dans la séquence positive en fonction de l'angle de déphasage. Dans ces modèles spécifiques, les résistances et les courants magnétisants sont toujours négligés.

Les transformateurs déphaseurs compris dans 4.5.7.5 sont mis en correspondance avec les classes CIM comme décrit dans le Tableau 1.

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Tableau 1 – Mise en correspondance des transformateurs déphaseurs avec les classes CIM

Type de déphaseur	Classe CIM
Cas général	cim:PhaseTapChangerTabular
Déphaseurs symétriques	cim:PhaseTapChangerSymmetrical ou cim:PhaseTapChangerLinear
Déphaseur asymétrique	cim:PhaseTapChangerAsymmetrical
Transformateur en phase et déphaseur symétrique	cim:PhaseTapChangerSymmetrical et cim:RatioTapChanger
Transformateur en phase et déphaseur asymétrique	cim:PhaseTapChangerAsymmetrical et cim:RatioTapChanger

Il est fortement recommandé d'utiliser des données tabulaires pour échanger les paramètres PST (cim:PhaseTapChangerTabular) au lieu de devoir recalculer les paramètres par prise selon le type de chaque modèle.

Les symboles utilisés dans les formules de 4.5.7.5 sont mis en correspondance avec les classes CIM comme décrit dans le Tableau 2.

Tableau 2 – Mise en correspondance des symboles utilisés dans les formules avec les attributs CIM

Attribut de transformateur déphaseur	Attribut CIM
n	cim:PhaseTapChangerTablePoint.step
n_0	cim:TapChanger.neutralStep
δu	cim:PhaseTapChangerNonLinear.voltageStepIncrement
r	cim:TapChangerTablePoint.ratio
α	cim:PhaseTapChangerTablePoint.angle
$\delta\alpha$	cim:PhaseTapChangerLinear.stepPhaseShiftIncrement
$X(\alpha)$	cim:TapChangerTablePoint.x
$X(0)$	cim:PhaseTapChangerLinear.xMin ou cim:PhaseTapChangerNonLinear.xMin ou PowerTransformerEnd.x en tant que .xMin est un attribut déconseillé
$X(\alpha_{max})$	cim:PhaseTapChangerLinear.xMax ou cim:PhaseTapChangerNonLinear.xMax ou PowerTransformerEnd.x en tant que .xMin est un attribut déconseillé
θ	cim:PhaseTapChangerAsymmetrical.windingConnectionAngle

La variation d'impédance en fonction de la position de prise sur le transformateur déphaseur est décrite dans le Tableau 3 et les variables dans le Tableau 4.

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Tableau 3 – Variations d'impédance dans un transformateur déphaseur

Type d'équipement	Réactance série équivalente en fonction de l'angle de déphasage
Déphaseurs symétriques	$X(\alpha) = X(0) + \left(X(\alpha_{\max}) - X(0)\right)\left(\frac{\sin(\alpha/2)}{\sin(\alpha_{\max}/2)}\right)^2$
Déphaseur asymétrique	$X(\alpha) = X(0) + \left(X(\alpha_{\max}) - X(0)\right)\left(\frac{\tan\alpha}{\tan\alpha_{\max}}\frac{\sin\theta - \tan\alpha_{\max}\cos\theta}{\sin\theta - \tan\alpha\cos\theta}\right)^2$
Transformateur en phase et déphaseur symétrique	$X(r,\alpha) = X_r(r_{nom})\left(\frac{r}{r_{nom}}\right)^2 + X_\alpha(0) + \left(X_\alpha(\alpha_{\max}) - X_\alpha(0)\right)\left(\frac{\sin(\alpha/2)}{\sin(\alpha_{\max}/2)}\right)^2$
Transformateur en phase et déphaseur asymétrique	$X(r,\alpha) = X_r(r_{nom})\left(\frac{r}{r_{nom}}\right)^2 + X_\alpha(0)$ $+ \left(X_\alpha(\alpha^0_{\max}) - X_\alpha(0)\right)\left(\frac{\tan\alpha}{\tan\alpha_{\max}(r)}\frac{\sin\theta - \tan\alpha_{\max}(r)\cos\theta}{\sin\theta - \tan\alpha\cos\theta}\right)^2$ avec $\alpha_{\max}(r) = A\tan\left(\frac{\sin\theta}{\frac{r}{r_{nom}\tan\alpha^0_{\max}}\left(\sin\theta - \tan\alpha^0_{\max}\cos\theta\right) + \cos\theta}\right)$ et $\alpha^0_{\max} = \alpha_{\max}(r_{nom})$

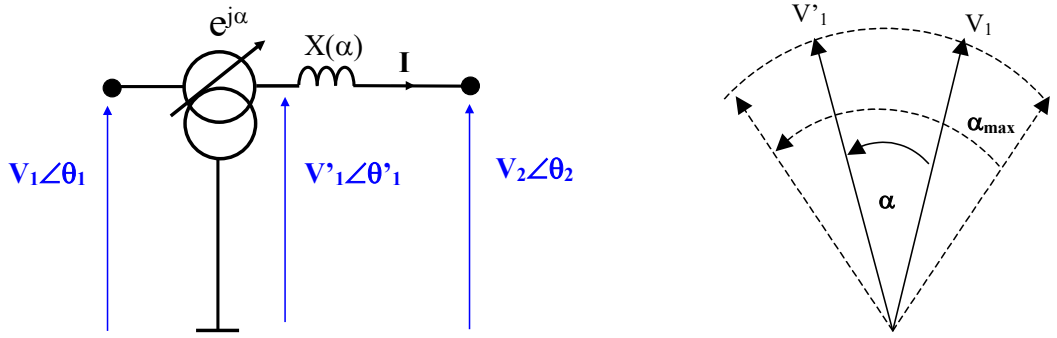
Tableau 4 – Description des variables

Variable	Signification
$\alpha_{\max}$	Déphasage maximal: valeur maximale d'angle figurant dans le tableau des angles de déphasage
r_{nom}	Rapport nominal du transformateur en phase
$\alpha^0_{\max}$	Déphasage maximal lorsque le rapport du transformateur en phase est nominal

4.5.7.5.2 Déphaseurs symétriques

Le diagramme et les équations du phaseur sont représentés à la Figure 15.

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$$V_2 = V_1 e^{j\alpha} - jX(\alpha)I \qquad V'_1 = V_1\left(1 + 2j\sin\frac{\alpha}{2}e^{j\frac{\alpha}{2}}\right) = e^{j\alpha}V_1$$

Figure 15 – Schéma et équations du phaseur

Expression de l'angle et du rapport par prise

Selon la Figure 15:

$\alpha = (n - n_0)\cdot\delta\alpha$ ou $\alpha = 2A\tan\left(\frac{(n-n_0)\cdot\delta u}{2}\right)$

$r = 1$

Expression de la réactance série équivalente en fonction de l'angle

En partant de l'hypothèse que la réactance de l'enroulement de régulation varie à mesure que le carré du nombre de tours évolue, la réactance équivalente pour les technologies non triangulaires-hexagonales peut être écrite comme suit:

$$X(\alpha) = X(0) + \left(X(\alpha_{max}) - X(0)\right)\left(\frac{\sin(\alpha/2)}{\sin(\alpha_{max}/2)}\right)^2$$

Paramètres:

α_{max} déphasage maximal

X(0) réactance série équivalente pour un déphasage nul $\alpha=0$

$X(\alpha_{max})$ réactance série équivalente pour un déphasage maximal $\alpha = \alpha_{max}$

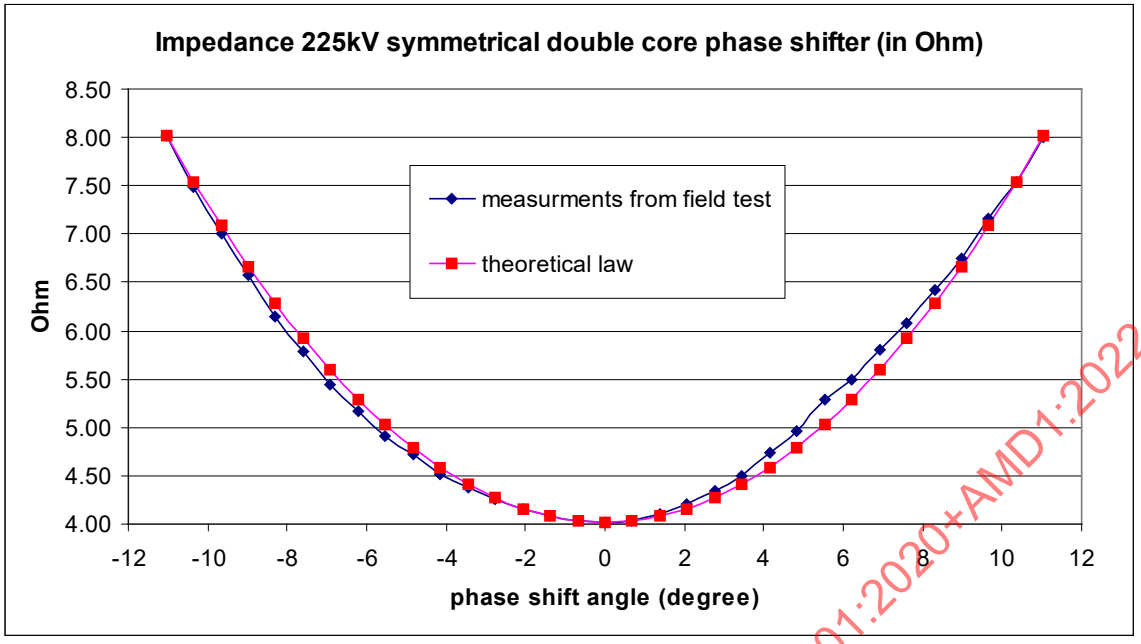
Variable:

α déphasage de courant

La formule ci-dessus est valide pour les déphaseurs symétriques simple ou double noyau, à l'exception de la technologie hexagonale.

Pour les déphaseurs symétriques à noyau simple: X(0) = 0. Un exemple de variation d'impédance est représenté à la Figure 16.

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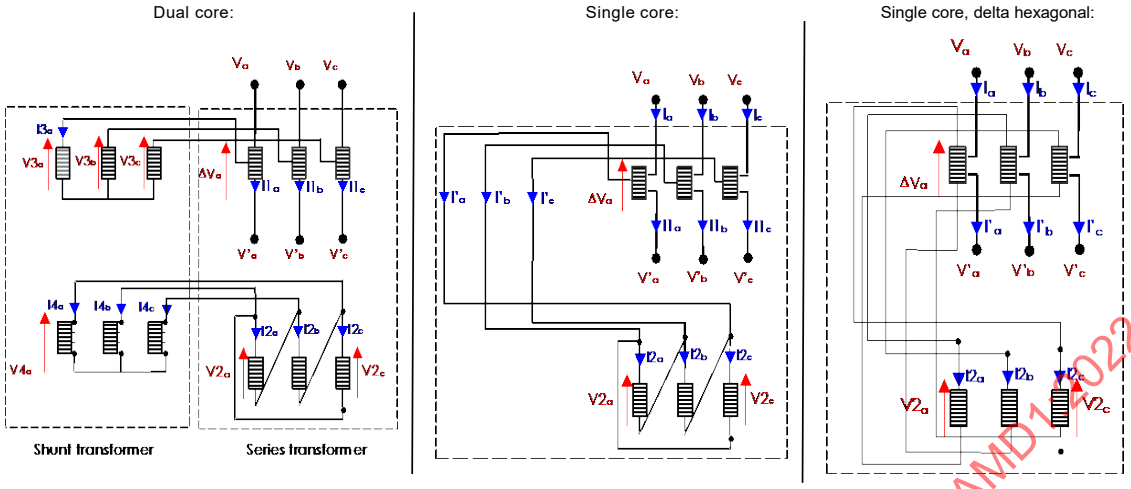


Anglais	Français
Impedance 225kV symmetrical double core phase shifter (in Ohm)	Déphaseur symétrique double noyau à 225kV d'impédance (en ohms)
measurements from field test	mesures effectuées lors des essais sur site
theoretical law	loi théorique
phase shift angle (degree)	angle de déphasage (degrés)

Figure 16 – Variation d'impédance de déphaseur symétrique

L'organisation triple noyau est représentée à la Figure 17.

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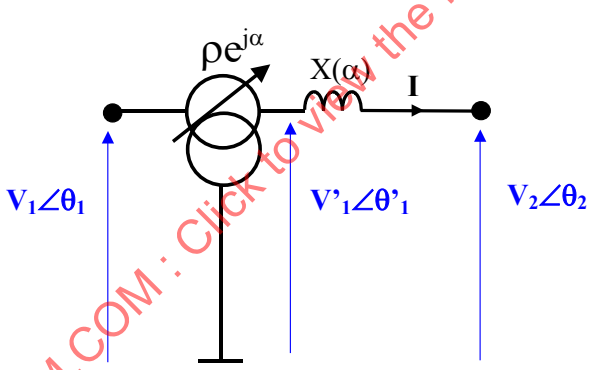


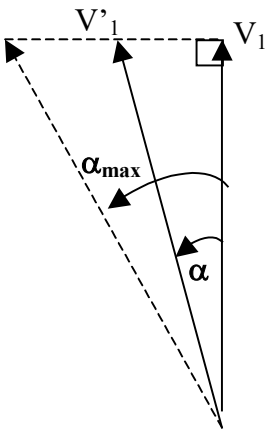
Anglais	Français
Shunt transformer	Transformateur shunt
Series transformer	Transformateur survolteur-dévolteur
Dual core	double noyau
Single core	Noyau simple
Single core, delta hexagonal	Noyau simple, triangle hexagonal

Figure 17 – Organisation du noyau

4.5.7.5.3 Transformateur déphaseur en quadrature

Le diagramme et les équations du phaseur sont représentés à la Figure 18.





$$V'_1 = V_1(1 + j\tan\alpha) = \rho e^{j\alpha} V_1 \qquad V_2 = V_1 \rho e^{j\alpha} - jX(\alpha)I$$

ρ et α vary avec ρ.cos α = constante.

Figure 18 – Schéma et équations du phaseur

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Expression de l'angle et du rapport par prise

D'après la Figure 18:

$$\alpha = A\tan((n - n_0)\cdot \delta u)$$

$$r = \frac{1}{\sqrt{((n - n_0)\cdot \delta u)^2 + 1}}$$

Expression de la réactance série équivalente en fonction de l'angle

En partant de l'hypothèse que la réactance de l'enroulement de régulation varie à mesure que le carré du nombre de tours évolue, la réactance équivalente du transformateur déphaseur en quadrature peut être écrite comme suit.

$$X(\alpha) = X(0) + \left(X(\alpha_{max}) - X(0)\right)\left(\frac{\tan(\alpha)}{\tan(\alpha_{max})}\right)^2$$

Paramètres:

α_{max} déphasage maximal

X(0) réactance série équivalente pour un déphasage nul

$X(\alpha_{max})$ réactance série équivalente pour un déphasage maximal

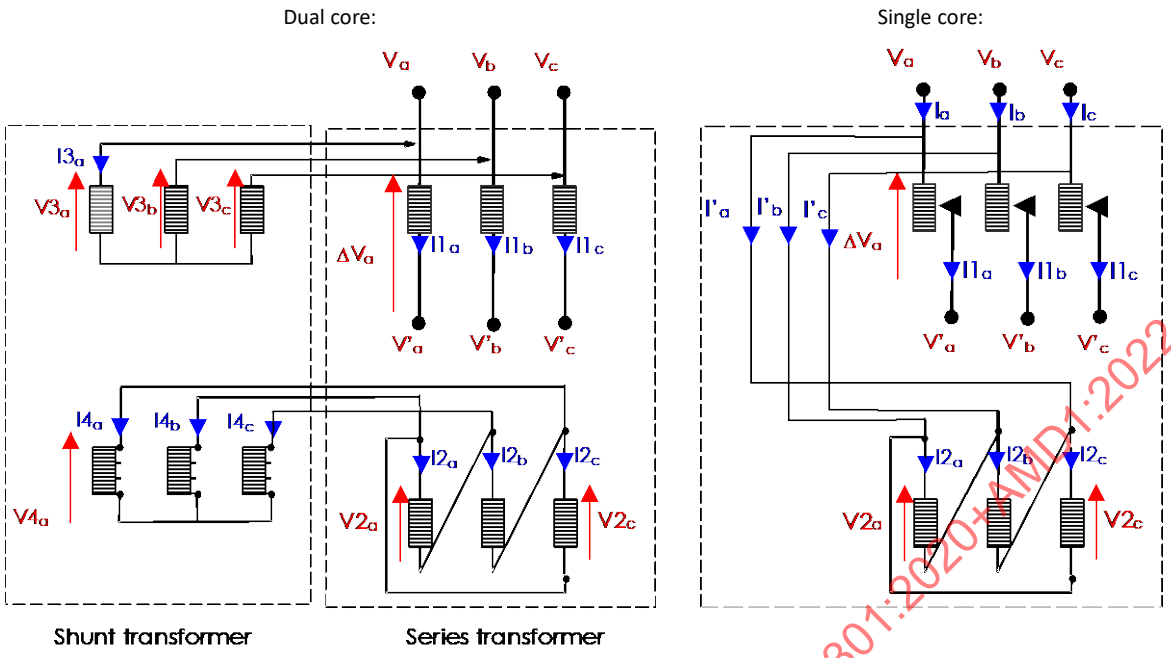
Variable:

α déphasage de courant

Pour des transformateurs déphaseurs en quadrature avec un noyau simple: X(0)=0

L'organisation triple noyau est représentée à la Figure 19

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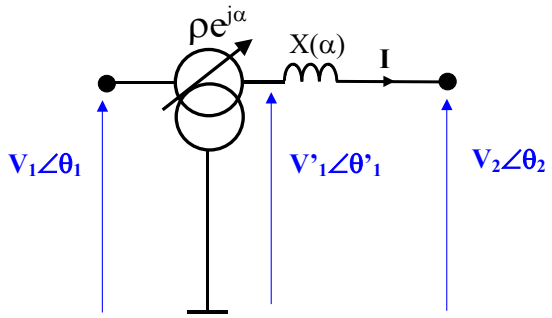
Anglais	Français
Shunt transformer	Transformateur shunt
Series transformer	Transformateur survolteur-dévolteur
Dual core	Double noyau
Single core	Noyau simple

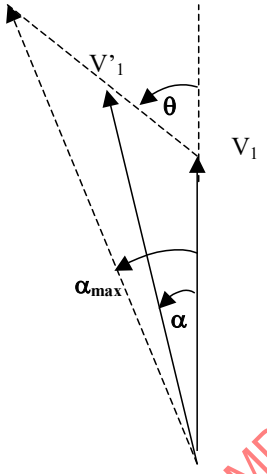
Figure 19 – Organisation du noyau

4.5.7.5.4 Modélisation d'un déphaseur asymétrique

Le diagramme et les équations du phaseur sont représentés à la Figure 20.

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$$V'_1 = V_1\left(1 + e^{j\theta}.\frac{\tan\alpha}{\sin\theta - \tan\alpha\cos\theta}\right) = \rho e^{j\alpha}V_1 \qquad V_2 = V_1.\rho e^{j\alpha} - jX(\alpha)I$$

θ Est fixe, seuls α et ρ varient.

Figure 20 – Schéma et équations du phaseur

Expression de l'angle et du rapport par prise

D'après la Figure 20:

$$\alpha = A\tan\left(\frac{(n-n_0)\cdot\delta u\cdot\sin\theta}{1+(n-n_0)\cdot\delta u\cdot\cos\theta}\right)$$

$$r = \frac{1}{\sqrt{\left((n-n_0)\cdot\delta u\cdot\sin\theta\right)^2 + \left(1+(n-n_0)\cdot\delta u\cdot\sin\theta\right)^2}}$$

Expression de la réactance série équivalente en fonction de l'angle

En partant de l'hypothèse que la réactance de l'enroulement de régulation varie à mesure que le carré du nombre de tours évolue, la réactance équivalente peut être écrite comme suit.

$$X(\alpha) = X(0) + \left(X(\alpha_{max}) - X(0)\right)\left(\frac{\tan\alpha}{\tan\alpha_{max}}\frac{\sin\theta - \tan\alpha_{max}\cos\theta}{\sin\theta - \tan\alpha\cos\theta}\right)^2$$

Paramètres:

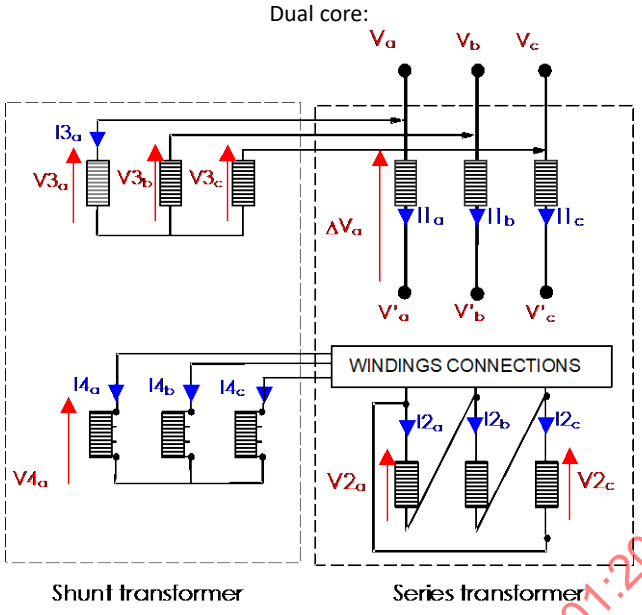
α_{max}	déphasage maximal
X(0)	réactance série équivalente pour un déphasage nul
$X(\alpha_{max})$	réactance série équivalente pour un déphasage maximal
θ	angle de la tension de charge rapide

Variable:

α déphasage de courant

Les organisations triphasées sont représentées à la Figure 21

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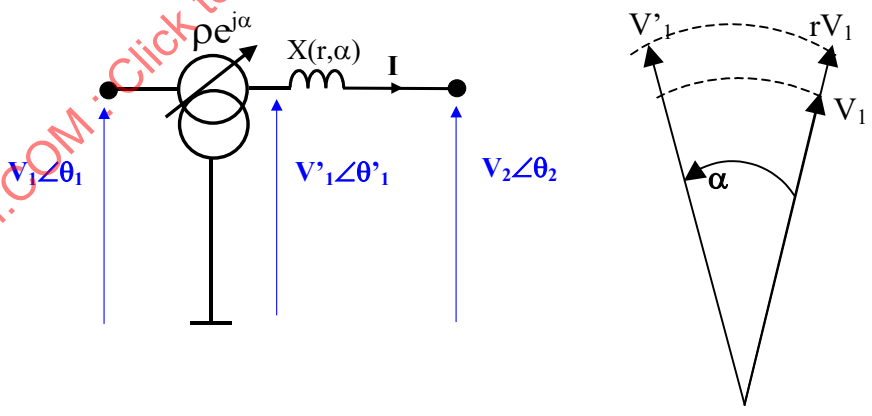


Anglais	Français
WINDINGS CONNECTIONS	CONNEXIONS ENTRE LES ENROULEMENTS
Shunt transformer	Transformateur shunt
Series transformer	Transformateur survolteur-dévolteur
Dual core	Double noyau

Figure 21 – Organisation du noyau

4.5.7.5.5 Transformateur en phase et déphaseur symétrique

Le diagramme et les équations du phaseur sont représentés à la Figure 22.



$$V_2 = \rho V_1 e^{j\alpha} - jX(\alpha)I. \qquad V'_1 = r.V_1\left(1 + 2j\sin\frac{\alpha}{2}e^{j\frac{\alpha}{2}}\right) = \rho e^{j\alpha}V_1$$

Figure 22 – Schéma et équations du phaseur

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Expression de l'angle et du rapport par prise

Idem qu'en 4.5.7.5.2 avec l'ajout du rapport r du transformateur en phase.

Réactance en série équivalente en fonction de l'angle et du rapport du transformateur en phase;

Hypothèses:

- la réactance de l'enroulement de régulation varie à mesure que le carré du nombre de tours évolue;
- la réactance équivalente est la somme de la réactance du transformateur en phase X_r et de la réactance de la partie X_α du déphaseur;
- l'angle de déphasage α ne dépend pas du rapport en phase r.

La réactance équivalente peut être écrite comme suit:

$$X(r,\alpha) = X_r(r_{nom})\left(\frac{r}{r_{nom}}\right)^2 + X_\alpha(0) + \left(X_\alpha(\alpha_{max}) - X_\alpha(0)\right)\left(\frac{\sin(\alpha/2)}{\sin(\alpha_{max}/2)}\right)^2$$

Paramètres:

r_{nom} rapport nominal du transformateur en phase

$X_r(r_{nom})$ réactance série équivalente du transformateur en phase pour le rapport nominal en phase

α_{max} déphasage maximal

$X_\alpha(0)$ réactance série équivalente de la partie du déphaseur en déphasage nul

$X_\alpha(\alpha_{max})$ réactance série équivalente de la partie du déphaseur en déphasage maximal pour le rapport nominal en phase (r_{nom})

Variables:

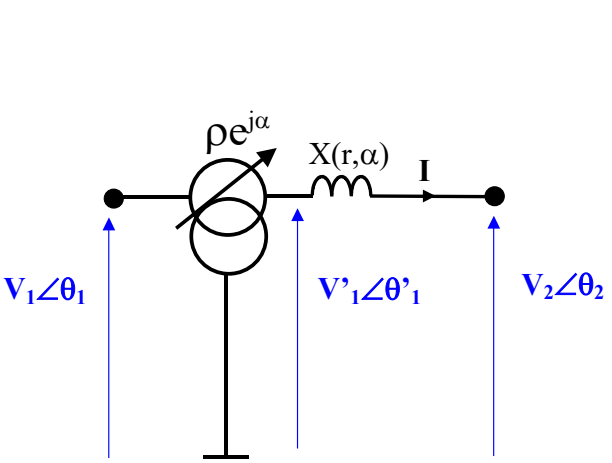
r rapport de courant du transformateur en phase

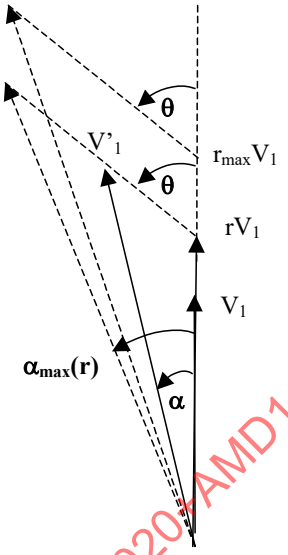
α déphasage de courant

4.5.7.5.6 Transformateur en phase et déphaseur asymétrique

Le diagramme et les équations du phaseur sont représentés à la Figure 23.

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$$V'_1 = rV_1\left(1 + e^{j\theta}.\frac{\tan\alpha}{\sin\theta - \tan\alpha\cos\theta}\right) = \rho e^{j\alpha}V_1 \qquad V_2 = (V1 - jX(\alpha)I).\rho e^{j\alpha}$$

θ est fixe, seuls r et α sont des variables, ρ varie de façon subséquente.

θ est fixe, seuls r et α sont des variables, ρ varie de façon subséquente.

Figure 23 – Schémas et équations du phaseur

Réactance série équivalente en fonction de l'angle et du rapport du transformateur en phase

Hypothèses:

- la réactance de l'enroulement de régulation varie à mesure que le carré du nombre de tours évolue;
- la réactance équivalente est la somme de la réactance du transformateur en phase X_r et de la réactance de la partie X_α du déphaseur.

La réactance série équivalente peut être écrite comme suit:

$$X(r,\alpha) = X_r(r_{nom})\left(\frac{r}{r_{nom}}\right)^2 + X_\alpha(0) + \left(X_\alpha(\alpha^0_{\max}) - X_\alpha(0)\right)\left(\frac{\tan\alpha}{\tan\alpha_{\max}(r)}\frac{\sin\theta - \tan\alpha_{\max}(r)\cos\theta}{\sin\theta - \tan\alpha\cos\theta}\right)^2$$

avec $\alpha_{\max}(r) = A\tan\left(\frac{\sin\theta}{\frac{r}{r_{nom}\tan\alpha^0_{\max}}\left(\sin\theta - \tan\alpha^0_{\max}\cos\theta\right) + \cos\theta}\right)$ avec $\alpha^0_{\max} = \alpha_{\max}(r_{nom})$

Paramètres:

r_{nom}	rapport nominal du transformateur en phase
$X_r(r_{nom})$	réactance série équivalente du transformateur en phase pour le rapport nominal en phase r_{nom}

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θ angle fixe de la tension de charge rapide

$\alpha^0_{max} = \alpha_{max}(r_{nom})$ déphasage maximal pour le rapport nominal en phase (r_{nom})

$X_\alpha(0)$ réactance série équivalente de la partie du déphaseur en déphasage nul

$X_\alpha(\alpha^0_{max})$ réactance série équivalente de la partie du déphaseur en déphasage maximal pour le rapport nominal en phase (r_{nom})

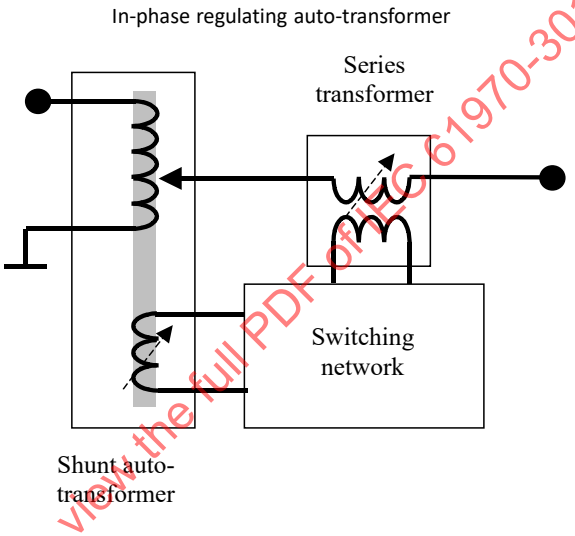
Variables:

r rapport de courant du transformateur en phase

α déphasage de courant

Pour $\theta = \pi/2$ (transformateur déphaseur en quadrature): $\alpha_{max}(r) = A\tan\left(\frac{r_{nom}}{r}\tan\alpha^0_{max}\right)$

Organisations triphasées sont représentées à la Figure 24



Anglais	Français
Series transformer	Transformateur survolteur-dévolteur
Switching network	Réseau de commutation
Shunt auto-transformer	Autotransformateur shunt
In-phase regulating auto-transformer	Autotransformateur de régulation en phase

Figure 24 – Organisation du noyau

La régulation du déphasage peut se faire sur le shunt ou sur le transformateur survolteur-dévolteur.

4.5.7.6 Modélisation tabulaire du transformateur déphaseur

Un PhaseTapChangerTabular est une représentation tabulaire explicite de la variation du déphasage, du rapport et de l'impédance sur la plage du changeur de prises. Le PhaseTapChangerTabular peut être associé au PhaseTapChanger représentant une relation non linéaire entre le nombre de prises, le déphasage, les rapports et les impédances.

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4.5.7.7 Commande du changeur de prises

La commande des changeurs de prises dans un type de calcul de répartition est effectuée à l'aide de la classe TapChangerControl et de TapChanger.ltcFlag. Si un TapChanger a une TapChangerControl (référencée comme TapChanger.TapChangerControl), cela signifie que le calcul de répartition peut commander le changeur de prises. L'attribut TapChanger.ltcFlag donne des informations selon lesquelles le TapChanger a la capacité physique de déplacer la prise en charge. L'attribut est également utilisé dans les calculs de l'IEC 60909.

La signification des combinaisons de TapChanger.TapChangerControl et TapChanger.ltcFlag est décrite au Tableau 5.

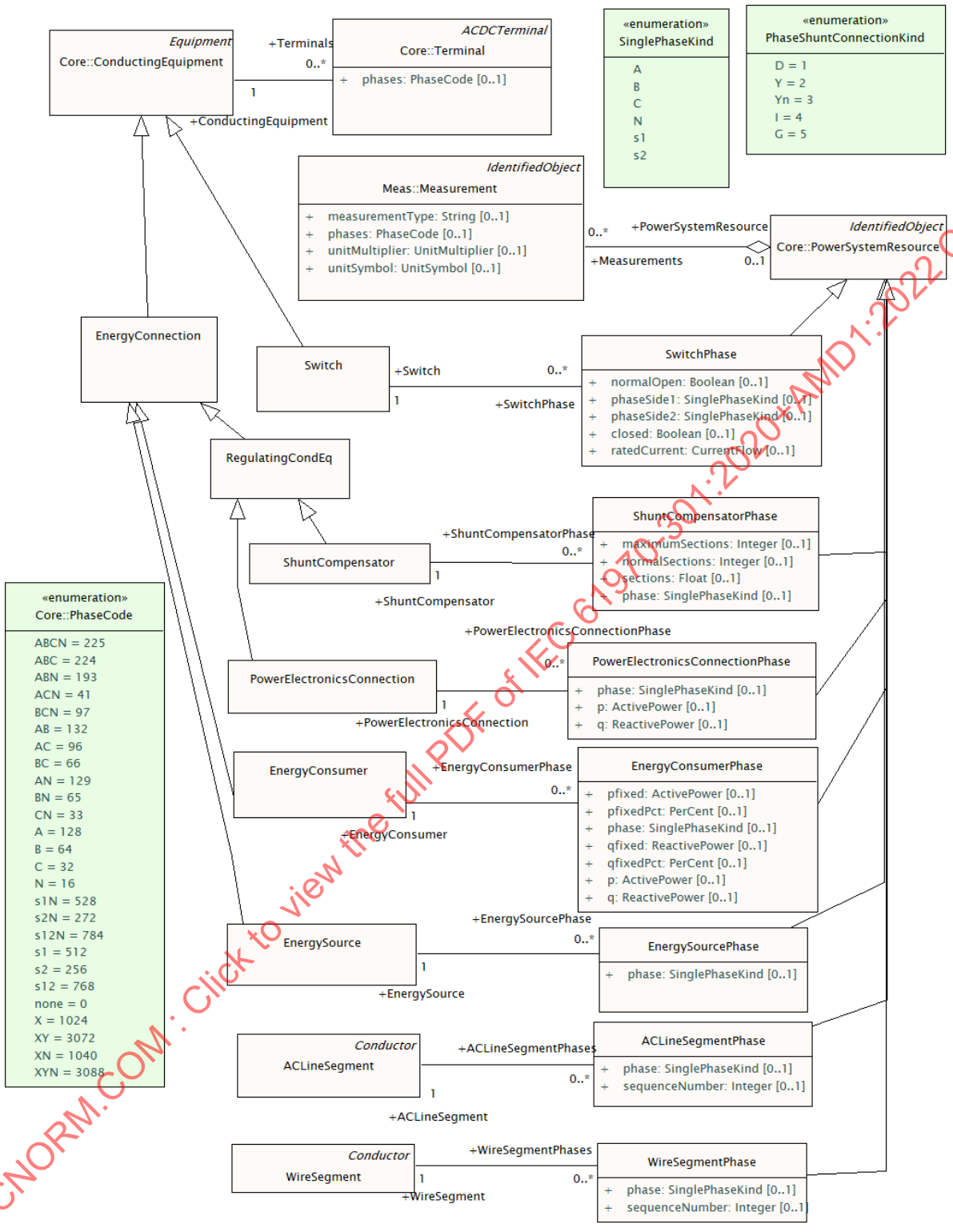
Tableau 5 – Options de commande du changeur de prises

TapChanger. ltcFlag	TapChanger. TapChangerControl	Description
False	Absent	Prise réelle et fixe non commandée et ne pouvant pas être déplacée en charge (changement manuel de prise). Le flux de puissance ne peut pas être défini de sorte à changer de prise pour commander la tension au cours du calcul.
True	Absent	Prise réelle et fixe non commandée mais pouvant être déplacée en charge, par exemple, manuellement. Le flux de puissance ne peut pas être défini de sorte à changer de prise pour commander la tension au cours du calcul. Le flux optimal de puissance peut avoir accès à ces prises et les changer à des fins d'optimisation. State Estimator (l'estimateur d'état) peut également estimer la position de prise afin de trouver une meilleure solution pour l'état du système.
True	Présent	Prise réelle présentant une possibilité de changer les prises de façon automatique pour activer la commande de la tension/la puissance active (flux de charge) activée. Le fait que le flux de puissance doit ou ne doit pas intervenir dans la régulation dépend de RegulatingControl.enabled et de TapChanger.controlEnabled dans SSH. Dans les cas où RegulatingControl est associé à plus d'un changeur de prises ou à d'autres appareils, l'attribut TapChanger.controlEnabled peut être réglé sur False afin de définir les prises non activées.
False	Présent	Prise artificielle pouvant être utilisée pour simuler le comportement de commande du flux de puissance.

4.5.8 Modélisation des phases

Les modèles du CIM fournissent des moyens de spécifier la représentation unifilaire équivalente de réseaux triphasés équilibrés ou, en sus ou en option, de spécifier le détail d'une phase donnée. Dans les réseaux monophasés, il y a correspondance directe entre les objets Terminal et les connexions physiques des fils. Dans une représentation unifilaire de réseaux triphasés équilibrés, une Terminal est utilisée pour représenter le groupe des connexions de phase de coordination. Une Terminal peut donc être utilisée pour spécifier une ou plusieurs connexions de phase de coordination en utilisant l'attribut Terminal.phases qui est un PhaseCode de type énumération. PhaseCode a pour combinaisons de phases possibles ABC, ABCN, AB, BC, CA, A, B, C et ainsi de suite. La spécification des phases à chaque borne permet de modéliser des cavaliers ou des commutateurs qui connectent les mêmes ou différentes phases. Cette spécification de la connectivité de phase est entendue comme spécification de phase nominale ou normale. Le résultat de la source de mise sous tension n'est pas reflété dans cette spécification. Cette spécification de phase fournit les moyens de connecter localement des phases semblables. La Figure 25 représente le modèle de données des phases.

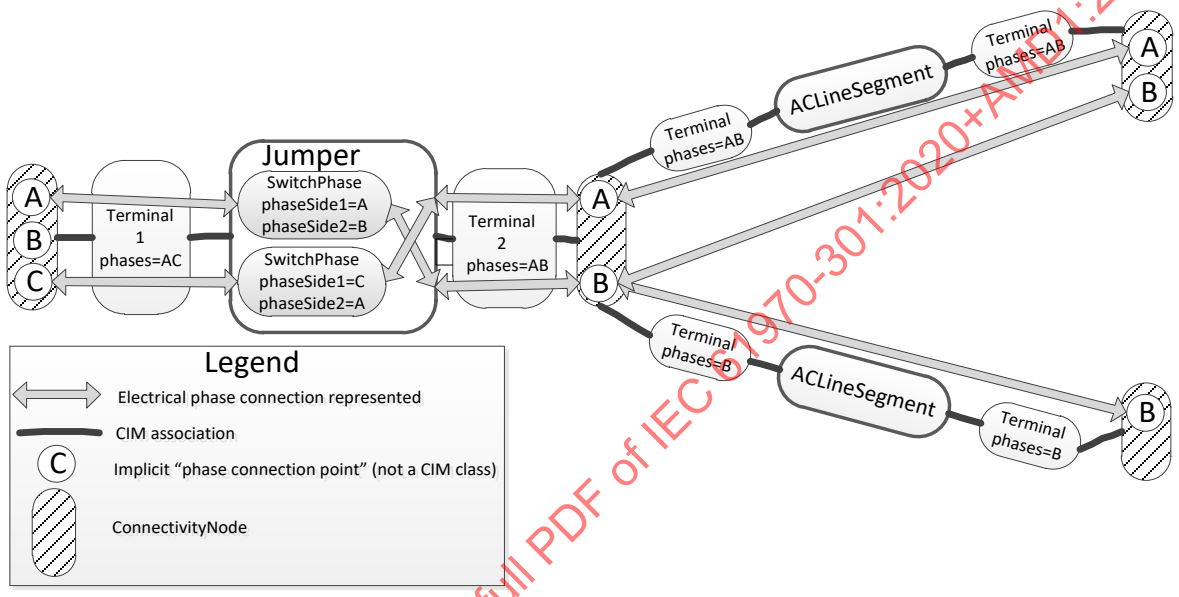
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Figure 25 – Modèle de données des phases

La Figure 26 donne un exemple de connexions de phases. Cet exemple présente une instance ConnectivityNode sur la gauche, les phases A, B et C étant concernées. Noter que ConnectivityNode ne spécifie pas le contenu de sa phase, mais connecte plutôt implicitement des phases semblables de bornes associées au ConnectivityNode. L'exemple présente un cavalier biphasé qui connecte sur la gauche (Terminal.sequenceNumber=1) les phases A et C et sur la droite (Terminal.sequenceNumber=2) les phases A et B, avec les parties intérieures des objets SwitchPhase du modèle de cavalier qui spécifient en détail le chemin des connexions de phases. L'attribut Terminal.phases spécifie uniquement la connexion externe d'un appareil. Plus loin sur la droite, deux tronçons de ligne sont raccordés. Le segment supérieur de la ligne est une ligne biphasée sur les phases A et B. Le segment inférieur de ligne est monophasé de phase B. Les lignes foncées indiquent les associations du CIM tandis que les flèches plus claires indiquent les connexions électriques représentées au niveau de la phase.



Anglais	Français
Legend	Légende
Electrical phase connection represented	Connexion de phase électrique représentée
CIM association	Association CIM
Implicit "phase connection point" (not a CIM class)	"Point de connexion de phase" implicite (pas une classe CIM)
ConnectivityNode	ConnectivityNode

Figure 26 – Connectivité de phase

A titre d'explication, l'attribut SwitchPhase appelé phaseSide1 spécifie une phase unique (comme A, B, C ou N) et se réfère à la Terminal dont le sequenceNumber est égal à 1. L'attribut SwitchPhase appelé phaseSide2 se réfère à la Terminal dont le sequenceNumber est égal à 2.

Le modèle de commutateur permet de modéliser les connexions entre phases de façon générale à l'intérieur de l'appareil. Le modèle de transformateur comporte aussi une modélisation explicite de la connectivité de phase interne de l'appareil. Actuellement, toutes les autres spécialisations de branche ConductingEquipment comme ACLineSegment prennent pour hypothèse que des phases identiques sont connectées aux deux bornes. Le modèle du CIM est ouvert aux extensions futures pour introduire la connectivité de phase interne des appareils.

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4.5.9 Modélisation des appareils de mise à la terre

4.5.9.1 Cas d'utilisation pour la modélisation des appareils de mise à la terre.

Ces appareils ont un impact important sur les courants de court-circuit pour les défauts déséquilibrés. Le fonctionnement des appareils est interchangé par des commutateurs lorsque le transformateur vers la commutation de lignes est reconfiguré. Une bobine Petersen est une bobine de mise à la terre utilisée dans les systèmes de transport de puissance à courant alternatif et conçue pour limiter l'intensité du courant vers la terre à l'emplacement d'un défaut en établissant un courant réactif vers la terre permettant d'équilibrer le courant capacitif circulant des lignes vers la terre. De plus, les bobines Petersen sont "accordées" pour correspondre au courant de charge attendu des défauts déséquilibrés. L'impédance des bobines Petersen peut être "accordée" en ajustant la position du régleur à la manière d'une prise. La position du régleur est parfois télémesurée. Parfois, un modèle linéaire suffit pour mettre en relation la position du régleur et la valeur d'impédance et parfois un tableau est nécessaire pour présenter la relation non linéaire entre la position de régleur et l'impédance.

4.5.9.2 Modèle

L'EarthFaultCompensator est un type d'équipement conducteur abstrait prévu pour modéliser les équipements de mise à la terre. L'EarthFaultCompensator est une spécialisation de ConductingEquipment, car un court-circuit exige des connexions appropriées et différents commutateurs qui peuvent s'ouvrir ou se fermer pour modifier la configuration de la topologie. L'EarthFaultCompensator est différent d'une branche telle que ACLineSegment, ShuntCompensator ou PowerTransformer dans le sens où il ne régule pas la tension et n'est jamais monté en étoile ou en triangle. Un transformateur de mise à la terre connecté en zigzag reste un PowerTransformer en raison de toutes les autres complexités du transformateur. Deux spécialisations permettent de manipuler les appareils à impédance fixe (GroundingImpedance) et les appareils réglables (variable) à bobine Petersen (PetersenCoil).

Le GroundingImpedance et le PetersenCoil se connectent de la même manière que les autres appareils utilisant la Terminal. L'attribut de phase sur la Terminal indique que la connexion est la phase neutre. L'une ou les deux bornes de l'EarthFaultCompensator peuvent être modélisées. Si la deuxième borne d'un EarthFaultCompensator est omise, la borne est par hypothèse solidement raccordée à la terre. S'il existe une sorte de topologie ou de résistivité locale à la terre qui est importante à la modélisation du côté terre de l'appareil, alors une deuxième borne est ajoutée.

Si un PowerTransformer à une connexion Y sur une Terminal (secondaire) et qu'un PetersenCoil est connecté à cette Terminal, il convient de spécifier la Terminal secondaire du PowerTransformer avec l'attribut de phase égal à ABCN, et il convient de spécifier la Terminal du PetersenCoil avec la phase N. Cela permet à ACLineSegment de se connecter avec les phases ABC (défaut) et au PetersenCoil de se connecter à la même TransformerTerminal, mais uniquement sur la phase N. Il est prévu que toutes les bornes PetersenCoil ne disposent que de la phase N.

Si une modélisation normale d'un réseau non neutre est réalisée, le modèle de bobine Petersen étant alors ajouté, lequel inclut:

1) ajout du phasage d'ABCN à la borne secondaire du transformateur, de manière à avoir une place pour connecter le neutre;
2) ajout de l'objet PetersenCoil à sa Terminal associée qui est la phase N, et étant donné qu'une seule Terminal est modélisée, la PetersenCoil est par hypothèse solidement mis à la terre;
3) association de la Terminal unique de la PetersenCoil au ConnectivityNode au niveau du transformateur secondaire.

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Une classe séparée de sectionneurs de terre (GroundDisconnector) est incluse étant donné que ces sectionneurs sont généralement très différents physiquement de la plupart des autres commutateurs et souvent exclus de l'analyse du flux normal de puissance. À l'instar des PetersenCoils, il est prévu que toutes les bornes GroundDisconnector ne comporteront que la phase N. Voir la Figure 27 pour la représentation du modèle de données.

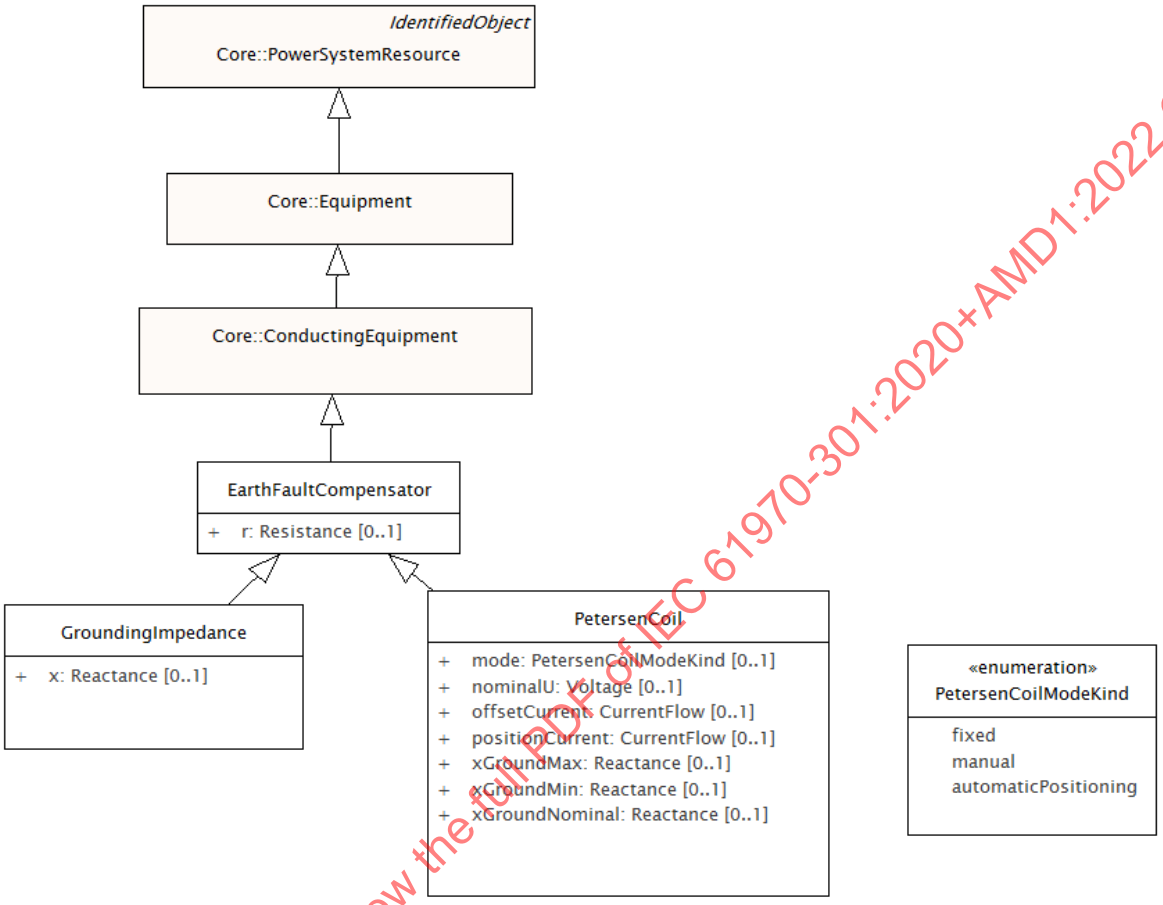


Figure 27 – Modèle de données de l'appareil de mise à la terre

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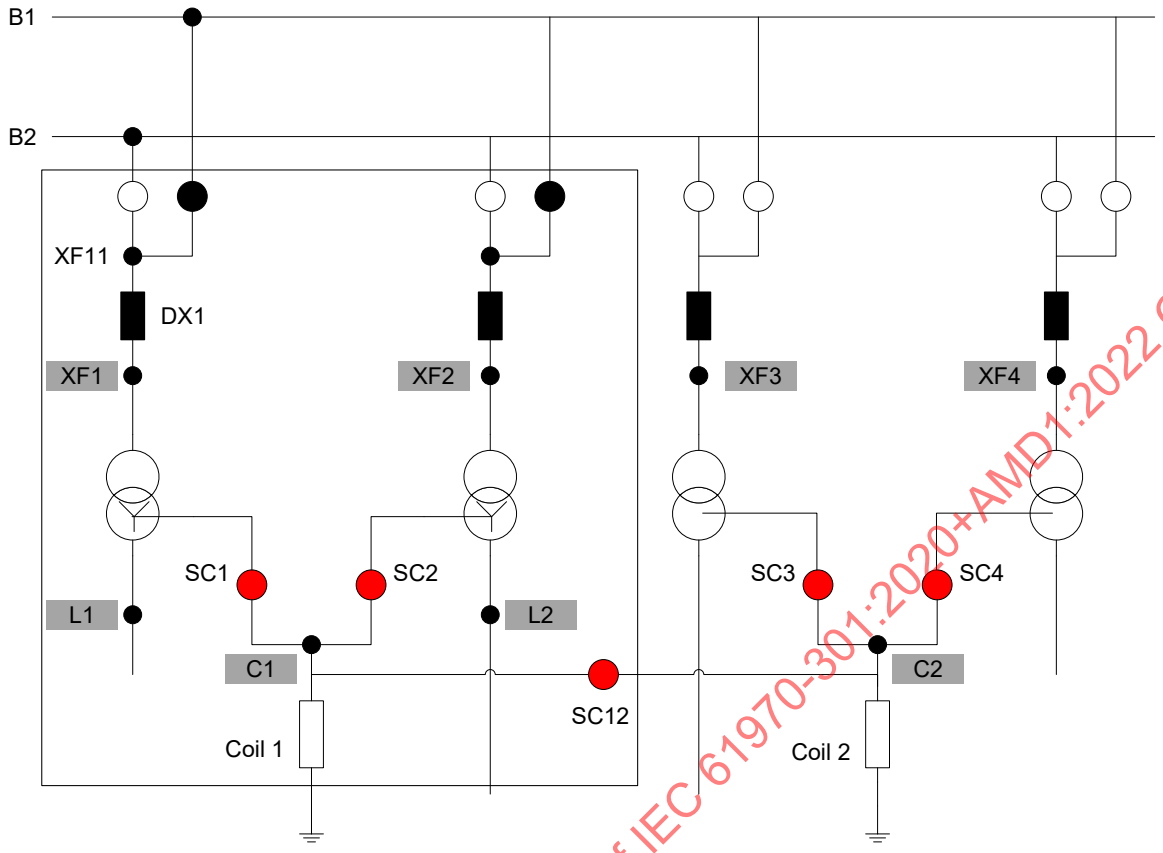


Figure 28 – Exemple de représentation de poste comprenant des bobines Petersen

Dans l'exemple ci-dessus, SC1, SC2, SC3, SC4 et SC12 sont les sectionneurs du circuit de mise à la terre. B1 et B2 sont les sections de jeu de barres. XF1, XF2, XF3, XF4, C1, C2, L1 et L2 sont les nœuds de connectivité.

Le point de mise à la terre d'un transformateur est le point médian des enroulements connectés en Y et les sectionneurs du circuit de mise à la terre sont connectés à ces points médians. Dans le CIM, le point médian est décrit par l'attribut de phasage de la Terminal au niveau des enroulements connectés en Y. Cela signifie que les commutateurs du circuit de mise à la terre sont connectés au nœud de connectivité au niveau de la Terminal avec les enroulements connectés en Y. Dans la Figure 28, cela signifie que SC1 est connecté à L1, que SC2 est connecté à L2 et que L1/L2 a les phases ABC ainsi que la phase N comme point médian.

4.5.9.3 Exemple de modèle d'instance CIM

La PetersenCoil représentée à la Figure 28 est modélisée à la Figure 29 avec une borne uniquement et la mise à la terre est implicite.

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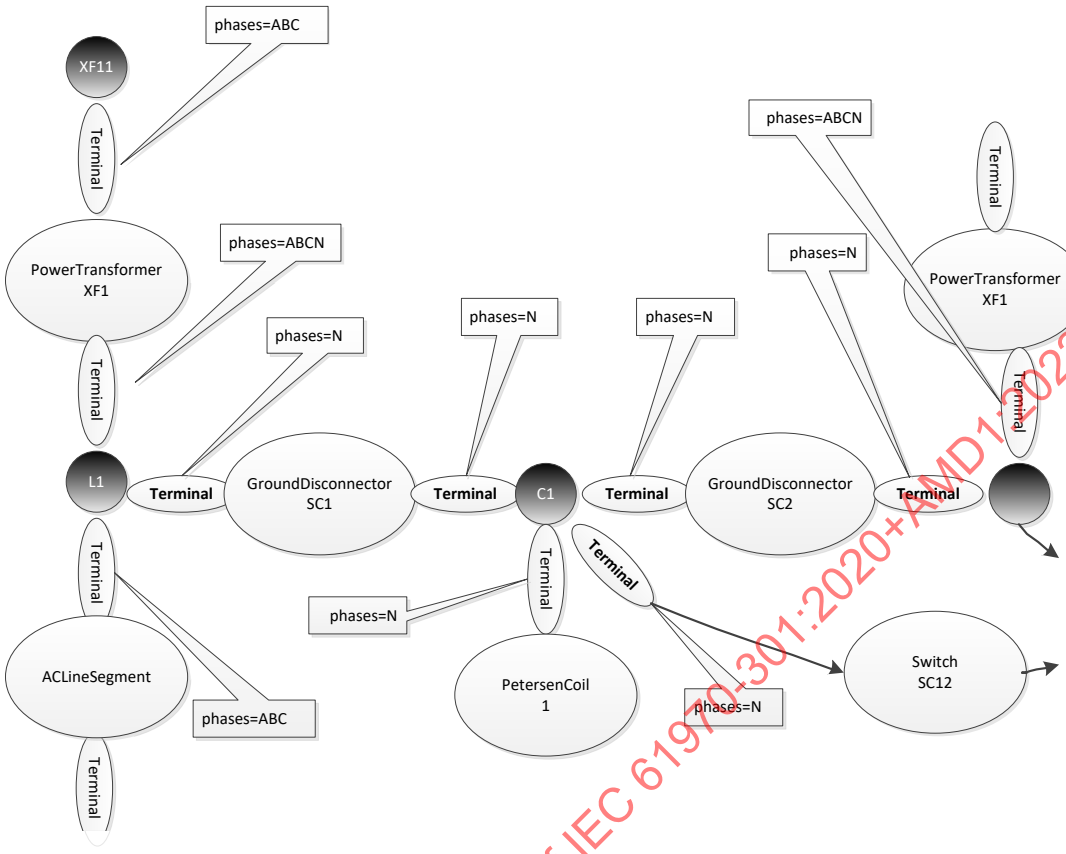


Figure 29 – Objets de diagramme d'instance avec une bobine à bornes

La Figure 29 représente la façon dont une Terminal du sectionneur de terre SC1 est en phase N et dont la Terminal du transformateur est connectée à L1 avec les phases ABCN.

4.5.10 Modèle de cuts, de clamps (serre-fils) et de jumpers (cavaliers)

Le modèle de l'UML pour les cuts et les jumpers (cavaliers) sur un segment de ligne et les connexions supplémentaires sont décrites à la Figure 30. La classe Jumper est une spécialisation de la classe plus générale Switch et permet des changements de phase ainsi qu'une connectivité de phase, comme représenté à la Figure 26. Les jumpers (cavaliers) peuvent donc connecter les bornes de façon normale. Les classes Cut et Clamp du CIM fournissent des moyens d'ajouter effectivement des Terminals à un ACLineSegment à une distance spécifiée sur la ligne en aval, en associant de nouveaux objets du CIM à un objet ACLineSegment sans autre modification du modèle ACLineSegment intégré. Chaque instance Clamp introduit une nouvelle borne connectée à la distance spécifiée en aval sur la ligne sans interrompre la ligne. Chaque instance Cut introduit deux nouvelles bornes qui sont effectivement les extrémités du cut. Par convention, chaque borne d'un cut est orientée vers la borne ACLineSegment dont le sequenceNumber est identique. Si le cut est ouvert, il n'y a pas de flux qui traverse l'ACLineSegment au point du cut mais le flux peut passer par l'un ou l'autre côté de l'ACLineSegment et par la borne de cut appropriée. Habituellement, les jumpers (cavaliers) sont connectés aux extrémités des cuts, mais ils peuvent aussi être connectés à un type quelconque d'équipement conducteur de façon normale en utilisant ConnectivityNode ou TopologicalNode.

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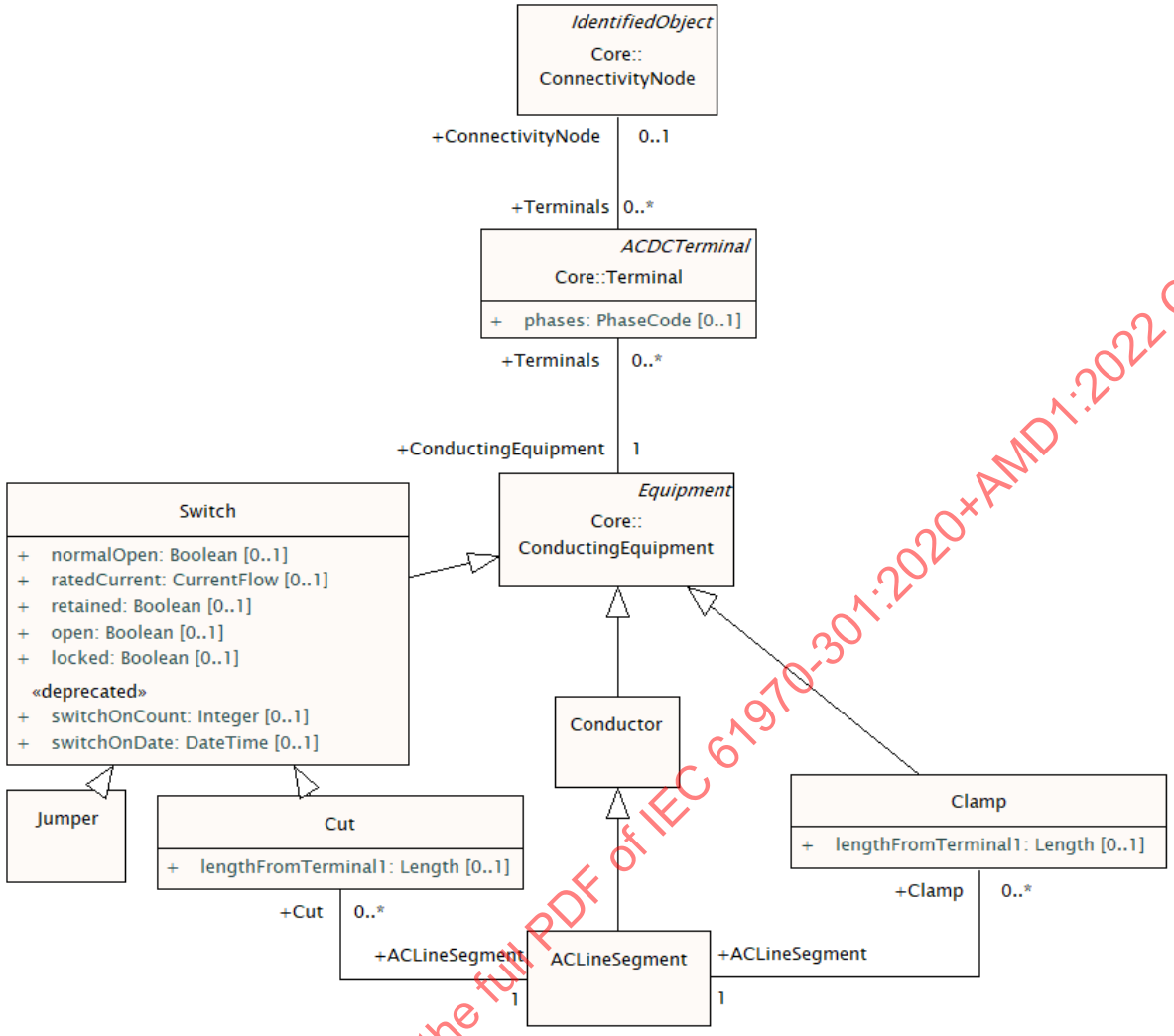
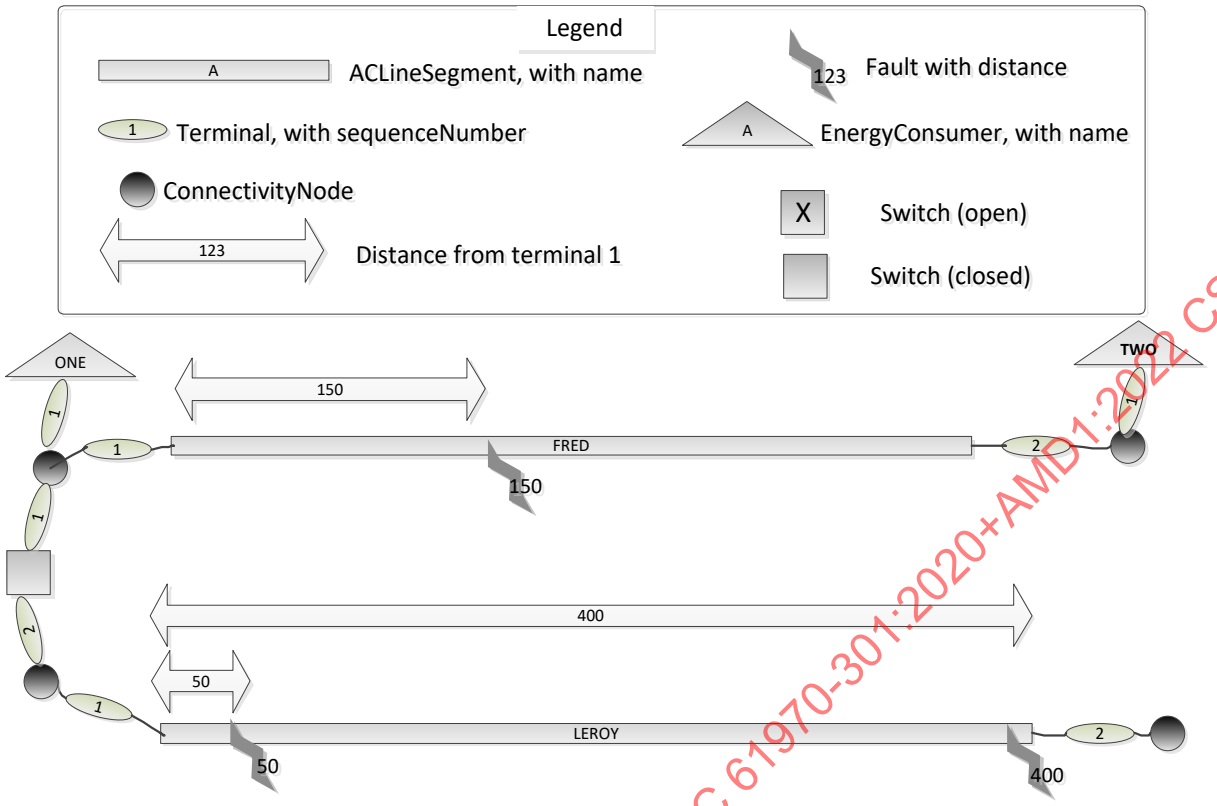


Figure 30 – Modèle UML de cuts, de clamps (serre-fils) et de jumpers (cavaliers)

Un exemple d'ajout de cuts et de clamps (serre-fils) à un modèle existant de CIM est donné à la Figure 31 et à la Figure 32. La Figure 31 représente deux tronçons de ligne physiques parallèles appelés "FRED" et "LEROY". Dans cet exemple, le système est mis sous tension à partir de la droite, le commutateur sur la gauche est fermé et les charges appelées "ONE" et "TWO" sont appliquées. Les trois défauts sont ensuite appliqués aux distances spécifiées par rapport à la Terminal 1 des tronçons respectifs de ligne. Dans cet exemple, le détail de phase n'est pas spécifié pour des raisons de simplicité mais le détail de phase peut suivre la même approche que celle présentée en 4.5.8.

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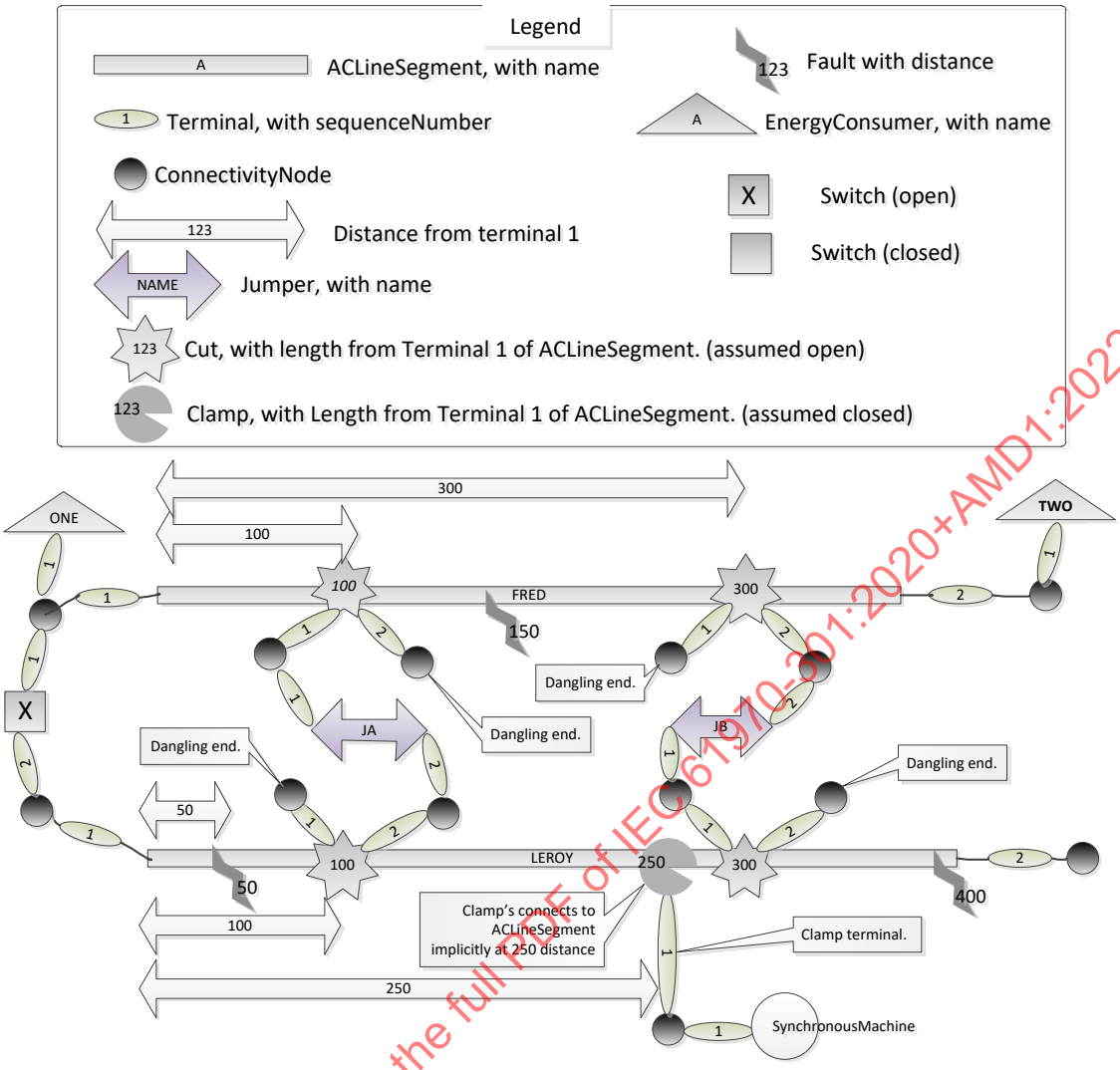


Anglais	Français
Legend	Légende
ACLineSegment, with name	ACLineSegment, avec nom
Terminal, with sequenceNumber	Borne, avec sequenceNumber
ConnectivityNode	ConnectivityNode
Distance from terminal 1	Distance du terminal 1
Fault with distance	Erreur avec distance
EnergyConsumer, with name	EnergyConsumer, avec nom
Switch (open)	Commutateur (ouvert)
Switch (closed)	Commutateur (fermé)
ONE	UN
TWO	DEUX

Figure 31 – Exemple avant application des cuts et des jumpers (cavaliers)

La Figure 32 représente la façon dont le simple ajout de Cut, ConnectivityNode, Jumper, Clamp et éventuellement d'un autre ConductingEquipment peut représenter des changements de modèle qui reflètent un travail temporaire typique. Les mêmes modèles peuvent donc être utilisés pour des changements permanents de modèle. L'exemple présente la façon dont des cuts appliqués aux distances spécifiées peuvent isoler les défauts en laissant pendre les extrémités défectueuses des cuts tandis que le réseau restant est connecté pour fournir les charges. Cet exemple présente également la façon dont plusieurs cuts peuvent être appliqués à un segment de ligne. Cet exemple présente des cuts ouverts, mais si un cut était fermé, le flux pourrait continuer à traverser ACLineSegment, avec une partie du flux potentiellement redirigée vers les bornes du cut, à peu près comme dans le cas d'un clamp (serre-fil).

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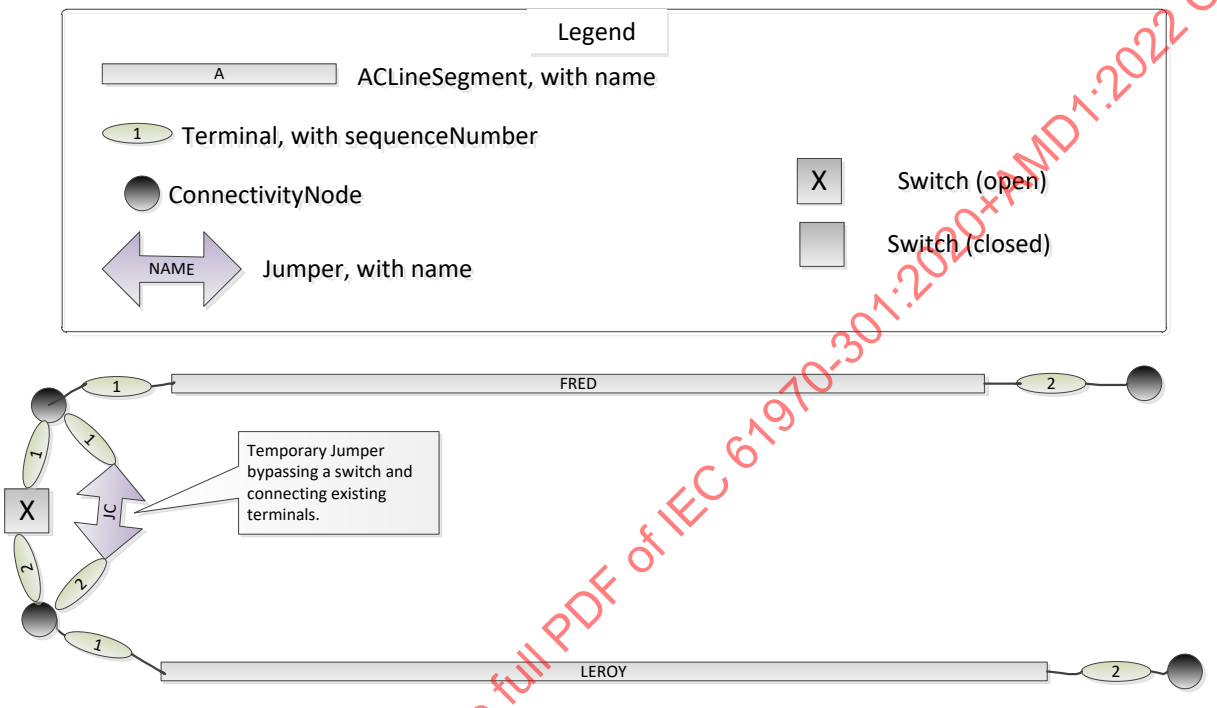
Anglais	Français
Legend	Légende
ACLineSegment, with name	ACLineSegment, avec nom
Terminal, with sequenceNumber	Borne, avec sequenceNumber
ConnectivityNode	ConnectivityNode
Distance from terminal 1	Distance du terminal 1
Jumper, with name	Cavalier, avec nom
Cut, with length from Terminal 1 of ACLineSegment. (assumed open)	Cut, avec longueur du Terminal 1 de ACLineSegment. (réputé être comme ouvert)
Clamp, with length from Terminal 1 of ACLineSegment. (assumed closed)	Serre-fil, avec longueur du Terminal 1 de ACLineSegment. (réputé être ouvert)
Fault with distance	Erreur avec distance
EnergyConsumer, with name	EnergyConsumer, avec nom
Switch (open)	Commutateur (ouvert)
Switch (closed)	Commutateur (fermé)
Dangling end	Extrémité qui pend
Clamp's connects to ACLineSegment implicitly at 250 distance	Le serre-fil se connecte à ACLineSegment de façon implicite à une distance de 250
Clamp terminal	Borne du serre-fil
ONE	UN
TWO	DEUX

Figure 32 – Exemple après application des cuts et des jumpers (cavaliers)

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Un cut fournit deux bornes et bien que l'exemple ci-dessus ne le représente pas, des connexions sont possibles à l'une des bornes du cut ou aux deux. Un cas d'exemple pourrait impliquer l'introduction d'un cut et la connexion des deux bornes de cut à l'aide d'un cavalier qui croise les phases.

Un cavalier peut être utilisé sans serre-fil ni cut lorsque des bornes existantes doivent être connectées. La Figure 33 représente un exemple d'utilisation d'un cavalier sans cut ni serre-fil. Dans ce cas, un cavalier temporaire peut être utilisé pour contourner un commutateur qui fait l'objet d'une maintenance.



Anglais	Français
Legend	Légende
Terminal, with sequenceNumber	Borne, avec sequenceNumber
ConnectivityNode	ConnectivityNode
Jumper, with name	Cavalier, avec nom
Switch (open)	Commutateur (ouvert)
Switch (closed)	Commutateur (fermé)
Temporary Jumper bypassing a switch and connecting existing terminals	Cavalier (Jumper) temporaire de contournement du commutateur et connexion des bornes existantes

Figure 33 – Exemple de cavalier sans cut ni serre-fil

4.5.11 Mesures et commandes

4.5.11.1 Vue d'ensemble des mesures (Measurements)

Les Measurements (mesures) sont utilisés pour représenter les variables d'état qui peuvent être rencontrées dans des processus industriels. Chaque processus industriel a ses types spécifiques de mesures. Un système de puissance a généralement des flux de puissance, des tensions, des positions (par exemple, disjoncteurs, isolateurs), des indicateurs de défauts (pression atmosphérique, pression d'huile, surchauffe, etc.), des compteurs (par exemple, énergie), etc.

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Le nom "Measurement" semble indiquer que toutes les variables d'état sont mesurées. Tel n'est pas toujours strictement le cas, car de nombreux "Measurement" sont calculés par des fonctions SCADA ou EMS/DMS, comme les calculs d'estimateur d'état ou de flux de puissance, par exemple. Par conséquent, un Measurement peut avoir plusieurs valeurs alternatives (par exemple, fournies manuellement, télémesurées, estimées par état, optimisées, etc.). Cela est pris en charge par les modèles Measurement et MeasurementValue dans le paquetage Meas. Les classes dans le paquetage StateVariables ont été ajoutées au modèle CIM, et ce, spécifiquement pour le besoin de prendre en charge l'échange de valeurs calculées par des fonctions telles que l'estimateur d'état et le calcul du flux de la puissance.

Le modèle de Measurement permet désormais de spécifier facultativement les phases spécifiques d'une mesure.

4.5.11.2 Vue d'ensemble des commandes

Les commandes sont utilisées pour représenter les variables de commande. Les variables de commande du système de puissance sont généralement des points de consigne, des commandes augmente/diminue, des commandes "Sélectionner avant d'exécuter" et des commandes marche/arrêt. Le paquetage Meas prend en charge les variables de commande avec le modèle Control.

4.5.11.3 Utilisation des classes liées à la classe Measurement

Un PowerSystemResource (PSR) peut avoir zéro à plusieurs Measurements qui lui sont associés en contenant un ou plusieurs Measurements. Chaque Measurement peut contenir une ou plusieurs valeurs de mesure. Le respect des lignes directrices suivantes permet aux applications de naviguer et de retrouver les valeurs de mesure exigées de manière cohérente (voir Figure 34):

a) les Measurements d'un PowerSystemResource sont classées par l'attribut measurementType (type de mesure). Les valeurs devant être utilisées pour Measurement.measurementType sont spécifiées dans le Tableau 6;

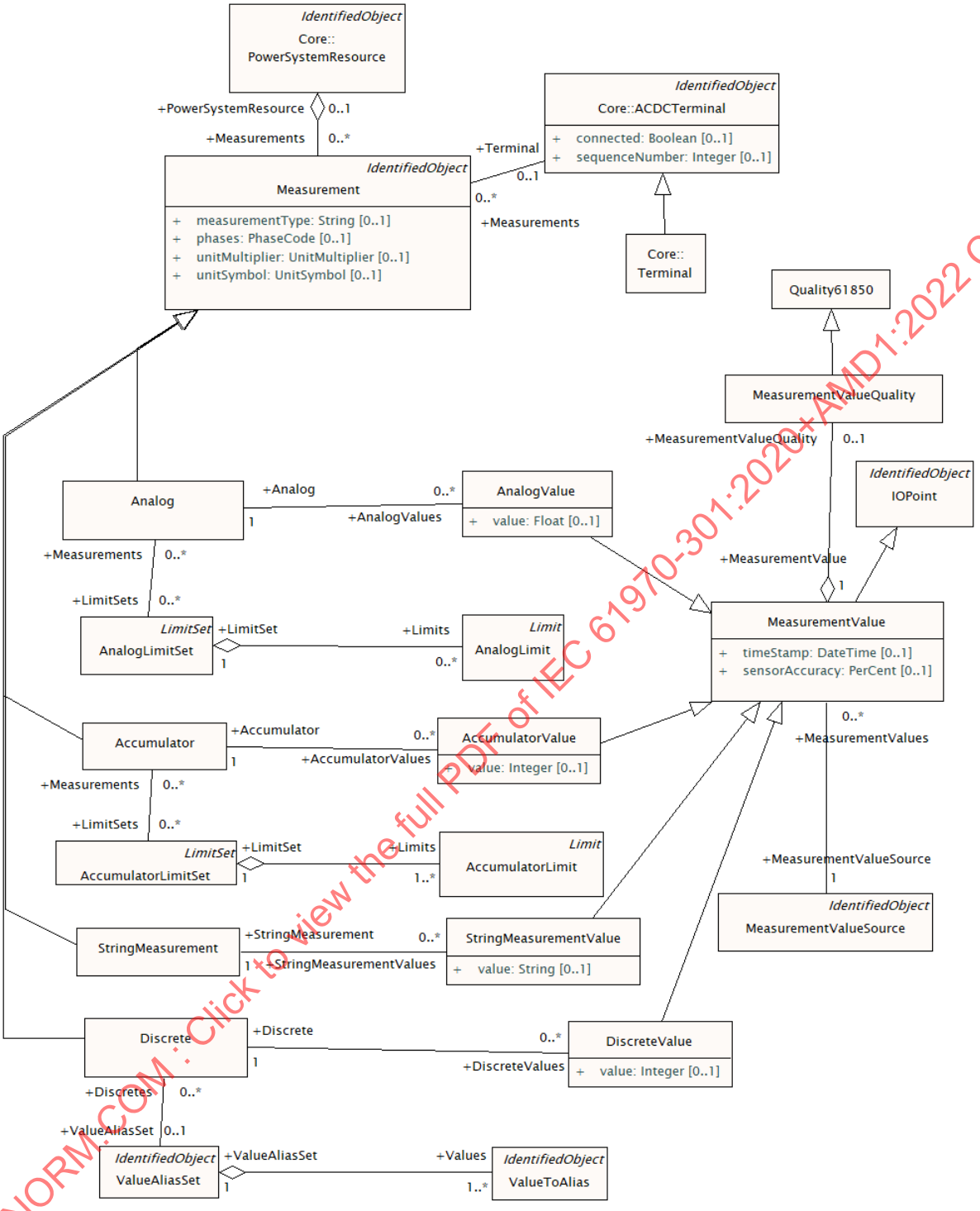
b) les MeasurementValues (valeurs de mesure) d'un Measurement sont classées par MeasurementValueSource (source de valeur de mesure);

c) measurementValueSource hérite de IdentifiedObject. Les valeurs à utiliser pour MeasurementValueSource.name sont spécifiées dans le Tableau 7. Ce tableau fournit plusieurs noms de sources à utiliser lorsque cela est possible. Cependant, les noms exacts à utiliser pour des applications spécifiques sont définis dans le document correspondant IEC 61970 CIS (Component Interface Specifications – Spécification d'interface de composants);

d) les tableaux peuvent être étendus pour des besoins propriétaires. Les noms ajoutés doivent commencer par un nom unique (par exemple, le nom de la société) et un caractère "souligné" ("underscore"). Exemple: xyz_AverageTemperature;

e) la valeur ValueAliasSet est utilisée pour des mesures discrètes et décrit des correspondances de valeurs vers des noms symboliques, comme des libellés d'énumération qui ont des valeurs entières spécifiques. Des protocoles de communication différents (par exemple pour les RTU (Remote Units – unités distantes) et pour les centres de conduite tels que ICCP (Intelligent Customer Contact Platform – plate-forme intelligente de relations avec l'abonné) ou ELCOM) utilisent des codages de données différents. Un système peut avoir une mise en correspondance à l'échelle du système pour toutes les valeurs Discrete (discrètes) ou regrouper les valeurs Discrete et effectuer la mise en correspondance par groupe. La création d'une mise en correspondance à l'échelle du système qui couvrirait des protocoles de communication existants ne relève pas du domaine d'application du présent document.

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Figure 34 – Navigation de PSR à MeasurementValue

Tableau 6 – Conventions de dénomination de measurementType

measurementType	61850 Name	description
Current	Amp	Courant (efficace) d'un circuit non triphasé
ThreePhaseCurrent	AvAmps	Courant total (efficace) dans un circuit triphasé
PhaseCurrent	A	Courant de phase mesuré.
Frequency	Hz	Fréquence
PowerFactor	PwrFact	Facteur de puissance non alloué à une phase
ThreePhasePowerFactor	TotPF	Facteur de puissance moyen dans un circuit triphasé
ThreePhaseApparentPower	TotVA	Puissance apparente totale dans un circuit triphasé
ThreePhaseReactivePower	TotVAr	Puissance réactive totale dans un circuit triphasé
ThreePhaseActivePower	TotW	Puissance réelle totale dans un circuit triphasé.
ApparentPower	VolAmp	Puissance apparente dans un circuit non triphasé
ReactivePower	VolAmpr	Puissance réactive dans un circuit non triphasé
Voltage	Vol	Tension (efficace) non allouée à une phase
ActivePower	Watt	Puissance réelle dans un circuit non triphasé
Pressure	Pres	Pression
Temperature	Tmp	Température
Angle	Ang	Angle entre la tension et le courant
ApparentEnergy	TotVAh	Énergie apparente
ReactiveEnergy	TotVArh	Énergie réactive
ActiveEnergy	TotWh	Énergie réelle
Automatic	Auto	Fonctionnement automatique (non manuel)
LocalOperation	Loc	Fonctionnement local (non télécommandé)
SwitchPosition	Pos	Position de commutation [2bits= intermédiaire,ouvert,fermé,ignorer]
TapPosition	TapPos	Position de prise du transformateur de puissance ou du déphaseur
Operation Count	OperCnt	Compteur d'opérations – généralement pour les commutateurs
LineToNeutralVoltage		Tension phase à neutre
LineToGroundVoltage		Tension phase à terre
Specialization		Utilisé lorsqu'une spécialisation de la classe Analog définit le type de mesure plutôt que l'attribut Measurement.measurementType.

Le Tableau 6 décrit divers types de mesures qui sont aussi définies dans l'IEC 61850. Les colonnes du Tableau 6 ont la signification suivante:

- measurementType (Measurement.measurementType) est le nom du type de mesure selon l'IEC 61970;
- 61850 Name est le nom attribué à l'objet de données dans l'IEC 61850. IEC 61850- 7- 4:2010, sémantique des noms d'objet de données);
- description est la description des données.

Il doit être noté que le Tableau 6 ne constitue pas une liste exhaustive et que la correspondance entre mesures telle que définie dans un centre de conduite et un poste n'est pas triviale.

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Tableau 7 – Conventions de dénomination de MeasurementValueSource (source de valeur de mesure)

Nom	description
SCADA	Valeurs télémesurées reçues d'un système SCADA local
CCLink	Valeur reçue d'un centre de conduite distant par l'intermédiaire de TASE.2 ou autre protocole
Operator	Valeur entrée par un opérateur (toujours maintenue manuellement, le PSR n'est pas connecté à une RTU)
Estimated	Valeur mise à jour par un estimateur d'état
PowerFlow	Valeur mise à jour par un Powerflow (flux de puissance)
Forecasted	Valeur qui est planifiée ou prévisionnelle.
Calculated	Valeur calculée à partir d'autres valeurs de mesure (par exemple, une somme)
Allocated	Valeur calculée par un allocateur de charge

En respectant ces conventions:

- chaque instance de Measurement représente une grandeur technique d'un PowerSystemResource;
- chaque MeasurementValue d'un Measurement représente une valeur pour la grandeur technique, fournie par une source unique;
- l'attribut source de MeasurementValueQuality indique alors si la source a vraiment fourni la valeur courante ou bien si elle est une valeur de substitution ou une valeur par défaut.

Noter qu'une nouvelle identité MeasurementValue n'est pas normalement créée pour chaque échange d'une valeur mesurée. Il est prévu que la même instance MeasurementValue puisse échanger de nouvelles valeurs dans des messages ultérieurs. C'est pourquoi l'identité d'une instance MeasurementValue peut être établie a priori pour échanger des valeurs mesurées. La modélisation d'une série chronologique de valeurs n'est pas explicitement mentionnée dans le modèle du CIM bien que le modèle permette aux systèmes de constituer en interne de tels modèles de série chronologique à l'aide d'une série d'échanges de valeurs de mesure.

4.5.11.4 Rattachement des Measurements

Comme mentionné en 4.5.11.3 et comme représenté à la Figure 34, les Measurements sont contenues par un PowerSystemResource. Cela est suffisant pour des Measurements qui ne sont pas reliées à la connectivité, par exemple la température, le poids, la taille.

Pour spécifier l'emplacement d'un Measurement dans le réseau, une association à Terminal est utilisée. Des exemples sont les flux de puissance, les tensions et les courants. Les tensions (Voltage) n'ont pas de sens et peuvent être jointes en fonction du placement du capteur. Les flux ont un sens et doivent être joints de façon à ce que le sens du flux soit évident d'après le placement.

La Figure 35 représente deux exemples de placement de Measurements.

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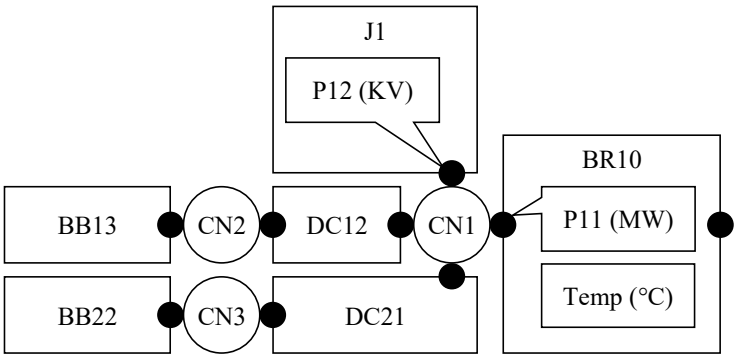


Figure 35 – Placement de Measurement

P12 est un Measurement de tension qui mesure la tension à la jonction J1. P12 est topologiquement relié au ConnectivityNode CN1 via la Terminal de la jonction J1. P11 est un Measurement qui mesure le flux traversant le disjoncteur BR10 du côté connecté au ConnectivityNode CN1. P11 est topologiquement relié au ConnectivityNode CN1 via la Terminal gauche du disjoncteur BR10. Temp est un Measurement qui mesure la température du disjoncteur. Comme la température n'est pas reliée à la connectivité, elle n'a pas de relation avec une Terminal – elle appartient seulement au disjoncteur BR10.

4.5.12 Modèles de commande de régulation

Une commande de régulation, par exemple une commande automatique de tension sur des générateurs ou une commande de prise de tension sur des transformateurs, est modélisée en utilisant la classe RegulatingControl qui offre la possibilité de modéliser plusieurs instances d'équipements qui participent à un plan de régulation. Ces plans de régulation peuvent être physiques ou mis en œuvre manuellement dans le fonctionnement réel du système de puissance, mais ils sont reflétés dans les modèles utilisés à des fins d'analyse des systèmes de puissance. La Figure 36 représente la façon dont les classes RegulatingCondEq et TapChanger peuvent participer à la régulation.

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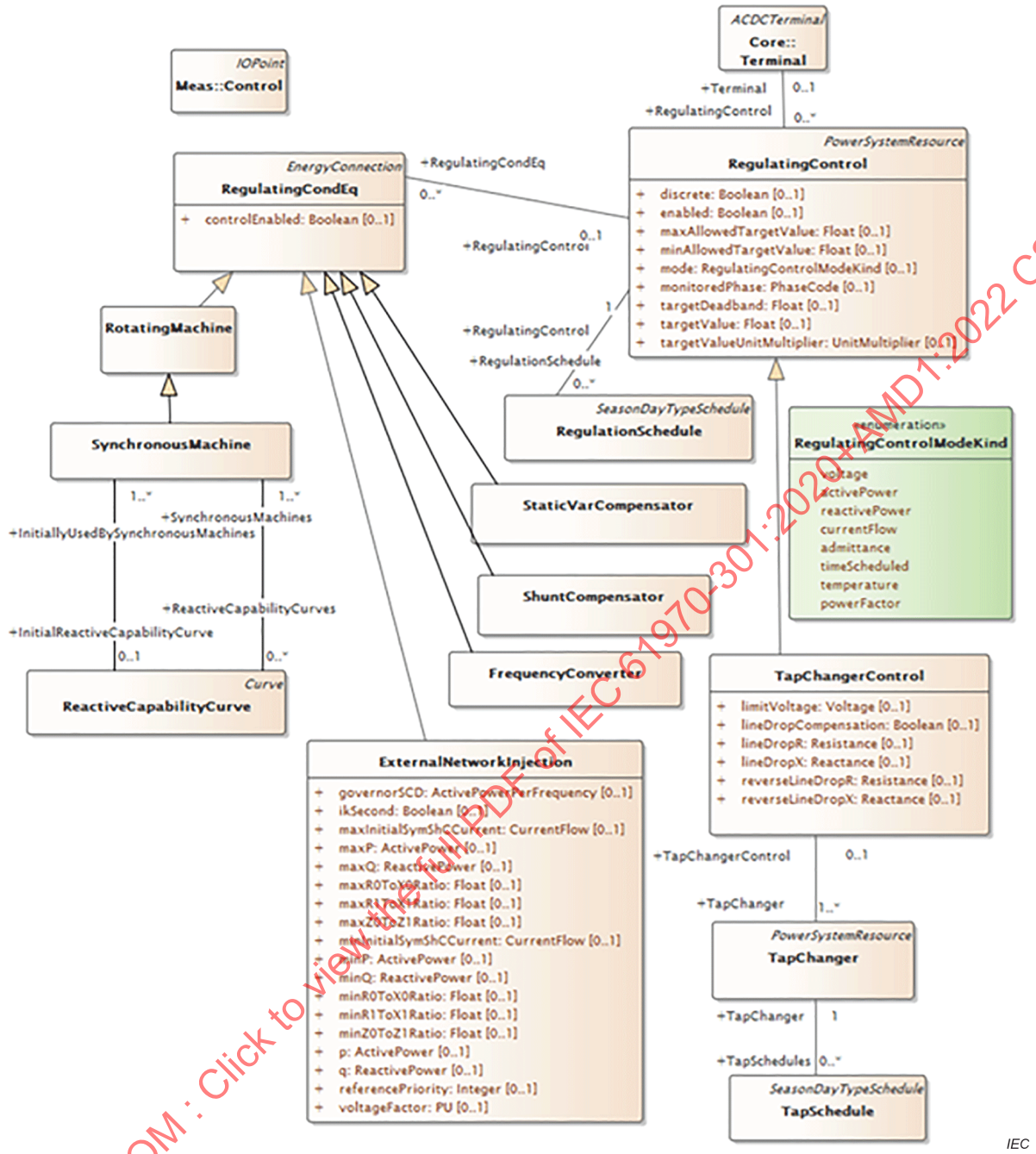


Figure 36 – Modèles de commande de régulation

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4.5.13 Modèle en courant continu pour le CIM

4.5.13.1 Introduction

4.5.13.1.1 Généralités

Les systèmes de commande qui modélisent l'interconnexion en courant continu à haute tension ont généralement trois niveaux de détail en matière de modélisation:

- le modèle simplifié d'injection n'utilisant pas le paquetage en courant continu du CIM;
- le modèle détaillé de courant continu à haute tension (CCHT) utilisant le paquetage en courant continu du CIM avec les postes CCHT fictifs;
- le modèle détaillé de courant continu à haute tension (CCHT) utilisant le paquetage en courant continu du CIM sans les postes CCHT fictifs.

Le présent document a pour objet de présenter le modèle de courant continu à haute tension le plus minimaliste possible pouvant être utilisé dans les calculs de flux de puissance de systèmes SCADA/EMS/de planification et de court-circuit et dans les études dynamiques. Les études transitoires ne sont pas couvertes.

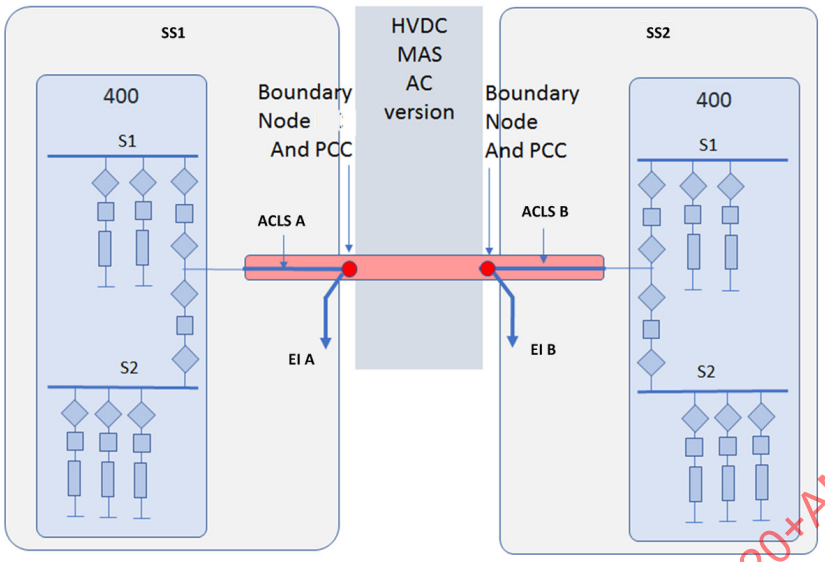
Les règles générales suivantes sont définies:

- le flux traversant un pôle en courant continu se rapporte au Point de couplage commun (PCC) aux extrémités d'un pôle. Ceci signifie que le PCC est toujours du côté du courant alternatif;
- le modèle détaillé CCHT utilisant le paquetage en courant continu du CIM sans postes CCHT fictifs constitue la modélisation préférentielle car il correspond à la méthode de construction des postes et de dénomination des équipements;
- les règles de commutation des filtres de courant alternatif des LCC ne sont pas prises en charge par la norme;
- le transformateur convertisseur est généralement raccordé aux commutateurs situés dans un VoltageLevel auquel le réseau en courant alternatif est raccordé;
- les filtres sont généralement situés dans le VoltageLevel auquel le transformateur convertisseur est raccordé;
- le transformateur convertisseur n'utilise aucun TapChangerControl, la fonction de commande est définie dans les ACDCConverter-s;
- la borne du côté haute tension du transformateur convertisseur, la plus proche du réseau en courant alternatif, doit être associée au point limite (Boundary Point)/point de connexion (Connection point) avec les autres MAS *(Master Authority Set* – Entité principale responsable des données);
- le transformateur convertisseur et chaque instance de ACDCConverter, appartenant au même pôle de poste, ainsi que tous les équipements de commande du convertisseur, les dispositifs essentiels de protection et de commutation et les appareils auxiliaires, le cas échéant, utilisés pour la conversion, doivent être contenus dans la même instance de conteneur cim:DCConverterUnit. Ceci s'applique également aux compensateurs shunt et série du côté basse tension du transformateur convertisseur et aux inductances de lissage en courant continu;
- en cas d'installations dos à dos, deux instances séparées de DCConverterUnit sont utilisées, chacune étant associée à un transformateur convertisseur;
- toutes les lignes et tous les câbles aériens raccordant deux postes ou plus doivent être contenus dans le même conteneur DCLine pour chaque pôle de système CCHT.

4.5.13.1.2 Modèle simplifié d'injection

Le modèle simplifié d'injection représenté à la Figure 37 raccorde les postes réels à chaque extrémité du pôle en courant continu à la Line comportant deux limites ConnectivityNodes (CN) ou TopologicalNodes dans le cas d'une représentation du modèle en topologie nodale, une pour chaque extrémité de pôle en courant continu. Les CN constituent également le Point de couplage commun (PCC) de chaque côté. Les postes réels raccordent la limite CN/PCC avec un ACLineSegment (ACLS) et une EquivalentInjection (EI).

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Anglais	Français
Boundary Node And PCC	Nœuds limites et PCC

Figure 37 – Exemple simplifié de représentation d'un modèle CCHT

Les éléments en bleu dans la Figure 37 représentent les objets dans un MAS régulier et les éléments en rouge représentent les objets dans une limite MAS.

Les ACLS "A", EI "A", ACLS "B" et EI "B" sont situés au niveau des PCC de chaque côté du pôle en courant continu. Les PCC représentent les nœuds limites ou les points de connexion convenus par les parties responsables du MAS de SS1 et SS2.

Pour un convertisseur de source de courant, la puissance réactive est fixée à zéro en partant du principe que la consommation de puissance réactive est maintenue à un niveau pratiquement nul par les filtres de courant alternatif. Si le poste à courant alternatif modélise les filtres de courant alternatif, la consommation de puissance réactive du LCC doit alors être prise en considération. La consommation de puissance réactive peut généralement être approchée par une demande en puissance réactive approximativement égale à 0,45-0,55 de la valeur absolue du transfert de puissance active. Lorsque les pôles CCHT sont remplacés par une représentation interne caractérisée par deux "modèles simplifiés d'injection CCHT", et que le transferr de puissance est modifié, la puissance réactive peut se maintenir à la même valeur. Ceci facilite l'application de la solution de flux de puissance sans nécessiter la commutation des filtres de courant alternatif.

Pour les convertisseurs de source de courant, les capacités de contrôle de la puissance réactive peuvent être définies en établissant les attributs EquivalentInjection.regulationCapability et regulatingStatus à True (vrai). Les limites minQ et maxQ ou la ReactiveCapabilityCurve associée doivent refléter la plage de capacité réactive si regulatingStatus est True (vrai).

4.5.13.1.3 Modèle détaillé CCHT utilisant le paquetage en courant continu du CIM et des postes CCHT fictifs

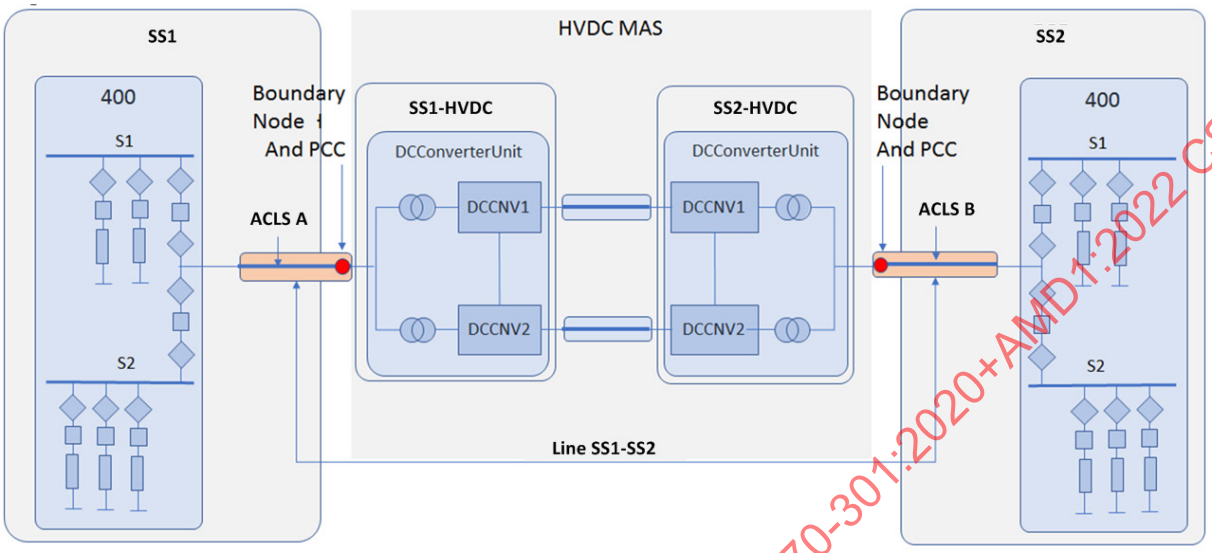
Un modèle détaillé comprend les éléments suivants:

- les postes réels de chaque côté de la connexion;
- la même limite que celle pour le modèle simplifié car dans tous les cas, les liaisons CCHT ont deux points limite/de connexion, voir 4.5.13.1.2;

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- pour chaque poste réel, un poste fictif qui représente la partie CCHT et se raccorde à la limite des PCC à chaque extrémité de pôle de courant continu.

La Figure 38 représente un modèle détaillé d'une connexion CCHT.



Anglais	Français
Boundary Node And PCC	Nœuds limites et PCC

Figure 38 – Exemple détaillé de représentation de modèle CCHT avec postes CCHT fictifs

Les éléments en bleu dans la Figure 38 représentent les objets dans un MAS régulier et les éléments en rouge représentent les objets dans la limite.

Les postes SS1 et SS2 constituent les postes réels, SS1-HVDC et SS2-HVDC constituent les postes fictifs avec l'équipement CCHT. "SS1-SS2" représente la limite Line avec les deux limites CN/PCC qui se raccordent aux pôles de courant continu.

Pour convertir un modèle détaillé en modèle simplifié, les postes CCHT fictifs sont retirés et les EI au niveau des PCC sont insérés.

4.5.13.1.4 Modèle détaillé CCHT utilisant le paquetage en courant continu du CIM sans postes CCHT fictifs

Le modèle CCHT préférentiel est constitué de tous les composants situés dans le poste réel sans postes fictifs ou limite Lines comme cela est représenté à la Figure 39.

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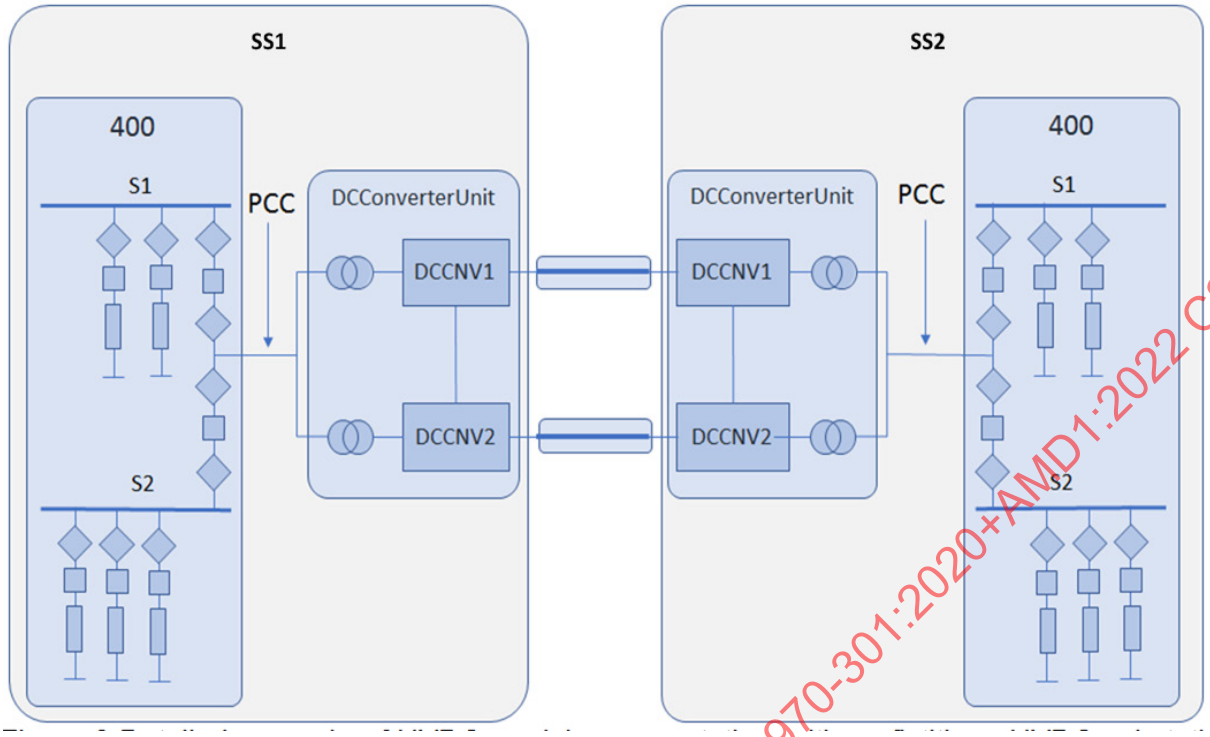


Figure 39 – Exemple détaillé de représentation de modèle CCHT sans postes CCHT fictifs

Un point limite dans un poste est défini par les flèches du PCC dans la Figure 39.

Il n'est pas facile de convertir un modèle détaillé CCHT utilisant le paquetage en courant continu du CIM sans postes CCHT fictifs en un modèle simplifié. Il doit tout d'abord être transformé en un modèle détaillé CCHT utilisant le paquetage en courant continu du CIM avec modèle de postes CCHT fictifs avant de pouvoir être converti.

4.5.13.2 Conception de base de courant continu à haute tension

4.5.13.2.1 Généralités

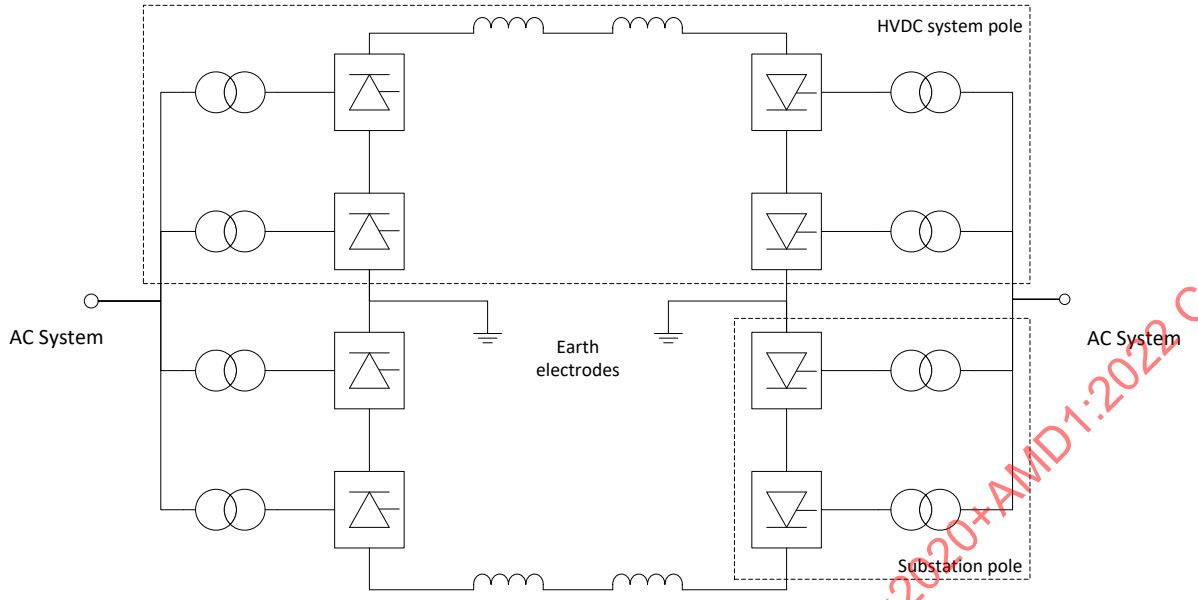
Le modèle proposé est issu des documents suivants:

- IEC 60633:1998+AMD1:2009, *Terminologie pour le transport d'énergie en courant continu à haute tension (CCHT);*
- "VSC Transmission", CIGRÉ B4-37, avril 2005;
- IEC 62747, *Terminologie relative aux convertisseurs de source de tension (VSC) des systèmes en courant continu à haute tension (CCHT);*
- HVDC Transmission by Dennis A. Woodford, Manitoba HVDC Research Centre;
- "ABB technical description of HVDC light technology";
- Flexible Power Transmission. Jos Arrillaga, Y. H. Liu, Neville R. Watson, 2007;
- "Power System Stability Benefits with VSC DC-Transmission Systems", CIGRÉ B4- 204, 2004.

4.5.13.2.2 Topologie d'un VSC (voltage source converter – convertisseur de source de tension)

Une liaison CCHT d'une source de courant est modélisée comme représenté à la Figure 40.

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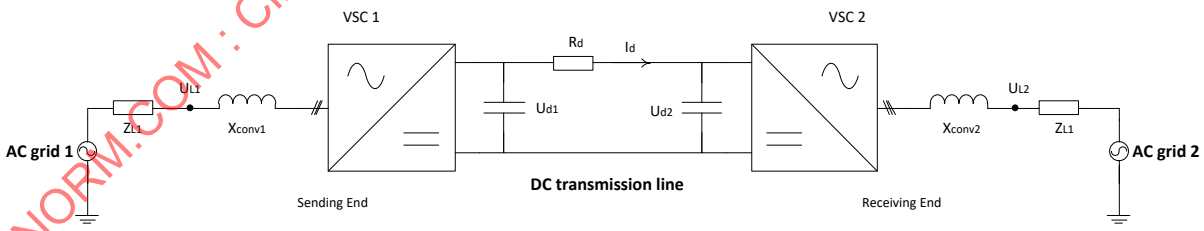


Anglais	Français
HVDC system pole	Pôle de système CCHT
AC System	Système en courant alternatif
Earth electrodes	Électrodes mises à la terre
Substation pole	Pôle du poste

Figure 40 – Liaison CCHT bipolaire issue de l'IEC 60633

Une liaison CCHT bipolaire est constituée de deux pôles, l'un avec une polarité positive et l'autre avec une polarité négative, les deux ayant leurs points naturels mis à la terre. Aucun flux de courant à la terre ne revient, car la circulation de courant dans les pôles est la même. Pour un CCHT CSC, le transformateur doit être modélisé de manière explicite.

4.5.13.2.3 Topologie d'un VSC (voltage source converter – convertisseur de source de tension)



Anglais	Français
AC grid 1	Réseau en courant alternatif 1
Sending end	Extrémité émettrice
DC transmission line	Ligne de transport de courant continu
Receiving end	Extrémité de réception
AC grid 2	Réseau en courant alternatif 2

Figure 41 – Schéma de transport point à point par un VSC

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Le schéma de transport point à point par un VSC représenté à la Figure 41 est constitué de deux VSC interconnectés du côté courant continu par le biais d'une ligne de transport de courant continu et connectés aux deux différents systèmes en courant alternatif du côté courant alternatif. L'une des caractéristiques du VSC est que la polarité de la tension continue est toujours la même. Par conséquent, le sens du flux de puissance sur la ligne de courant continu est déterminé par le sens du courant continu.

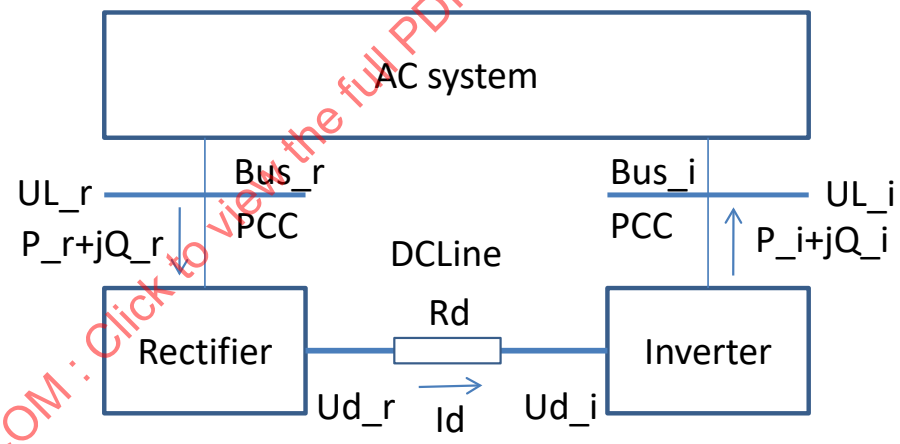
Le sens du courant continu va toujours du niveau de tension continue le plus élevé au niveau de tension continue le plus faible. La tension continue à l'extrémité émettrice de la ligne de courant continu doit, par conséquent, être plus élevée que la tension continue à l'extrémité de réception.

Dans un convertisseur commuté en ligne CCHT, le flux de puissance en courant continu peut être commandé en maintenant la tension continue au niveau du convertisseur à l'extrémité de réception (l'onduleur) à une valeur constante, et en laissant le convertisseur à l'extrémité émettrice (le redresseur) commander le courant continu. La même approche peut être utilisée pour le transport par VSC. Cependant, une des principales différences est que dans un convertisseur commuté en ligne CCHT, le sens du courant est toujours le même. Par conséquent, le sens de la puissance est modifié lors de la modification de la polarité de la tension continue.

4.5.13.3 Modélisation de flux de puissance CCHT

4.5.13.3.1 Généralités

Un modèle de flux de puissance dérivé de la Figure 41 est représenté à la Figure 42.



Anglais	Français
AC system	Système en courant alternatif
Rectifier	Redresseur
Inverter	Onduleur
PCC = Point of Common Coupling	PCC = point de couplage commun

Figure 42 – Modèle de flux de puissance CCHT

Les variables côté courant alternatif sont les suivantes:

- P est l'injection de puissance active côté courant alternatif au niveau du redresseur (indice r) et de l'onduleur (indice i);

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- Qest l'injection de puissance réactive côté courant alternatif au niveau du redresseur (indice r) et de l'onduleur (indice i);
- U_{L} est l'injection de tension côté courant alternatif au niveau du redresseur (indice r) et de l'onduleur (indice i).

Les variables côté courant continu sont les suivantes:

- U_{d} est l'injection de tension côté courant continu au niveau du redresseur (indice r) et de l'onduleur (indice i);
- U_{dN} est la tension continue assignée;
- I_{d} est le courant de la ligne de courant continu;
- I_{dN} est le courant assigné de la ligne de courant continu;
- R_{d} est la résistance de la ligne de courant continu.

L'interface entre le système CCHT et le système en courant alternatif est établie par les deux bus Bus_r et Bus_i. La tension aux bornes de Bus_r est $U_{\mathrm{L_r}}$ et la tension aux bornes de Bus_i est $U_{\mathrm{L_i}}$. La puissance injectée dans le redresseur depuis le système en courant alternatif est $P_{\mathrm{r}} + jQ_{\mathrm{r}}$ et la puissance injectée dans l'onduleur est $P_i + jQ_{\mathrm{i}}$. Les bus Bus_r et Bus_i proviennent du système en courant alternatif et sont perçus comme des nœuds PQ pour une source de courant CCHT et comme nœuds PV pour une source de tension CCHT. Pour les nœuds PQ, les injections $P_{\mathrm{r}} + jQ_{\mathrm{r}}$ et $P_{\mathrm{i}} + jQ_{\mathrm{i}}$ et pour les nœuds PV, l'injection de puissance active et la tension $P_{\mathrm{r}}, UL_{\mathrm{r}}$ et $P_{\mathrm{i}}, UL_{\mathrm{i}}$ sont calculées à partir de la liaison CCHT. Les conditions initiales de la liaison CCHT sont fournies de deux manières:

- P_{r} ou P_{i} ;
- $U_{\mathrm{d_r}}$ ou $U_{\mathrm{d_i}}$.

La relation entre les variables est donnée par $I_d = P_{\mathrm{r}}/U_{d_{\mathrm{r}}} = P_{\mathrm{i}}/U_{\mathrm{d}_i}$.

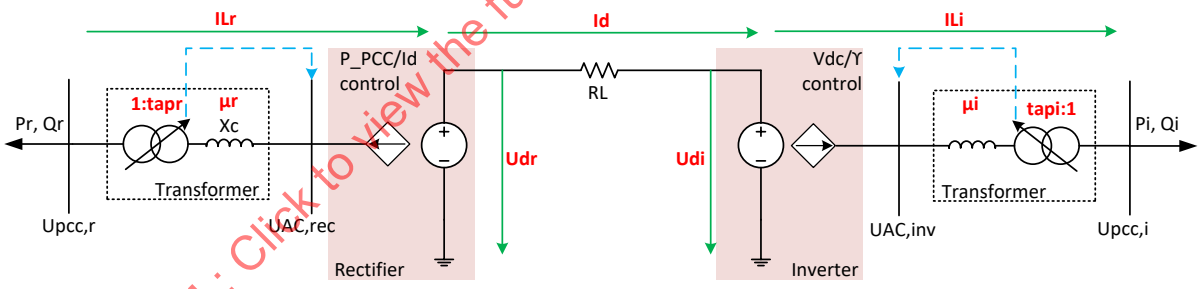


Figure 43 – Modèle détaillé de flux de puissance CCHT

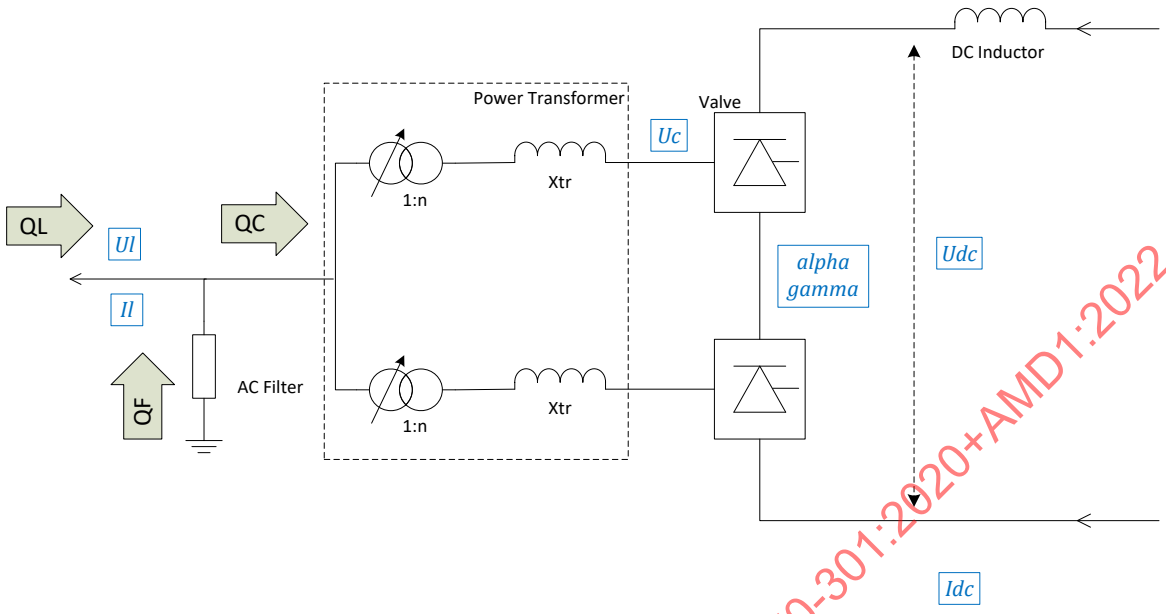
La puissance active et la puissance réactive au niveau des PCC sont dérivées, pour les convertisseuts sans pertes, par les équations suivantes:

- $P_{\mathrm{r}} = U_{\mathrm{dr}} * I_{\mathrm{d}}$;
- $Q_{\mathrm{r}} = U_{\mathrm{d0r}} * I_{\mathrm{d}} * \frac{\sin 2\alpha - \sin 2(\alpha - \mu_r) + 2\mu_r}{4*(\cos\alpha - \cos(\alpha + \mu_r))}$;
- $P_i = -U_{\mathrm{d}i} * I_{\mathrm{d}}$
- $Q_i = U_{\mathrm{d0}i} * I_{\mathrm{d}} * \frac{\sin 2\gamma - \sin 2(\gamma - \mu_r) + 2\mu_r}{4*(\cos\gamma - \cos(\gamma + \mu_r))}$.

Le flux de puissance est représenté à la Figure 44 et à la Figure 45.

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4.5.13.3.2 Convertisseur de source de courant (CSC)



Anglais	Français
DC inductor	Inductance de courant continu
Power transformer	Transformateur de puissance
Valve	Valve
AC filter	Filtre de courant alternatif

Figure 44 – Flux de puissance d'un convertisseur de source de courant

Dans un convertisseur de source de courant, la puissance réactive n'est pas commandée. Au lieu de cela, elle est déterminée par l'angle d'amorçage de pont qui affecte le facteur de puissance. Les équations des CSC exigent une commande en cascade de la réactance de commutation, du changeur de prises et de l'angle d'amorçage. La réactance de commutation pour les CsConverters est fondée sur le PowerTransformer qui appartient à DcConverterUnit, c'est-à-dire que l'impédance du transformateur convertisseur est utilisée en tant que Xc. La commande du changeur de prises pour le réglage de l'angle d'amorçage utilise également les données du changeur de prises du transformateur convertisseur. Dans le cas d'un changeur de prises partagé dans les configurations à 2 ponts à 6 impulsions (transformateur convertisseur à 3 enroulements), les ponts à 6 impulsions doivent être commandés en maître/esclave.

Les équations suivantes doivent être prises en compte:

- $U_{\mathrm{d}} = U_{\mathrm{d0}} * \cos\alpha - \left(\frac{3}{\pi}\right) * X_{\mathrm{tr}} * I_{\mathrm{d}} * B$ ou $U_{\mathrm{d}} = U_{\mathrm{d0}} * \cos\gamma - \left(\frac{3}{\pi}\right) * X_{\mathrm{tr}} * I_{\mathrm{d}} * B$;
- $\varphi \approx cos^{-1}\left(\frac{V_d}{V_{d0}}\right)$;
- $P = V_{\mathrm{d}} * I_{\mathrm{d}} = P_{\mathrm{ac}}$;
- $Q = P * tan\varphi$
- tension continue assignée: $U_{\mathrm{d0}} = ((3 * \sqrt{2})/\pi) * U_{\mathrm{C}} * B * T$;
- $U_{\mathrm{t}} = U_{\mathrm{L}} * tapratio$.

L'approximation de l'injection de puissance réactive peut être présentée de la manière suivante:

- $Q_{\mathrm{L}} = Q_{\mathrm{C}} - Q_{\mathrm{F}} = \left(\frac{P}{2}\right) - Q_{\mathrm{F}} \approx \frac{P}{2}$

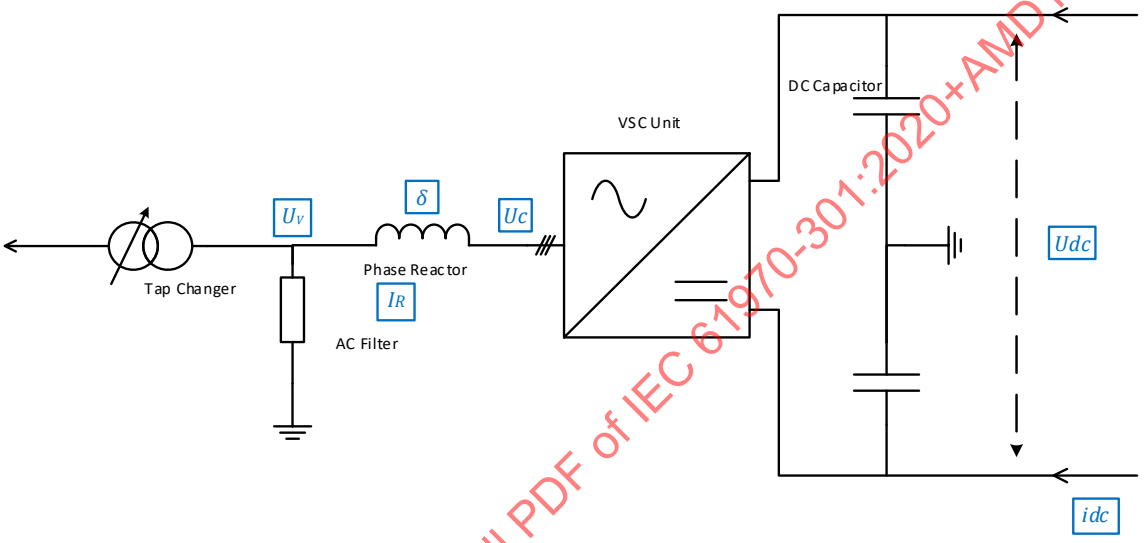
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où:

- α – angle d'amorçage;
- B – nombre de ponts en séries;
- T – rapport des nombres de spires du transformateur;
- I_d, V_d – courant continu et tension continue par pôle.

4.5.13.3.3 Convertisseur de source de tension

Les composants électriques et leurs interconnexions au sein d'un convertisseur sont représentés à la Figure 45. La Figure 45 sert de référence pour les formules en 4.5.13.3.



Anglais	Français
Tap Changer	Changeur de prises
Phase Reactor	Composant réactif de phase
VSC Unit	Unité de VSC
DC Capacitor	Condensateur de courant continu
AC Filter	Filtre de courant alternatif

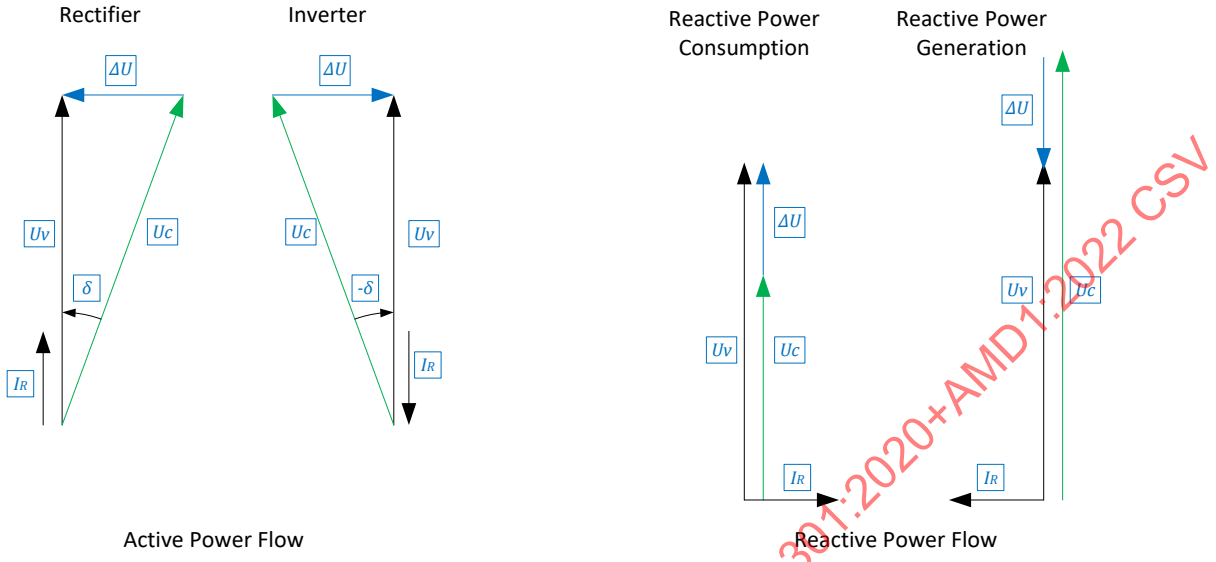
Figure 45 – Flux de puissance d'un convertisseur de source de tension

Les paramètres supplémentaires qui viennent s'ajouter à ceux énumérés précédemment sont les suivants:

- U_{dc} est la tension côté courant continu du VSC;
- I_{dc} est le courant côté courant continu du VSC;
- U_C est la tension côté courant alternatif du VSC, également appelée tension du convertisseur;
- U_V est la tension aux bornes du bus du filtre;
- l'indice de modulation est le rapport entre U_{dc} et U_C. Il s'agit d'un paramètre du VSC dont les valeurs types sont comprises entre 0 et 1;
- I_R est le courant qui circule dans le composant réactif de phase;
- X_C est la réactance du composant réactif de phase;
- δ est l'angle entre les tensions U_V et U_C.

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Les diagrammes de la Figure 46 représentent les vecteurs de tension et les cas de flux de puissance subséquents.



Anglais	Français
Rectifier	Redresseur
Inverter	Onduleur
Reactive Power Consumption	Consommation de puissance réactive
Reative Power Generation	Production de puissance réactive
Active Power Flow	Flux de puissance active
Reactive Power Flow	Flux de puissance réactive

Figure 46 – Cas de flux de puissance

Le comportement du redresseur et de l'onduleur peut être décrit par un ensemble de formules ayant les mêmes paramètres, dont certains sont représentés à la Figure 42 et la Figure 45.

- U_{rated} est la tension continue assignée du convertisseur (une de chaque pour le redresseur et l'onduleur).
- S_{rated} est la puissance continue assignée du convertisseur.
- R_{C} est la résistance du composant réactif de phase
- nombre de ponts de convertisseur (un de chaque pour le redresseur et l'onduleur)
- I_{dmax} et I_{dmin} sont les limites supérieure et inférieure du flux en courant continu.
- R_{d} est la résistance de la ligne de courant continu.
- Les composants actif et réactif (voir la Figure 46) sont calculés par $P = U_{\text{V}} * U_{\text{C}} * (\sin(\delta)/X_{\text{C}})$
- $Q = U_{\text{V}} * (U_{\text{V}} - U_{\text{C}}) * (\cos(\delta)/X_{\text{C}})$

Les pertes au niveau d'un pôle sont décrites par l'équation:

- $P(poleLoss) = idleLossFactor + switchLossFactor * I_{\text{dc}} + resistiveLossFactor * I_{\text{dc}} + resistiveLossFactor * I_{\text{dc}}^2$

Où:

- $P_{\text{dc}} = P_{\text{ac}}$ pour un fonctionnement sans perte;

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- $P_{dc} = P_{ac} - P_{loss}$ pour un fonctionnement du redresseur avec des pertes;
- $P_{dc} = P_{ac} + P_{loss}$ pour un fonctionnement de l'onduleur avec des pertes.

La Figure 47 représente un diagramme de convertisseur de source de tension à monopole symétrique.

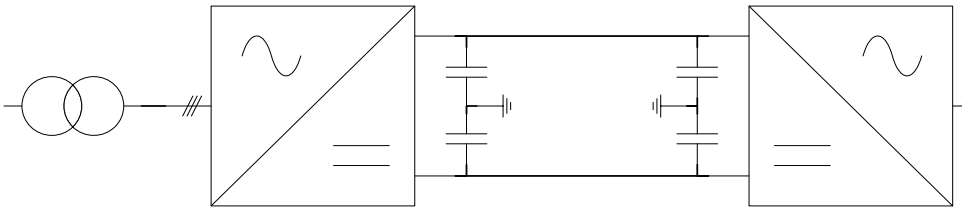
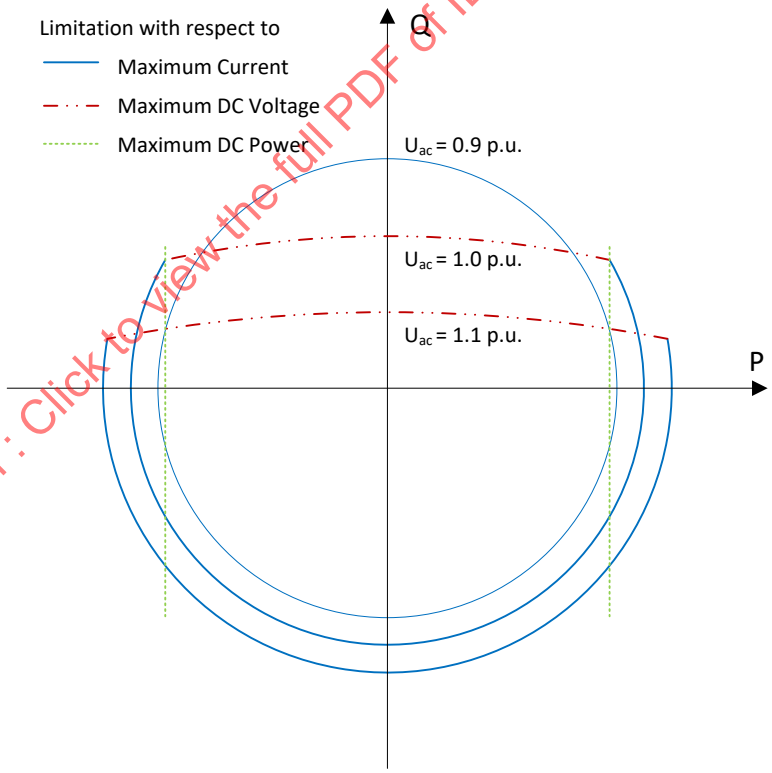


Figure 47 – Transport par VSC à monopole symétrique représenté avec mise à la terre capacitive côté courant continu (IEC 62747)

En commandant l'angle δ entre les tensions U_V/U_C et l'écart de tension $U_V - U_C$, la commande indépendante des puissances active et réactive est possible.

Les limites des résultats donnés par le VSC donnent lieu à une courbe P-Q. Un exemple de courbe P-Q est représenté à la Figure 48.



Anglais	Français
Limitation with respect to	Limite relative
Maximum Current	À l'intensité maximale
Maximum DC Voltage	À la tension continue maximale
Maximum DC Power	À la puissance continue maximale

Figure 48 – Courbe de capacité P-Q du VSC

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Le VSC peut également être utilisé dans les configurations bipolaires, comme représenté à la Figure 49.

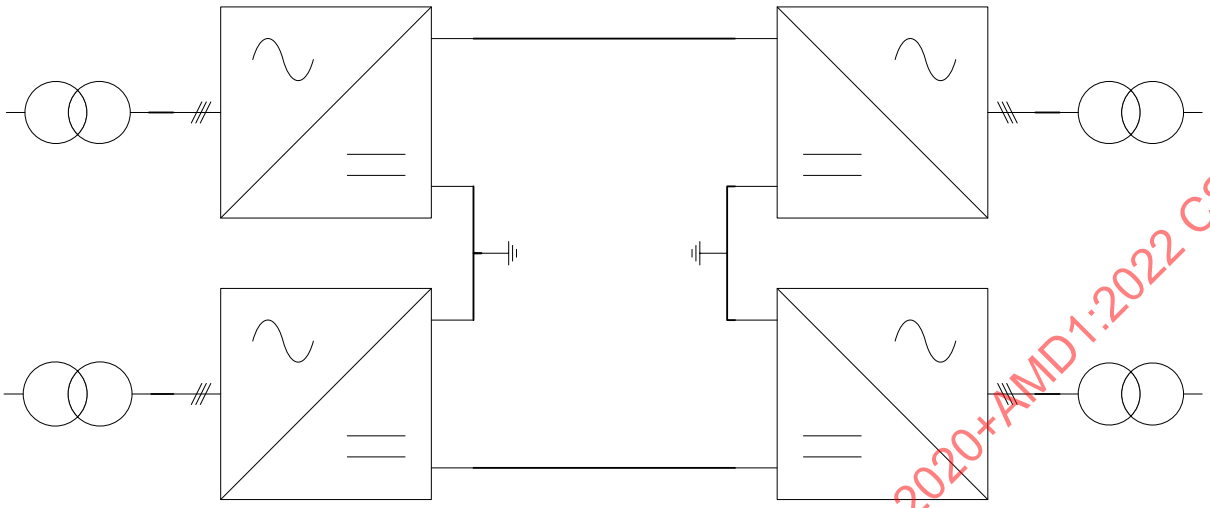


Figure 49 – Transport par VSC bipolaire avec retour par la terre (IEC 62747)

Dans cette configuration, deux câbles CCHT sont utilisés pour les tensions positives (+DC) et négatives (−DC). Une tension médiane est utilisée pour le neutre.

4.5.13.4 Modèle de données

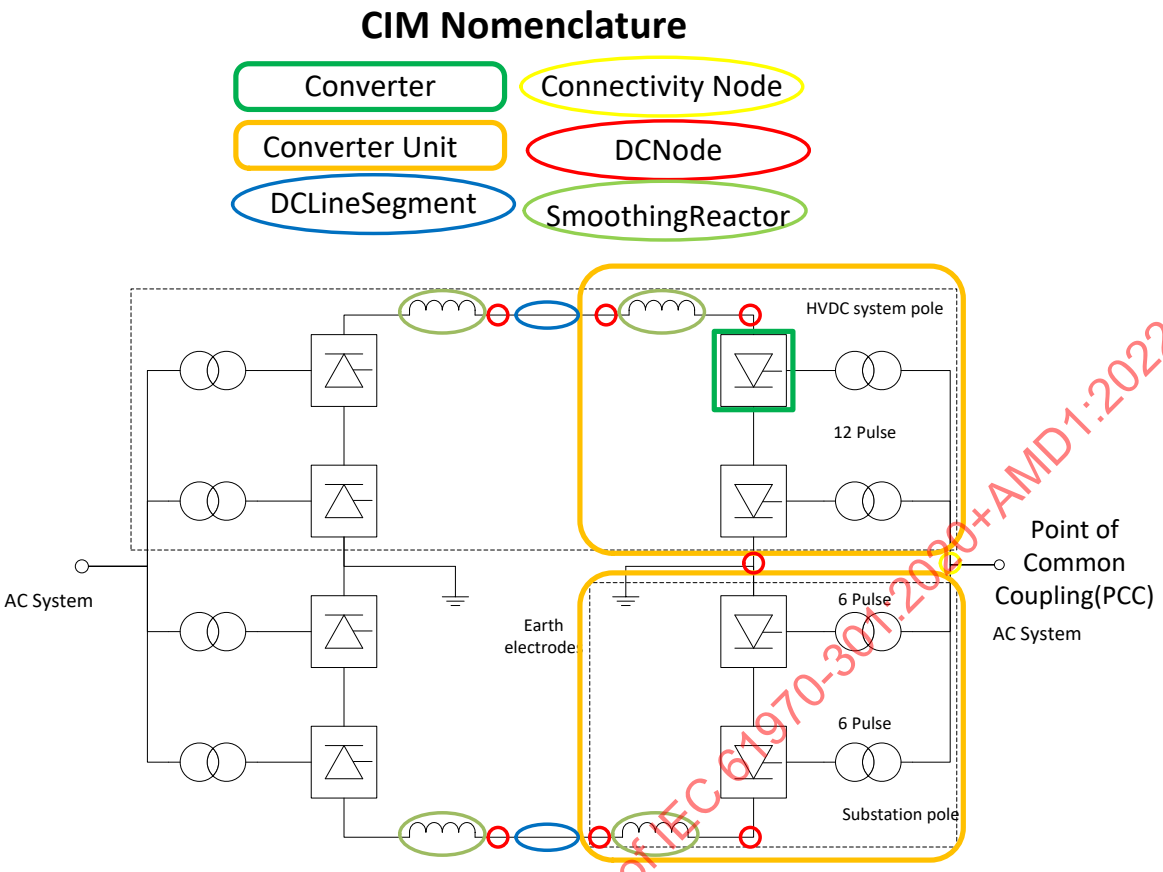
4.5.13.4.1 Généralités

Un modèle de données est créé sur la base des hypothèses suivantes.

- La DCConverterUnit du CIM est identique à celle du pôle de poste de l'IEC 60633 qui est un conteneur.
- Le pôle de système de l'IEC 60633 n'est pas modélisé dans le CIM. Cela s'explique par le fait que le pôle de système de l'IEC°60633 n'est pas pertinent pour les réseaux en courant continu. Les ponts, les filtres et les montages en pont ne sont pas explicitement modélisés dans le CIM et sont considérés comme faisant partie du Converter.
- L'utilisation de ConnectivityNode et Terminal également pour la connectivité dans les réseaux en courant continu établit une connexion ensemble des composants en courant continu et en courant alternatif, c'est-à-dire une erreur. Les attributs ont également différentes significations dans les réseaux en courant alternatif et en courant continu. Par exemple, DCNode n'a pas d'angle de phase ou d'injection de puissance réactive. Par conséquent, les artéfacts sont utilisés pour décrire les réseaux en courant alternatif et en courant continu.

La Figure 50 donne un exemple d'objets modélisés d'une ligne CCHT de source bipolaire de courant.

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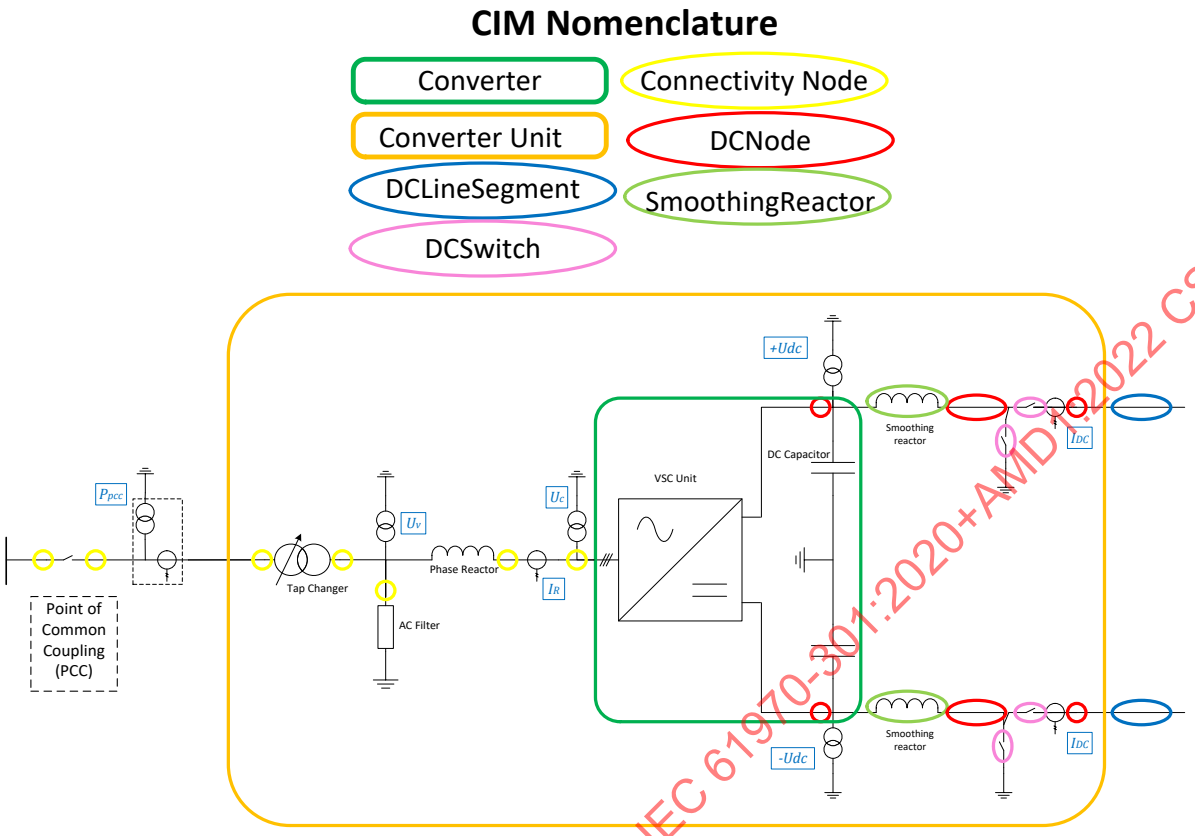
Anglais	Français
CIM Nomenclature	Nomenclature du CIM
Converter	Convertisseur
Connectivity Node	Nœud de connectivité
Converter Unit	Unité de convertisseur
DCNode	DCNode
DCLineSegment	DCLineSegment
SmoothingReactor	SmoothingReactor
HVDC System pole	Pôle du système CCHT
12 Pulse	12 impulsions
AC system	Système en courant alternatif
Earth electrode	Électrode de mise à la terre
Point of Common Coupling (PCC)	Point de couplage commun (PCC)
Substation pole	Pôle du poste

Figure 50 – Instances d'objets d'une ligne CCHT de source bipolaire de courant

La Converter Unit (unité de convertisseur) est l'objet qui établit un pont entre les réseaux en courant alternatif et ceux en courant continu.

Le diagramme correspondant pour les VSC est représenté à la Figure 51.

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Anglais	Français
CIM Nomenclature	Nomenclature du CIM
Converter	Convertisseur
Connectivity Node	Nœud de connectivité
Converter Unit	Unité de convertisseur
DCNode	DCNode
DCLineSegment	DCLineSegment
SmoothingReactor	SmoothingReactor
DCSwitch	DCSwitch
Point of Common Coupling (PCC)	Point de couplage commun (PCC)
Tap changer	Changeur de prises
AC Filter	Filtre de courant alternatif
Phase Reactor	Composant réactif de phase
VSC Unit	Unité de VSC
DC Capacitor	Condensateur de courant continu
Smoothing reactor	Inductance de lissage

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Figure 51 – Instances d'objets d'un modèle de données CCHT d'un VSC à monopole symétrique

Comme indiqué dans la Figure 50 et la Figure 51, un poste CCHT est constitué

- d'un ou de plusieurs convertisseurs;
- de SmoothingReactors (inductances de lissage);

- de commutateurs de courant continu pour la reconfiguration des lignes de courant continu;
- d'un point de couplage commun qui établit l'interface avec le système en courant alternatif.

Un Converter est constitué d'un ou de plusieurs ensembles des éléments suivants:

- des ponts;
- un PowerTransformer;
- un filtre de courant alternatif;
- un convertisseur ou un composant réactif de phase pour VSC, dans les systèmes CCHT à plusieurs niveaux, plusieurs Bridges (ponts) existent dans les bras de convertisseur. L'inductance de Converter fait alors partie des bras plutôt que d'être une inductance unique comme représentée à la Figure 51;
- des disjoncteurs et des sectionneurs.

La HVDC Link (liaison CCHT) peut être établie de plusieurs manières:

- bipolaire, voir la Figure 49;
- monopole symétrique avec mise à la terre capacitive côté courant continu, voir la Figure 47;
- monopole asymétrique avec retour par la terre – cette capacité de puissance active inférieure et le fonctionnement prolongé ne sont pas admis;
- monopole asymétrique avec retour métallique – cette capacité de puissance active inférieure et le fonctionnement prolongé sont admis.

Un Converter comprenant plusieurs Bridges peut avoir la capacité de reconfigurer la manière dont les Bridges sont connectés. Une reconfiguration donne normalement lieu à une réduction des limites assignées.

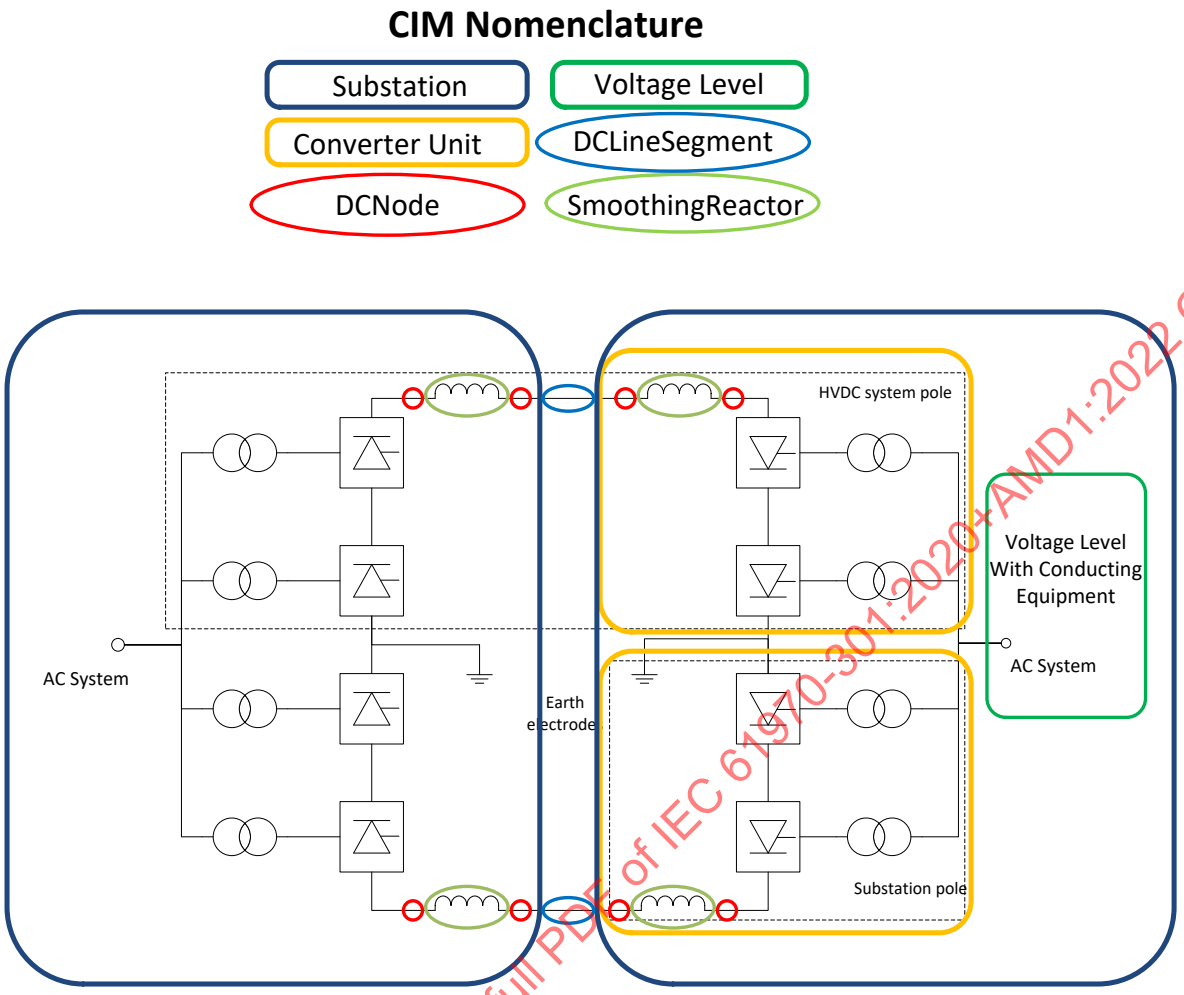
Un poste CCHT envoie l'état opérationnel sous forme des signaux SCADA à un SCADA supérieur. Dans le mode de fonctionnement bipolaire, la réduction des limites assignées du Converter est généralement envoyée au SCADA de niveau supérieur.

Les structures d'emboîtement pour deux cas distincts sont représentées à la Figure 52 et à la Figure 53.

- Pour les transformateurs, noter qu'ils ne sont pas situés dans un Substation (poste), mais dans une DCConverterUnit.
- Aucun VoltageLevel n'existe des côtés haute tension et basse tension d'un transformateur.

Par conséquent, les règles d'emboîtement pour les transformateurs du réseau en courant alternatif sont remplacées par des règles spécifiques au DCConverterUnit.

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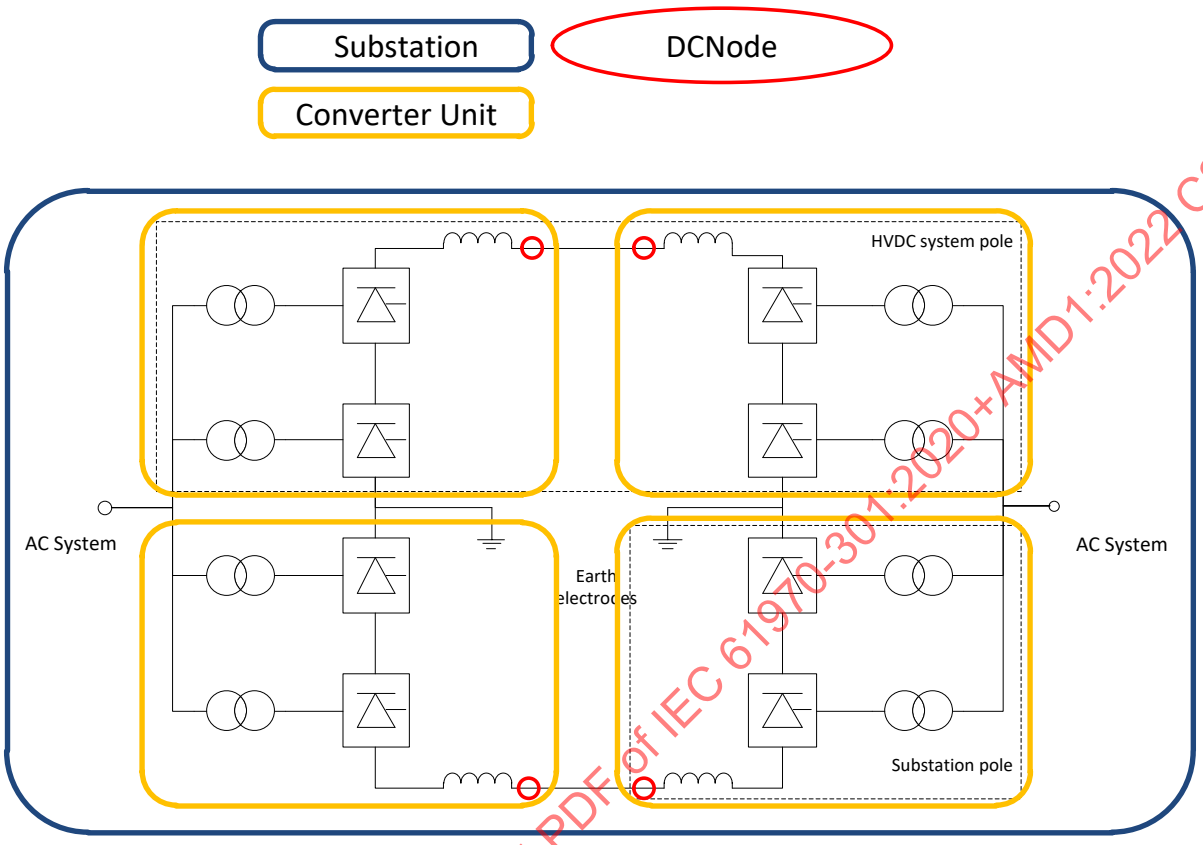
Anglais	Français
CIM Nomenclature	Nomenclature du CIM
Substation	Poste
Converter Unit	Unité de convertisseur
DCLineSegment	DCLineSegment
DCNode	DCNode
SmoothingReactor	SmoothingReactor
HVDC system pole	Pôle du système CCHT
AC system	Système en courant alternatif
Earth electrode	Electrode de mise à la terre
Voltage Level with Conducting Equipment	Niveau de tension avec équipement conducteur
Substation pole	Pôle du poste

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Figure 52 – Structure d'emboîtement d'une ligne CCHT bipolaire

Les deux DCLineSegments font partie d'une Line. Cela s'explique par le fait que les DCLineSegments sont généralement au même pylône ou dans le même caniveau.

Les deux postes sont des Substations normaux qui mélangent des équipements en courant continu et en courant alternatif. La DCConverterUnit et les Converters sont au niveau Substation et sont connectés à l'équipement en courant alternatif d'un VoltageLevel.



Anglais	Français
CIM Nomenclature	Nomenclature du CIM
Substation	Poste
Converter Unit	Unité de convertisseur
DCNode	DCNode
HVDC system pole	Pôle du système CCHT
AC system	Système en courant alternatif
Earth electrodes	Electrodes de mise à la terre
Substation pole	Pôle du poste

Figure 53 – Structure d'emboîtement d'un poste CCHT bipolaire dos à dos

4.5.13.4.2 Réseaux en courant continu

Les réseaux en courant continu utilisent des commutateurs pour reconfigurer les DCLine-s du réseau. Pour ce faire, il est important d'inclure les commutateurs dans le modèle et de les placer aux emplacements appropriés du réseau. La Figure 51 représente une DCLine connectée à un Converter avec une disposition simple de commutateurs. Étant donné que l'inductance de lissage appartient au Substation plutôt qu'à la DCLine, elle ne peut pas être comprise comme l'inductance de la DCLine. Pour le réseau en courant continu, les connexions DCLine entrantes établies avec le Converter ont plus de commutateurs, et il est nécessaire que le modèle d'informations prenne ceci en charge. Le traitement de la topologie du réseau en courant continu est exigé de la même manière que le traitement de la topologie du réseau en courant alternatif déjà effectué.

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4.5.13.4.3 Topologie

La connectivité de base d'un système en courant alternatif est représentée à la Figure 54.

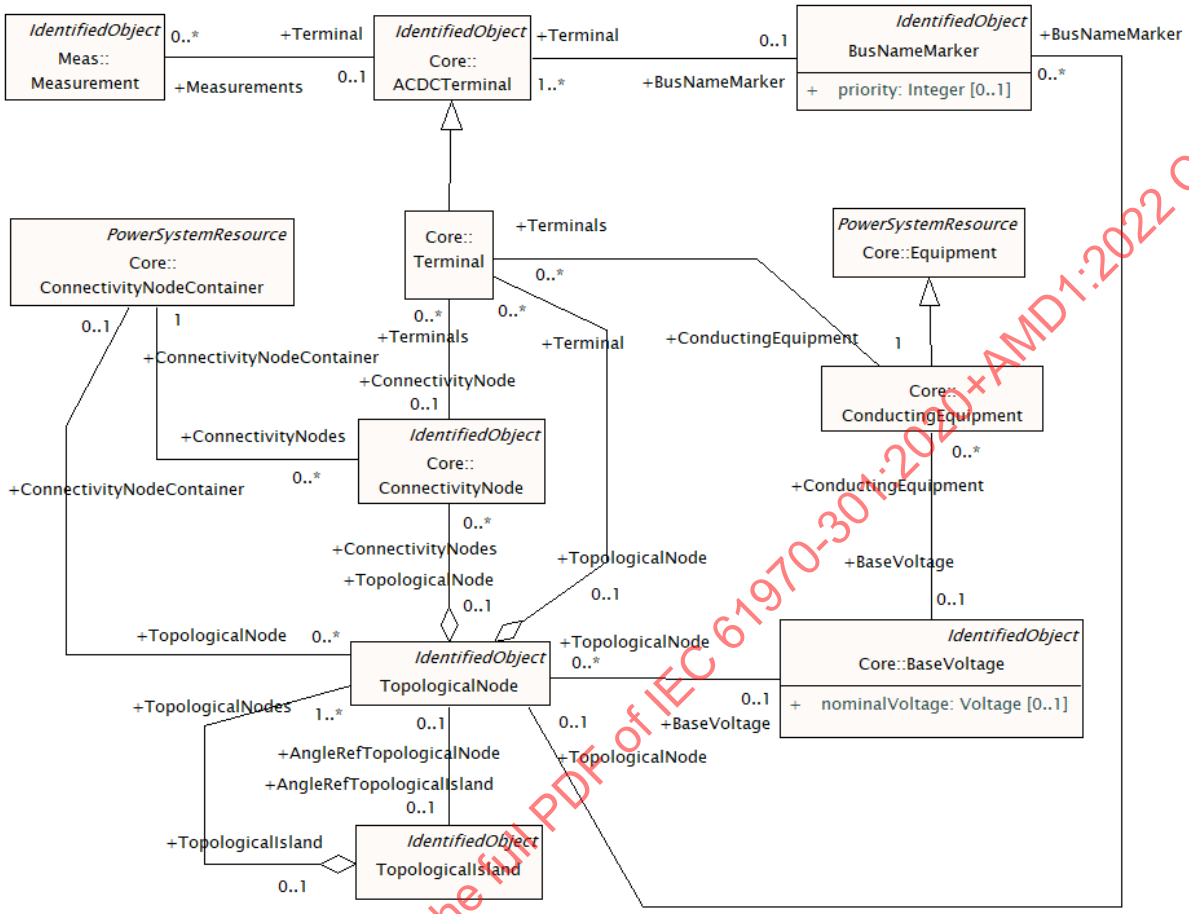


Figure 54 – Topologie de base (Basic) dans le paquetage Core

Comme représenté à la Figure 54, la Terminal est utilisée uniquement pour ConductingEquipment en courant alternatif. Une nouvelle classe ACDCTerminal a été ajoutée pour conserver les caractéristiques communes en courant alternatif et en courant continu.

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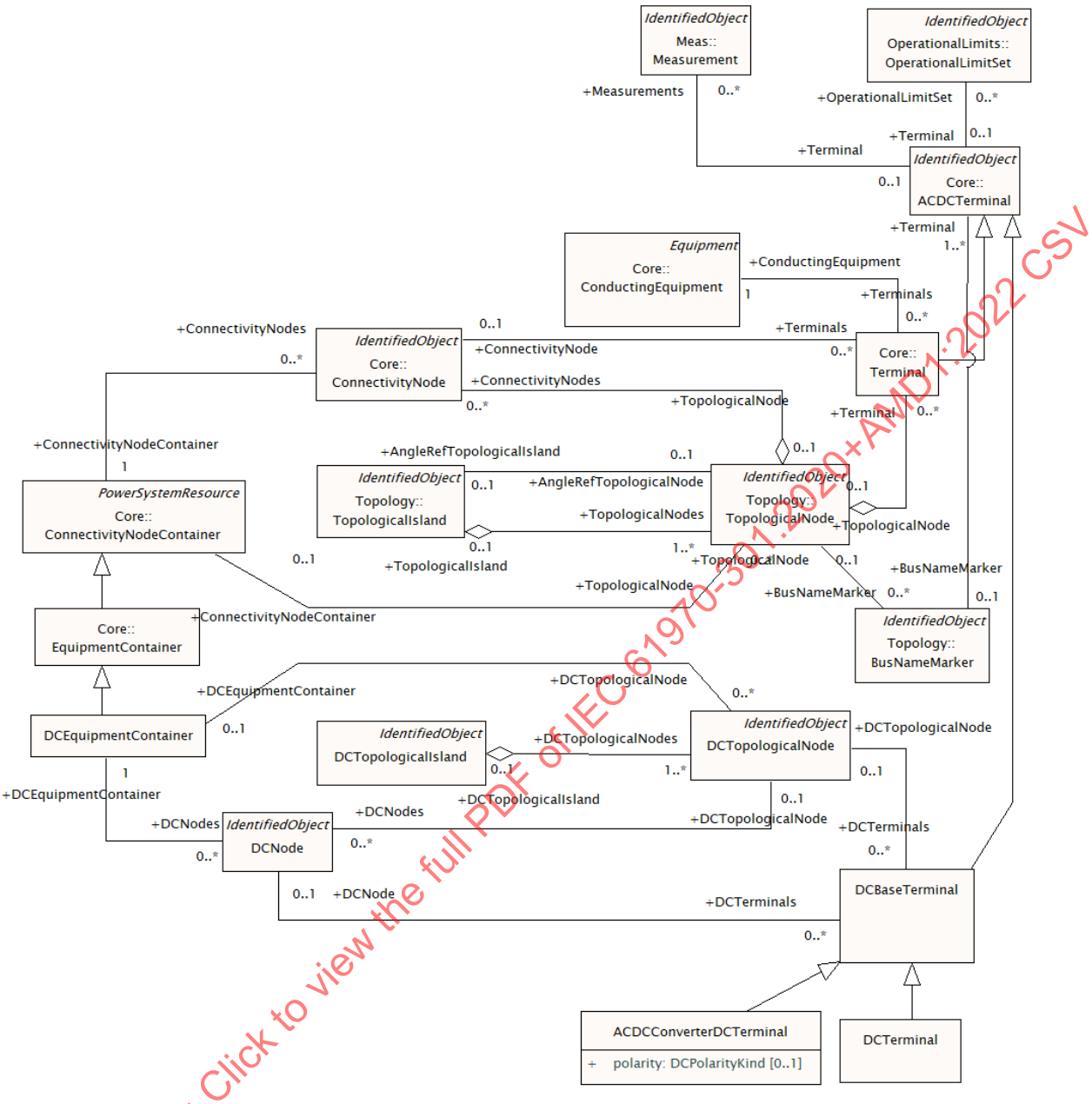


Figure 55 – Topologie en courant continu et en courant alternatif

Comme représenté à la Figure 55, le modèle ConductingEquipment-Terminal-ConnectivityNode provenant du réseau en courant alternatif est répété pour le réseau en courant continu avec les classes DCConductingEquipment-DCTerminal-DCNode.

4.5.13.4.4 Equipment

Le modèle d'Equipment à courant continu est représenté à la Figure 56.

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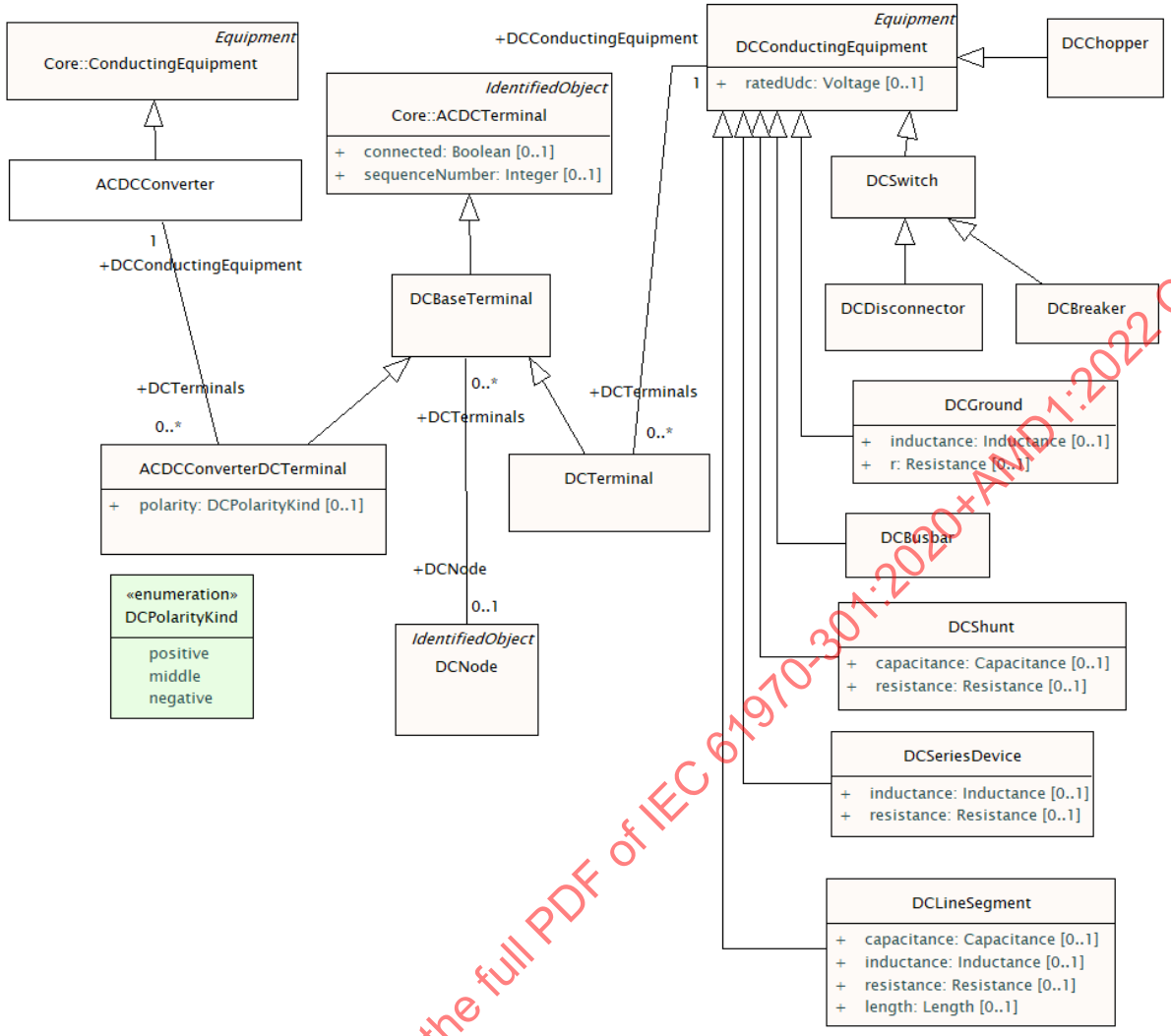


Figure 56 – Modèle d'Equipment

Afin que l'ACDCTerminal comprenne à la fois ACDCConverter et DCConductingEquipment, deux types de bornes à courant continu ont été mis en œuvre, comme représenté à la Figure 56: ACDCConverterDCTerminal et DCTerminal. ACDCConverterDCTerminal est associée à ACDCConverter. La DCTerminal est associée à DCConductingEquipment. Afin d'associer DCNode avec DCTerminal et ACDCConverterDCTerminal, DCBaseTerminal, héritée de ACDCTerminal, est ajoutée.

Étant donné que, dans de nombreux cas, DCConductingEquipment a des paramètres différents en comparaison avec l'équipement à courant alternatif correspondant, des classes spécifiques de courant continu sont nécessaires dans tous les cas, par exemple le DCBreaker et le DCBusbar.

Les SvPowerFlow-s aux bornes des PCCTerminal-s maintiennent les injections de courant alternatif dans le convertisseur.

Le modèle de ligne à courant continu est représenté à la Figure 57.

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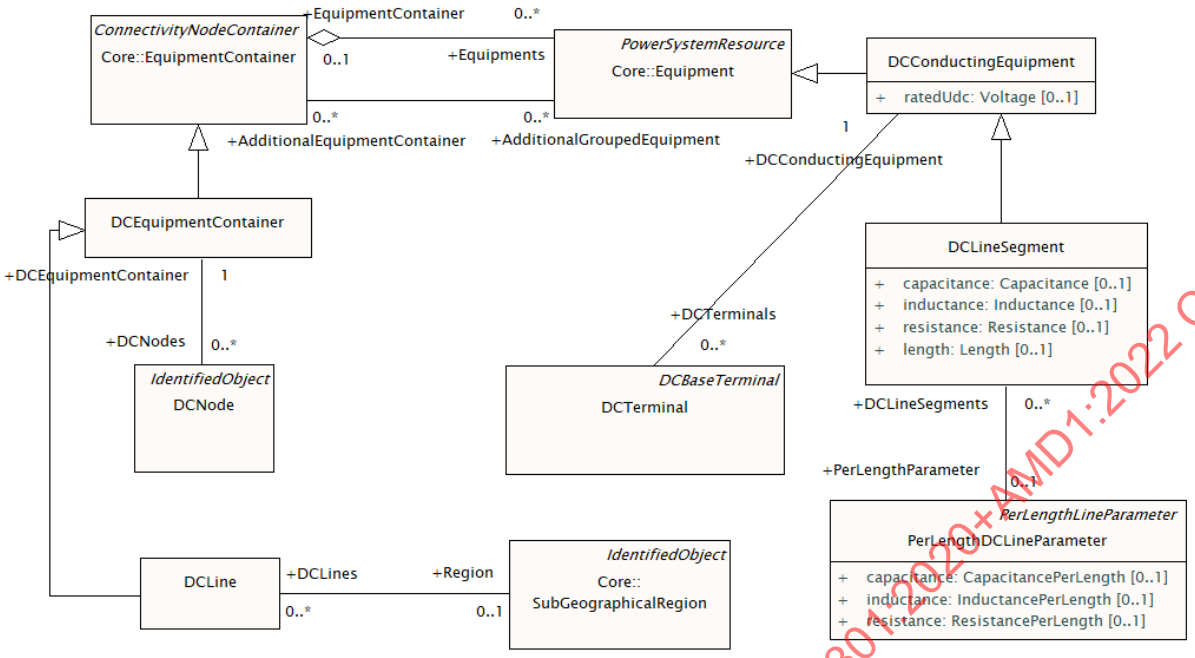


Figure 57 – Modèle de ligne CCHT

Comme représenté à la Figure 57, DCLineSegment n'est plus un Conductor mais un DCConductingEquipment, et n'est pas connecté au réseau à courant alternatif. Il a ses propres attributs par classe de longueur PerLengthDCLineParameter.

Chaque type d'équipement d'un réseau CCHT nécessite sa classe... à courant continu. Les types existants d'équipements sont

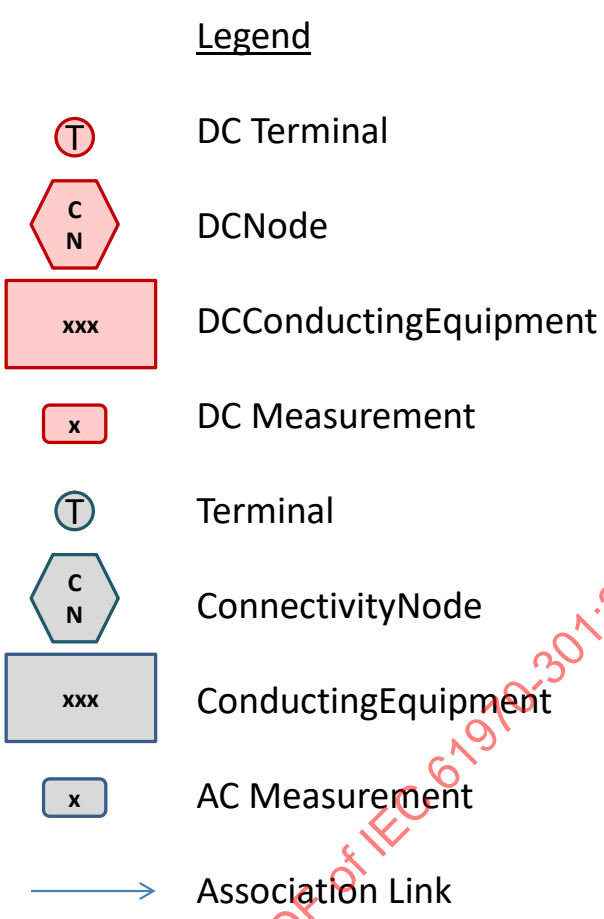
- DCSwitch
- DCGround

La méthode des classes... à courant continu spécifiques peut donner lieu à la duplication des attributs avec les classes... à courant alternatif correspondantes.

4.5.13.5 Diagrammes d'instances

La Figure 58 est la légende des exemples d'équipements à courant continu: monopole simple, bipolaire simple et côté détaillé d'un monopole (voir respectivement la Figure 59, la Figure 60 et la Figure 61).

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Anglais	Français
Legend	Légende
DC Terminal	Borne de courant continu
DC Measurement	Mesure de courant continu
Terminal	Borne
AC Measurement	Mesure de courant alternatif
Association Link	Liaison d'association

Figure 58 – Légende

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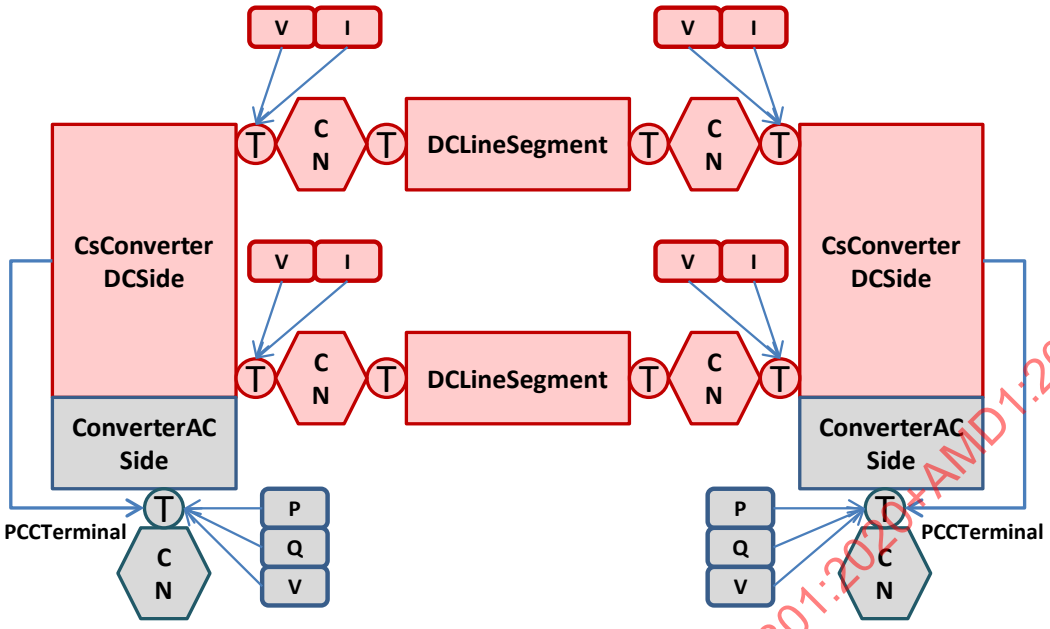


Figure 59 – Monopole simple et mesures

Voir la Figure 58 pour avoir une explication concernant les symboles de la Figure 59.

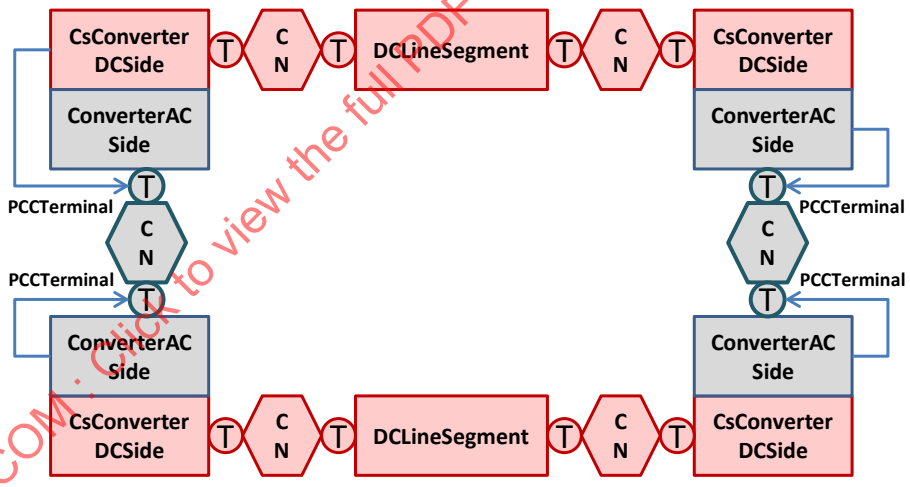


Figure 60 – Bipolaire simple

Voir la Figure 58 pour avoir une explication concernant les symboles de la Figure 60.

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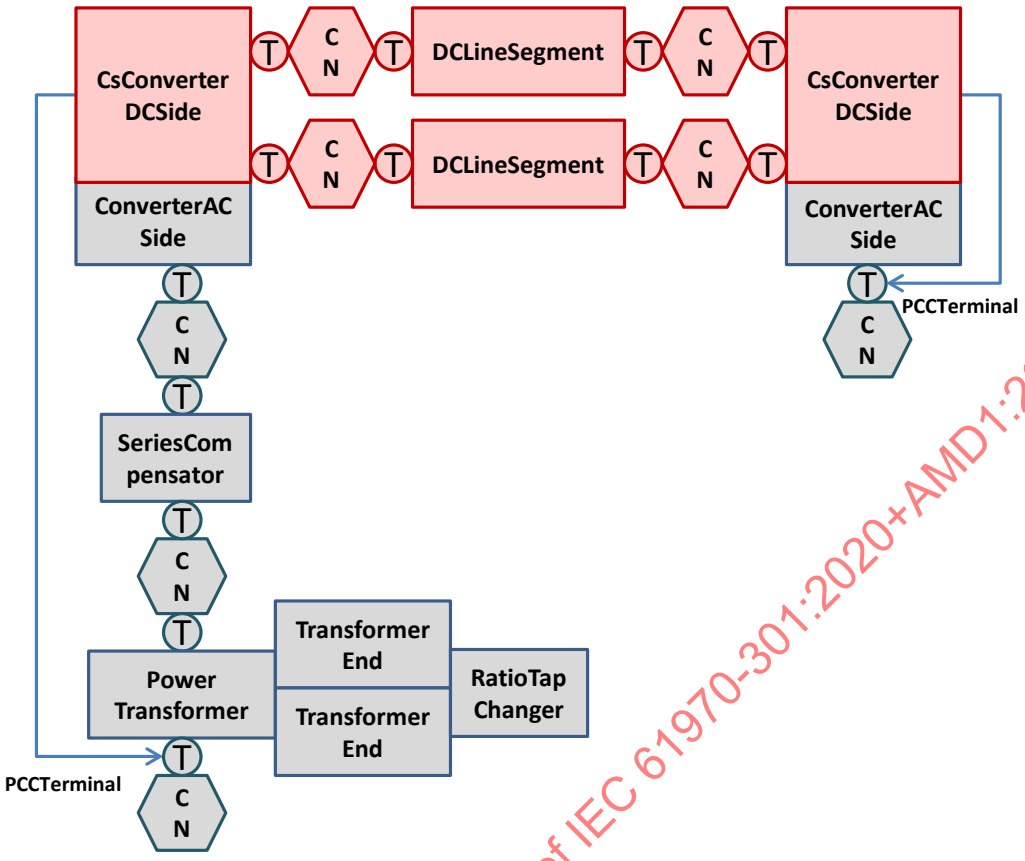


Figure 61 – Côté de monopole avec modèle détaillé

Voir la Figure 58 pour avoir une explication concernant les symboles de la Figure 61.

4.5.14 Régulation de la tension du compensateur de Var statique

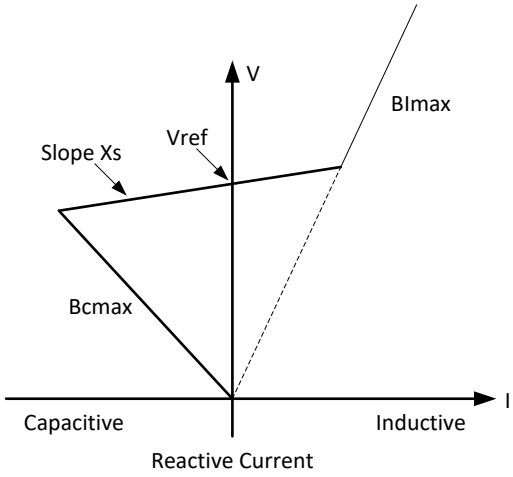
4.5.14.1 Historique

Le compensateur de VAR statique (SVC – Static VAR Compensator) est un appareil shunt de la famille des FACTS (systèmes flexibles de transport à courant alternatif) utilisant l'électronique de puissance pour commander le flux de puissance et améliorer la stabilité transitoire sur les réseaux de puissance. Le SVC peut fonctionner dans deux modes différents:

- le mode de régulation de la tension (la tension est régulée dans les limites spécifiées ci-dessous);
- le mode commande de la Var (la susceptance du SVC reste constante).

Lorsque le SVC fonctionne en mode de régulation de la tension, il met en œuvre la caractéristique V-I représentée à la Figure 62.

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Anglais	Français
Capacitive	Capacitif
Reactive current	Courant réactif
Inductive	Inductif

Figure 62 – Caractéristique V-I du SVC

Tant que la susceptance B du SVC reste dans les valeurs maximale et minimale de susceptance imposées par la puissance réactive totale des batteries de condensateurs (Bcmax) et des batteries d'inductance (BI_{max}), a tension est régulée à la tension de référence V_{ref} (également appelée point de consigne de la tension). La tension à laquelle le SVC n'absorbe pas ou ne produit pas de puissance réactive est la tension de référence (V_{ref}).

Un statisme de tension est normalement utilisé (généralement entre 1 % et 4 % à la puissance réactive maximale en sortie), et la caractéristique V-I a la pente indiquée dans la figure. La caractéristique V-I est décrite par les trois équations suivantes:

$$V = \begin{cases} V_{ref} + X_S * I & si\ le\ SVC\ est\ en\ mode\ de\ régulation \quad (-Bc_{max} < B < BI_{max}) \\ -\dfrac{I}{Bc_{max}} & si\ le\ SVC\ est\ entièrement\ capacitif \quad (B = Bc_{max}) \\ \dfrac{I}{BI_{max}} & si\ le\ SVC\ est\ entièrement\ inductif \quad (B = BI_{max}) \end{cases}$$

Où:

V est la tension directe (pu) aux bornes du bus régulé;

I est le courant réactif ($I > 0$ indique un courant inductif);

X_S est la pente ou réactance de statisme;

V_{ref} est la tension de référence (point de consigne de la tension);

Bc_{max} est la susceptance capacitive maximale;

BI_{max} est la susceptance inductive maximale.

Le point de consigne de la tension est généralement choisi de sorte que, dans des conditions normales de fonctionnement, le SVC fournisse une puissance réactive proche de zéro et fonctionne sur sa plage totale de commande.

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Le point de consigne de tension d'un SVC est fondamentalement différent d'une tension cible. La sortie réactive d'un SVC est proportionnelle au carré de la différence entre la tension régulée du bus et le point de consigne de la tension. Si le SVC produit ou absorbe de la puissance réactive, par définition, une différence s'établit entre la tension régulée du bus et le point de consigne de la tension.

4.5.14.2 Modèle CIM

StaticVarCompensator hérite des attributs suivants de RegulatingCondEq:

controlEnabled – Spécifie le statut de régulation de l'équipement. True, il régule. False, il ne régule pas.

La Terminal de StaticVarCompensator est régulée par l'association à RegulatingControl, hérité de RegulatingCondEq.

4.5.15 Modèle de configuration ICCP

4.5.15.1 Cas d'utilisation de la configuration

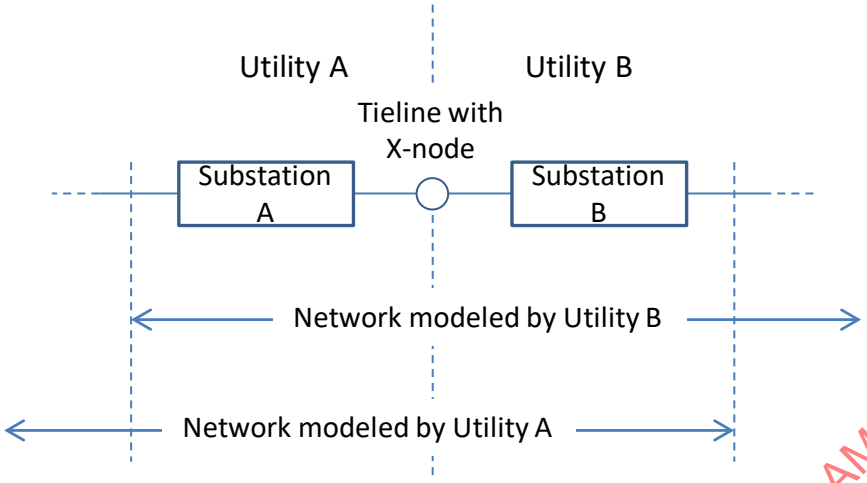
Une configuration ICCP peut être créée de deux manières:

1) les points E/S (valeurs de mesure et commandes) qui sont échangés sur ICCP sont connus dans le cadre d'un échange du profil d'équipement IEC 61970-452/EQ, la configuration ICCP étant directement associée à ces points E/S;
2) les points E/S qui sont échangés sur ICCP ne sont pas connus dans le cadre d'un échange du profil d'équipement, et la configuration ICCP utilise à la place un nom intermédiaire faisant l'objet d'un accord commun, le nom de point fourni par ICCP pour les points E/S à échanger sur ICCP. Cela correspond au cas de configuration ICCP traditionnel.

L'exemple suivant concerne le cas d'utilisation 1 ci-dessus.

Deux services publics d'électricité, Utility A et Utility B, peuvent disposer de modèles de réseau chevauchant (voir la Figure 63) et échanger des fichiers CIMXML EQ avec le nœud de connectivité en limite. Utility A et Utility B souhaitent obtenir des valeurs de mesure provenant de chacune d'elles. La description des points E/S dans le modèle de réseau est incluse dans les fichiers CIMXML IEC 61970-452/EQ échangés. Utility A et Utility B disposent d'un sous-ensemble de mesures dans les fichiers CIMXML IEC 61970-452/EQ pour l'échange ICCP.

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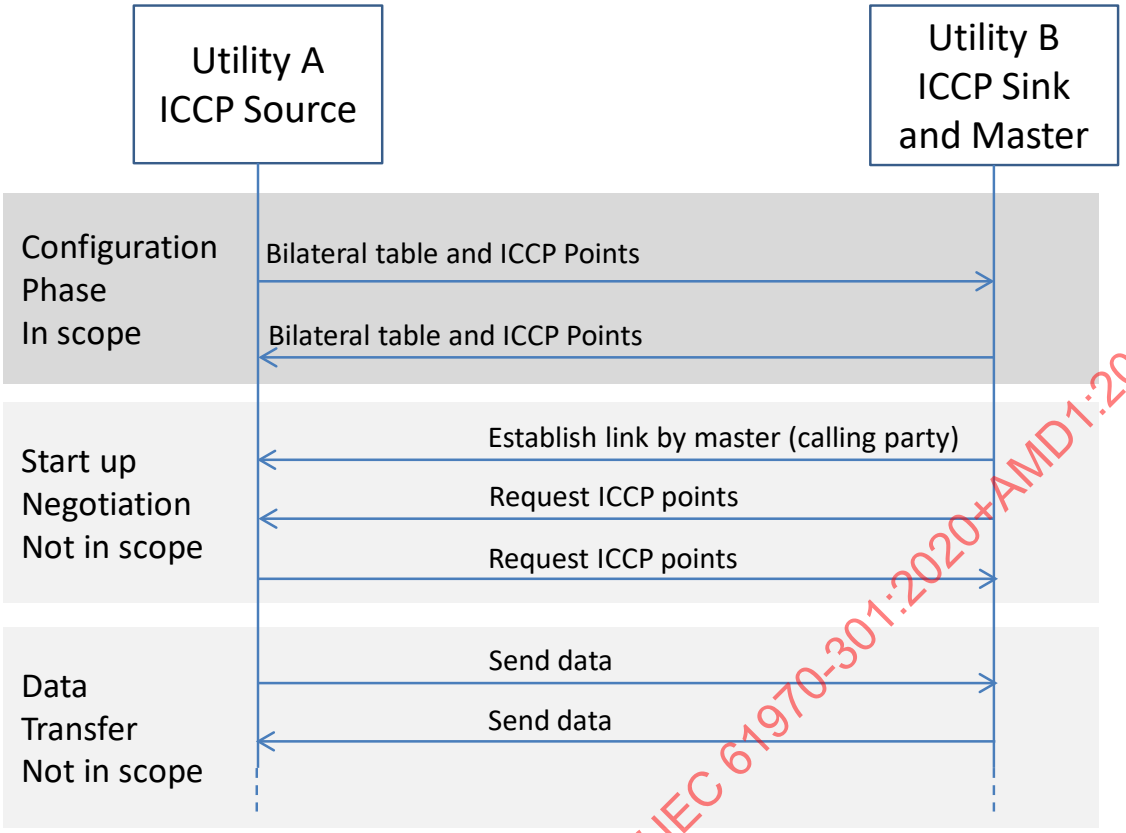
Anglais	Français
Utility A	Utility A
Utility B	Utility B
Tieline with X-node	Ligne d'interconnexion avec X-node
Substation	Poste
Network modeled by Utility B	Réseau modélisé par Utility B
Network modeled by Utility A	Réseau modélisé par Utility A

Figure 63 – Mesures ICCP et modèles de réseau

Selon le cas d'utilisation 2 ci-dessus, le moyen traditionnel de configurer ICCP consiste, pour les différentes parties, à convenir d'un ensemble commun de noms pour les mesures échangées, les points fournis par ICCP. Il est pris pour hypothèse que les deux parties utilisent des noms différents pour la même mesure et, de ce fait, qu'un troisième nom ayant fait l'objet d'un accord commun est nécessaire, les noms de point fournis par ICCP.

En s'appuyant sur cette hypothèse, la Figure 64 représente une séquence simplifiée de configuration et de démarrage d'ICCP.

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Anglais	Français
Utility A ICCP source	Source ICCP de Utility A
Utility B ICCP sink and master	Collecteur et maître ICCP de Utility B
Configuration phase in scope	Phase de configuration dans le domaine d'application
Bilateral table and ICCP points	Table bilatérale et points ICCP
Start up negotiation not in scope	Démarrage de la négociation hors du domaine d'application
Establish link by master (calling party)	Etablir liaison par maître (partie appelante)
Request ICCP points	Demande de points ICCP
Data transfer not in scope	Transfert de données hors du domaine d'application
Send data	Envoi des données

Figure 64 – Configuration et démarrage d'ICCP

Dans la phase de configuration, les fichiers décrivant les tables bilatérales et les listes de points ICCP sont échangés, la zone ombrée en gris foncé étant représentée à la Figure 64. La configuration de cet échange relève du domaine d'application du présent document.

La configuration ICCP implique de créer une référence croisée pour chaque valeur de mesure entre les parties. La création d'une référence croisée est un travail manuel fastidieux.

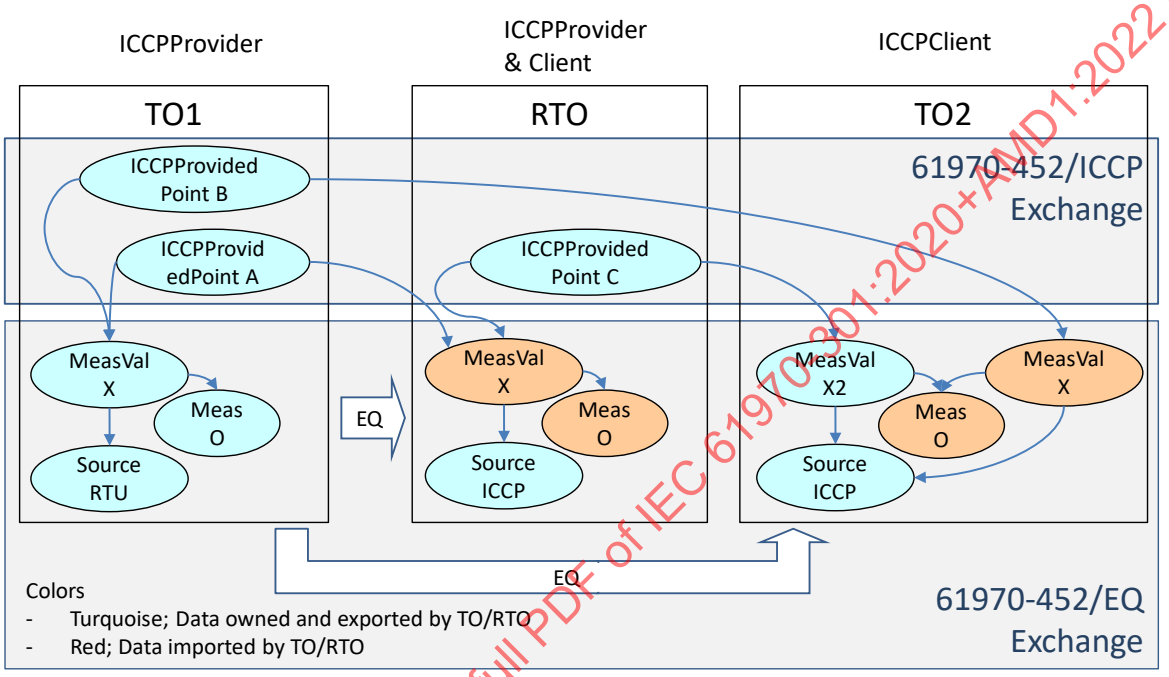
Si les modèles de réseau sont échangés sous la forme de données CIMXML, les données IEC 61970-452/EQ et les données de configuration ICCP décrites dans le présent document sont échangées. Dès lors, les identifiants de point E/S et les noms sont connus des deux parties. Par conséquent, la mise en correspondance de point ICCP est déjà connue et le référencement croisé manuel est remplacé par une liaison automatique.

Tous les points E/S définis dans un fichier IEC 61970-452/EQ peuvent ne pas être disponibles sur ICCP. De ce fait, il y a lieu de décrire la disponibilité d'un point E/S sur ICCP par point E/S.

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Le protocole ICCP aide les fournisseurs de données ICCP à accorder différents droits d'accès à différents utilisateurs ICCP, par exemple, pour l'exemple de la Figure 63, Utility A peut souhaiter autoriser Utility B à accéder à Substation A pour les mesures, mais pas aux autres services publics d'électricité. Ainsi, un fournisseur ICCP doit pouvoir décrire la disponibilité de point ICCP par utilisateur ICCP. ICCP prend également en charge les points E/S qui sont globalement disponibles à tous les utilisateurs ICCP.

La Figure 65 donne un exemple de configuration ICCP pour une valeur de mesure entre différentes parties.



Anglais	Français
Colors	Couleurs
Turquoise; Data owned and exported by TO/RTO	Turquoise: données détenues et exportées par TO/RTO
Red; Data imported by TO/RTO	Rouge: données importées par TO/RTO

Figure 65 – Exemple de fournisseur et d'utilisateur de valeur de mesure

TO1 et RTO sont des centres de conduite où TO1 fournit la valeur de mesure MeasVal X à un RTO et à TO2. TO2 peut obtenir la valeur de mesure MeasVal X directement auprès de TO1 ou indirectement auprès du RTO. L'échange indirect comme entre le RTO et TO2 peut ne pas être admis, même s'il est possible d'un point de vue technique.

4.5.15.2 Modèle d'informations

Les données ICCP (appelées officiellement IEC 61870-6 TASE.2) sont échangées à l'aide des classes Measurement (Analog, Discrete et Accumulator), des classes MeasurementValue (AnalogValue, DiscreteValue, et AccumulatorValue) et de la classe MeasurementValueSource. La classe MeasurementValueSource est utilisée pour définir le centre de conduite qui fournit les données ICCP. La MeasurementValueSource doit être associée à une instance du Name dans laquelle l'attribut Name.name contient le nom du centre de conduite fournisseur. L'instance du NameType associée au Name du centre de conduite doit avoir "ICCP Provider ID" pour attribut NameType.name.

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Les classes MeasurementValue sont utilisées pour spécifier l'ICCP ID. La MeasurementValue doit être associée à une instance de Name dont l'attribut Name.name contient l'ICCP ID. L'instance du NameType associé à l'ICCP ID Name doit avoir "ICCP ID" pour attribut NameType.name. L'attribut MeasurementValue.name contient le nom de point SCADA. Chaque MeasurementValue est associée à un Measurement.

Chaque MeasurementValue qui est fournie à l'aide d'ICCP doit aussi avoir une association à une MeasurementValueSource.

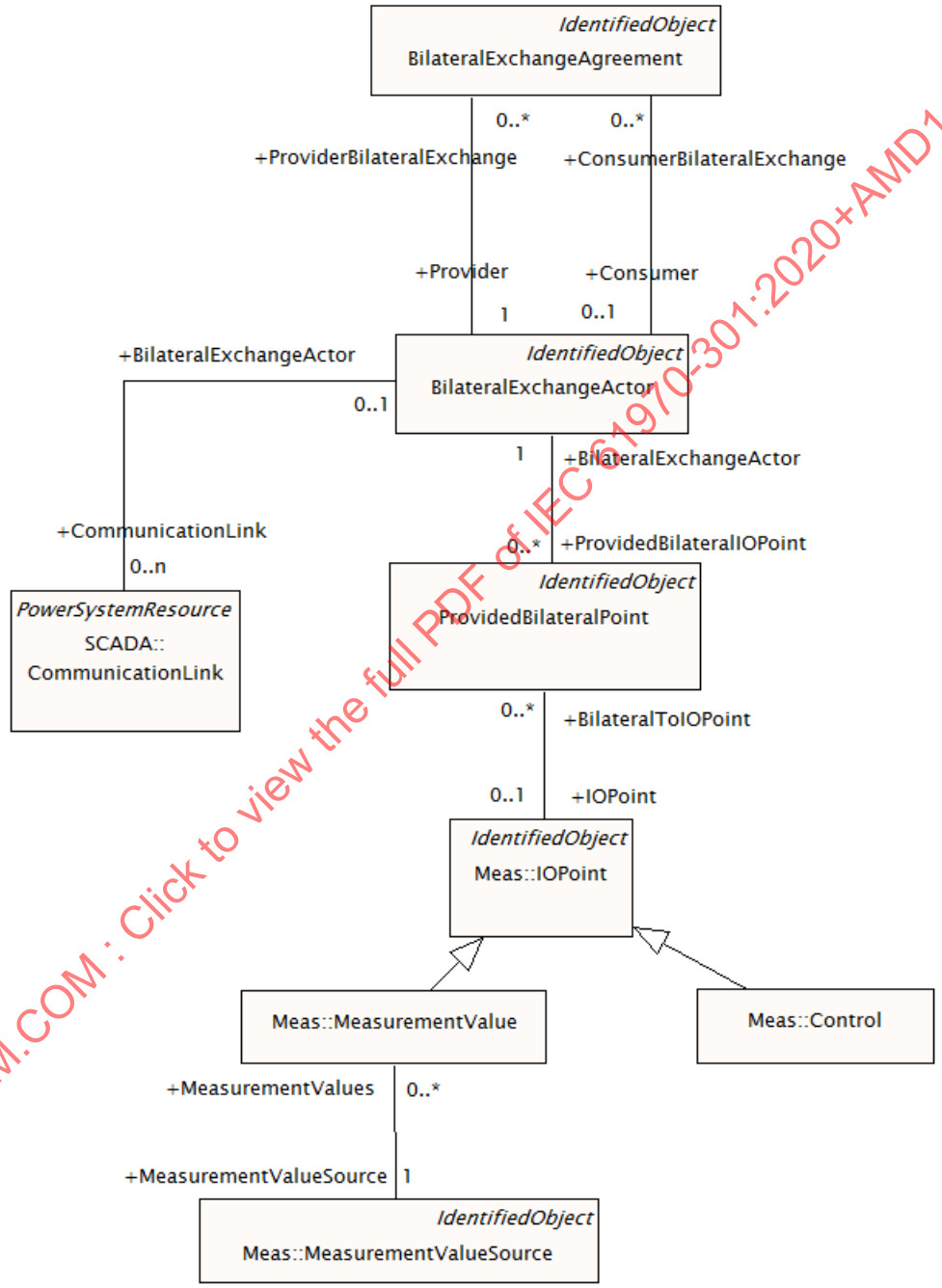


Figure 66 – Modèle de données d'échange bilatéral généralisé

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Le modèle de données de la Figure 66 est généralisé à tous les échanges bilatéraux. Il décrit les acteurs de ce type d'échange avec BilateralExchangeActor. Il existe deux types d'acteurs:

- les fournisseurs qui peuvent également être des consommateurs;
- des consommateurs uniquement.

Les fournisseurs offrent des IOPoint-s disponibles à l'échange, actuellement MeasurementValue-s et Controls. La disponibilité des données est décrite par BilateralExchangeAgreement. Un BilateralExchangeAgreement comporte deux BilateralExchangeActor-s référencés par BilateralExchangeAgreement.Provider et BilateralExchangeAgreement.Consumer. L'acteur référencé par BilateralExchangeAgreement.Provider est toujours un fournisseur, mais il peut également s'agir d'un consommateur. L'acteur référencé par BilateralExchangeAgreement.Consumer est toujours un consommateur, mais il peut également s'agir d'un fournisseur. Si l'acteur référencé par BilateralExchangeAgreement.Consumer est également un fournisseur, cela signifie que celui référencé par BilateralExchangeAgreement.Provider est également un consommateur, de sorte que l'échange de données est bidirectionnel pour ce BilateralExchangeAgreement. Un échange bidirectionnel entre deux acteurs peut également être assuré avec deux BilateralExchangeAgreement-s unidirectionnels, où l'un des BilateralExchangeAgreement-s comporte un acteur en tant que fournisseur uniquement et l'autre en tant que consommateur uniquement, ce qui est l'inverse dans l'autre BilateralExchangeAgreement.

Les données fournies par un BilateralExchangeActor sont décrites par le ProvidedBilateralPoint qui représente une relation plusieurs à plusieurs entre le BilateralExchangeActor et l'IOPoint. IOPoint est une classe de base pour MeasurementValue et Control, et fournit l'association entre les mesures et les points ICCP décrite par la classe ProvidedBilateralPoint.

Si les modèles de réseau sont échangés sous la forme de fichiers IEC 61970-452/EQ CIMXML, la référence ProvidedBilateralPoint.IOPont donne l'IOPoint de sorte qu'un consommateur connaisse les identifiants IOPoint (mRIDs) et les noms. Sur cette base, un consommateur peut choisir l'ensemble ou un sous-ensemble des IOPoint-s fournis pour l'échange sur ICCP. Il s'agit d'une décision interne côté consommateur qu'il n'y a pas lieu d'échanger en tant que données de configuration.

Si les modèles de réseau ne sont pas échangés sous la forme de fichiers IEC 61970-452/EQ CIMXML, la référence ProvidedBilateralPoint.IOPont n'est pas spécifiée, et un consommateur ne connaît pas les identifiants IOPoint (mRIDs) et les noms. Le nom ProvidedBilateralPoint est alors utilisé comme étant le nom ICCP ayant fait l'objet d'un accord commun. L'industrie électrique a établi les règles concernant les noms ICCP, qu'il convient de respecter lorsqu'ils sont utilisés.

L'accord d'échange bilatéral UML pour ICCP est représenté à la Figure 72.

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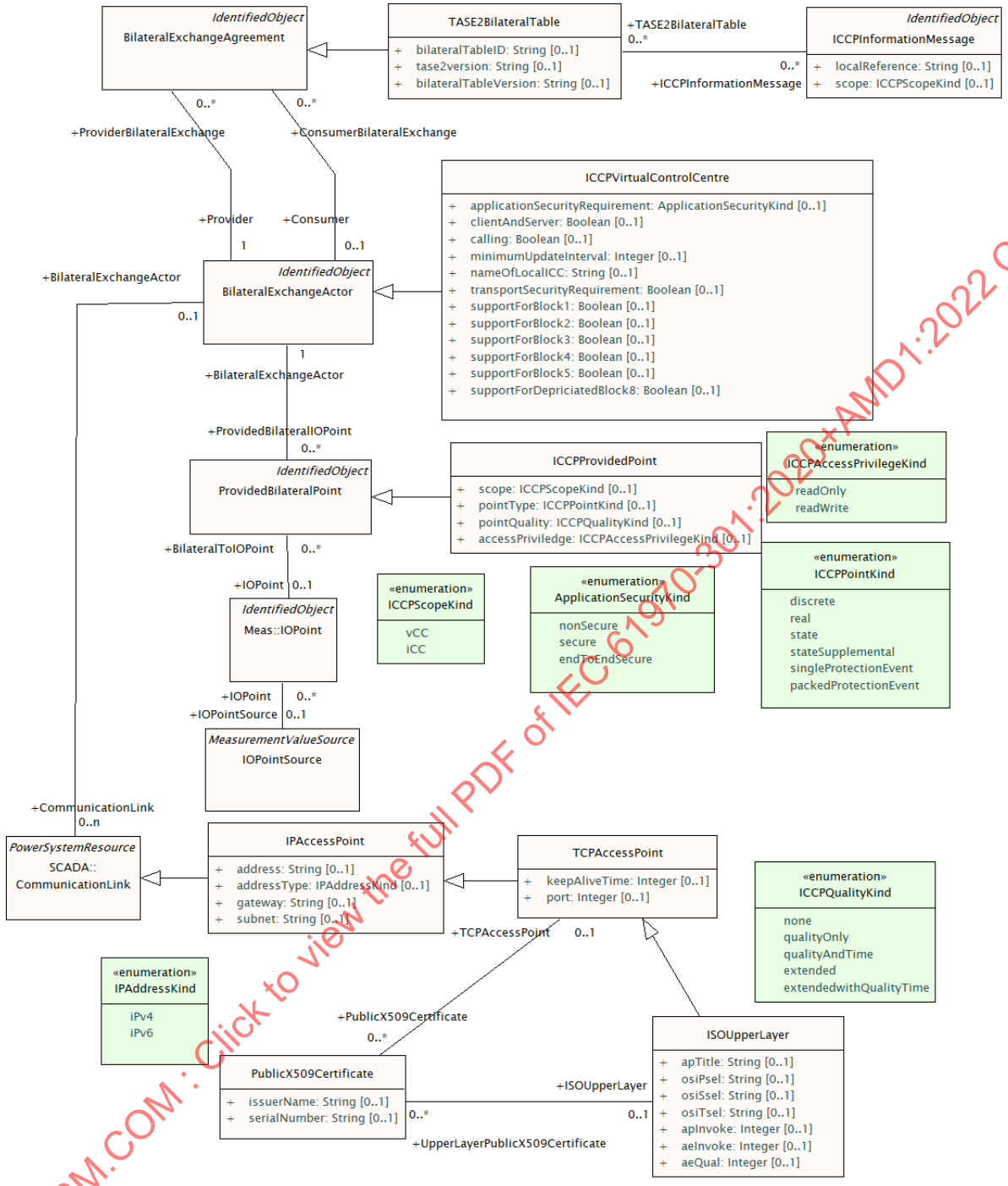


Figure 67 – Modèle de données d'échange bilatéral ICCP

Les sous-types suivants issus du modèle de données générique sont définis

- BilateralExchangeAgreement à TASE2BilateralTable.
- BilateralExchangeActor à ICCPVirtualControlCenter.
- ProvidedBilateralPoint à ICCPProvidedPoint.
- CommunicationLink à IPAccessPoint.

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4.5.16 Modèle Feeder

Le modèle Feeder est utilisé pour représenter les lignes d'alimentation "intégrées". Feeder étant un type de ConnectivityNodeContainer, il peut contenir un Equipment, comme un Substation ou un VoltageLevel. Outre l'association d'emboîtement entre EquipmentContainer et Equipment, utilisée pour les besoins de dénomination hiérarchique, il existe une seconde association entre ces deux classes, laquelle permet de regrouper un élément d'Equipment avec un EquipmentContainer supplémentaire. Cette modélisation permet d'associer Equipment à plusieurs Feeder.

Un Feeder peut être contenu par le Substation qui a alimenté de manière nominale la ligne d'alimentation. Au moins une borne (Terminal) peut également être associée à un Feeder pour définir la hauteur de chute normale spécifique qui l'alimente. Un Feeder peut également contenir un Substation de distribution secondaire. Un Substation secondaire peut être associé à plusieurs Feeder pour représenter les Feeders qui alimentent en principe le Substation.

Le modèle UML pour le Feeder est représenté à la Figure 68.

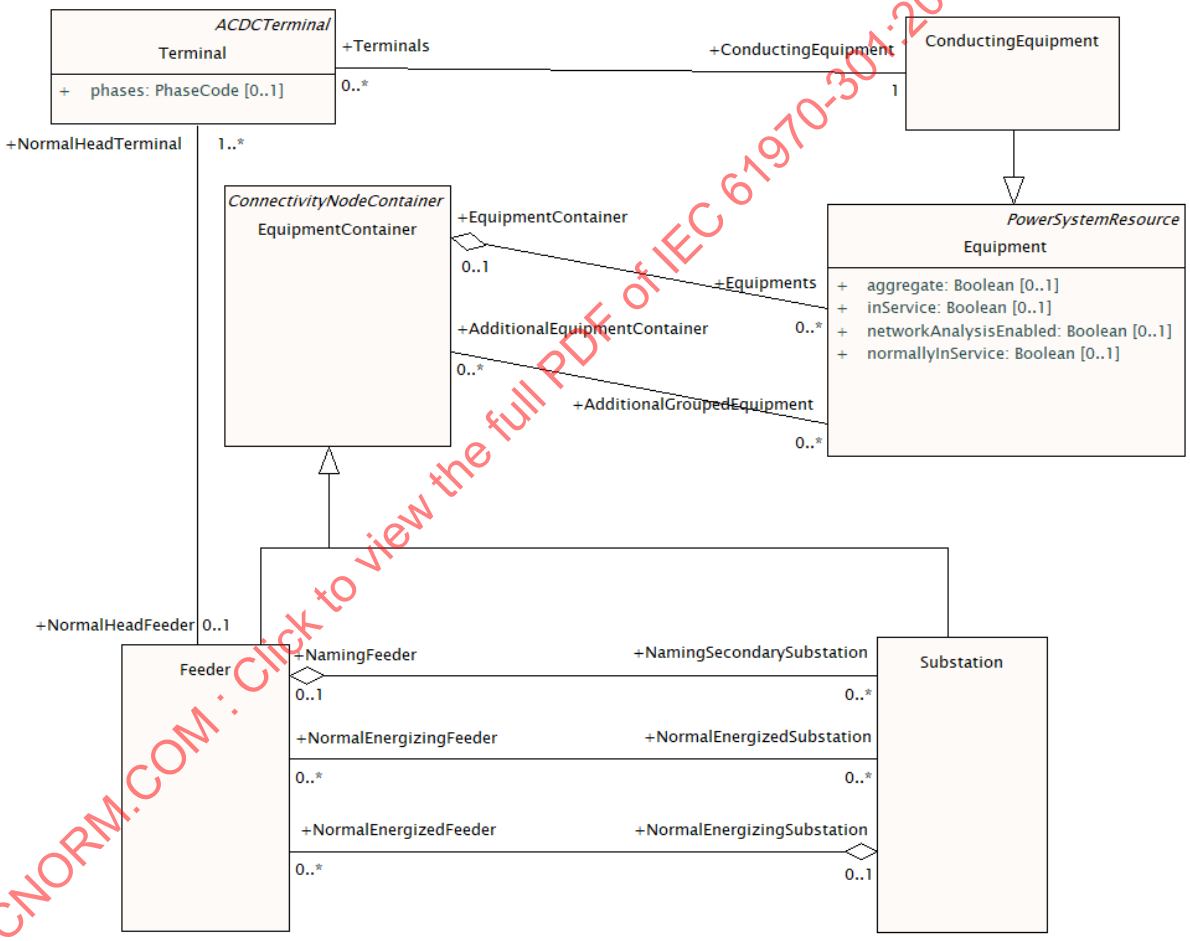


Figure 68 – Modèle de données Feeder

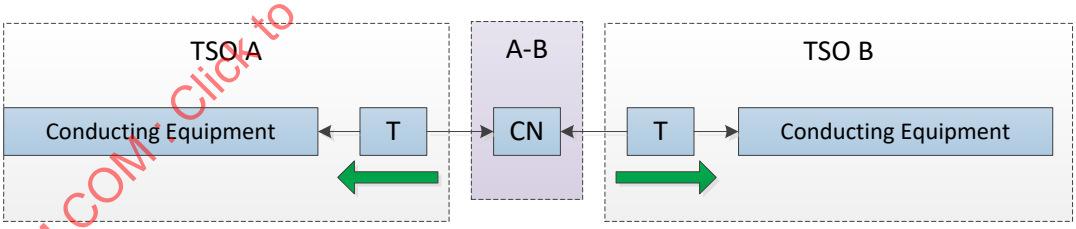
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4.5.17 Modélisation de la zone de commande

Les contraintes d'échange net de la zone de commande sont importantes pour l'analyse du réseau car lors de l'établissement des cas de flux de puissance, la situation à étudier commence pratiquement toujours par une spécification de la charge utile et de l'échange net pour chaque zone de commande. Les contraintes de la zone de commande doivent être correctement définies pour correspondre aux définitions des responsables d'équilibre dans le réseau. Les contraintes de la zone de commande dans le flux de puissance sont représentées comme un ensemble de contraintes d'égalité de la zone de commande comme suit:

> Echange net de la zone de commande = SUM (flux de la zone de commande dans la zone sur chaque interconnexion)

Les interconnexions définissent les zones de commande et elles doivent être définies de sorte que chaque élément conducteur du réseau soit exactement à l'intérieur d'une zone de commande – en d'autres termes, les zones de commande recouvrent le réseau et ne se chevauchent pas. C'est également ce qui se produit dans le réseau réel de manière naturelle et ainsi les emplacements des interconnexions sont généralement bien connus. L'échange net de la zone de commande est déterminé en faisant la somme des flux dans les Terminals. Les Terminals sont identifiées en créant un ensemble d'objets TieFlow associés à un objet ControlArea. Chaque objet TieFlow est associé à une Terminal. Un attribut de l'objet ControlArea spécifie l'échange net (ControlArea.netInterchange). L'orientation de la zone de commande pour l'échange net est positive pour une importation, elle est négative pour une exportation. Une interconnexion entre deux zones de commande apparaît dans les deux spécifications de la zone de commande. Elle doit être modélisée dans chaque zone de sorte que la somme des deux représentations du flux d'interconnexion soit égale à zéro. L'orientation normale du flux de la Terminal est positive pour le flux vers l'équipement conducteur de la Terminal. (C'est-à-dire que la direction du flux d'un bus vers un appareil est positive.) Cependant, l'orientation de chaque flux dans la spécification de la zone de commande doit être conforme à la convention de la zone de commande, c'est-à-dire que l'importation est positive. Si l'orientation du flux de la Terminal référencée par un TieFlow est positive dans la zone de commande, ceci est ensuite confirmé en réglant TieFlow.positiveFlowIn flag TRUE. Dans le cas contraire, l'orientation doit être inversée en réglant TieFlow.positiveFlowIn flag FALSE. La Figure 69 représente une interconnexion simple dans laquelle les flèches vertes indiquent l'orientation du flux de la Terminal (non le flux réel mais la direction du flux qui comporte un signe plus):

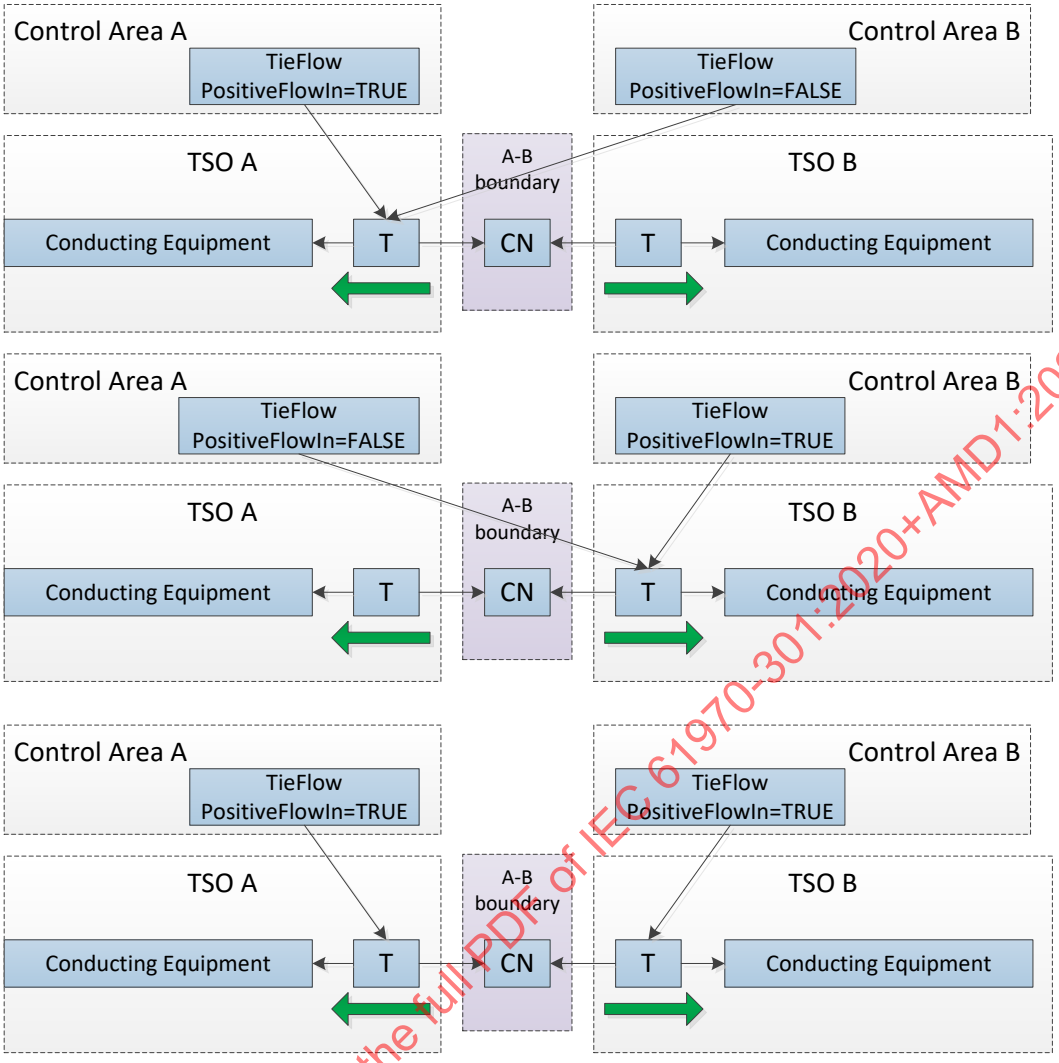


Anglais	Français
Conducting equipment	Équipement conducteur

Figure 69 – Orientation du flux de la Terminal

La Figure 70 représente les différentes manières qu'il est possible d'appliquer pour décrire correctement les interconnexions correspondantes de la zone de commande. Les deux premiers exemples ci-dessous impliquent une seule Terminal simple dont les deux parties mesurent le flux. Le troisième exemple concerne des Terminals se situant dans le modèle de réseau TSO de sorte que la commande de zone fait toujours référence à son propre modèle de réseau.

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Anglais	Français
Conducting equipment	Équipement conducteur
Control area	Zone de commande
A-B boundary	Limite entre A et B

Figure 70 – Différentes manières de décrire les interconnexions de la zone de commande

4.6 Lignes directrices de modélisation

4.6.1 Modélisation pour modifications

Les Paragraphes 4.6.2 à 4.6.5 donnent des lignes directrices sur la façon de maintenir et étendre le CIM.

Le CIM est destiné à contenir les classes et les attributs qui sont échangés sur des interfaces publiques entre des applications principales. L'objectif est de ne conserver, autant que possible, que les caractéristiques génériques à partir desquelles une mise en œuvre détaillée peut être extraite. Il est, en général, plus facile de modifier la valeur ou le domaine d'un attribut que de modifier une définition de classe. Cela rend le modèle plus solide, car il peut supporter une plus large classe d'exigences, et plus stable, car il peut être possible de gérer de nouvelles exigences sans avoir à modifier le modèle.

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4.6.2 Processus pour les amendements au CIM

Il peut être souhaitable de modifier le CIM pour réviser le modèle existant ou pour étendre le CIM afin de modéliser des éléments supplémentaires d'un système de puissance. Le processus recommandé pour ces amendements est le suivant.

1) Préparer un ou plusieurs cas d'utilisation et une demande de modification qui décrivent les modifications souhaitées. Il convient que cela inclue les modifications proposées aux diagrammes de classes concernés avec représentation des classes, attributs et associations nouveaux ou révisés.
2) Le ou les cas d'utilisation et la demande de modification sont ensuite examinés par le Groupe de Travail approprié de l'IEC, qui va décider s'il convient que les modifications demandées soient traitées en tant que révisions de la norme CIM actuelle ou s'il convient qu'elles soient traitées comme des amendements privés sans exigence de modification pour la norme.
3) Les propositions d'amendements acceptés par le groupe de travail sont ajoutées à la liste des sujets majeurs et le moment venu, une nouvelle version du modèle CIM est élaborée et une mise à jour de la spécification du CIM appropriée de l'IEC est faite.

4.6.3 Modifications apportées au modèle UML du CIM

Du point de vue de la modélisation, lorsque le CIM est étendu, l'approche consiste à partir du modèle UML de CIM existant. Les extensions peuvent être ajoutées de plusieurs façons disponibles avec UML, mais dans tous les cas, la bonne approche consiste à examiner le modèle actuel et à déterminer le meilleur moyen pour commencer à partir des diagrammes de classes existants. Les extensions peuvent prendre une des formes suivantes, de la plus simple à la plus complexe:

- ajouter des attributs supplémentaires à des classes existantes;
- ajouter de nouvelles classes qui sont des spécialisations de classes existantes;
- ajouter de nouvelles classes à l'aide d'associations avec des classes existantes.

Dans le but d'étendre la présente norme, le principal objectif est de réutiliser le CIM existant dans toute la mesure du possible. Du point de vue des paquetages, il convient que les extensions soient faites aux paquetages existants chaque fois que c'est possible. Si les extensions comprennent un nouveau domaine d'application, il convient d'envisager de créer un nouveau paquetage pour les ajouts, mais en créant toujours les associations nécessaires au paquetage existant, en gardant à l'esprit que, bien qu'un nouveau paquetage soit créé, le CIM continue d'être un modèle unique.

Quand il s'agit d'apporter des modifications non normatives au modèle d'information, il convient d'étendre le CIM normalisé sans modifier le CIM normalisé. Il convient, de préférence, de placer ces extensions dans de nouveaux paquetages, à la fois pour identifier que les modifications ne sont pas normatives et pour faciliter le transfert des modifications vers une version de la norme mise à jour.

4.6.4 Modifications apportées aux documents normatifs du CIM

D'un point de vue documentaire, lorsque le CIM est étendu, une décision doit être prise quant à la question de savoir si les modifications constituent des mises à jour de documents normatifs existants sur le CIM ou si une nouvelle IEC 61970-3x spécifique est exigée. Dans les deux cas, les extensions deviennent une partie de la norme IEC sur le CIM.

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4.6.5 Éléments déconseillés

Le modèle du CIM peut parfois contenir des paquetages, des classes, des attributs ou des associations qui sont considérés comme déconseillés. Ces éléments sont notés "déconseillés" dans la documentation ou portent un stéréotype de l'UML "déconseillé". Un élément déconseillé figure dans la présente version du modèle, mais il est prévu de le supprimer dans les versions futures. Il n'est pas garanti qu'un élément non déconseillé soit retenu dans les versions futures, mais il convient d'éviter autant que possible l'utilisation d'un terme marqué comme déconseillé.

4.6.6 Profils CIM

Une mise en œuvre du CIM ne nécessite pas d'inclure toutes les classes, attributs et associations de la spécification de la norme CIM pour être conforme à la norme CIM. Des profils peuvent être définis pour spécifier les éléments qui doivent être inclus (c'est-à-dire, les éléments obligatoires) pour une utilisation particulière du CIM, ainsi que ceux qui sont facultatifs. Ces profils sont définis dans les documents concernant les profils de la série IEC 61970 ainsi que dans d'autres séries de normes IEC qui utilisent et étendent le CIM de base spécifié dans le présent document.

Un exemple est l'IEC 61970-452, Profils du modèle de réseau de transport statique CIM. Ce profil spécifie comment le CIM doit être utilisé pour échanger des modèles de systèmes de puissance en XML, et il spécifie aussi les classes, attributs et associations, obligatoires et facultatifs, devant être pris en charge pour cette utilisation du CIM. Les profils peuvent être maintenus à l'aide de nombreux outils tels que l'outil open source (c'est-à-dire de source ouverte) CIMTool[1].

4.7 Outils de modélisation

Cette version du CIM a été établie en utilisant le produit Enterprise Architect[2]). Le modèle UML du CIM complet existe sous la forme d'un fichier de projet Enterprise Architect et peut être visualisé avec cet outil, y compris les diagrammes de classe et les descriptions des classes, des attributs, des types et des relations. La visualisation du CIM de cette façon offre une interface de navigation graphique qui permet de visualiser toutes les données de spécification du CIM par simple pointer-cliquer sur le diagramme de classe dans chaque paquetage. Une visionneuse gratuite est disponible auprès de Sparx Systems.

Idéalement, le modèle d'informations du CIM est indépendant de tout outil UML spécifique, bien que l'expérience ait montré que les échanges entre des outils différents soient souvent loin d'être parfaits. En attendant la réalité de l'interopérabilité des outils, les futures modifications apportées à la spécification du CIM, débouchant sur de nouvelles versions de la présente norme, sont incorporées en premier lieu dans la description du projet Enterprise Architect pour garantir une source unique pour les données de modèle CIM.

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1 Disponible à l'adresse <https://cimug-org.github.io/CIMTool/>. CIMTool est l'appellation commerciale d'un produit distribué par Free Software Foundation. Cette information est donnée à l'intention des utilisateurs du présent document et ne signifie nullement que l'IEC approuve ou recommande l´emploi exclusif du produit ainsi désigné. Des produits équivalents peuvent être utilisés s'il peut être démontré qu'ils conduisent aux mêmes résultats.

2 Enterprise Architect est l'appellation commerciale d'un produit distribué par Sparx Systems. Cette information est donnée à l'intention des utilisateurs du présent document et ne signifie nullement que l'IEC approuve ou recommande l´emploi exclusif du produit ainsi désigné. Des produits équivalents peuvent être utilisés s'il peut être démontré qu'ils conduisent aux mêmes résultats.

L'Article 6 du présent document a été généré automatiquement en utilisant l'outil libre jCleanCim[3]), qui utilise les interfaces d'automatisation de Microsoft® Word[4]) et d'Enterprise Architect ainsi que le format et les styles normalisés de l'IEC.

4.8 Conventions de mise en œuvre pour les utilisateurs

4.8.1 Conventions au-delà de l'UML

Le paragraphe 4.8 propose des conventions d'utilisateur recommandées pour l'utilisation du CIM dans la mise en œuvre des systèmes réels.

4.8.2 Nombre de bornes pour les objets ConductingEquipment

Les classes ConductingEquipment suivantes ont deux bornes: ACLineSegment, DCLineSegment, DCSeriesDevice, DCSwitch (et ses spécialisations), DCChopper, Switch et toutes leurs spécialisations (y compris Jumper, Fuse, Breaker, Disconnector, LoadBreakSwitch et Cut), SeriesCompensator et EquivalentBranch. La classe PowerTransformer a généralement deux bornes, mais elle peut aussi avoir une borne ou davantage. Par exemple, un transformateur de mise à la terre connecté en zigzag peut avoir une borne. Des transformateurs à trois bornes sont couramment utilisés dans des systèmes de transport et les transformateurs pour cas spéciaux peuvent comporter quatre, cinq bornes ou davantage. Toutes les autres sous-classes ConductingEquipment (notamment qui comprennent Clamp et BusbarSection) et DCConductingEquipment ont une seule borne.

4.8.3 Grandeurs nominales

De nombreux attributs du modèle de réseau expriment des grandeurs nominales. Les principes suivants s'appliquent à ces attributs.

- Les grandeurs nominales ne sont pas liées à l'équipement, mais à la tension nominale du système dans le réseau.
- Les grandeurs assignées (ratedU, par exemple) sont liées aux données de la plaque d'identification.

4.8.4 Datatypes

Le document W3C XML Schema Definition Language (XSD) 1.1 Part 2: Datatypes permet d'utiliser les valeurs particulières suivantes: INF, NaN pour exprimer des grandeurs telles que l'infinité positive, l'infinité négative, et non un nombre. Les types de données CIM dans leur ensemble et la primitive Float ne peuvent pas utiliser INF et NaN s'ils n'y sont pas explicitement autorisés dans une description d'un attribut.

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3 Disponible à l'adresse <http://tanjakostic.org/jcleancim>. JCleanCim est l'appellation commerciale d'un produit distribué par Free Software Foundation. Cette information est donnée à l'intention des utilisateurs du présent document et ne signifie nullement que l'IEC approuve ou recommande l´emploi exclusif du produit ainsi désigné. Des produits équivalents peuvent être utilisés s'il peut être démontré qu'ils conduisent aux mêmes résultats.

4 Word est l'appellation commerciale d'un produit distribué par Microsoft. Cette information est donnée à l'intention des utilisateurs du présent document et ne signifie nullement que l'IEC approuve ou recommande l´emploi exclusif du produit ainsi désigné. Des produits équivalents peuvent être utilisés s'il peut être démontré qu'ils conduisent aux mêmes résultats.

4.9 Exemples de modélisation CIM

Des modèles de systèmes de puissance ont été créés de plusieurs façons à partir du modèle UML du CIM. Le premier exemple est une version du schéma RDF (Resource Description Framework – cadre général pour la description des ressources) du CIM, qui utilise XML (eXtensible Markup Language – langage de balisage extensible) pour décrire un modèle de réseau de système de puissance. L'IEC 61970-501 et d'autres normes de profil en développement sont utilisées pour spécifier le format d'échange de modèles. Des versions de schémas RDF du CIM ont été utilisées pour créer les fichiers de modèles XML de réseaux réels pour des essais d'interopérabilité. Une version de schéma RDF du CIM est générée à partir du fichier de modèle UML du CIM en utilisant des outils logiciels fondés sur une spécification de schéma RDF du CIM.

Il convient de noter qu'une version de schéma RDF du CIM est du niveau métadonnées plutôt qu'une instanciation d'un réseau réel. Cependant, des fichiers de modélisation complets de réseaux avec tous les éléments du réseau ainsi que leurs connexions électriques peuvent être générés par des fournisseurs utilisant des outils d'exportation propriétaires, puis importés par d'autres systèmes avec un outil d'importation similaire, qui est utilisé pour remplir une base de données technique locale sur le réseau.

5 Modèle détaillé

5.1 Vue d'ensemble

La partie du Modèle d'Information Commun (CIM) dont traite l'IEC 61970-301 représente une vue logique complète des informations échangées entre différents systèmes des entreprises de service public d'électricité. Cette définition inclut les classes et les attributs publics, ainsi que leurs relations.

5.2 Contexte

Le CIM est fractionné en sous-paquetages. Les classes au sein des paquetages sont répertoriées dans l'ordre dans lequel elles sont définies dans le modèle UML. Les attributs natifs de la classe sont d'abord répertoriés, suivis des attributs hérités dans l'ordre de la hiérarchie d'héritage. Les associations natives sont énumérées en premier pour chaque classe, suivies des associations héritées dans l'ordre de profondeur d'héritage, puis par ordre alphabétique selon le nom de l'extrémité d'association. Les associations sont décrites selon le rôle de chaque classe participant à l'association. Les extrémités d'associations sont répertoriées pour chaque classe à chaque extrémité d'une association.

La Figure 71 représente les paquetages de haut niveau inclus dans le présent document.

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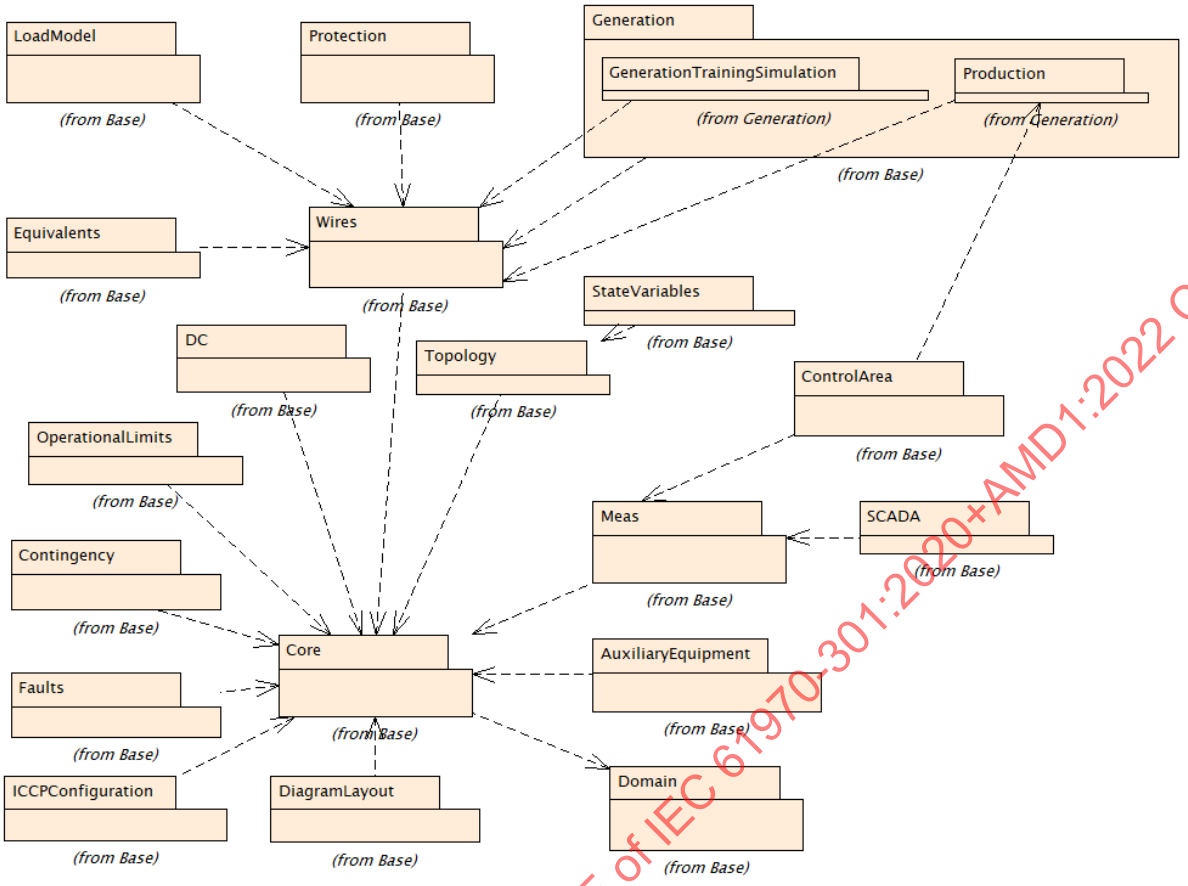


Figure 71 – Paquetages de haut niveau du CIM

Pour chaque paquetage, le modèle d'information de chaque classe est entièrement décrit. Les informations d'attribut et d'extrémité d'association pour des attributs natifs et hérités sont énumérées dans le Tableau 8 et dans le Tableau 9 en prenant une classe appelée "Class1" à titre d'exemple dans un paquetage "Package1" à titre d'exemple. Pour tous les éventuels attributs ou extrémités d'association hérités, la colonne "description" contient le texte indiquant que les attributs sont hérités d'une classe spécifique. Dans cet exemple, Class1 est par hypothèse héritée de la classe IdentifiedObject. La colonne "description" pour les attributs natifs et extrémités d'associations contient la description réelle. Pour des attributs hérités, la classe de base est notée dans la description et la documentation complète sur l'attribut est disponible dans cette classe de base sous forme d'attribut natif.

Tableau 8 – Attributs de Package1::Class1

nom	type	description
native1	Float	Un attribut natif virgule flottante de la classe est décrit ici.
native2	ActivePower	Documentation pour un autre attribut natif du type ActivePower.
name	String	Hérité de: IdentifiedObject

Dans les cas où un attribut est une constante, le Tableau 8 ajoute l'expression "(const)" à la colonne du nom. Dans ces cas, l'attribut a normalement une valeur initiale aussi qui est précédée du signal "égal" et accolée au nom d'attribut.

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Tableau 9 – Extrémités d'association de Package1::Class1 avec d'autres classes

[mult à partir de]	[mult vers] name	type	description
[0..*]	[0..1] Class2	Class2	Description de l'extrémité d'association à une autre classe appelée "Class1". Noter qu'il est typique, mais non exigé, que l'extrémité d'association soit identique au type de référence. Cette extrémité d'association peut référencer zéro ou un objet. L'autre extrémité de l'association peut référencer un Nabre quelconque d'instances de Class1.
[0..1]	[0..*] SecondClass2	Class2	Description de références à la classe appelée "Class2". Dans ce cas, un nombre quelconque de références peut être effectué. La référence inverse peut référencer zéro ou une instance de Class1.
[1..1]	[0..*] Class3	Class3	Référence à un nombre quelconque d'instances de Class3. La référence inverse doit référencer une seule instance de Class1.
[0..*]	[0..*] Class4	Class4	Association plusieurs à plusieurs.
[0..1]	[0..*] DiagramObjects	DiagramObject	hérité de: IdentifiedObject
[1..1]	[0..*] Names	Name	hérité de: IdentifiedObject

Dans le Tableau 9, la première colonne décrit la multiplicité en cette extrémité de l'association (c'est-à-dire, la façon dont cette classe participe à l'association). La deuxième colonne décrit l'autre extrémité d'association. Sa multiplicité est insérée entre des crochets. Le nom de l'extrémité d'association est répertorié en texte en clair. La classe à l'autre extrémité de l'association est donnée dans la troisième colonne. Une multiplicité zéro indique une association facultative. Une multiplicité "*" indique que n'importe quel nombre est autorisé. Par exemple, une multiplicité [1..*] indique qu'une plage allant de 1 à n'importe quel nombre plus grand est autorisée.

Lorsqu'une classe est une énumération appelée "Enumeration1", le tableau des attributs est remplacé par la documentation de libellés comme représenté au Tableau 10, puisque les libellés d'énumération n'ont pas de type. Il n'existe pas de libellés d'énumération hérités pour une classe d'énumération.

Tableau 10 – Libellés de Package1::Enumeration1

libellé	description
native1	Il s'agit de la première valeur enumeration native.
native2	Il s'agit de la deuxième valeur enumeration native.
native3	Il n'y a généralement pas d'attributs hérités pour les énumérations.

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6 Paquetage Base

6.1 Généralités

[nsuri = http://iec.ch/TC57/CIM100#, nsprefix = cim]

Contenu de la CIM de base publié comme IEC 61970-301.

6.2 Paquetage Domain

6.2.1 Généralités

Le paquetage Domain définit les types primitifs de données qui sont utilisés par des classes dans d'autres paquetages. Des stéréotypes sont utilisés pour décrire les types de données. Les stéréotypes suivants sont définis:

- <<enumeration>> Liste des valeurs constantes permises;
- <<Primitive>> type de données le plus simple qui est utilisé pour composer tous les autres types de données;
- <<CIMDatatype>> Type de données qui contient un attribut de valeur, une unité facultative de mesure et un multiplicateur d'unité. L'unité et le multiplicateur peuvent être spécifiés comme des variables statiques initialisées à la valeur autorisée;
- <<Compound>> Composé de Primitive, enumeration, CIMDatatype ou classes Compound, dans la mesure où les classes Compound ne sont pas inversées.

Pour tous les types de données, des valeurs positives et négatives sont admises, sauf indication contraire pour un type de données particulier.

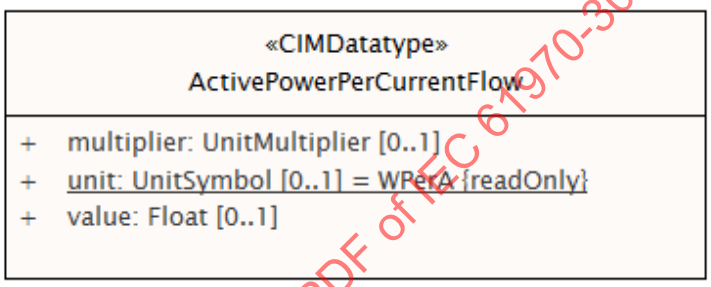


Figure 72 – Diagramme de classe Domain::CombinedElectricalDatatypes

Figure 72: Ce diagramme représente les types de données électriques qui sont des combinaisons d'autres types de données électriques.

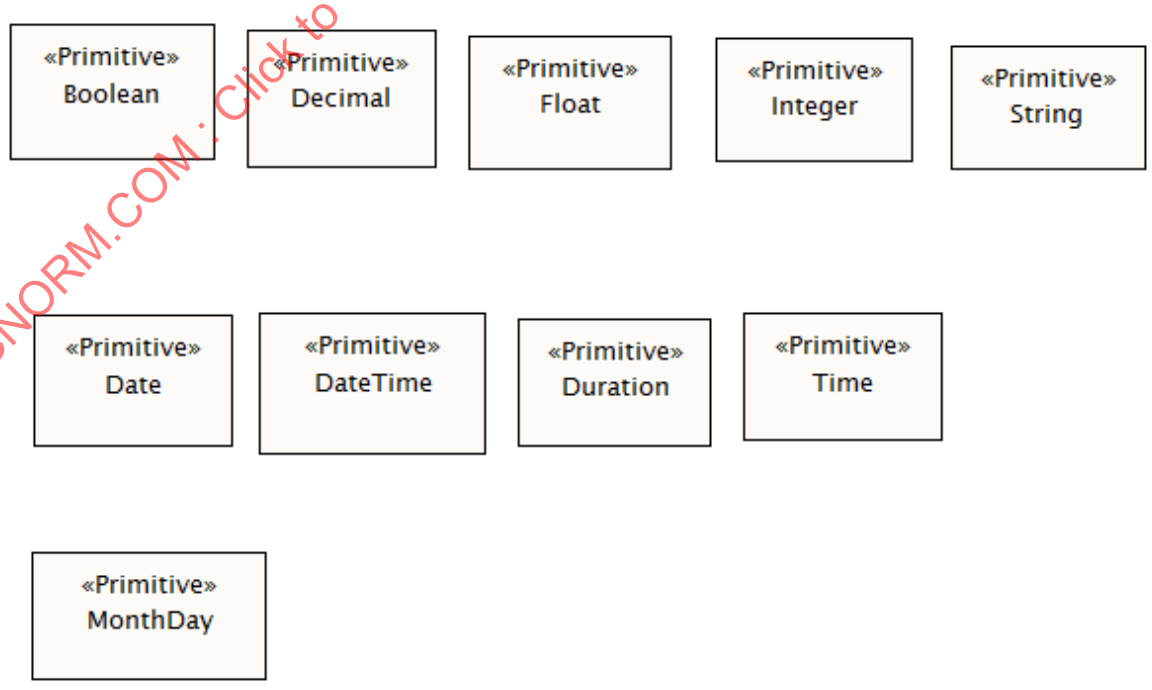
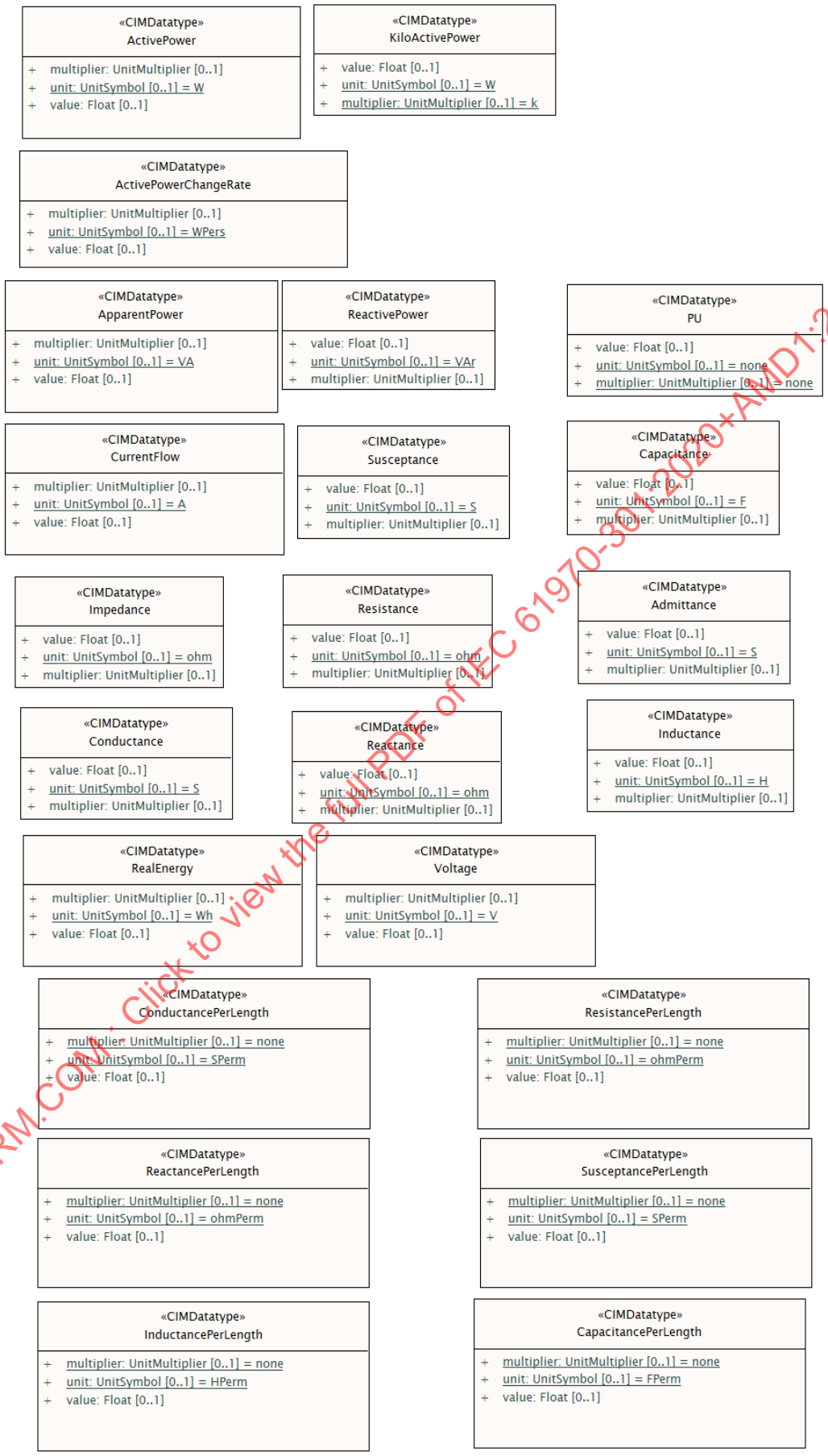


Figure 73 – Diagramme de classe Domain::BasicDatatypes

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Figure 73: Ce diagramme représente les types de données de base qui sont à l'origine de tous les autres types de données.

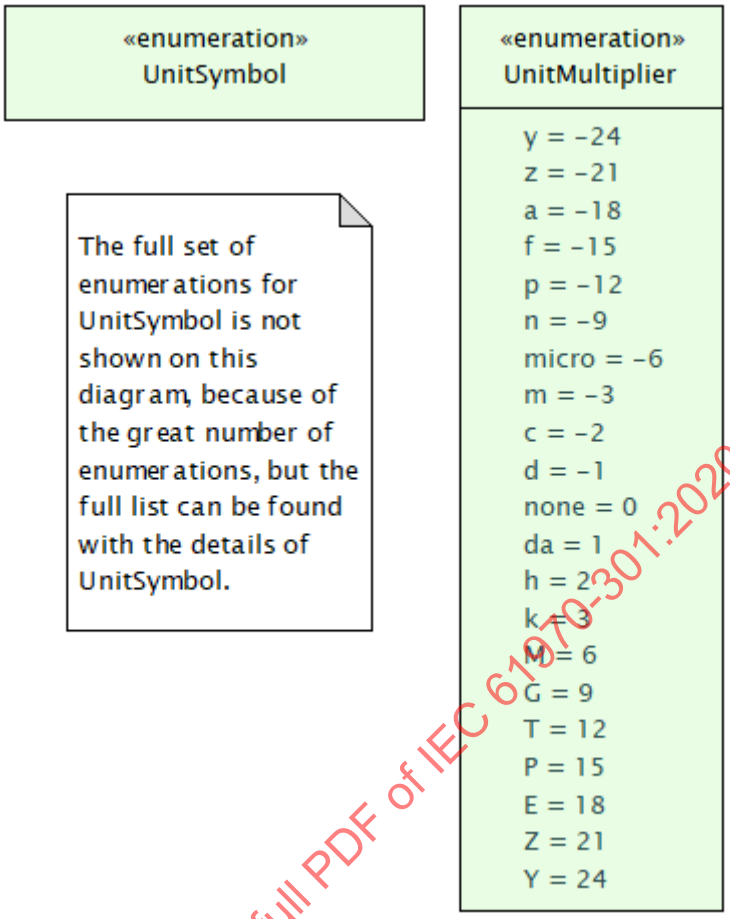
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Figure 74 – Diagramme de classe Domain::ElectricityDatatypes

Figure 74: Ce diagramme représente les types de données liées à l'électricité.

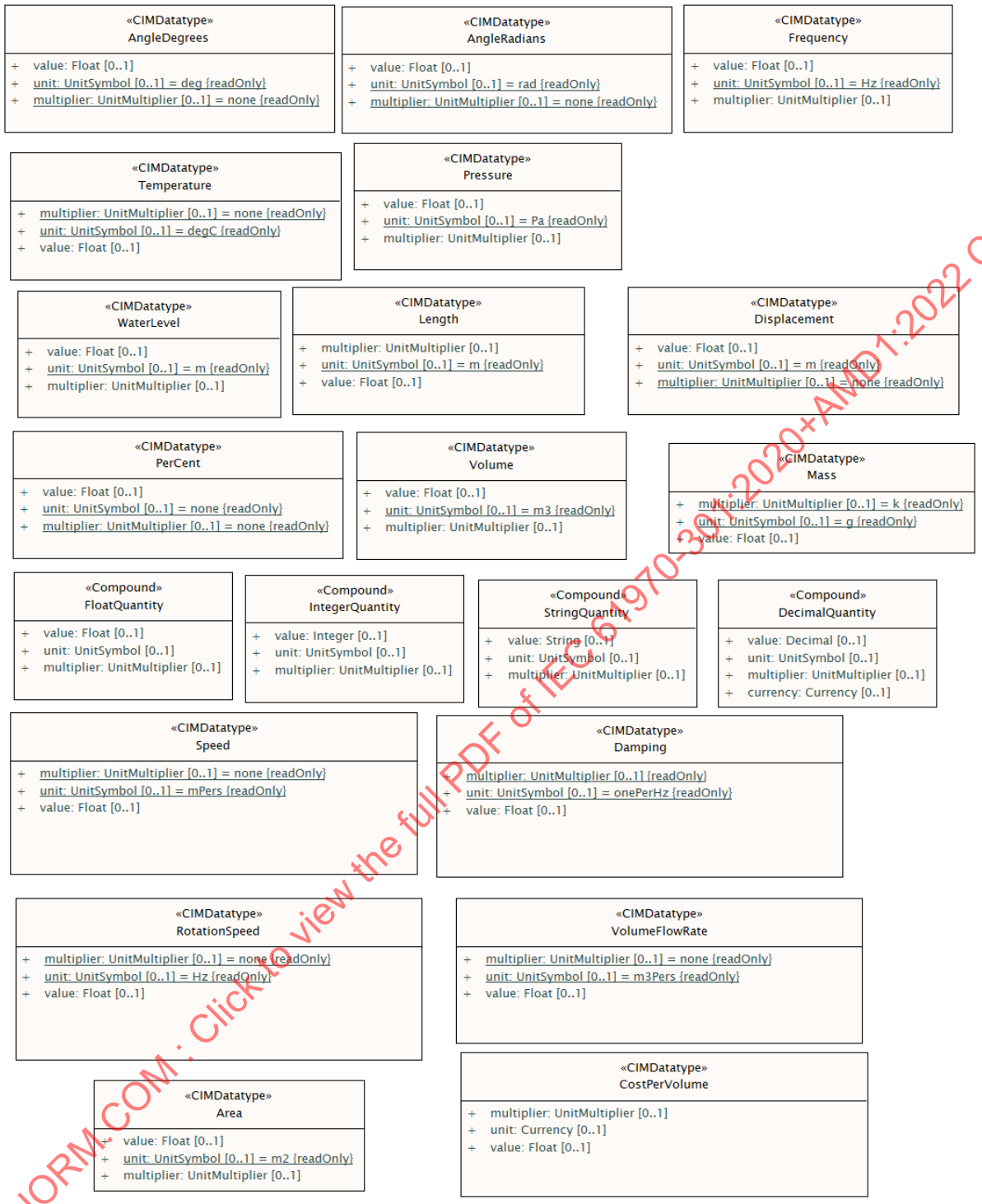


Anglais	Français
The full set of enumerations for UnitSymbol is not shown on this diagram, because of the great number of enumerations, but the full list can be found with the details of UnitSymbol	L'ensemble complet des énumérations pour UnitSymbol n'est pas représenté dans ce diagramme du fait du grand nombre d'énumérations mais la liste complète peut être consultée dans les informations détaillées de UnitSymbol

Figure 75 – Diagramme de classe Domain::EnumeratedUnitDatatypes

Figure 75: Ce diagramme représente les types de données énumérés liés au système d'unités SI.

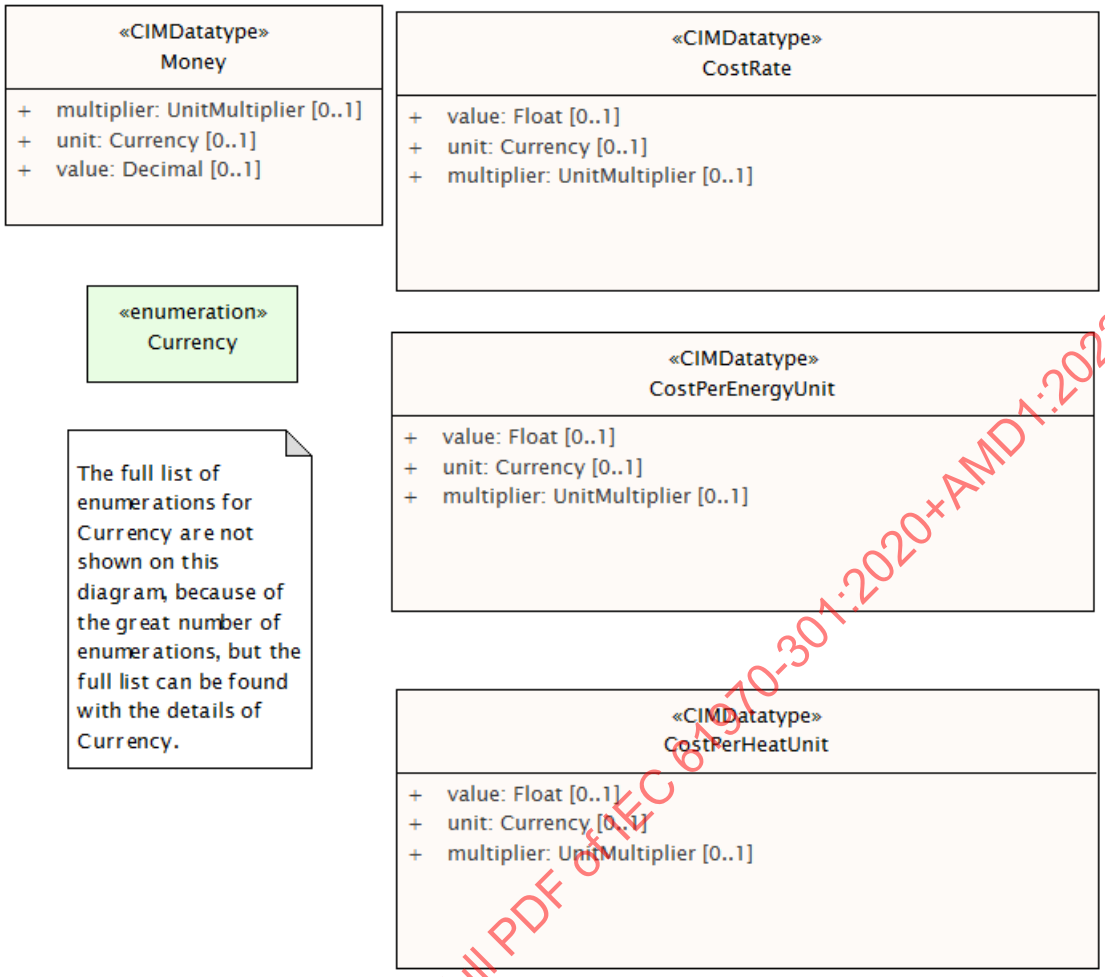
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Figure 76 – Diagramme de classe Domain::GeneralDatatypes

Figure 76: Ce diagramme représente les types généraux de données.



Anglais	Français
The full set of enumerations for Currency are not shown on this diagram, because of the great number of enumerations, but the full list can be found with the details of Currency	L'ensemble complet des énumérations pour Currency n'est pas représenté dans ce diagramme du fait du grand nombre d'énumérations mais la liste complète peut être consultée dans les informations détaillées de Currency

Figure 77 – Diagramme de classe Domain::MonetaryDatatypes

Figure 77: Ce diagramme représente les types de données liés à la monnaie.

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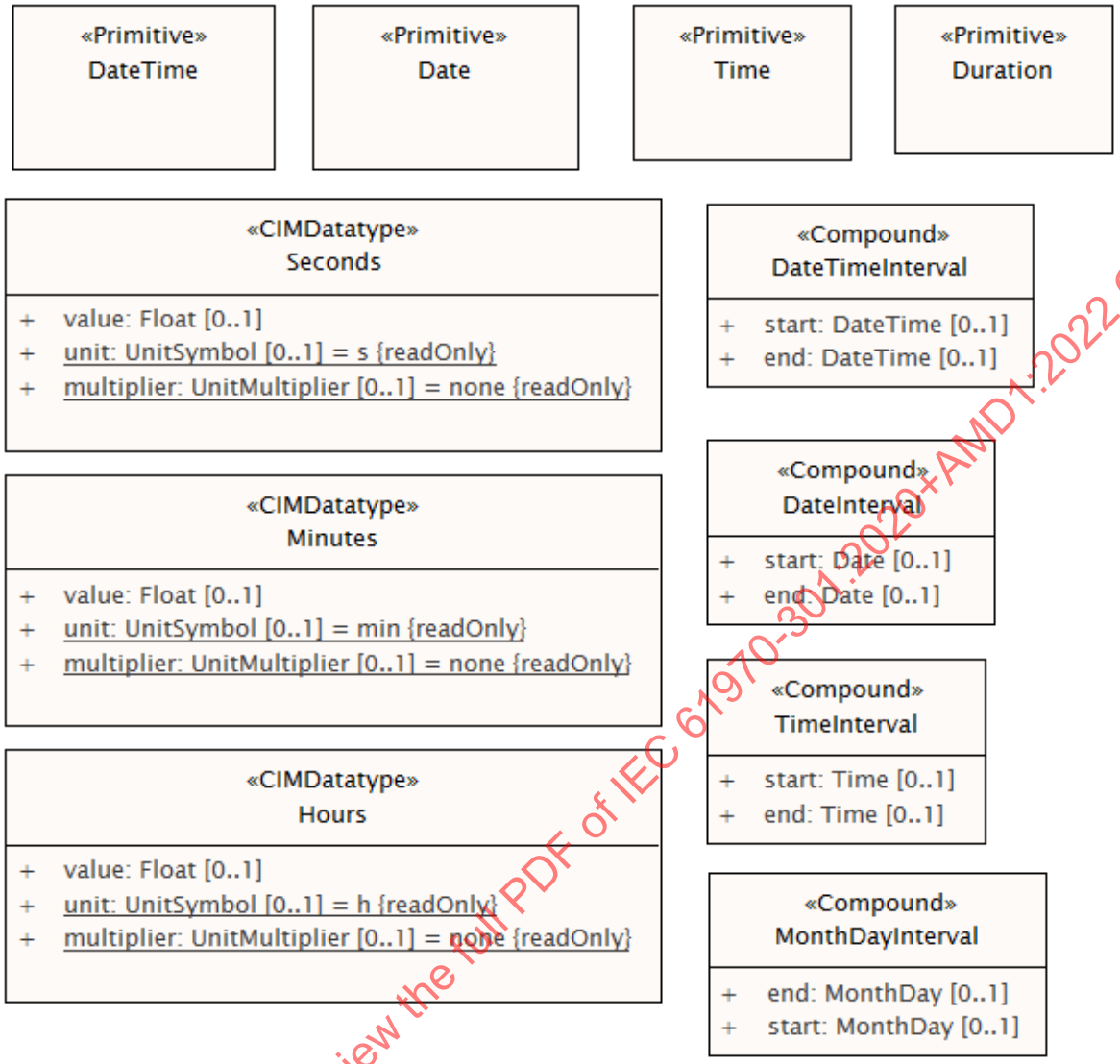


Figure 78 – Diagramme de classe Domain::TimeDatatypes

Figure 78: Ce diagramme représente les types de données liés au temps.

6.2.2 Type de données ActivePower

Produit de la valeur RMS (valeur efficace) de la tension et de la valeur RMS de l'élément en phase du courant.

Le Tableau 11 présente tous les attributs de ActivePower.

Tableau 11 – Attributs de Domain::ActivePower

nom	mult	type	description
multiplier	0..1	UnitMultiplier	
unit	0..1	UnitSymbol	(const=W)
value	0..1	Float	

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6.2.3 Type de données ActivePowerChangeRate

Taux de variation de la puissance active par unité de temps.

Le Tableau 12 présente tous les attributs de ActivePowerChangeRate.

Tableau 12 – Attributs de Domain::ActivePowerChangeRate

nom	mult	type	description
multiplier	0..1	UnitMultiplier	
unit	0..1	UnitSymbol	(const=WPers)
value	0..1	Float	

6.2.4 Type de données ActivePowerPerCurrentFlow

Variation de puissance active avec l'intensité.

Le Tableau 13 présente tous les attributs de ActivePowerPerCurrentFlow.

Tableau 13 – Attributs de Domain::ActivePowerPerCurrentFlow

nom	mult	type	description
multiplier	0..1	UnitMultiplier	
unit	0..1	UnitSymbol	(const=WPerA)
value	0..1	Float	

6.2.5 Type de données ActivePowerPerFrequency

Variation de puissance active avec la fréquence.

Le Tableau 14 présente tous les attributs de ActivePowerPerFrequency.

Tableau 14 – Attributs de Domain::ActivePowerPerFrequency

nom	mult	type	description
multiplier	0..1	UnitMultiplier	
unit	0..1	UnitSymbol	(const=WPers)
value	0..1	Float	

6.2.6 Type de données Admittance

Rapport courant/tension.

Le Tableau 15 présente tous les attributs de Admittance.

Tableau 15 – Attributs de Domain::Admittance

nom	mult	type	description
value	0..1	Float	
unit	0..1	UnitSymbol	(const=S)
multiplier	0..1	UnitMultiplier	

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