IEC 61970-452

Edition 4.0 2021-10

INTERNATIONAL STANDARD

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Energy management system application program interface (EMS-API) – Part 452: CIM static transmission network model profiles

Interface de programmation d'application pour système de gestion d'énergie (EMS-API) – Partie 452: Profils du modèle de réseau de transport statique CIM

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

Part 452: CIM static transmission network model profiles

FOREWORD

1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
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International Standard IEC 61970 has been prepared by IEC technical committee 57: Power systems management and associated information exchange.

This fourth edition cancels and replaces the third edition published in 2017. This edition constitutes a technical revision. It is based on the IEC 61970 UML version ‘IEC61970CIM17v40’, dated 2020-08-24.

This edition includes the following significant technical changes with respect to the previous edition:

a) The classes PowerElectronicsConnection, PowerElectronicsUnit and PowerElectronicsWindUnit are added to the Core Equipment profile.

The text of this International Standard is based on the following documents:

FDIS	Report on voting
57/2400/FDIS	57/2407/RVD

Full information on the voting for its approval can be found in the report on voting indicated in the above table.

The language used for the development of this International Standard is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/standardsdev/publications.

A list of all parts in the IEC 61970 series, published 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 this document will remain unchanged until the stability date indicated on the IEC website under webstore.iec.ch in the data related to the specific document. At this date, the document will be

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

IMPORTANT – The "colour inside" logo on the cover page of this document 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.

INTRODUCTION

This part of IEC 61970 is part of the IEC 61970 series that define an application program interface (API) for an energy management system (EMS).

The IEC 61970-300 series specifies a Common Information Model (CIM). The CIM is an abstract model that represents all of the major objects in an electric utility enterprise typically needed to model the operational aspects of a utility. It provides the semantics for the IEC 61970 APIs specified in the IEC 61970-400 series of Component Interface Standards (CIS). The IEC 61970-300 series includes IEC 61970-301, *Common Information Model (CIM) base* and draft standard IEC 61970-302, *Common Information Model (CIM) for Dynamics*.

This document is one of the IEC 61970-400 series of Component Interface Standards that specify the functional requirements for interfaces that a component (or application) shall implement to exchange information with other components (or applications) and/or to access publicly available data in a standard way. The component interfaces describe the specific message contents and services that can be used by applications for this purpose. The implementation of these messages in a particular technology is described in the IEC 61970-500 series.

This document specifies the specific profiles (or subsets) of the CIM for exchange of static power system data between utilities, security coordinators and other entities participating in an interconnected power system, such that all parties have access to the modelling of their neighbour's systems that is necessary to execute state estimation or power flow applications. Currently three profiles, the CoreEquipment Profile, the Operation Profile and the Short Circuit Profile, have been defined. A companion standard, IEC 61970-552, defines the CIM XML Model Exchange Format based on the Resource Description Framework (RDF) Schema specification language. IEC 61970-552 is the common industry approach and is recommended to be used to transfer power system model data for the IEC 61970-452 profile.

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

Part 452: CIM static transmission network model profiles

1 Scope

This document is one of the IEC 61970-450 to 499 series that, taken as a whole, defines at an abstract level the content and exchange mechanisms used for data transmitted between control centres and/or control centre components, such as power systems applications.

The purpose of this document is to define the subset of classes, class attributes, and associations from the CIM necessary to execute state estimation and power flow applications. The North American Electric Reliability Council (NERC) Data Exchange Working Group (DEWG) Common Power System Modelling group (CPSM) produced the original data requirements, which are shown in Annex F. These requirements are based on prior industry practices for exchanging power system model data for use primarily in planning studies. However, the list of required data has been extended starting with the first edition of this standard to facilitate a model exchange that includes parameters common to breaker-oriented applications. Where necessary this document establishes conventions, shown in Clause 6, with which an XML data file must comply in order to be considered valid for exchange of models.

The data exchange use cases which this standard is meant to support are described in Annex A. The idea of a modelling authority as the source responsible for the modeling of a given region is described in Annex B. The concept of a boundary between regions is explained in Annex C. Annex D explains the processing of multiple profiles such as the three profiles described in this standard. The use of different curve styles to define ReactiveCapabilityCurve-s is explained in Annex E.

This document is intended for two distinct audiences, data producers and data recipients, and may be read from two perspectives.

From the standpoint of model export software used by a data producer, this document describes a minimum subset of CIM classes, attributes, and associations which must be present in an XML formatted data file for model exchange. This document does not dictate how the network is modelled, however. It only dictates what classes, attributes, and associations are to be used to describe the source model as it exists.

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.

NOTE For general glossary definitions, see IEC 60059, International Electrotechnical Vocabulary.

IEC 61970-301:2020, *Energy management system application program interface (EMS-API) – Part 301: Common information model (CIM) base*

3 Terms and definitions

No terms and definitions are listed in this document.

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

4 Application profile specification

4.1 General

An extensive discussion of the model exchange use cases can be found in Annex A. In all cases, the purposes of this document are:

- To improve the accuracy of power system models used in critical systems, particularly the representation of parts of the network outside the primary domain of the system in question.
- To achieve consistency among the models used by the various systems that play a role in operating or planning the interconnection.
- To reduce the overall cost of maintaining critical models used in operating or planning an interconnection.

The classes, attributes, and associations identified in IEC 61970-301 and specified in this document represent the minimum subset of the full CIM model necessary to exchange sufficient power system data to support state estimation and power flow for HV(high voltage) and MV (medium voltage) networks. IEC 61968-13 describes the profiles used to exchange distribution MV/LV (low voltage) network models.

4.2 Version information

4.2.1 Core equipment profile

- Title: Core Equipment Vocabulary
- Keyword: EQ
- Description: This vocabulary is describing the core equipment profile from IEC 61970-452.
- Version IRI: http://iec.ch/TC57/ns/CIM/CoreEquipment/4.0
- Version info: 4.0.0
- Prior version: http://iec.ch/TC57/61970-452/CoreEquipment/3
- Conforms to: urn:iso:std:iec:61970-452:ed-4|urn:iso:std:iec:61970-301:ed-7:amd1|file://iec61970cim17v40_iec61968cim13v13a_iec62325cim03v17a.eap|urn:iso:std:iec:61970-401:draft:ed-1|urn:iso:std:iec:61970-501:draft:ed-2
- Identifier: urn:uuid:aa5a0075-82df-4e6a-8879-8e860deb4da9

4.2.2 Operation profile

- Title: Operation Vocabulary
- Keyword: OP
- Description: This vocabulary is describing the operation profile from IEC 61970-452.
- Version IRI: http://iec.ch/TC57/ns/CIM/Operation/4.0
- Version info: 4.0.0
- Prior version: http://iec.ch/TC57/61970-452/Operation/3
- Conforms to: urn:iso:std:iec:61970-452:ed-4|urn:iso:std:iec:61970-301:ed-7:amd1|file://iec61970cim17v40_iec61968cim13v13a_iec62325cim03v17a.eap|urn:iso:std:iec:61970-401:draft:ed-1|urn:iso:std:iec:61970-501:draft:ed-2
- Identifier: urn:uuid:26cd507d-95c2-4003-95a8-6c148a8fcd71

4.2.3 Short-Circuit profile

- Title: Short Circuit Vocabulary
- Keyword: SC
- Description: This vocabulary is describing the short circuit profile from IEC 61970-452.
- Version IRI: http://iec.ch/TC57/ns/CIM/ShortCircuit/4.0
- Version info: 4.0.0
- Prior version: http://iec.ch/TC57/61970-452/ShortCircuit/3
- Conforms to: urn:iso:std:iec:61970-452:ed-4|urn:iso:std:iec:61970-301:ed-7:amd1|file://iec61970cim17v40_iec61968cim13v13a_iec62325cim03v17a.eap|urn:iso:std:iec:61970-401:draft:ed-1|urn:iso:std:iec:61970-501:draft:ed-2
- Identifier: urn:uuid:e75168b4-6581-46ab-bc1c-fa7ef332558e

4.3 Requirements and constraints

This subclause defines requirements and constraints that shall be fulfiled by applications that conform to this document. The naming of the rules shall not be used for machine processing. The rule names are just strings. The naming convention of the constraints is as follows.

"{rule.Type}:{rule.Standard}:{rule.Profile}:{rule.Property}:{rule.Name}"

where

rule.Type: C – for constraint; R – for requirement

rule.Standard: the number of the standard part, e.g. 452 for IEC 61970-452.

rule.Profile: the abbreviation of the profile.

- EQ – Core Equipment Profile
- OP – Operation Profile
- SC – Short Circuit Profile
- ALL – All profiles (the constraint applies to all IEC 61970-452 profiles)

rule.Property: for UML classes, the name of the class, for attributes and associations, the name of the class and attribute or association end, e.g. EnergyConsumer, IdentifiedObject.name, etc. If set to "NA" the property is not applicable to a specific UML element.

rule.Name: the name of the rule. It is unique for the same property.

Example: C:452:ALL:IdentifiedObject.name:stringLength.

- C:452:ALL:NA:datatypes

  According to 61970-501, datatypes are not exchanged in the instance data. The UnitMultiplier is 1 in cases none value is specified in the profile.

- R:452:ALL:NA:exchange

  Optional and required attributes and associations must be imported and exported if they are in the model file prior to import.

- R:452:ALL:NA:exchange1

  If an optional attribute does not exist in the imported file, it does not have to be exported in case exactly the same data set is exported, i.e. the tool is not obliged to automatically provide this attribute. If the export is resulting from an action by the user performed after the import, e.g. data processing or model update the export can contain optional attributes.

- R:452:ALL:NA:exchange2

  In most of the profiles the selection of optional and required attributes is made so as to ensure a minimum set of required attributes without which the exchange does not fulfil its basic purpose. Business processes governing different exchanges can require mandatory exchange of certain optional attributes or associations. Optional and required attributes and associations shall therefore be supported by applications which claim conformance with certain functionalities of the IEC 61970-452. This provides flexibility for the business processes to adapt to different business requirements and base the exchanges on IEC 61970-452 compliant applications.

- R:452:ALL:NA:exchange3

  An exporter may, at his or her discretion, produce a serialization containing additional class data described by the CIM Schema but not required by this document provided these data adhere to the conventions established in Clause 5.

- R:452:ALL:NA:exchange4

  From the standpoint of the model import used by a data recipient, the document describes a subset of the CIM that importing software shall be able to interpret in order to import exported models. Data providers are free to exceed the minimum requirements described herein as long as their resulting data files are compliant with the CIM Schema and the conventions established in Clause 5. The document, therefore, describes additional classes and class data that, although not required, exporters will, in all likelihood, choose to include in their data files. The additional classes and data are labelled as required (cardinality 1..1) or as optional (cardinality 0..1) to distinguish them from their required counterparts. Please note, however, that data importers could potentially receive data containing instances of any and all classes described by the CIM Schema.

- R:452:ALL:NA:cardinality

  The cardinality defined in the CIM model shall be followed, unless a more restrictive cardinality is explicitly defined in this document. For instance, the cardinality on the association between VoltageLevel and BaseVoltage indicates that a VoltageLevel shall be associated with one and only one BaseVoltage, but a BaseVoltage can be associated with zero to many VoltageLevels.

- R:452:ALL:NA:associations

  Associations between classes referenced in this document and classes not referenced here are not required regardless of cardinality.

- C:452:ALL:NA:minMaxValues

  Maximum values shall always be greater than or equal to minimum values if not specified otherwise explicitly.

- R:452:ALL:IdentifiedObject.name:rule

  The attribute "name" inherited by many classes from the abstract class IdentifiedObject is not required to be unique. It must be a human readable identifier without additional embedded information that would need to be parsed. The attribute is used for purposes such as User Interface and data exchange debugging. The MRID defined in the data exchange format is the only unique and persistent identifier used for this data exchange. The attribute IdentifiedObject.name is, however, always required for CoreEquipment profile and Short Circuit profile.

- C:452:ALL:IdentifiedObject.name:stringLength

  The string IdentifiedObject.name has a maximum of 128 characters.

- R:452:ALL:IdentifiedObject.description:rule

  The attribute "description" inherited by many classes from the abstract class IdentifiedObject must contain human readable text without additional embedded information that would need to be parsed.

- R:452:ALL:NA:uniqueIdentifier

  All IdentifiedObject-s shall have a persistent and globally unique identifier (Master Resource Identifier – mRID).

- R:452:ALL:ConductingEquipment:connectivity

  All subtypes of ConductingEquipment are required to have associations to Terminals. The number of associated Terminals is specified in IEC 61970-301:2020, 4.8.2 "Number of terminals for ConductingEquipment objects." The associated Terminal(s) are not require to have associations to ConnectivityNodes, for instance a ShuntCompensator whose Terminal is not associated to a ConnectivityNode.

- R:452:ALL:NA:classes

  Instance data to be exchanged must make use of the most detailed class possible within a profile, i.e. using sub-typed classes rather than general classes e.g. NuclearGeneratingUnit instead of GeneratingUnit.

- R:452:ALL:NA:ground

  There shall not be any ground voltage level. The ConnectivityNode connected to the Ground instance belongs to the same containment instance as the grounding device. This means that the Ground instances are contained in the same voltage level where other switching devices are contained with a non-zero BaseVoltage.

- R:452:ALL:NA:unitMultiplier

  For exchange of attributes defined using CIM Data Types (ActivePower, Susceptance, etc.) a unit multiplier of 1 is used if the UnitMultiplier specified in this document is "none".

- C:452:ALL:NA:float

  An attribute that is defined as float (e.g. has a type Float or a type which is a Datatype with .value attribute of type Float) shall support ISO/IEC 60559:2020 for floating-point arithmetic using single precision floating point. A single precision float supports 7 significant digits where the significant digits are described as an integer, or a decimal number with 6 decimal digits. Two float values are equal when the significant with 7 digits are identical, e.g. 1234567 is equal 1.234567E6 and so are 1.2345678 and 1.234567E0.

- C:452:EQ:ACLineSegment.BaseVoltage:calculations

  All implementations shall use association to a BaseVoltage for the purpose of any per unit calculations and shall not rely on the voltages (neither nominal nor actual values obtained by previous or current solution) at the nodes, which the ACLineSegment connects to.

- C:452:EQ:ACLineSegment.BaseVoltage:calculations2

  In case there are interconnected ACLineSegments with different BaseVoltage for different parts of the networks (when assembling different model authority sets) the application needs to handle this to ensure accurate physical units.

- C:452:EQ:ACLineSegment.r:valueRange

  ACLineSegment.r shall be a positive value or zero.

- C:452:EQ:ACLineSegment.x:valueRange

  ACLineSegment.x shall be a positive value. As negative reactance values are not allowed for ACLineSegment-s it is recommended to model series compensators explicitly.

- C:452:EQ:AsynchronousMachine:aggregate

  If one AsynchronousMachine is associated with one GeneratingUnit the flag Equipment.aggregate shall be consistent in case it is provided at both AsynchronousMachine and GeneratingUnit.

- C:452:EQ:AsynchronousMachine.ratedS:dynamicSimulation

  RotatingMachine.ratedS is required in case of data exchange to support dynamic simulations.

- C:452:EQ:ConductingEquipment.BaseVoltage:whereRequired

  The ConductingEquipment.BaseVoltage association is required for the following ConductingEquipment: ACLineSegment, EquivalentBranch and SeriesCompensator.

  For all other Equipment-s, not contained in a VoltageLevel, the association ConductingEquipment.BaseVoltage can be provided (as it is optional), however the association to BaseVoltage coming from the container or transformer ends takes precedence.

- C:452:EQ:ConnectivityNode:containment

  The association ConnectivityNode.ConnectivityNodeContainer is required however the type of EquipmentContainer the association shall point to is not specified. Therefore the association ConnectivityNode.ConnectivityNodeContainer shall point to any type of EquipmentContainer given by the connecting equipment (that is linked to the associated Terminal). Machine based validation is not performed. It is required that import and export shall not make any changes to this association.

- C:452:EQ:CurveData.Curve:equationY1

  If CurveData.Curve is a ReactiveCapabilityCurve, each CurveData shall satisfy the following relation:

  – CurveData.xvalue^2+CurveData.y1value^2 shall be less than or equal to RotatingMachine.ratedS^2

- C:452:EQ:CurveData.Curve:equationY2

  If CurveData.Curve is a ReactiveCapabilityCurve, each CurveData shall satisfy the following relation:

  – CurveData.xvalue^2+CurveData.y2value^2 shall be less than or equal to RotatingMachine.ratedS^2.

- C:452:EQ:CurveData.Curve:reactive

  If CurveData.Curve is a ReactiveCapabilityCurve, the CurveData.y2value shall be greater than or equal to CurveData.y1value.It is not allowed that all CurveData.y2value values are equal to CurveData.y1value values.

- C:452:EQ:CurveData.Curve:reactiveCountP

  For a SynchronousMachine with a ReactiveCapabilityCurve the number of CurveData instances depends on the attribute SynchronousMachine.type as follows:

  – condenser, reactive capability limits are given by SynchronousMachine.maxQ and SynchronousMachine.minQ. There shall not be any association to ReactiveCapabilityCurve.

  – generator or generatorOrCondenser, at least two CurveData instances with CurveData.xvalue greater than or equal to 0.

  – motor or motorOrCondenser, at least two CurveData instances with CurveData.xvalue less than or equal to 0.

  – generatorOrMotor or generatorOrCondenserOrMotor, at least three CurveData instances with at least one having CurveData.xvalue greater than or equal to 0 and one having CurveData.xvalue less than or equal to 0.

It is required that the points defining a ReactiveCapabilityCurve include at least two different values of xvalue (active power) and that the values of y1value and y2value (reactive minimum and maximum respectively) can not be equal except at the minimum and maximum values of xvalue.

- C:452:EQ:CurveData.Curve:VsCapabilityCurve

  If CurveData.Curve is a VsCapabilityCurve, the CurveData.y2value shall be greater than CurveData.y1value.

- C:452:EQ:CurveData.Curve:VsCapabilityCurveCount

  If CurveData.Curve is a VsCapabilityCurve at least two CurveData shall be associated.

- C:452:EQ:CurveData.xvalue:value

  If CurveData.Curve is a ReactiveCapabilityCurve, the GeneratingUnit.minOperatingP shall be equal of the minimum of the CurveData.xvalue among all points defined for the ReactveCapabilityCurve. The GeneratingUnit.maxOperatingP shall be equal of the maximum of the CurveData.xvalue among all points defined for the ReactveCapabilityCurve.

- C:452:EQ:DayType.name:validValues

  For DayType the name attribute indicates the days of the week that a given DayType represents. The name attribute is restricted to the following names: Monday, Tuesday, Wednesday, Thursday, Friday, Saturday, Sunday, Weekday, Weekend, All. If the name attribute is All, it represents all seven days of the week. If the name attribute is Weekday, it represents Monday through Friday. If the name attribute is Weekend, it represents Saturday and Sunday.

- C:452:EQ:DCGround:instance

  At least one DCGround shall be defined for each DC circuit.

- C:452:EQ:DCLineSegment.resistance:valueRange

  The attribute DCLineSegment.resistance shall be a positive value.

- C:452:EQ:AuxilaryEquipment:containment

  For AuxilaryEquipment (CurrentTransformer, PotentialTransformer, PostLineSensor, SurgeArrester, WaveTrap, FaultIndicator) the association Equipment.EquipmentContainer is required and shall point to EquipmentContainer of type Bay or Line.

- C:452:EQ:EnergyConnection:containment

  For EnergyConnection (EnergySource, EnergyConsumer, NonConformLoad, ConformLoad, LinearShuntCompensator, NonlinearShuntCompensator, ExternalNetworkInjection, StaticVarCompensator, SynchronousMachine, AsynchronousMachine) the association Equipment.EquipmentContainer is required and shall point to EquipmentContainer of type VoltageLevel.

- C:452:EQ:ProtectedSwitch:containment

  For ProtectedSwitch (Breaker, DisconnectingCircuitBreaker, LoadBreakSwitch) the association Equipment.EquipmentContainer is required and shall point to EquipmentContainer of type Bay, VoltageLevel or DCConverterUnit.

- C:452:EQ:Ground:containment

  For Ground the association Equipment.EquipmentContainer is required and shall point to EquipmentContainer of type Bay or VoltageLevel.

- C:452:EQ:EarthFaultCompensator:containment

  For EarthFaultCompensator (GroundingImpedance, PetersenCoil) the association Equipment.EquipmentContainer is required and shall point to EquipmentContainer of type VoltageLevel.

- C:452:EQ:Conductor:containment

  For Conductor (ACLineSegment) the association Equipment.EquipmentContainer is required and shall point to EquipmentContainer of type Line.

- C:452:EQ:SeriesCompensator:containment

  For SeriesCompensator the association Equipment.EquipmentContainer is required and shall point to EquipmentContainer of type VoltageLevel when in substation, DCConverterUnit or Line when outside substation.

- C:452:EQ:BusbarSection:containment

  For BusbarSection the association Equipment.EquipmentContainer is required and shall point to EquipmentContainer of type VoltageLevel or Bay (when a disconnector is splitting a busbar section in two).

- C:452:EQ:Junction:containment

  For Junction the association Equipment.EquipmentContainer is required and shall point to EquipmentContainer of type Line (in case they model T-junction of a Line), or VoltageLevel or Bay (in case they model named join locations within a Substation).

- C:452:EQ:PowerTransformer:containment

  For PowerTransfomer the association Equipment.EquipmentContainer is required and shall point to EquipmentContainer of type Substation or DCConverterUnit. For the case of a transformer that connects two substations, the terminal of one of the PowerTransformerEnd-s can be connected to a ConnectivityNode defined in another substation.

- C:452:EQ:Disconnector:containment

  For Disconnector the association Equipment.EquipmentContainer is required and shall point to EquipmentContainer of type Bay, VoltageLevel, DCConverterUnit or Line when outside substation.

- C:452:EQ:GroundDisconnector:containment

  For GroundDisconnector the association Equipment.EquipmentContainer is required and shall point to EquipmentContainer of type Bay, VoltageLevel, DCConverterUnit or Line when outside substation.

- C:452:EQ:Fuse:containment

  For Fuse the association Equipment.EquipmentContainer is required and shall point to EquipmentContainer of type Bay, VoltageLevel, DCConverterUnit or Line when outside substation.

- C:452:EQ:Jumper:containment

  For Jumper the association Equipment.EquipmentContainer is required and shall point to EquipmentContainer of type Bay, VoltageLevel, DCConverterUnit or Line when outside substation.

- C:452:EQ:Cut:containment

  For Cut the association Equipment.EquipmentContainer is required and shall point to EquipmentContainer of type Bay, VoltageLevel or DCConverterUnit or Line when outside substation.

- C:452:EQ:Clamp:containment

  For Clamp the association Equipment.EquipmentContainer is required and shall point to EquipmentContainer of type Bay or Line when outside substation.

- C:452:EQ:GeneratingUnit:containment

  For GeneratingUnit (SolarGeneratingInit, NuclearGeneratingUnit, ThermalGeneratingUnit, HydroGeneratingUnit, WindGeneratingUnit) the association Equipment.EquipmentContainer is required and shall point to EquipmentContainer of type Substation.

- C:452:EQ:HydroPump:containment

  For HydroPump the association Equipment.EquipmentContainer is required and shall point to EquipmentContainer of type Substation.

- C:452:EQ:EquivalentInjection:containment

  For EquivalentInjection the association Equipment.EquipmentContainer is required and shall point to EquipmentContainer of type VoltageLevel or Line.

- C:452:EQ:EquivalentShunt:containment

  For EquivalentShunt the association Equipment.EquipmentContainer is required and shall point to EquipmentContainer of type VoltageLevel.

- C:452:EQ:EquivalentBranch:containment

  For EquivalentBranch the association Equipment.EquipmentContainer is required and shall point to EquipmentContainer of type VoltageLevel, Line or Substation.

- C:452:EQ:DCSwitch:containment

  For DCSwitch (DCDisconnector, DCBreaker) the association Equipment.EquipmentContainer is required and shall point to EquipmentContainer of type DCConverterUnit.

- C:452:EQ:DCGround:containment

  For DCGround the association Equipment.EquipmentContainer is required and shall point to EquipmentContainer of type DCConverterUnit.

- C:452:EQ:DCBusbar:containment

  For DCBusbar the association Equipment.EquipmentContainer is required and shall point to EquipmentContainer of type DCConverterUnit.

- C:452:EQ:DCChopper:containment

  For DCChopper the association Equipment.EquipmentContainer is required and shall point to EquipmentContainer of type DCConverterUnit.

- C:452:EQ:DCShunt:containment

  For DCShunt the association Equipment.EquipmentContainer is required and shall point to EquipmentContainer of type DCConverterUnit.

- C:452:EQ:DCSeriesDevice:containment

  For DCSeriesDevice the association Equipment.EquipmentContainer is required and shall point to EquipmentContainer of type DCConverterUnit.

- C:452:EQ:DCLineSegment:containment

  For DCLineSegment the association Equipment.EquipmentContainer is required and shall point to EquipmentContainer of type DCLine. In the case of modelling back to back configuration the association shall point to EquipmentContainer of type Substation.

- C:452:EQ:ACDCConverter:containment

  For ACDCConverter (CsConverter, VsConverter) the association Equipment.EquipmentContainer is required and shall point to DCEquipmentContainer of type DCConverterUnit. In this case the association DCConverterUnit.Substation is required.

- C:452:EQ:Equipment:details

  Instance data to be exchanged shall make use of the most detailed class possible based on the level of detailed information currently available about the equipment at the time of the exchange. The classes GeneratingUnit, Switch, and EnergyConsumer should only be used if the information to determine the more detailed class (ThermalGeneratingUnit, HydroGeneratingUnit, Breaker, Disconnector, etc.) is not available.

If in the future the more detailed information becomes available, the instance data shall be exchanged with the more specific specialisation class. The more specific specialization class in the newer serialization shall be exchanged with the same MRID as the more generic class exchanged previously. (Note: Rules such as this pertaining to serialization shall be moved to a document pertaining to all IEC 61970 profiles when that document becomes available.)

- R:452:EQ:EnergySource:instance

  The EnergySource class is a simplified representation of an energy supplier without regulation capability or the possibility of an associated ReactiveCapabilityCurve. Consequently it should only be used when the information to determine a more detailed class (GeneratingUnit, PhotoVoltaicUnit, etc) is not available.

- C:452:EQ:EquivalenInjection:instance

  Using EquivalentInjection to model a distribution network equivalent is recommended practice instead of using ExternalNetworkInjection-s.

- C:452:EQ:GeneratingUnit:maxOperatingP:ratedS

  GeneratingUnit.maxOperatingP shall be less than or equal to the sum of RotatingMachine.ratedS for RotatingMachine-s associated to the GeneratingUnit.

- R:452:EQ:GeneratingUnit:realPowerLimits

  The net real power limits for a GeneratingUnit can be defined in three ways; 1) with the attributes "maxOperatingP" and "minOperatingP", or 2) with the attribute "ratedNetMaxP" or 3) with the attributes "ratedGrossMinP" and "ratedGrossMaxP" used in conjunction with an associated GrossToNetActivePowerCurve.

- C:452:EQ:GeneratingUnit.minOperatingP:valueRangePair

  GeneratingUnit.maxOperatingP shall be greater than or equal to GeneratingUnit.minOperatingP.

- C:452:EQ:GrossToNetActivePowerCurve:values

  For GrossToNetActivePowerCurve used in transmission system data exchanges where the x and y values will always be specified in MW, the xMultiplier and y1Multiplier attributes do not need to be supplied thus not included in the profile.

- C:452:EQ:HydroGeneratingUnit.energyConversionCapability:typeConsistency

  If HydroGeneratingUnit.energyConversionCapability is "generator" the associated SynchronousMachine shall have SynchronousMachine.type set to "generator" or "generatorOrCondenser". If HydroGeneratingUnit.energyConversionCapability is "pumpAndGenerator" the associated SynchronousMachine shall have SynchronousMachine.type set to "motor", "generatorOrMotor" or "generatorOrCondenserOrMotor".

- C:452:EQ:LinearShuntCompensator.gPerSection:valueRange

  LinearShuntCompensator.gPerSection shall be a positive value or zero.

- C:452:EQ:NonlinearShuntCompensatorPoint.g:valueRange

  NonlinearShuntCompensatorPoint.g shall be a positive value or zero.

- C:452:EQ:OperationalLimitSet:limits

  OperationalLimitSet has associations with ACDCTerminal and Equipment. In case the OperationalLimitSet is the operational limit of the AuxiliaryEquipment, then the association end OperationalLimitSet.Equipment is also required. In the case where OperationalLimitSet.Equipment is associated with an instance of ConductingEquipment, OperationalLimitSet.Terminal shall be one of the ConductingEquipment’s Terminal-s.

- C:452:EQ:PhaseTapChanger:controlModeP

  The association TapChanger.TapChangerControl for PhaseTapChanger-s shall only point to a TapChangerControl that has the following control modes for RegulatingControl.mode: activePower or voltage.

- C:452:EQ:PowerTransformerEnd:pu

  The parameters r, x, g and b are specified for each end and are not related to the overall base voltage. These values are specified in engineering units. Any PU calculations are internal to particular tools and are not part of the data exchange.

- C:452:EQ:PowerTransformerEnd.b:valueRange

  PowerTransformerEnd.b shall be negative value or zero. Negative magnetising branch susceptance (PowerTransformerEnd.b) means inductive reactive power losses in no load.

- C:452:EQ:PowerTransformerEnd.g:valueRange

  PowerTransformerEnd.g shall be positive value or zero. Positive magnetising branch conductance (PowerTransformerEnd.g) means positive active power losses in no load.

- C:452:EQ:PowerTransformerEnd.x:value

  Transformers with zero series reactance do not exist. PowerTransformerEnd.x of high voltage end in case of a two winding transformer shall be a positive value. In case of a three winding transformer the PowerTransformerEnd.x shall not be zero, but it can be a negative value.

- C:452:EQ:RatioTapChanger:controlMode

  The association TapChanger.TapChangerControl for RatioTapChanger-s shall only point to a TapChangerControl which has the following control modes for RegulatingControl.mode: voltage, reactivePower and powerFactor.

- C:452:EQ:ReactiveCapabilityCurve.CurveData:xvalue

  All CurveData.xvalue for a given ReactiveCapabilityCurve shall be unique, e.g. it is not allowed for two or more .xvalue to have the same float value for a given ReactiveCapabilityCurve.R:452:EQ:ReactiveCapabilityCurve:styles

  Two different styles of ReactiveCapabilityCurve-s can be defined for a SynchronousMachine. The style is defined by Curve.curveStyle attribute as shown in the Annex E.

- C:452:EQ:ReactiveCapabilityCurve:units

  For a ReactiveCapabilityCurve associated with SynchronousMachine, the Curve.xUnit shall be set to UnitSymbol.W and both Curve.y1Unit and Curve.y2Unit shall be set to UnitSymbol.VAr. As the multiplier is not included in the profile it is defined the same as the multiplier used for datatype ActivePower and ReactivePower, i.e. UnitMultiplier.M.

- C:452:EQ:RegulatingControl:RegulatingEquipment

  A RegulatingControl that is not a TapChangerControl must have at least one regulating equipment associated through the RegulatingCondEq.RegulatingControl. That is, a RegulatingControl cannot exist without some equipment using it for regulating.

- C:452:EQ:RegulatingControl:point

  In cases where the controlling point is a ConnectivityNode multiple instances of RegulatingControl maybe be needed for proper modelling and connectivity of the grid.

- C:452:EQ:RegulatingControl:samePoint

  A RegulatingControl will have associations to one or more instances of RegulatingCondEq and an association to a Terminal. The ConnectivityNode associated with the Terminal is the regulated point. It is common to have cases where multiple pieces of equipment regulate ConnectivityNodes that under normal network topology are associated with the same TopologicalNode. In this case, the same instance of RegulatingControl should be used by all of those regulating equipment if possible. If it is not possible, such as the case where a SynchronousMachine and a RatioTapChanger are regulating the same point using associations to instances of RegulatingControl and TapChangerControl, the number of instances of RegulatingControl and TapChangerControl should be minimized. Additionally, the target and deadband values for the same regulated point should not be contradictory.

Profile restriction: If multiple instances of RegulatingControl control the same regulation point, the targetValues must not be contradictory.

- C:452:EQ:RegulatingControl.targetValue:tapChanger

  In cases where RequlatingControl.mode is "voltage" and both TapChanger.controlEnabled and RequlatingControl.enabled are "true",

  – The RegulatingControl.targetValue in per unit value is calculated by RegulatingControl.targetValue/BaseVoltage.nominalVoltage.

  shall be within the regulating capability limits:

  – The tap changer upper capability limit in per unit value is calculated by 1+RatioTapChanger.stepVoltageIncrement/100*(TapChanger.highStep-TapChanger.neutralStep).

  – The tap changer lower capability limit in per unit value is calculated by 1-RatioTapChanger.stepVoltageIncrement/100*(TapChanger.neutralStep-TapChanger.lowStep).

- C:452:EQ:ShuntCompensator:controlMode

  For ShuntCompensator, the association RegulatingCondEq.ReqularingControl shall only point to a ReqlatingControl that has the following control modes for RegulatingControl.mode: voltage, reactivePower and powerFactor.

- C:452:EQ:ShuntCompensator.voltageSensitivity:valueRange

  The ShuntCompensator.voltageSensitivity attribute shall be greater than zero.

- C:452:EQ:StaticVarCompensator:controlMode

  For StaticVarCompensator, the association RegulatingCondEq.ReqlatingControl is required and shall only point to a ReqlatingControl that has the following control modes for RegulatingControl.mode: voltage and reactivePower.

- C:452:EQ:Switch:containment

  For Switch, the association Equipment.EquipmentContainer is required and shall point to EquipmentContainer of type Bay, VoltageLevel or DCConverterUnit.

- C:452:EQ:SynchronousMachine:aggregate

  If only one SynchronousMachine is associated with the GeneratingUnit then the Equipment.aggregate flag shall be consistent between the SynchronousMachine and GeneratingUnit if it exists in both.

- C:452:EQ:SynchronousMachine:controlMode

  For SynchronousMachine, the association RegulatingCondEq.ReqlatingControl shall only point to a ReqlatingControl that has the following control modes for RegulatingControl.mode: voltage, reactivePower and powerFactor.

- C:452:EQ:SynchronousMachine:reactiveLimits

  ReactiveCapabilityCurve-s are not required if the reactive power limits of the SynchronousMachine do not vary with real power output. SynchronousMachine.minQ and SynchronousMachine.maxQ are required if SynchronousMachine.InitialReactiveCapabilityCurve is not provided. If the association SynchronousMachine.InitialReactiveCapabilityCurve is provided it takes precedence to the information provided by the attributes SynchronousMachine.minQ and SynchronousMachine.maxQ. However, if both SynchronousMachine.minQ, SynchronousMachine.maxQ and ReactiveCapabilityCurve are present, the SynchronousMachine.minQ shall be equal to min of CurveData.y1value-s and SynchronousMachine.maxQ shall be equal to max CurveData.y2value-s.C:452:EQ:SynchronousMachine:ratedS

  For SynchronousMachine, the attribute RotatingMachine.ratedS is required in case of data exchange to support dynamic simulations.

- C:452:EQ:SynchronousMachine.maxQ:valueRangePair

  SynchronousMachine.maxQ shall be greater than or equal to SynchronousMachine.minQ.

- C:452:EQ:SynchronousMachine.type:condenser

  The SynchronousMachine is not required to be associated with a GeneratingUnit via the association RotatingMachine.GeneratingUnit in cases where a synchronous condenser is being modelled as there is no capability for real power output. In this case, the SynchronousMachine.type shall be set to "condenser". If there is no capability for real power output, the SynchronousMachine.type-s: "motorOrCondenser", "generatorOrCondenser", and "generatorOrCondenserOrMotor" are not allowed to be used.

- C:452:EQ:Switch:connection

  Switch and its subclasses shall only connect to ConnectivityNode-s that are contained in either the same VoltageLevel or in different VoltageLevel-s which have the same BaseVoltage.

- C:452:EQ:TapChangerControl:remoteQcontrol

  A power transformer cannot efficiently control reactive power flow on remote Terminal-s. Therefore, a TapChangerControl with RegulatingControl.mode which equals to reactivePower shall only control the reactive flow at one of the Terminal-s (via the association RegulatingControl.Terminal), which is also associated with PowerTransformerEnd-s of the PowerTransformer where the TapChanger is located.

- C:452:EQ:Terminal:connection

  Terminal-s of the two sides of a two-terminal ConductingEquipment (or any of its subclasses) shall not be connected to the same ConnectivityNode.

- C:452:EQ-SynchronousMachine.qPercent:usage

  The attribute SynchronousMachine.qPercent in the EQ profile specifies a default value. The participation of the devices regulating a particular node can be set in other profiles such as SSH. Therefore, the implementations shall consider this in the load flow calculation and normalize the participation based on what devices are participating in the regulation of a particular node.

- C:452:EQ:Switch:usage

  Busbar couplers shall be modelled explicitly if they are to be retained. The substitution of busbar couplers with zero impedance branches shall not be permitted for exchanges.

- C:452:EQ:NA:zeroImpedance

  Zero impedance lines are permitted if they represent real elements in the model.

- C:452:EQ:NA:negativeImpedance

  Except for series capacitors, negative branch reactance shall not represent real devices. Negative impedance is allowed for EquivalentBranch. Negative value limits the selection of load flow solution techniques and shall be avoided, if possible.

- C:452:EQ:EnergyConsumer:constantP

  If the association EnergyConsumer.LoadResponse to LoadResponseCharacteristic is missing, this load is assumed to be constant power.

- C:452:OP:NA:measurement

  In the context of this profile the following classes: AccumulatorValue, AnalogValue, DiscreteValue, StringMeasurementValue are only used to define measurements that are available via ICCP (inter-control center communications protocol) and to define the location of SCADA (supervisory control and data acquisition) measurements for use by state estimator. It is not used to supply values for those measurements. Consequently, the value attribute is not included in this profile.

- C:452:OP:Measurement.Terminal:requiredCases

  The association Measurement.Terminal shall reference a Terminal of the Equipment referenced by Measurement.PowerSystemResource except in cases where Measurement.measurementType is either "TapPosition" or "SwitchPosition" in which the association is not exchanged.

- C:452:ALL:IdentifiedObject.description:stringLength

  The string IdentifiedObject.description is maximum 256 characters.

- C:452:OP:Measurement.measurementType:analogValues

  For Analog, Measurement.measurementType is restricted to the following valid values: ThreePhasePower, ThreePhaseActivePower, ThreePhaseReactivePower, LineCurrent, PhaseVoltage, Voltage, Angle, Frequency and TapPosition.

- C:452:OP:Measurement.measurementType:accumulatorValues

  For Accumulator, Measurement.measurementType is restricted to the following valid values: ApparentEnergy, ReactiveEnergy, ActiveEnergy.

- C:452:OP:Measurement.measurementType:discreteValues

  For Discrete, Measurement.measurementType is restricted to the following valid values: SwitchPosition.

- C:452:OP:Measurement.unitSymbol:analogValues

  For Analog, Measurement.unitSymbol is restricted to the following valid values: W, deg, VA, A, VAr, V, Hz.

- C:452:OP:Measurement.unitSymbol:accumulatorValues

  For Accumulator, Measurement.unitSymbol is restricted to the following valid values: VAh, VArh, Wh.

- C:452:OP:Measurement.unitSymbol:discreteValues

  For Discrete, Measurement.unitSymbol is restricted to the following valid values: none.

- C:452:OP:MeasurementValueSource:name

  For MeasurementValueSource, attribute IdentifiedObject.name is restricted to the following strings for MeasurementValueSource: ICCP, SCADA.

- C:452:EQ:RegularTimePoint:values

  RegularTimePoint is associated with types of schedules (ConformLoadSchedule, NonConformLoadSchedule) where value1 will always be specified in MW and value2 will always be specified in MVAr. In these cases, the value1Multiplier and value2Multiplier attributes of BasicIntervalSchedule do not need to be specified thus not included in the profile.

- C:452:EQ:RegulationSchedule:values

  By convention, for RegulationSchedule the attribute "value1" represents the target voltage or real power. "value2" is the deviation. For instance, a value1 of 100 and value2 of 1 means regulating to 100 kV plus or minus 1 kV, if the units are set to kV. In this case the range would be from 99 kV to 101 kV.

- C:452:SC:BusbarSection.ipMax:optional

  The attribute BusbarSection.ipMax is an optional attribute even if short circuit data is exchanged, as not always entered by the user (e.g. the IEC TR 60909-4 example test model described in Subclause 6.2 of IEC TR 60909-4:2021 does not include these values).

- C:452:SC:PowerTransformerEnd.grounded:grounding

  If TransformerEnd.grounded is true, then TransformerEnd.rground and TransformerEnd.xground are required.

- C:452:SC:SeriesCompensator.varistorRatedCurrent:required

  The SeriesCompensator.varistorRatedCurrent is required if SeriesCompensator.varistorPresent is true.

- C:452:SC:SeriesCompensator.varistorVoltageThreshold:required

  The SeriesCompensator.varistorVoltageThreshold is required if SeriesCompensator.varistorPresent is true.

- C:452:SC:SynchronousMachine.earthing:attributes

  If SynchronousMachine.earthing is true, then SynchronousMachine.earthingStarPointR and SynchronousMachine.earthingStarPointX are required.

4.4 Transformer modelling

A two winding PowerTransformer has two PowerTransformerEnds. This gives the option to specify the impedance values for the equivalent pi-model completely at one end or split them between the two ends. The impedances shall be specified at the primary voltage side as shown in Figure 1 where the left side is the "primary" (high voltage) voltage side.

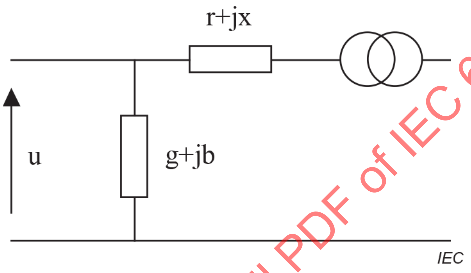

Figure 1 – Two winding transformer impedance

A three winding PowerTransformer has three PowerTransformerEnds. The equivalent pi-model corresponds to three ends connected in wye configuration as shown below. The impedance values for a three winding transformer are specified on each of the three TransformerWindings. Each of the ends has series impedances rn+jxn and shunt gn+jbn where n is: p for primary, s for secondary and t for tertiary as shown in Figure 2.

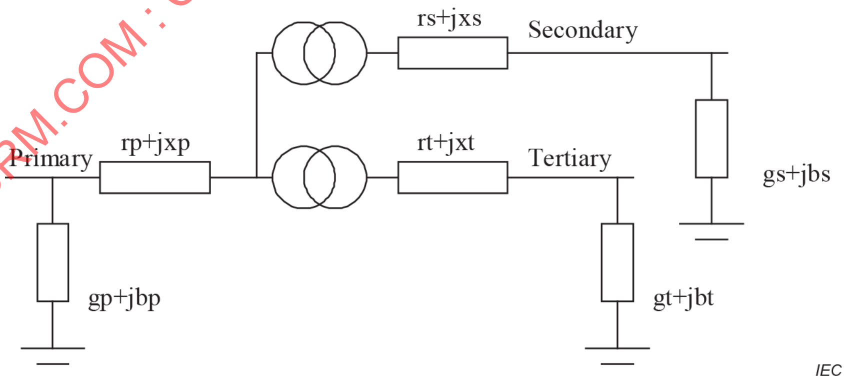

Figure 2 – Three winding transformer impedance

Additional requirements related to transformer modelling are listed below.

- Each PowerTransformer shall have at least two and no more than three PowerTransformerEnds.

- Each PowerTransformerEnd can have at most one tap changer (RatioTapChanger, PhaseTapChangerLinear, PhaseTapChangerSymmetrical, or PhaseTapChangerAsymmetrical). If a PowerTransformerEnd does not have an associated tap changer, the end should be considered to have a fixed tap.

Multiple types of regulating transformers are supported by the CIM model. Depending on the regulation capabilities, the effects of tap movement will be defined using the RatioTapChanger class, PhaseTapChangerLinear class, PhaseTapChangerSymmetrical class, or PhaseTapChangerAsymmetrical class. Each of these classes are subtypes of the TapChanger class. The use of the various subtypes is explained in IEC 61970-301.

4.5 Modelling authorities

From the use cases for model exchange detailed in Annex A, it is clear that most situations involve multiple entities that shall cooperate. In these situations, it is very important to establish which entity has the authority for modelling each region or set of data objects. For this purpose we use the concepts of ModelingAuthority and ModelingAuthoritySet. ModelingAuthority and ModelingAuthoritySet are not defined as classes in the normative portion of the CIM. When multiple modelling entities are involved, each modelled object is assigned to a ModelingAuthoritySet. A ModelingAuthority can be responsible for one or more ModelingAuthoritySets. A more detailed description of the use ModelingAuthorities and ModelingAuthoritySets can be found in Annex B. When using the concept of ModelingAuthoritySets, a single file shall contain only data objects associated with a single ModelingAuthoritySet.

4.6 Use of measurement classes

4.6.1 General

Use of the CIM Measurement classes (Analog, Accumulator, and Discrete) is frequently misunderstood and has changed over time. Previously in addition to the use representing points in the system where telemetry is available, the classes had been used to associate Limits with a piece of Equipment and to define regulated points. Measurements are now only used to define where telemetry is available and to facilitate exchange of ICCP data.

A Measurement shall be associated with a PowerSystemResource to convey containment information for the Measurement. Transmission line measurements should be associated with an ACLineSegment, not with a Line. Transformer measurements should be associated with a PowerTransformer, not with a Transformer Winding. Voltage measurements should be associated with a piece of equipment, not with a VoltageLevel. A TapPosition measurement shall be associated with a tap changer (RatioTapChanger, PhaseTapChangerLinear, PhaseTapChangerSymmetrical or PhaseTapChangerAsymmetrical). A SwitchPosition measurement shall be associated with a Switch or a subtype of Switch.

The Measurement may also be associated with one of the Terminals associated with the piece of equipment. For measurements representing actual telemetered points, it is especially important that the association to a Terminal defines the specific topological point in the network that is measured. A Measurement can be associated with at most one Terminal. Each flow measurement (active power, reactive power, or current) shall be associated with a terminal. This association is particularly important for State Estimation. The measurement shall be associated with the correct terminal of the piece of conducting equipment that is being measured (SynchronousMachine, EnergyConsumer, ACLineSegment, PowerTransformer, etc.). Associating the measurement with a terminal of the wrong equipment or the terminal on the wrong end of the correct piece of equipment will cause problems for State Estimation. Only two types of measurement, TapPosition and SwitchPosition, do not require an association to a Terminal.

Three subtypes of Measurement are included in this profile, Analog, Accumulator, and Discrete. To describe what is being measured, the attribute Measurement.measurementType is used, but only particular measurementTypes are valid for each of the subtypes of Measurement. The valid associations are defined in Table 436.

4.6.2 ICCP data exchange

Refer to IEC 61970-301 for rules regarding ICCP data.

4.7 Voltage or active power regulation

To use CIM to define how a piece of equipment regulates a point in the system, an association is defined between the regulating conducting equipment (SynchronousMachine, LinearShuntCompensator, NonLinearShuntCompensator, StaticVarCompensator, RatioTapChanger, PhaseTapChangerLinear, PhaseTapChangerSymmetrical, PhaseTapChangerAsymmetrical, PhaseTapChangerTabular or ExternalNetworkInjection) and an instance of RegulatingControl or TapChangerControl. The RegulatingControl or TapChangerControl shall be associated with a Terminal. The control for a piece of regulating equipment can refer to a Terminal associated with another PowerSystemResource. For instance, for voltage regulation purposes the control for a SynchronousMachine could refer to a Terminal associated with a BusbarSection. The specified Terminal shall be associated with the connectivity node that is the controlled point.. The association between RegulatingControl or TapChangerControl and Terminal is required to define regulation of voltage or active power.

For a piece of equipment that is not regulating, the association to RegulatingControl or TapChangerControl is not required.

4.8 Use of curves

4.8.1 General

The use of the Curve and CurveData attributes will differ for the different types of curves derived from Curve (GrossToNetActivePowerCurve, ReactiveCapabilityCurve and VsCapabilityCurve). Annex E summarizes the use of of ReactiveCapabilityCurve styles.Data requirements are described below for the case of a generating unit where the reactive power limits of the generating unit do not vary with the real power output.

4.8.2 Generating unit reactive power limits

Generating unit reactive power limits shall be included in data exchange, but may be specified differently depending on the characteristics of the generating unit being represented. In most cases, a SynchronousMachine should be associated with a default ReactiveCapabilityCurve using the SynchronousMachine.InitialReactiveCapabilityCurve association.

If the reactive power limits of the generating unit do not vary with the real power output, the reactive power limit attributes on the SynchronousMachine class, minQ and maxQ, can be used. If the reactive power output of the generating unit is fixed, the reactive power limits should both be set to the fixed reactive output value.

4.9 Definition of schedules

The use of the RegularIntervalSchedule and RegularTimePoint attributes will differ for the different types of schedules derived from RegularIntervalSchedule. To specify a relative time for a schedule, the date portion of the dateTime format can be eliminated, which leaves the ISO 8601 time of day format "hh:mm:ss". In this format, hh is the number of complete hours that have passed since midnight, mm is the number of complete minutes since the start of the hour, and ss is the number of complete seconds since the start of the minute.

The earliest allowed time used in a schedule (BasicIntervalSchedule.startTime) is "00:00:00". The latest allowed time used in a schedule (RegularIntervalSchedule.endTime) is "24:00:00". The point in time specified by the endTime is not included in the period of the schedule.

A schedule defining a day shall be defined with multiple RegularTimePoints associated with the same RegularIntervalSchedule. It shall not be defined with multiple schedules.

For schedules that are associated with Season and DayType, the associations to Season and DayType are not required. If a schedule does not have an associated Season, the schedule will be considered valid for all Seasons. Similarly, if a schedule does not have an association to a DayType, the schedule will be considered to apply to all days of the week.

When SeasonDayTypeSchedules are defined for a given entity, such as ConformLoadSchedules for a given ConformLoadGroup, only one schedule can be defined for a given combination of Season and DayType.

5 Detailed profile specification

5.1 General

This clause lists the profiles that will be used for data exchange and the classes, attributes, and associations that are a part of each profile. Included are all the classes that a data consumer would be expected to recognize in the data being consumed. Additional classes are referenced in this chapter, when the classes to be exchanged inherit attributes or associations. For instance, many classes inherit attributes from the class IdentifiedObject. However, no instances of the class IdentifiedObject would exist in the data exchanged, so IdentifiedObject has not been included in the set of CIM classes for exchange.

The CoreEquipment profile primarily defines the existence of equipment in the network model and specifies the physical characteristics of the network model equipment such as impedance and connectivity. The Operation profile specifies data pertaining to how the system is operated such as limits and voltage regulation. The ShortCircuit profile specifies additional electrical characteristics necessary to execute Short Circuit studies. The Operation and Short Circuit profiles reference data defined in the CoreEquipment profile. A particular data exchange may or may not include all of these profiles. Data validation, such as cardinality of attributes and associations, only applies to the profiles specified for the exchange.

5.2 Core Equipment Profile

5.2.1 General

This is the IEC 61970-452 core equipment profile.

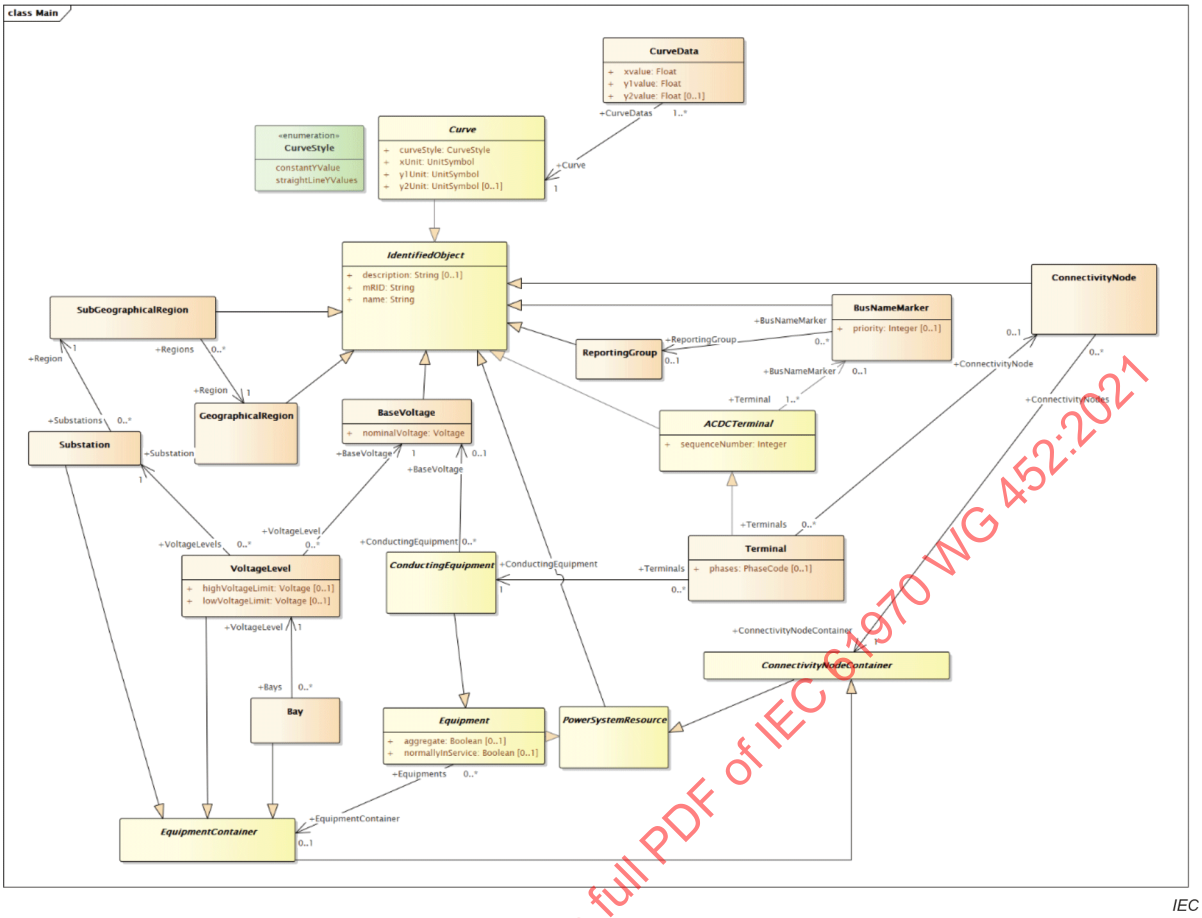

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Figure 3 – Class diagram CoreEquipmentProfile::Main

Figure 3: The main diagram of the equipment core profile.

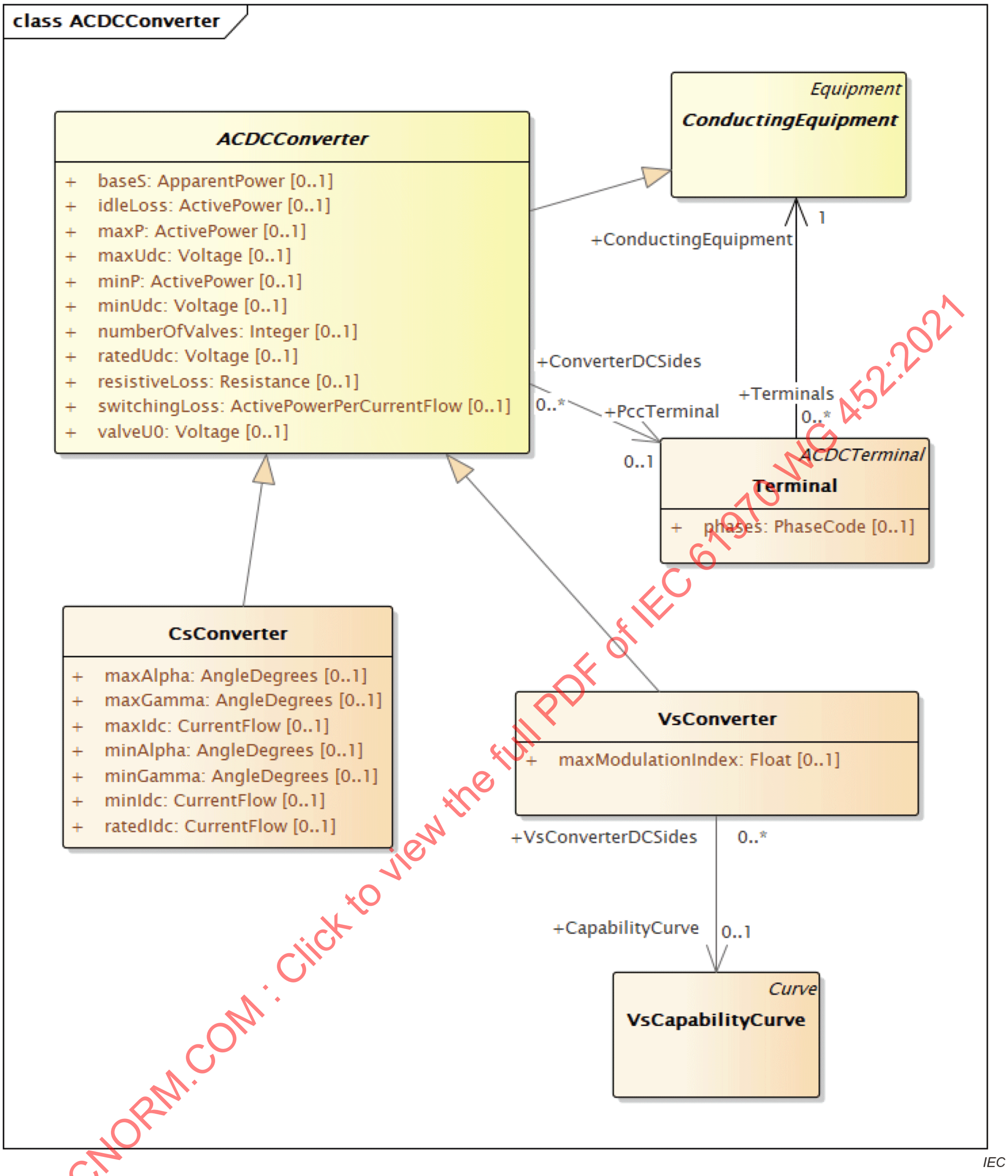
class ACDCConverter
ACDCConverter
+ baseS: ApparentPower [0..1]
+ idleLoss: ActivePower [0..1]
+ maxP: ActivePower [0..1]
+ maxUdc: Voltage [0..1]
+ minP: ActivePower [0..1]
+ minUdc: Voltage [0..1]
+ numberOfValves: Integer [0..1]
+ ratedUdc: Voltage [0..1]
+ resistiveLoss: Resistance [0..1]
+ switchingLoss: ActivePowerPerCurrentFlow [0..1]
+ valveU0: Voltage [0..1]
Equipment
ConductingEquipment
+ConductingEquipment
1
+ConverterDCSides
0..*
+PccTerminal
0..1
+Terminals
0..*
ACDCTerminal
Terminal
+ phases: PhaseCode [0..1]
CsConverter
+ maxAlpha: AngleDegrees [0..1]
+ maxGamma: AngleDegrees [0..1]
+ maxIdc: CurrentFlow [0..1]
+ minAlpha: AngleDegrees [0..1]
+ minGamma: AngleDegrees [0..1]
+ minIdc: CurrentFlow [0..1]
+ ratedIdc: CurrentFlow [0..1]
VsConverter
+ maxModulationIndex: Float [0..1]
+VsConverterDCSides
0..*
+CapabilityCurve
0..1
Curve
VsCapabilityCurve
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Figure 4 – Class diagram CoreEquipmentProfile::ACDCConverter

Figure 4: This diagram shows the classes used to model DC converters.

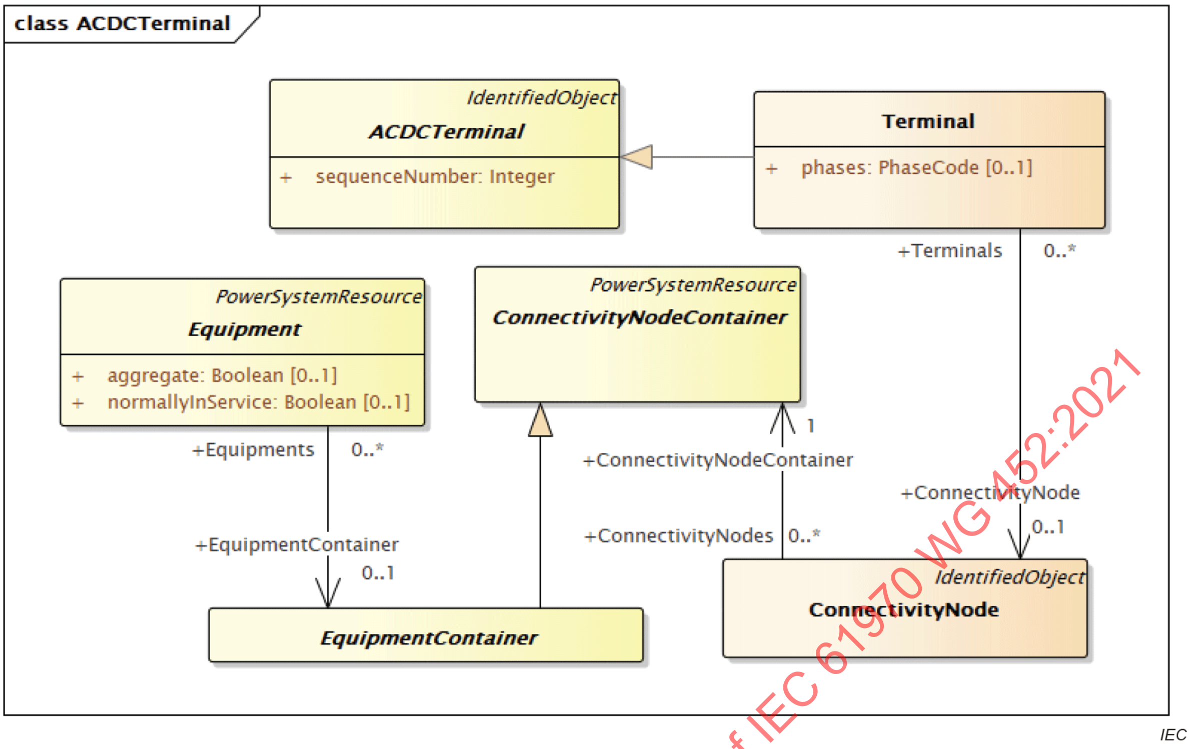

Figure 5 – Class diagram CoreEquipmentProfile::ACDCTerminal

Figure 5: The diagram shows the ACDCTerminal and related classes.

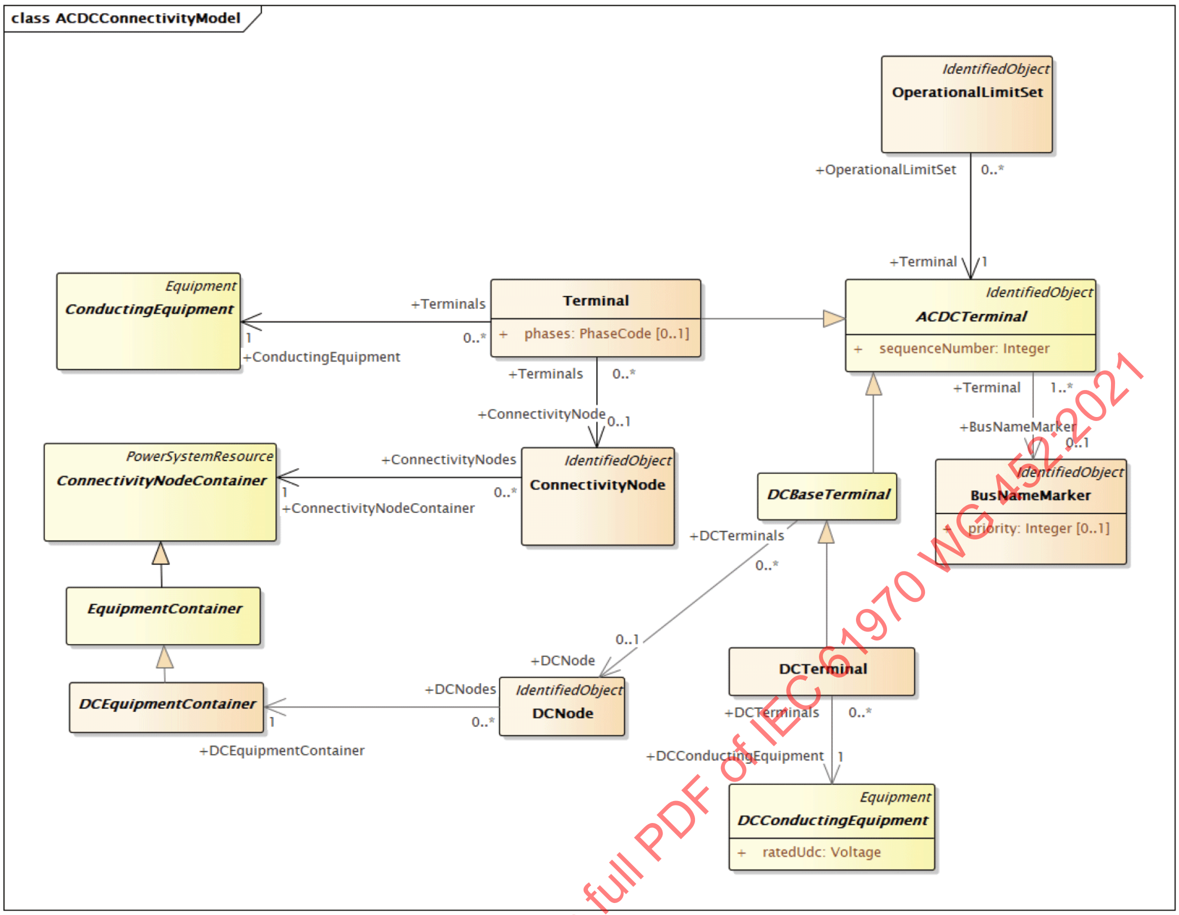

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Figure 6 – Class diagram CoreEquipmentProfile::ACDCConnectivityModel

Figure 6: This diagram shows the connectivity and topology model for both AC and DC networks.

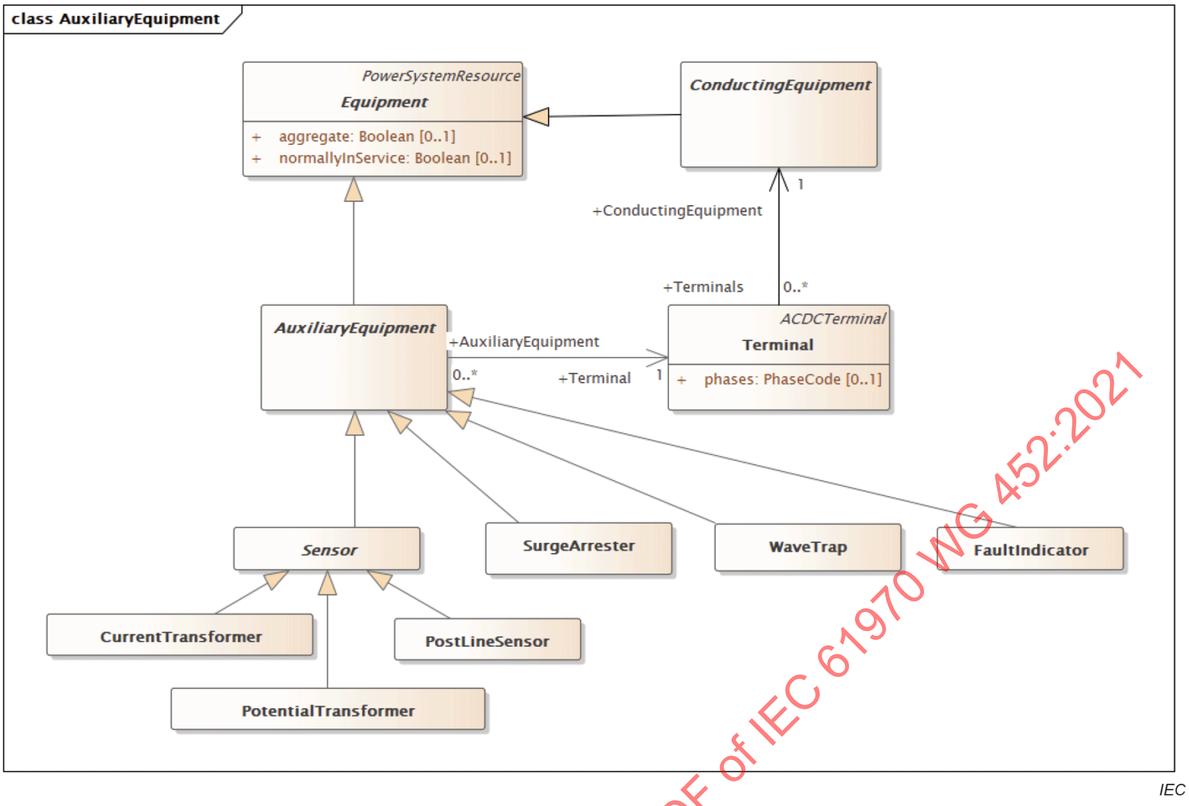

Figure 7 – Class diagram CoreEquipmentProfile::AuxiliaryEquipment

Figure 7: The diagram shows main classes related to auxiliary equipment.

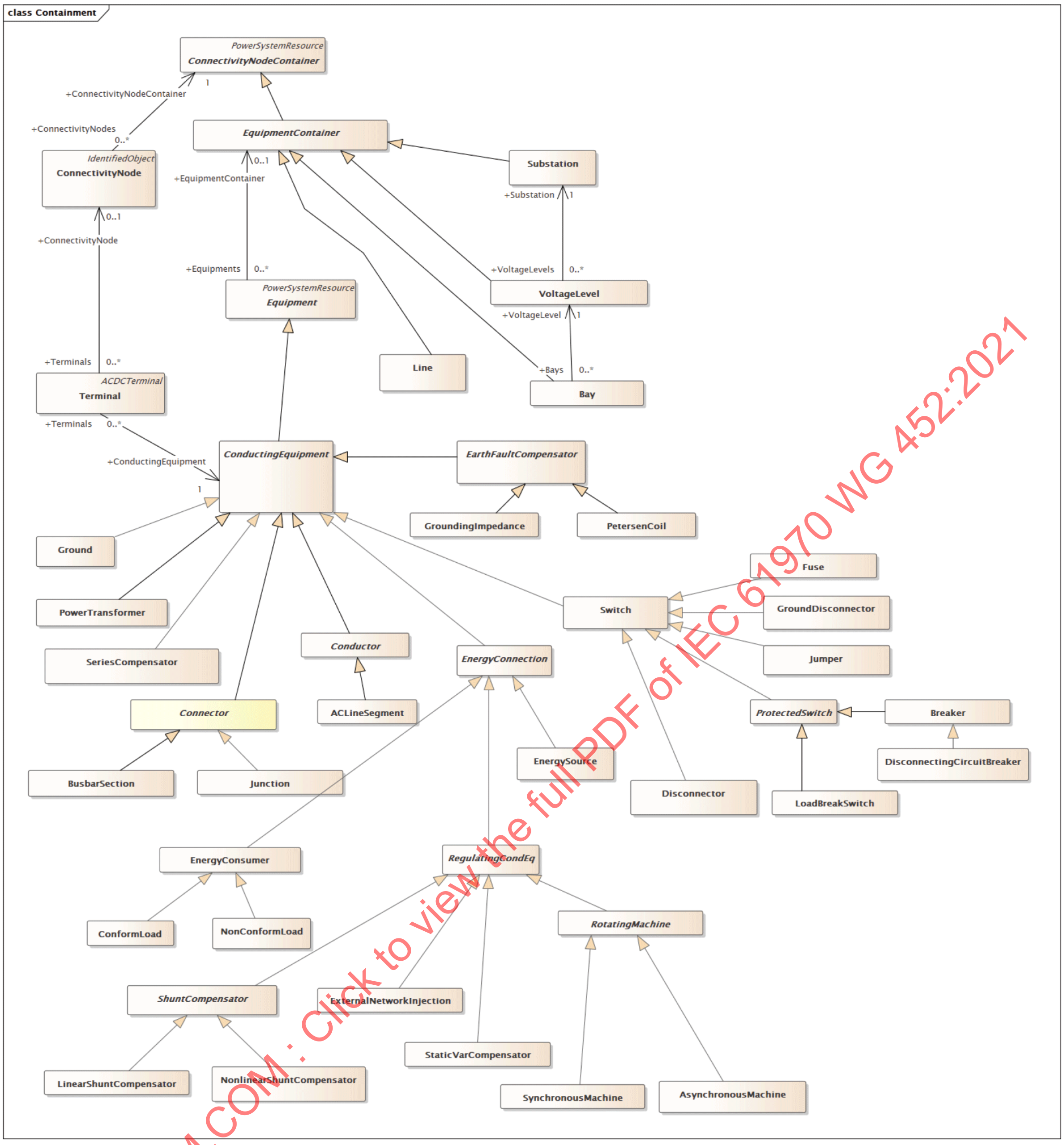

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Figure 8 – Class diagram CoreEquipmentProfile::Containment

Figure 8: The diagram shows the main classes related to containment.

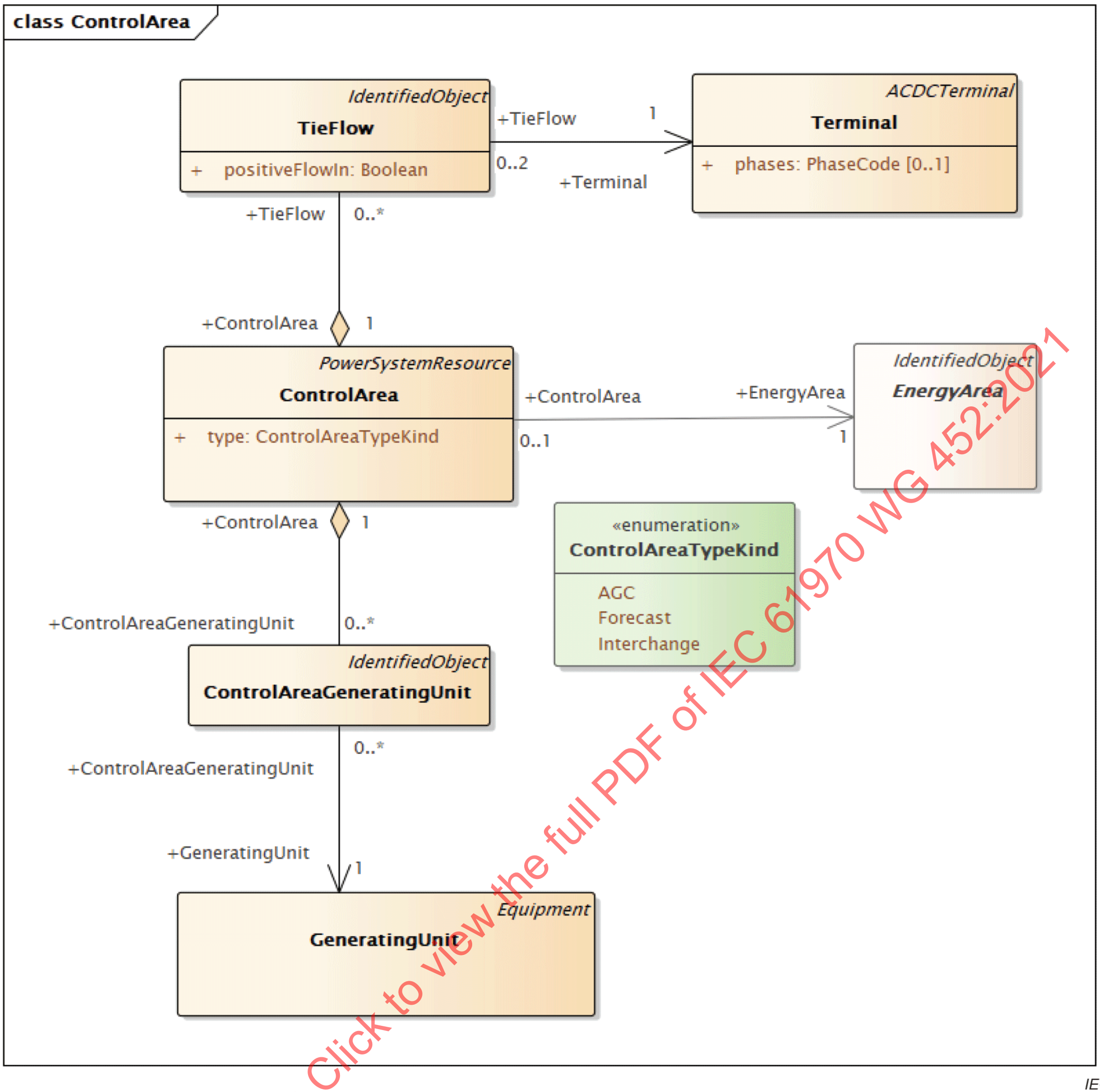


Figure 9 – Class diagram CoreEquipmentProfile::ControlArea

Figure 9: This diagram shows control area specification and some related classes. The TieFlow association to Terminal connects the model to the Measurement classes in the Operation profile.

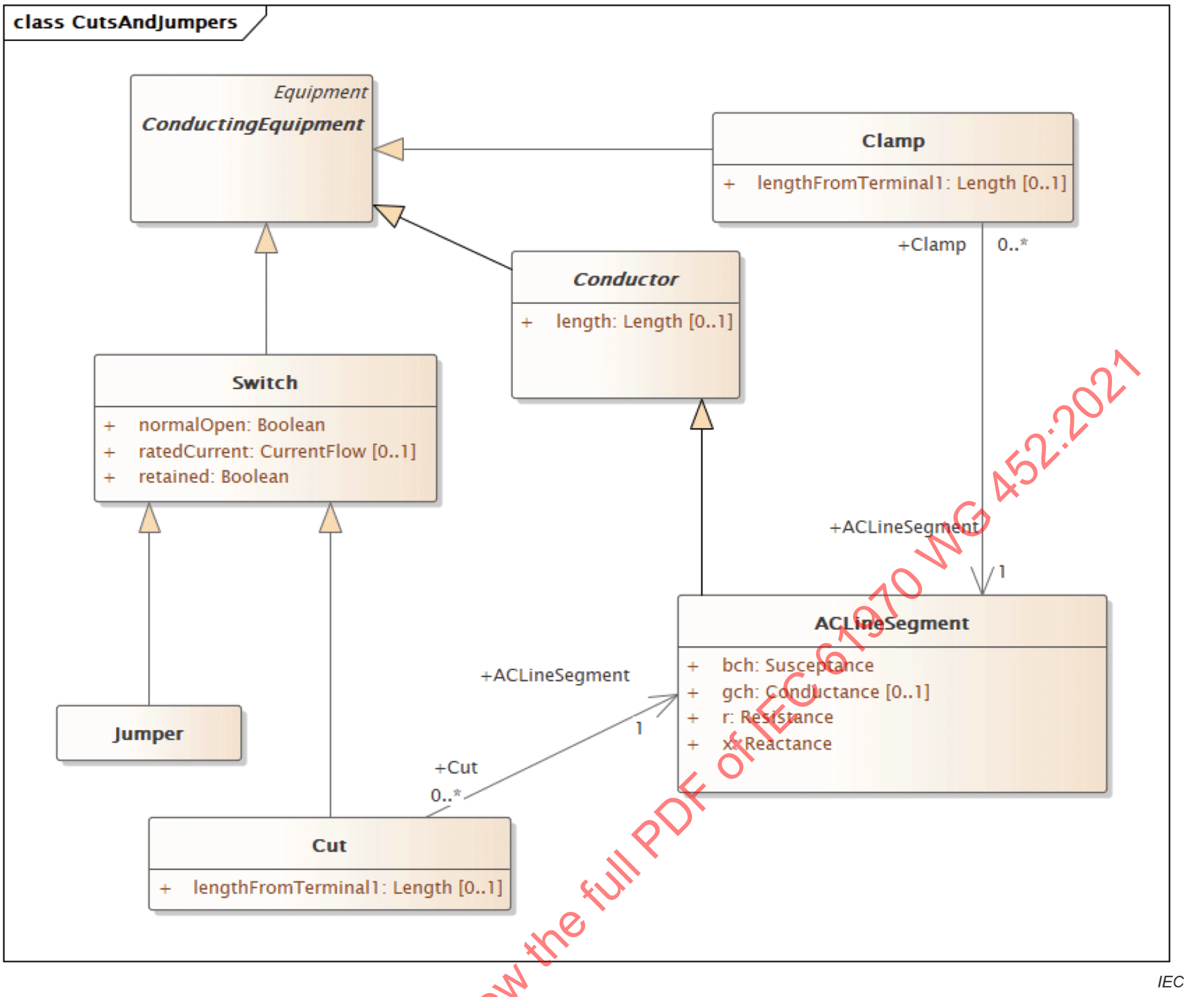


Figure 10 – Class diagram CoreEquipmentProfile::CutsAndJumpers

Figure 10: The diagram shows classes related to cuts and jumpers.

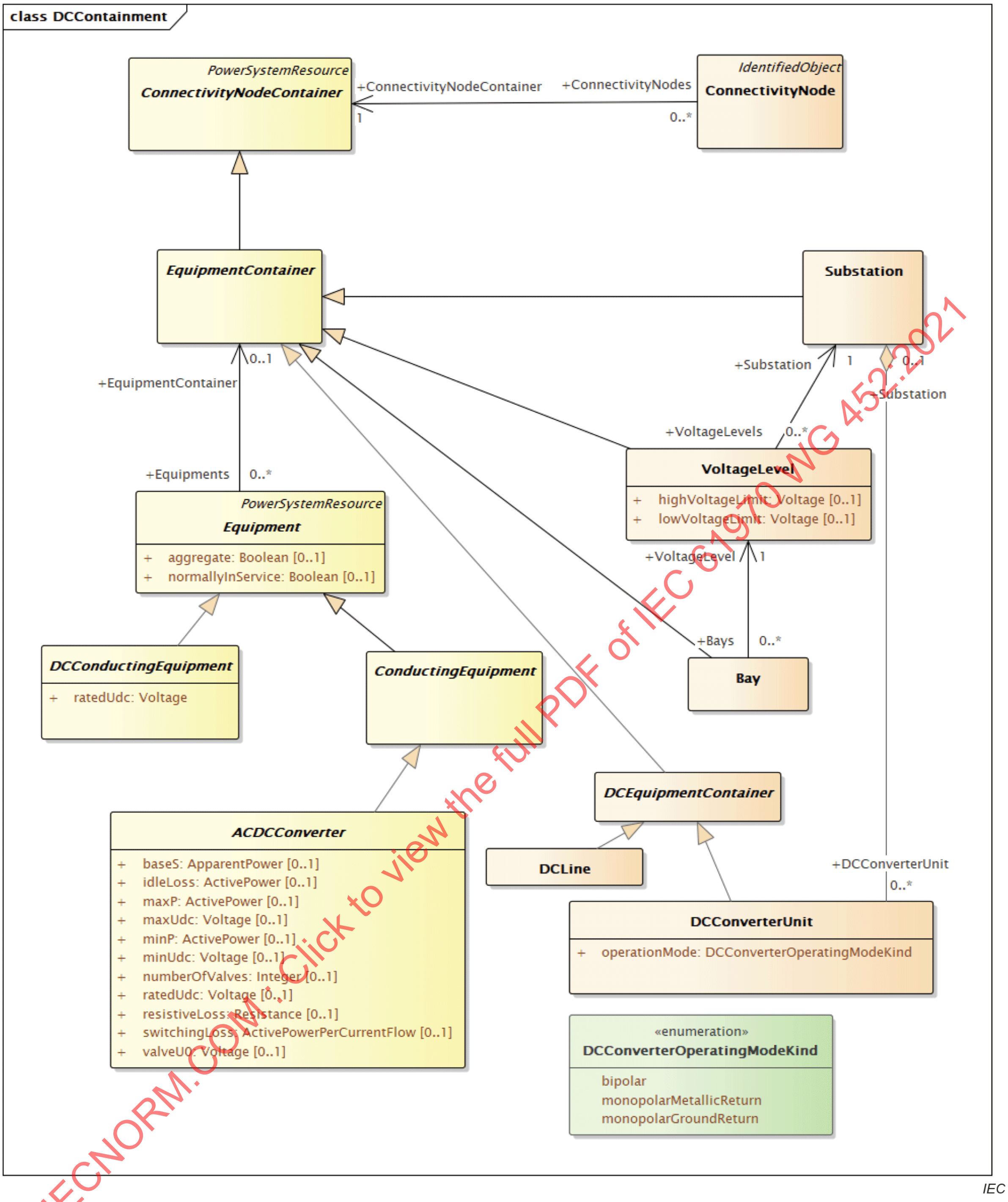
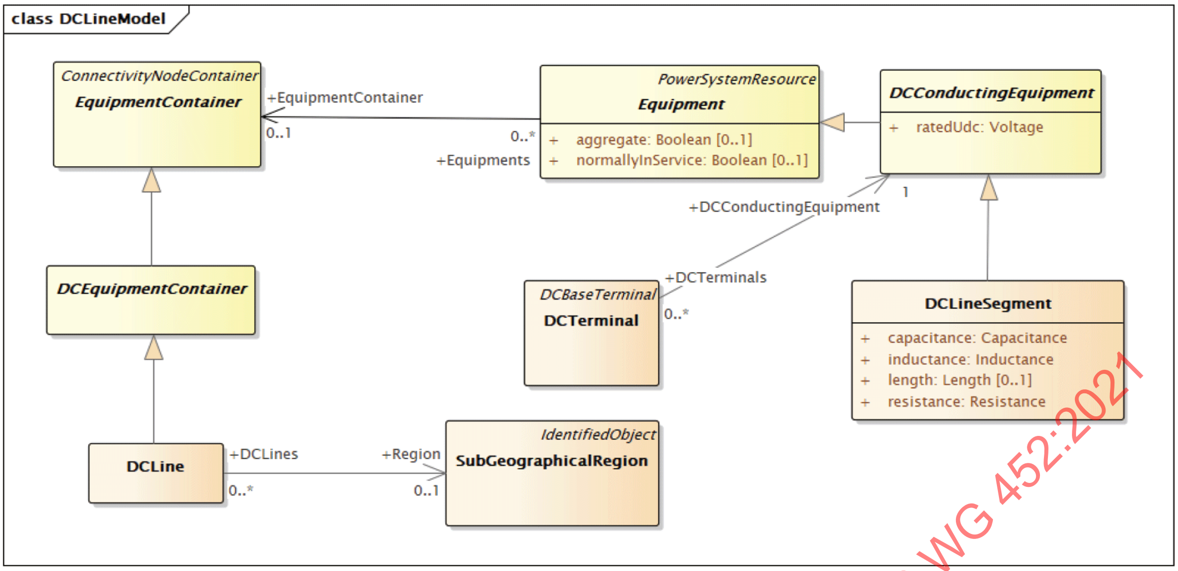

class DCContainment
PowerSystemResource
ConnectivityNodeContainer
+ConnectivityNodeContainer
1
+ConnectivityNodes
0..*
IdentifiedObject
ConnectivityNode
EquipmentContainer
Substation
0..1
+EquipmentContainer
+Substation
1
0..1
+Substation
+VoltageLevels
0..*
VoltageLevel
+ highVoltageLimit: Voltage [0..1]
+ lowVoltageLimit: Voltage [0..1]
+Equipments
0..*
PowerSystemResource
Equipment
+ aggregate: Boolean [0..1]
+ normallyInService: Boolean [0..1]
+VoltageLevel
1
+Bays
0..*
Bay
DCConductingEquipment
+ ratedUdc: Voltage
ConductingEquipment
DCEquipmentContainer
ACDCConverter
+ baseS: ApparentPower [0..1]
+ idleLoss: ActivePower [0..1]
+ maxP: ActivePower [0..1]
+ maxUdc: Voltage [0..1]
+ minP: ActivePower [0..1]
+ minUdc: Voltage [0..1]
+ numberOfValves: Integer [0..1]
+ ratedUdc: Voltage [0..1]
+ resistiveLoss: Resistance [0..1]
+ switchingLoss: ActivePowerPerCurrentFlow [0..1]
+ valveU0: Voltage [0..1]
DCLine
+DCConverterUnit
0..*
DCConverterUnit
+ operationMode: DCConverterOperatingModeKind
«enumeration»
DCConverterOperatingModeKind
bipolar
monopolarMetallicReturn
monopolarGroundReturn
IEC

Figure 11 – Class diagram CoreEquipmentProfile::DCContainment

Figure 11: The diagram shows the DC containment model.



IEC

Figure 12 – Class diagram CoreEquipmentProfile::DCLineModel

Figure 12: The diagram shows the DC line model.

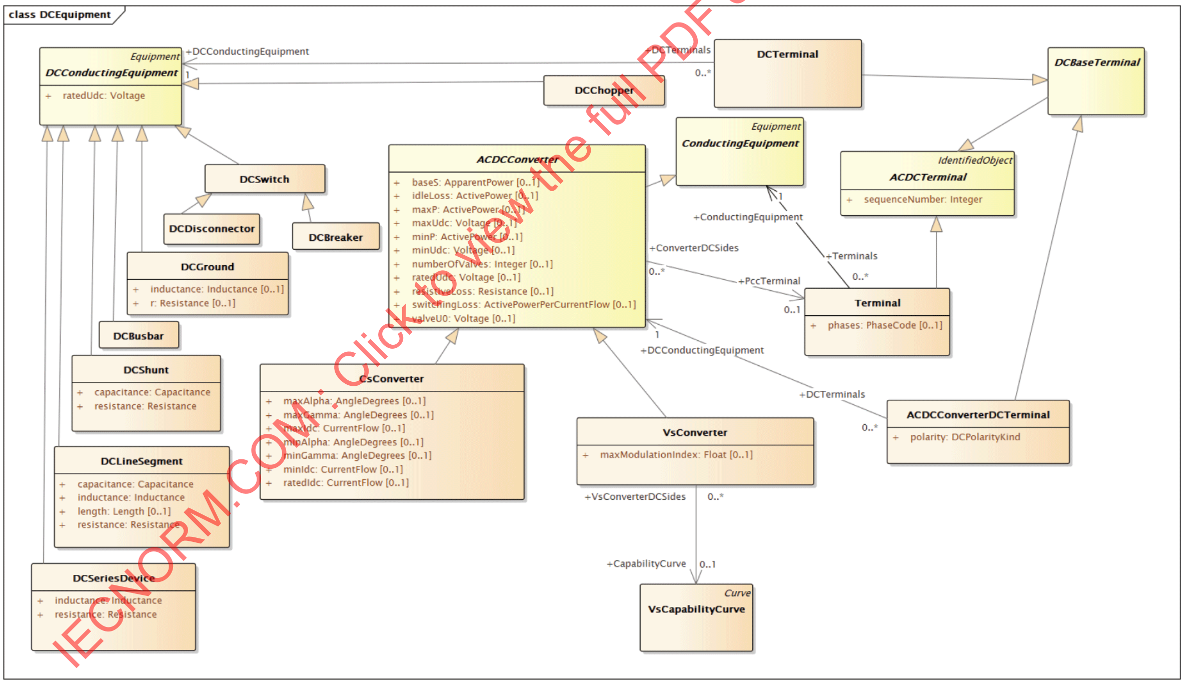


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Figure 13 – Class diagram CoreEquipmentProfile::DCEquipment

Figure 13: The diagram shows the DC equipment model.

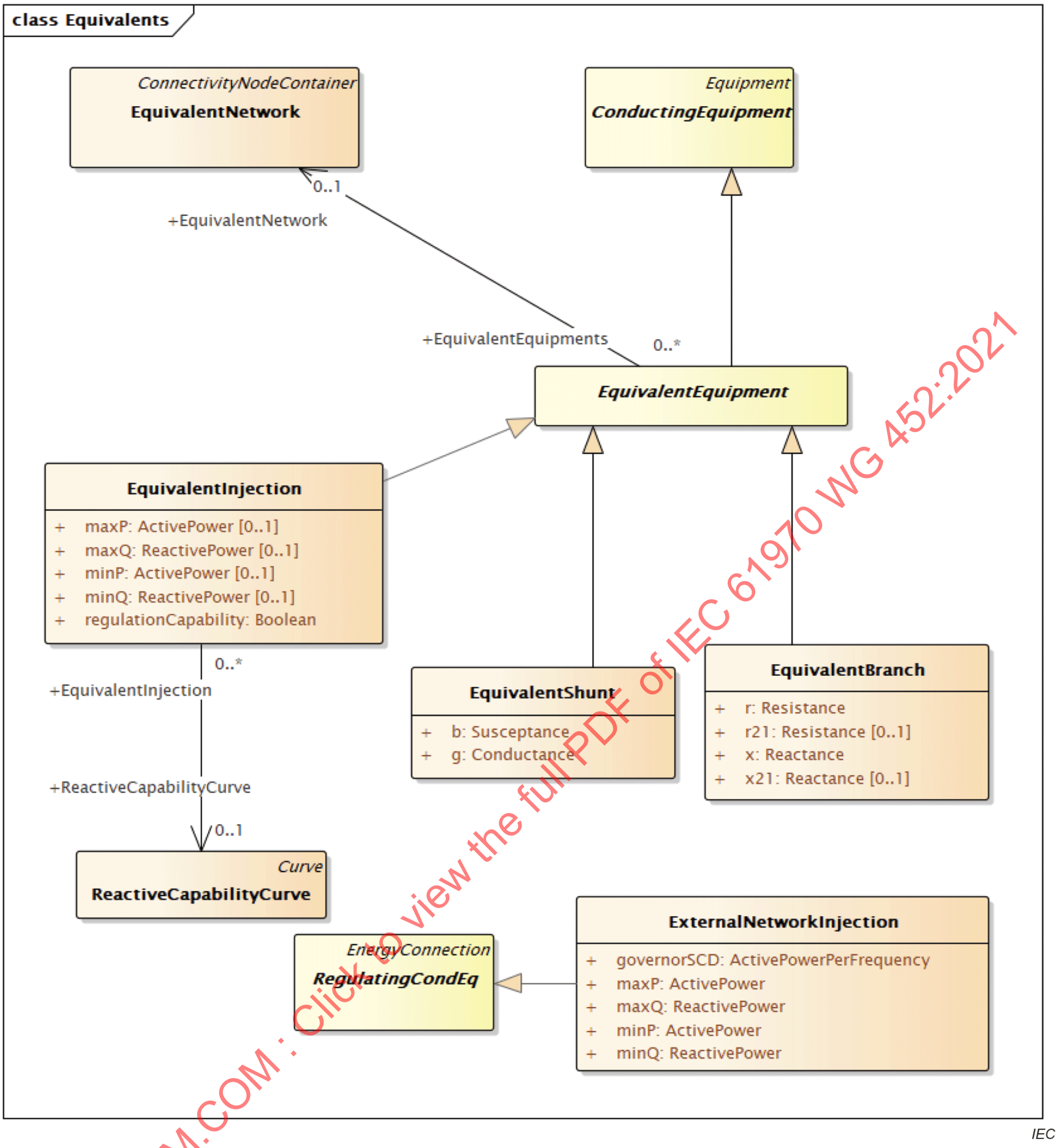

Figure 14 – Class diagram CoreEquipmentProfile::Equivalents

Figure 14: The diagram shows classes related to equivalents.

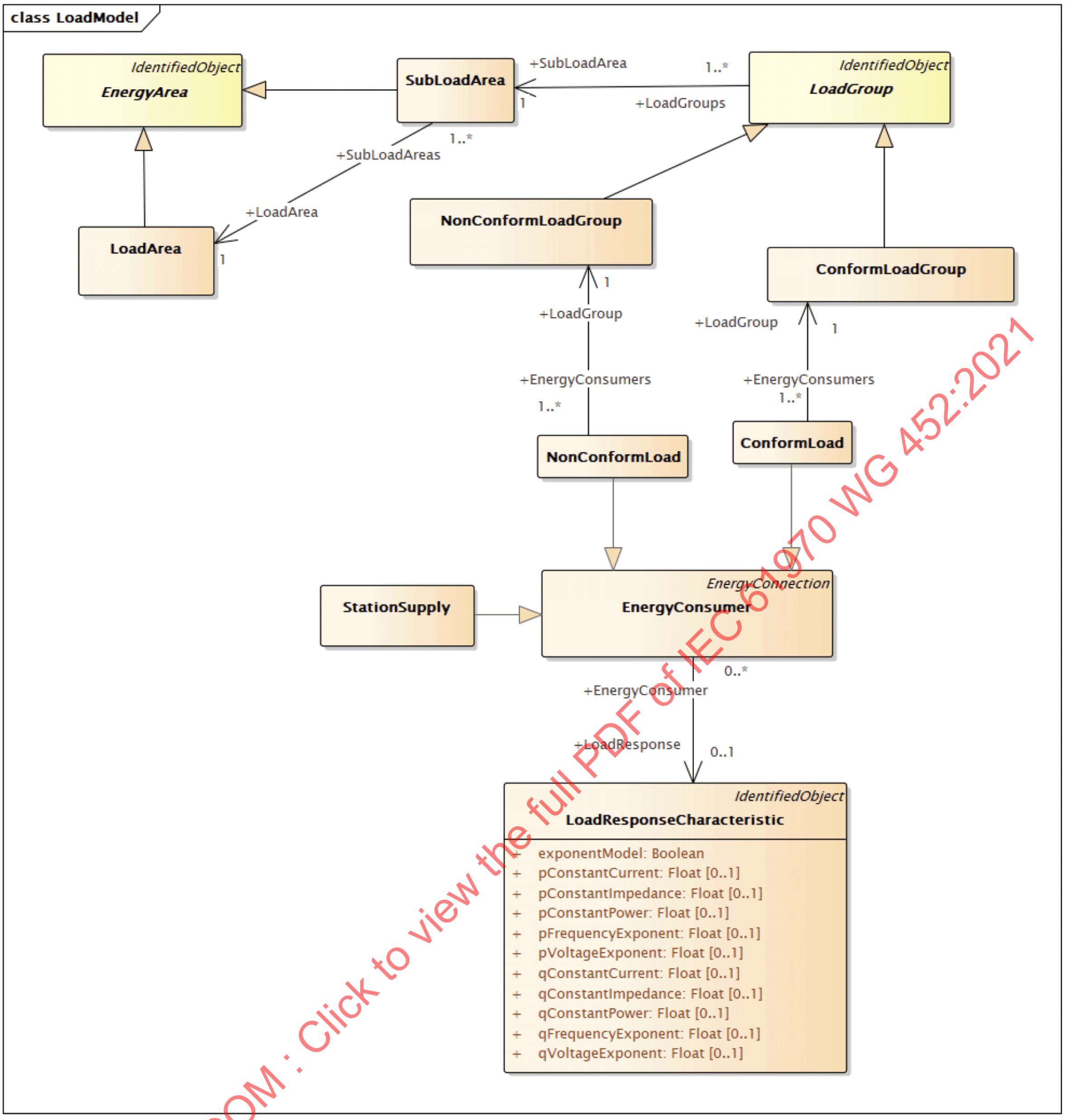

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Figure 15 – Class diagram CoreEquipmentProfile::LoadModel

Figure 15: The diagram shows classes related to the load model.

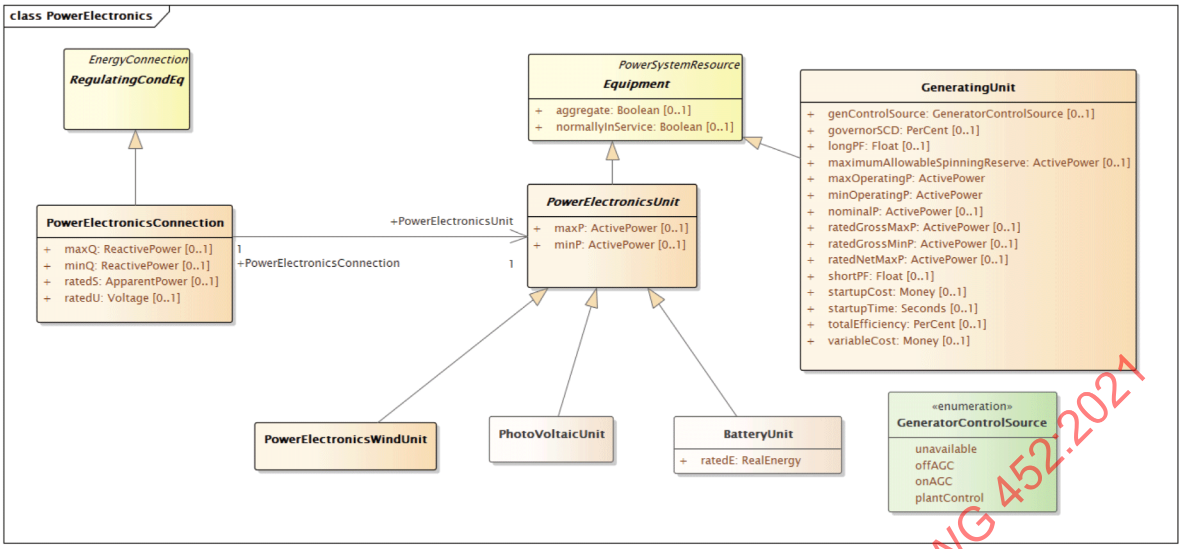
class PowerElectronics
EnergyConnection
RegulatingCondEq
PowerSystemResource
Equipment
+ aggregate: Boolean [0..1]
+ normallyInService: Boolean [0..1]
GeneratingUnit
+ genControlSource: GeneratorControlSource [0..1]
+ governorSCD: PerCent [0..1]
+ longPF: Float [0..1]
+ maximumAllowableSpinningReserve: ActivePower [0..1]
+ maxOperatingP: ActivePower
+ minOperatingP: ActivePower
+ nominalP: ActivePower [0..1]
+ ratedGrossMaxP: ActivePower [0..1]
+ ratedGrossMinP: ActivePower [0..1]
+ ratedNetMaxP: ActivePower [0..1]
+ shortPF: Float [0..1]
+ startupCost: Money [0..1]
+ startupTime: Seconds [0..1]
+ totalEfficiency: PerCent [0..1]
+ variableCost: Money [0..1]
PowerElectronicsConnection
+ maxQ: ReactivePower [0..1]
+ minQ: ReactivePower [0..1]
+ ratedS: ApparentPower [0..1]
+ ratedU: Voltage [0..1]
+PowerElectronicsUnit
1
+PowerElectronicsConnection
1
PowerElectronicsUnit
+ maxP: ActivePower [0..1]
+ minP: ActivePower [0..1]
PowerElectronicsWindUnit
PhotoVoltaicUnit
BatteryUnit
+ ratedE: RealEnergy
«enumeration»
GeneratorControlSource
unavailable
offAGC
onAGC
plantControl

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Figure 16 – Class diagram CoreEquipmentProfile::PowerElectronics

Figure 16: This diagram shows power electronics classes and inheritance.

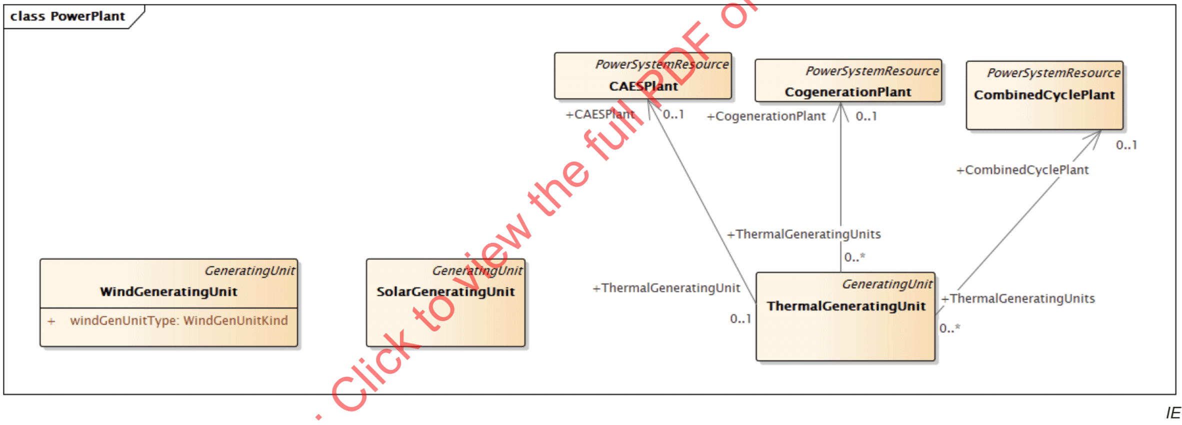

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Figure 17 – Class diagram CoreEquipmentProfile::PowerPlant

Figure 17: The diagram shows the power plant model.

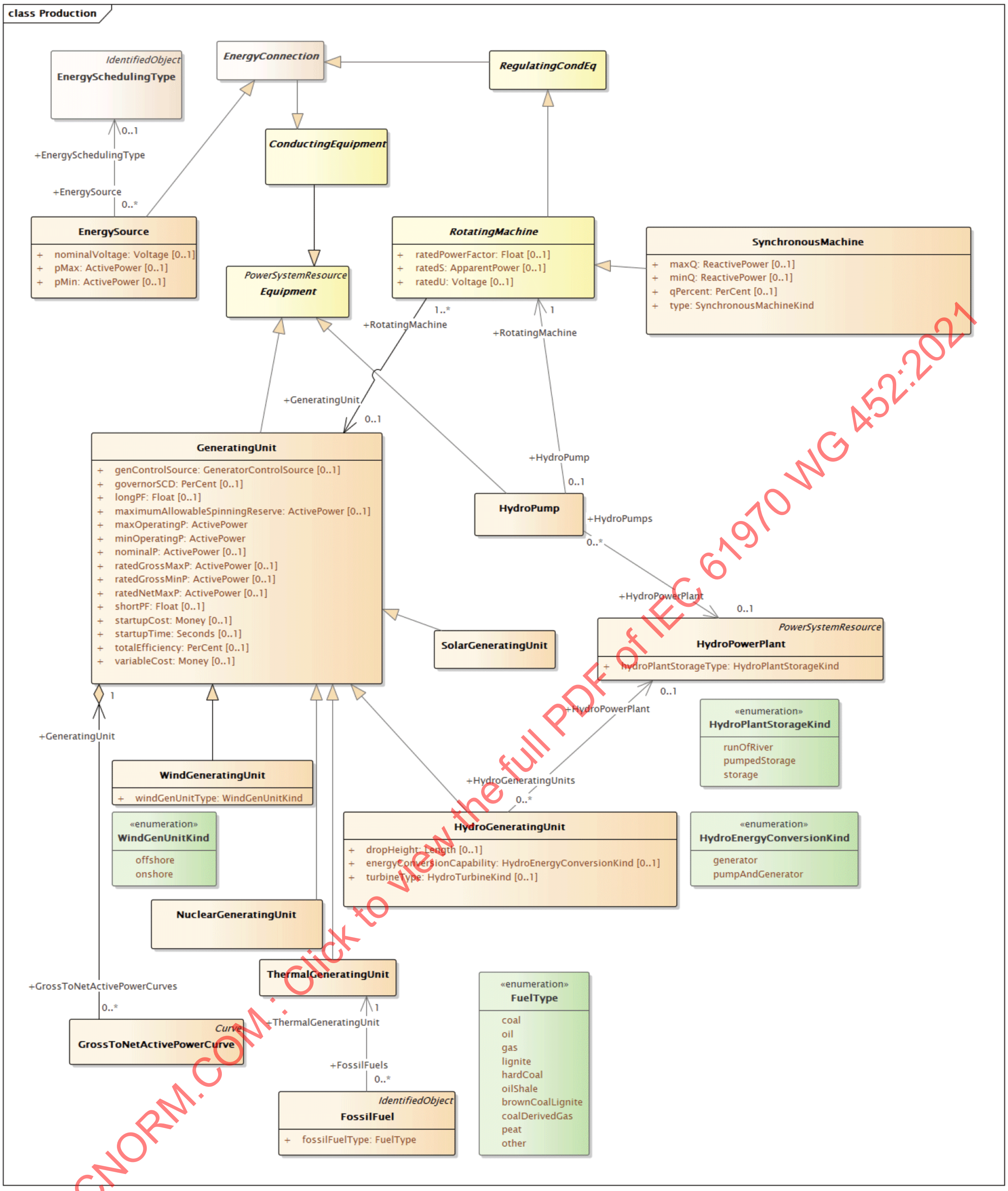
class Production
IdentifiedObject
EnergySchedulingType
EnergyConnection
RegulatingCondEq
ConductingEquipment
0..1
+EnergySchedulingType
+EnergySource
0..*
EnergySource
+ nominalVoltage: Voltage [0..1]
+ pMax: ActivePower [0..1]
+ pMin: ActivePower [0..1]
PowerSystemResource
Equipment
RotatingMachine
+ ratedPowerFactor: Float [0..1]
+ ratedS: ApparentPower [0..1]
+ ratedU: Voltage [0..1]
SynchronousMachine
+ maxQ: ReactivePower [0..1]
+ minQ: ReactivePower [0..1]
+ qPercent: PerCent [0..1]
+ type: SynchronousMachineKind
1..*
+RotatingMachine
1
+RotatingMachine
+GeneratingUnit
0..1
GeneratingUnit
+ genControlSource: GeneratorControlSource [0..1]
+ governorSCD: PerCent [0..1]
+ longPF: Float [0..1]
+ maximumAllowableSpinningReserve: ActivePower [0..1]
+ maxOperatingP: ActivePower
+ minOperatingP: ActivePower
+ nominalP: ActivePower [0..1]
+ ratedGrossMaxP: ActivePower [0..1]
+ ratedGrossMinP: ActivePower [0..1]
+ ratedNetMaxP: ActivePower [0..1]
+ shortPF: Float [0..1]
+ startupCost: Money [0..1]
+ startupTime: Seconds [0..1]
+ totalEfficiency: PerCent [0..1]
+ variableCost: Money [0..1]
+HydroPump
0..1
HydroPump
+HydroPumps
0..*
+HydroPowerPlant
0..1
PowerSystemResource
HydroPowerPlant
+ hydroPlantStorageType: HydroPlantStorageKind
SolarGeneratingUnit
1
+GeneratingUnit
0..1
+HydroPowerPlant
«enumeration»
HydroPlantStorageKind
runOfRiver
pumpedStorage
storage
WindGeneratingUnit
+ windGenUnitType: WindGenUnitKind
«enumeration»
WindGenUnitKind
offshore
onshore
+HydroGeneratingUnits
0..*
HydroGeneratingUnit
+ dropHeight: Length [0..1]
+ energyConversionCapability: HydroEnergyConversionKind [0..1]
+ turbineType: HydroTurbineKind [0..1]
«enumeration»
HydroEnergyConversionKind
generator
pumpAndGenerator
NuclearGeneratingUnit
ThermalGeneratingUnit
+GrossToNetActivePowerCurves
0..*
Curve
GrossToNetActivePowerCurve
1
+ThermalGeneratingUnit
+FossilFuels
0..*
IdentifiedObject
FossilFuel
+ fossilFuelType: FuelType
«enumeration»
FuelType
coal
oil
gas
lignite
hardCoal
oilShale
brownCoalLignite
coalDerivedGas
peat
other

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Figure 18 – Class diagram CoreEquipmentProfile::Production

Figure 18: The diagram shows production related classes.

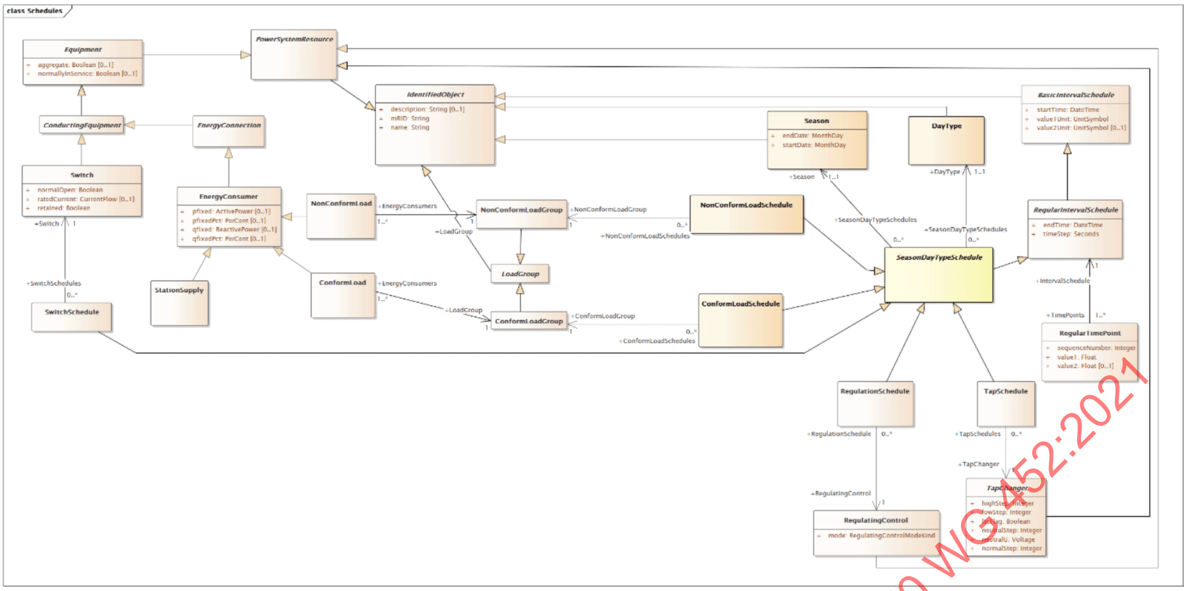

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Figure 19 – Class diagram CoreEquipmentProfile::Schedules

Figure 19: The diagram shows main classes related to schedules.

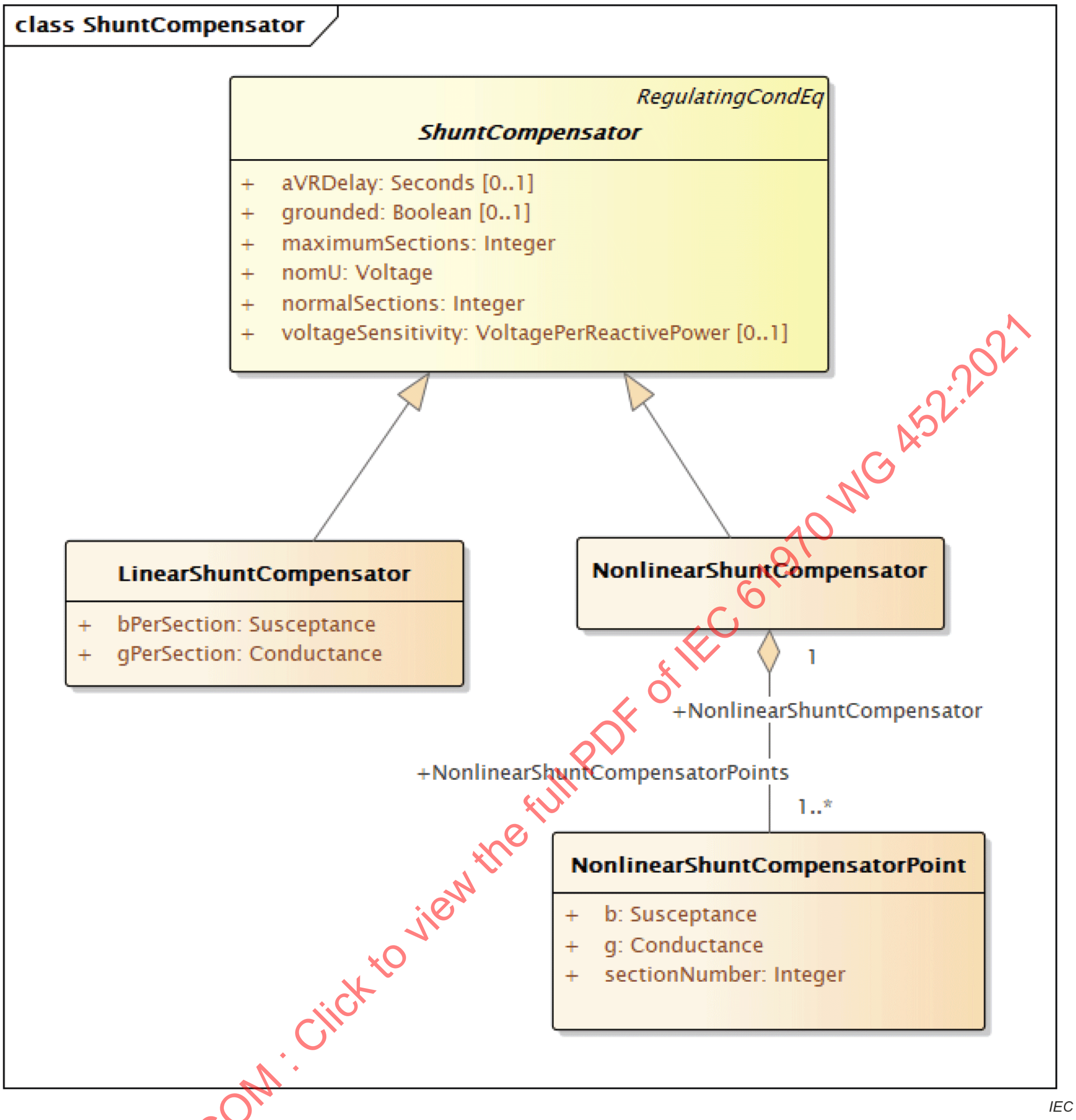
class ShuntCompensator
RegulatingCondEq
ShuntCompensator
+ aVRDelay: Seconds [0..1]
+ grounded: Boolean [0..1]
+ maximumSections: Integer
+ nomU: Voltage
+ normalSections: Integer
+ voltageSensitivity: VoltagePerReactivePower [0..1]
LinearShuntCompensator
+ bPerSection: Susceptance
+ gPerSection: Conductance
NonlinearShuntCompensator
1
+NonlinearShuntCompensator
+NonlinearShuntCompensatorPoints
1..*
NonlinearShuntCompensatorPoint
+ b: Susceptance
+ g: Conductance
+ sectionNumber: Integer
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Figure 20 – Class diagram CoreEquipmentProfile::ShuntCompensator

Figure 20: Shows the shunt compensator inheritance structure.

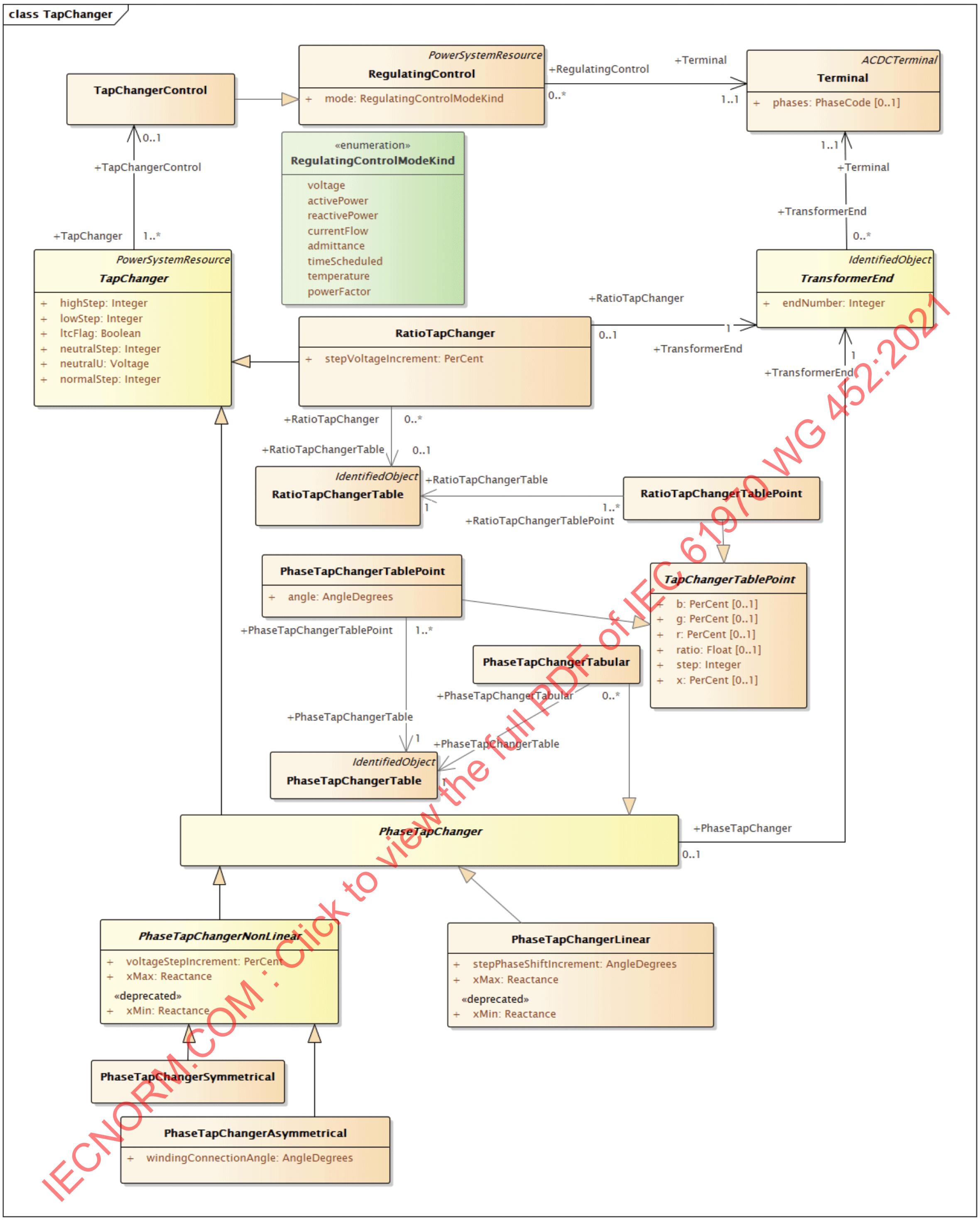

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Figure 21 – Class diagram CoreEquipmentProfile::TapChanger

Figure 21: This diagram shows all classes related to the transformer tap model.

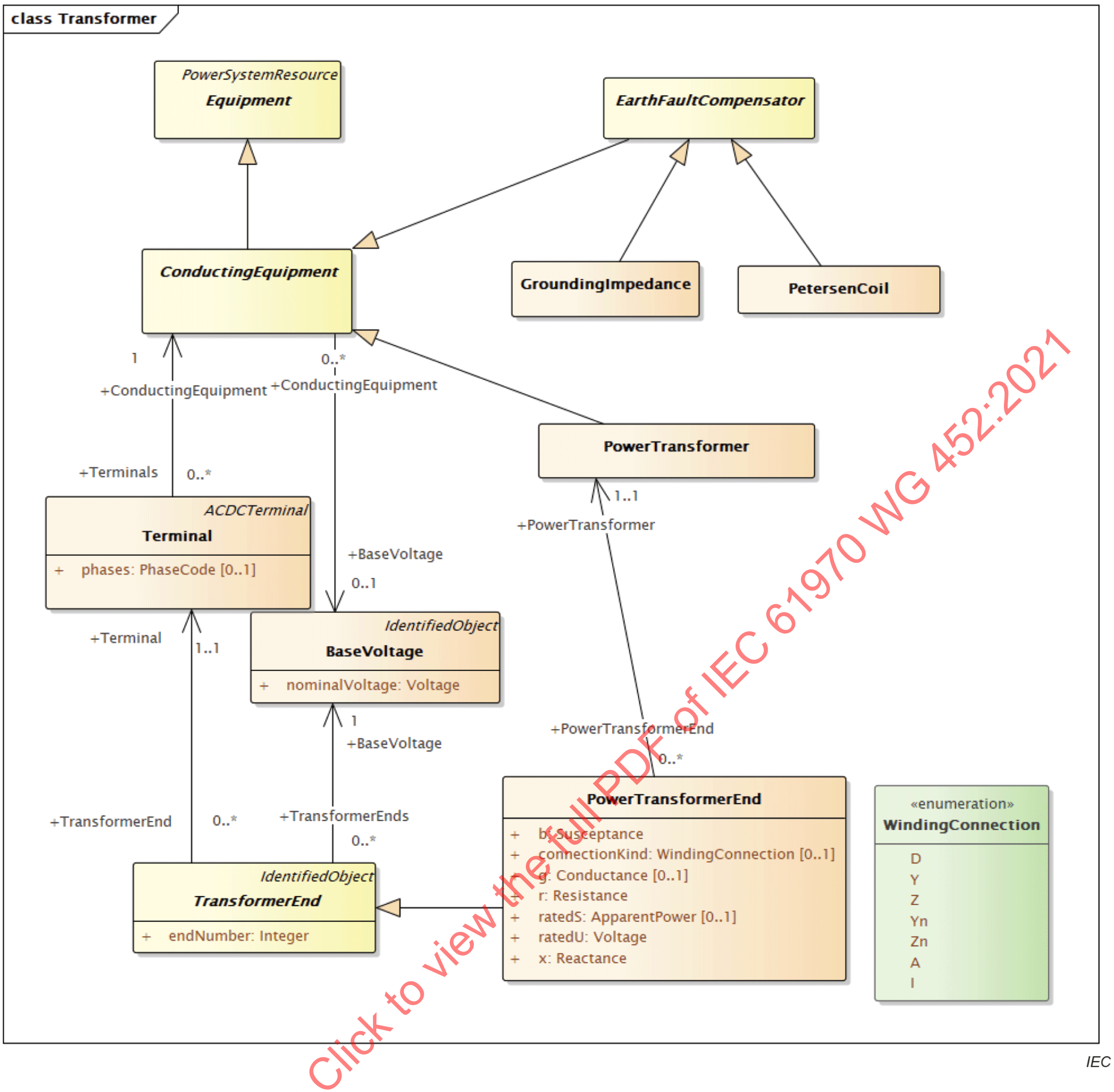

Figure 22 – Class diagram CoreEquipmentProfile::Transformer

Figure 22: This diagram shows classes related to the core transformer model, but does not show the tap changer details.

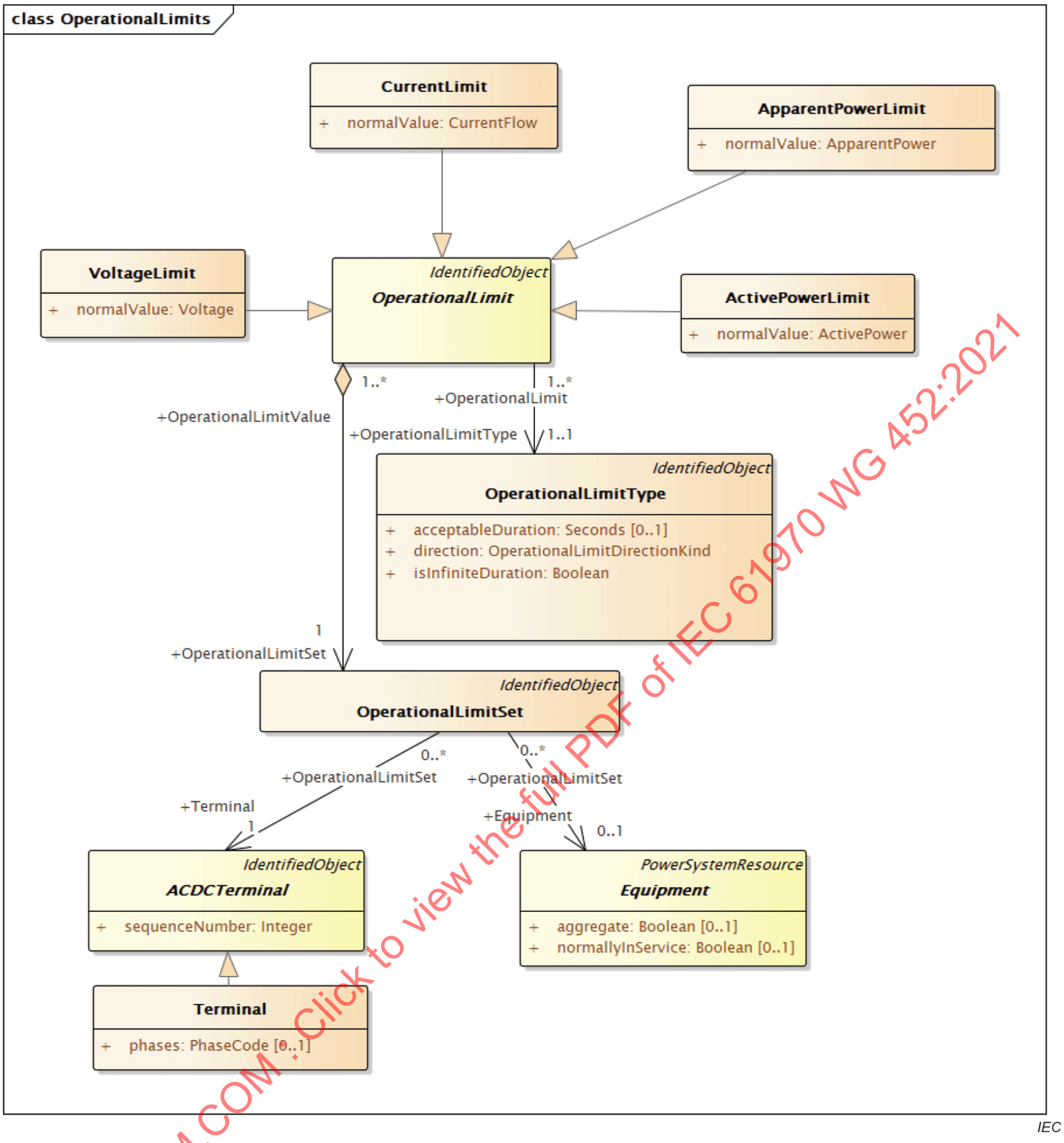

Figure 23 – Class diagram CoreEquipmentProfile::OperationalLimits

Figure 23: This diagram shows operational limits as they tie back into the core model.

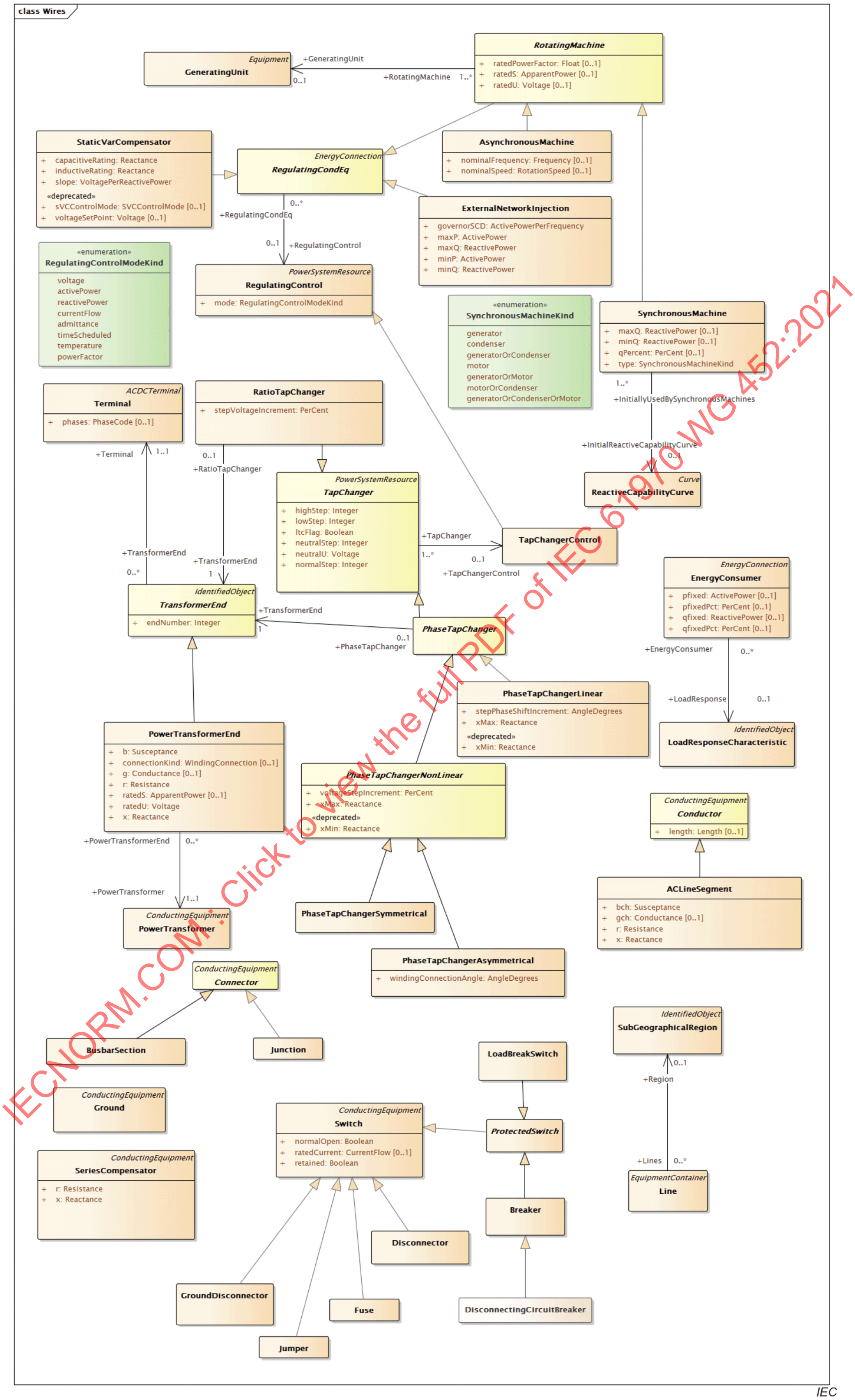

Figure 24 – Class diagram CoreEquipmentProfile::Wires

Figure 24: The diagram shows the main classes from the wires package in the canonical CIM.

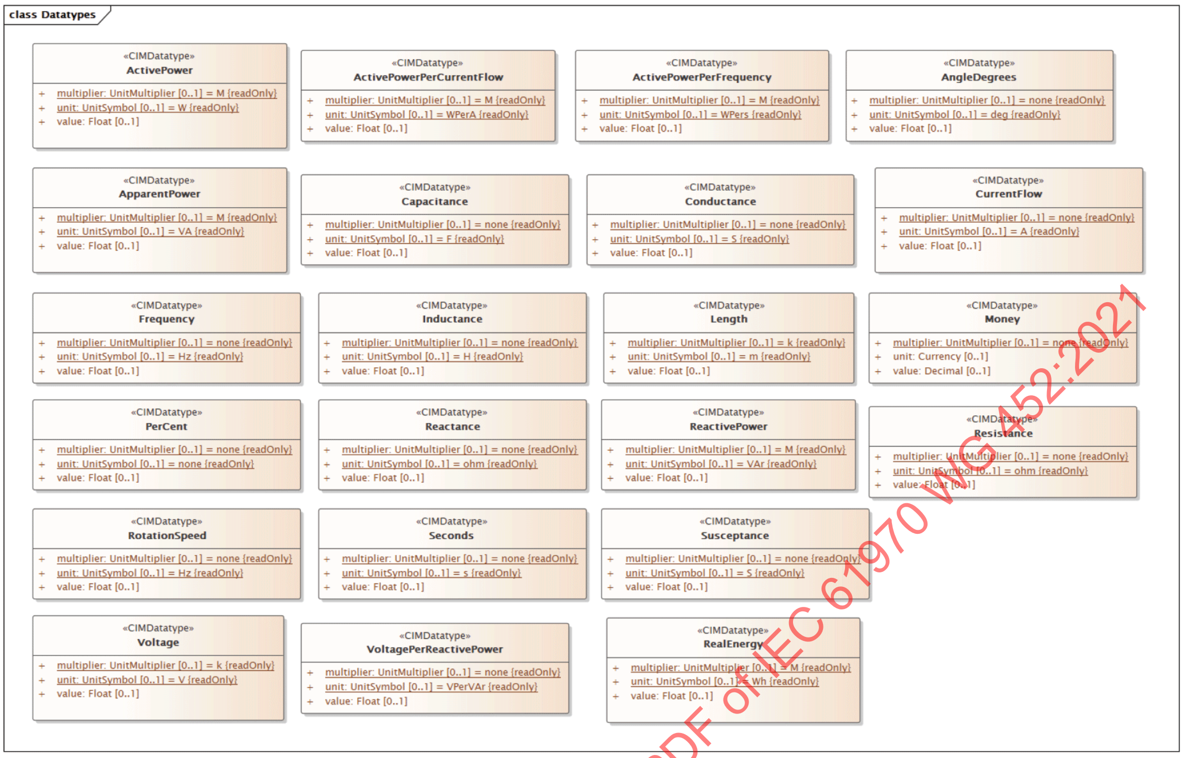
class Datatypes
«CIMDatatype»
ActivePower
+ multiplier: UnitMultiplier [0..1] = M {readOnly}
+ unit: UnitSymbol [0..1] = W {readOnly}
+ value: Float [0..1]
«CIMDatatype»
ActivePowerPerCurrentFlow
+ multiplier: UnitMultiplier [0..1] = M {readOnly}
+ unit: UnitSymbol [0..1] = WPerA {readOnly}
+ value: Float [0..1]
«CIMDatatype»
ActivePowerPerFrequency
+ multiplier: UnitMultiplier [0..1] = M {readOnly}
+ unit: UnitSymbol [0..1] = WPers {readOnly}
+ value: Float [0..1]
«CIMDatatype»
AngleDegrees
+ multiplier: UnitMultiplier [0..1] = none {readOnly}
+ unit: UnitSymbol [0..1] = deg {readOnly}
+ value: Float [0..1]
«CIMDatatype»
ApparentPower
+ multiplier: UnitMultiplier [0..1] = M {readOnly}
+ unit: UnitSymbol [0..1] = VA {readOnly}
+ value: Float [0..1]
«CIMDatatype»
Capacitance
+ multiplier: UnitMultiplier [0..1] = none {readOnly}
+ unit: UnitSymbol [0..1] = F {readOnly}
+ value: Float [0..1]
«CIMDatatype»
Conductance
+ multiplier: UnitMultiplier [0..1] = none {readOnly}
+ unit: UnitSymbol [0..1] = S {readOnly}
+ value: Float [0..1]
«CIMDatatype»
CurrentFlow
+ multiplier: UnitMultiplier [0..1] = none {readOnly}
+ unit: UnitSymbol [0..1] = A {readOnly}
+ value: Float [0..1]
«CIMDatatype»
Frequency
+ multiplier: UnitMultiplier [0..1] = none {readOnly}
+ unit: UnitSymbol [0..1] = Hz {readOnly}
+ value: Float [0..1]
«CIMDatatype»
Inductance
+ multiplier: UnitMultiplier [0..1] = none {readOnly}
+ unit: UnitSymbol [0..1] = H {readOnly}
+ value: Float [0..1]
«CIMDatatype»
Length
+ multiplier: UnitMultiplier [0..1] = k {readOnly}
+ unit: UnitSymbol [0..1] = m {readOnly}
+ value: Float [0..1]
«CIMDatatype»
Money
+ multiplier: UnitMultiplier [0..1] = none {readOnly}
+ unit: Currency [0..1]
+ value: Decimal [0..1]
«CIMDatatype»
PerCent
+ multiplier: UnitMultiplier [0..1] = none {readOnly}
+ unit: UnitSymbol [0..1] = none {readOnly}
+ value: Float [0..1]
«CIMDatatype»
Reactance
+ multiplier: UnitMultiplier [0..1] = none {readOnly}
+ unit: UnitSymbol [0..1] = ohm {readOnly}
+ value: Float [0..1]
«CIMDatatype»
ReactivePower
+ multiplier: UnitMultiplier [0..1] = M {readOnly}
+ unit: UnitSymbol [0..1] = VAr {readOnly}
+ value: Float [0..1]
«CIMDatatype»
Resistance
+ multiplier: UnitMultiplier [0..1] = none {readOnly}
+ unit: UnitSymbol [0..1] = ohm {readOnly}
+ value: Float [0..1]
«CIMDatatype»
RotationSpeed
+ multiplier: UnitMultiplier [0..1] = none {readOnly}
+ unit: UnitSymbol [0..1] = Hz {readOnly}
+ value: Float [0..1]
«CIMDatatype»
Seconds
+ multiplier: UnitMultiplier [0..1] = none {readOnly}
+ unit: UnitSymbol [0..1] = s {readOnly}
+ value: Float [0..1]
«CIMDatatype»
Susceptance
+ multiplier: UnitMultiplier [0..1] = none {readOnly}
+ unit: UnitSymbol [0..1] = S {readOnly}
+ value: Float [0..1]
«CIMDatatype»
Voltage
+ multiplier: UnitMultiplier [0..1] = k {readOnly}
+ unit: UnitSymbol [0..1] = V {readOnly}
+ value: Float [0..1]
«CIMDatatype»
VoltagePerReactivePower
+ multiplier: UnitMultiplier [0..1] = none {readOnly}
+ unit: UnitSymbol [0..1] = VPerVAr {readOnly}
+ value: Float [0..1]
«CIMDatatype»
RealEnergy
+ multiplier: UnitMultiplier [0..1] = M {readOnly}
+ unit: UnitSymbol [0..1] = Wh {readOnly}
+ value: Float [0..1]

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Figure 25 – Class diagram CoreEquipmentProfile::Datatypes

Figure 25: The diagram shows datatypes that are used by classes in the profile. 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.

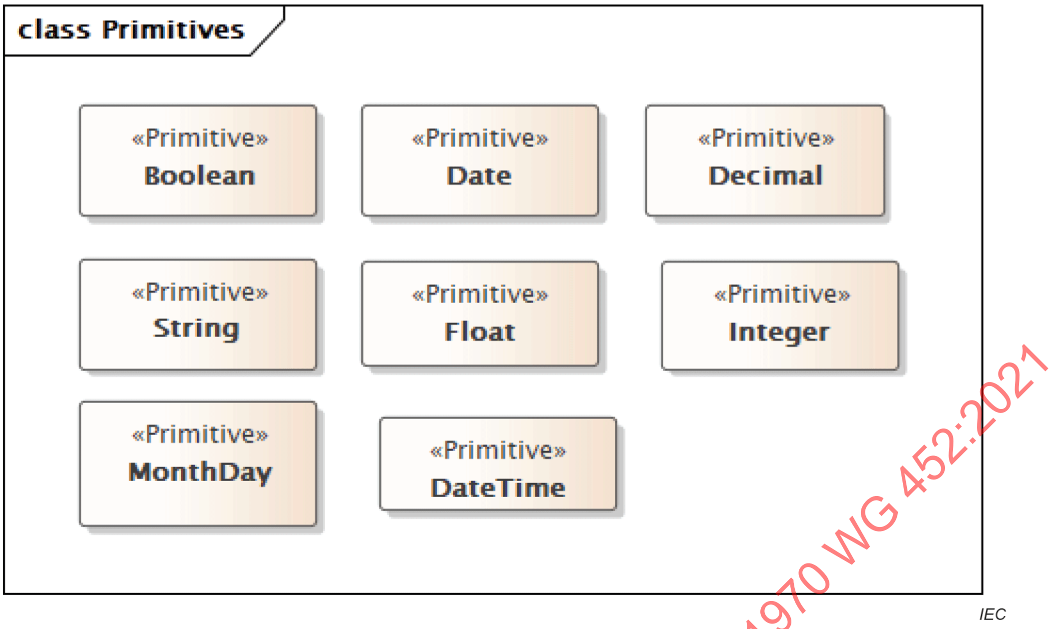


Figure 26 – Class diagram CoreEquipmentProfile::Primitives

Figure 26: The diagram shows datatypes that are used by classes in the profile.

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

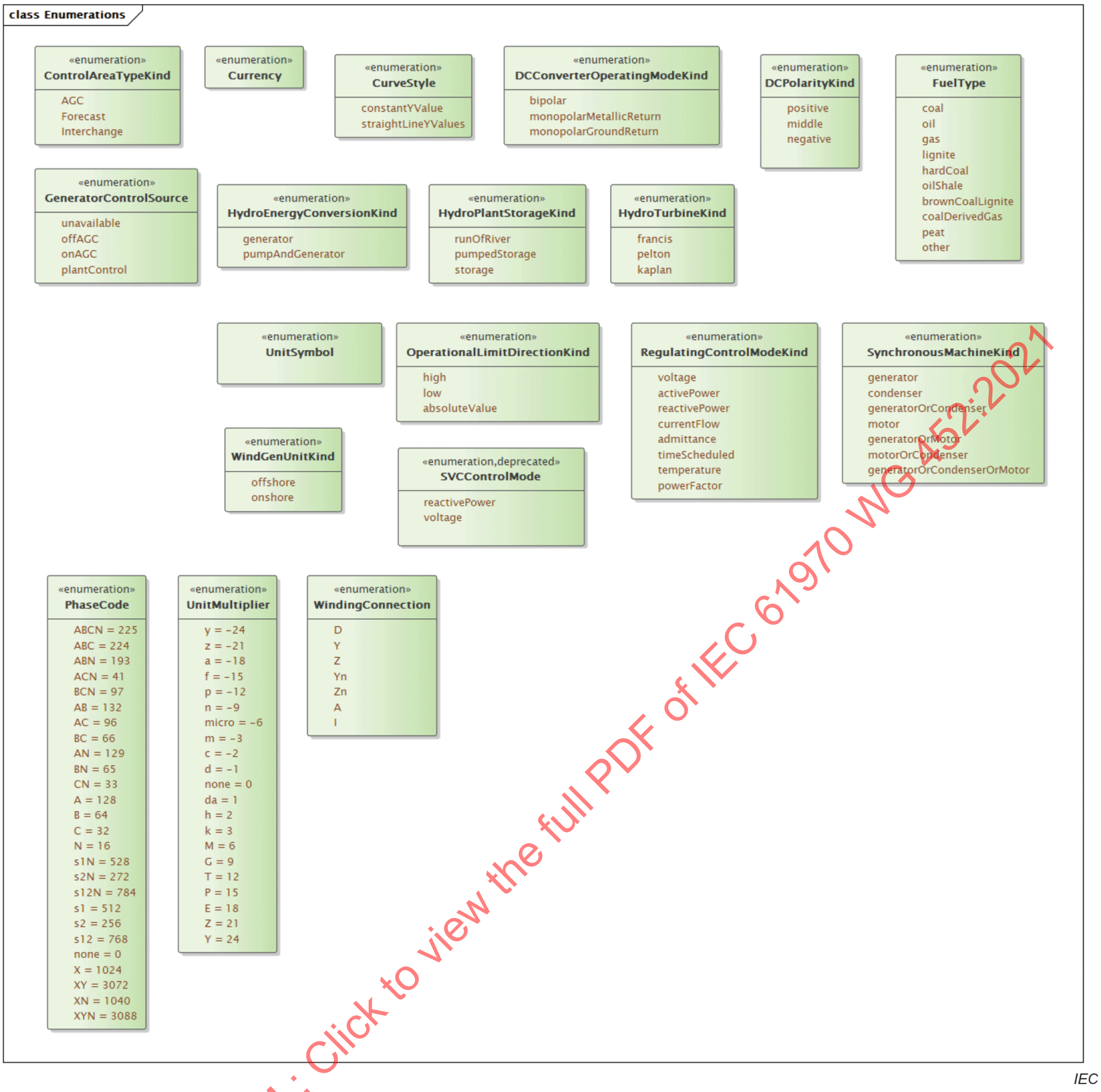


Figure 27 – Class diagram CoreEquipmentProfile::Enumerations

Figure 27: The diagram shows enumerations that are used by classes in the profile.

5.2.2 (abstract) EarthFaultCompensator

Inheritance path = ConductingEquipment: Equipment: PowerSystemResource: IdentifiedObject

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 1 shows all attributes of EarthFaultCompensator.

Table 1 – Attributes of CoreEquipmentProfile::EarthFaultCompensator

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

Table 2 shows all association ends of EarthFaultCompensator with other classes.

Table 2 – Association ends of CoreEquipmentProfile:: EarthFaultCompensator with other classes

mult from	name	mult to	type	description
0..*	BaseVoltage	0..1	BaseVoltage	inherited from: ConductingEquipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment

5.2.3 (abstract) EnergyArea

Inheritance path = IdentifiedObject

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 3 shows all attributes of EnergyArea.

Table 3 – Attributes of CoreEquipmentProfile::EnergyArea

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

5.2.4 (abstract) EnergyConnection

Inheritance path = ConductingEquipment: Equipment: PowerSystemResource: IdentifiedObject

A connection of energy generation or consumption on the power system model.

Table 4 shows all attributes of EnergyConnection.

Table 4 – Attributes of CoreEquipmentProfile::EnergyConnection

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

Table 5 shows all association ends of EnergyConnection with other classes.

Table 5 – Association ends of CoreEquipmentProfile:: EnergyConnection with other classes

mult from	name	mult to	type	description
0..*	BaseVoltage	0..1	BaseVoltage	inherited from: ConductingEquipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment

5.2.5 EnergyConsumer

Inheritance path = EnergyConnection: ConductingEquipment: Equipment: PowerSystemResource: IdentifiedObject

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 6 shows all attributes of EnergyConsumer.

Table 6 – Attributes of CoreEquipmentProfile::EnergyConsumer

name	mult	type	description
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.
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.
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.
aggregate	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment

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

Table 7 shows all association ends of EnergyConsumer with other classes.

Table 7 – Association ends of CoreEquipmentProfile:: 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.
0..*	BaseVoltage	0..1	BaseVoltage	inherited from: ConductingEquipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment

5.2.6 EnergySchedulingType

Inheritance path = IdentifiedObject

Used to define the type of generation for scheduling purposes.

Table 8 shows all attributes of EnergySchedulingType.

Table 8 – Attributes of CoreEquipmentProfile::EnergySchedulingType

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

5.2.7 TapSchedule

Inheritance path = SeasonDayTypeSchedule: RegularIntervalSchedule: BasicIntervalSchedule: IdentifiedObject

A pre-established pattern over time for a tap step.

Table 9 shows all attributes of TapSchedule.

Table 9 – Attributes of CoreEquipmentProfile::TapSchedule

name	mult	type	description
timeStep	1..1	Seconds	inherited from: RegularIntervalSchedule
endTime	1..1	DateTime	inherited from: RegularIntervalSchedule
startTime	1..1	DateTime	inherited from: BasicIntervalSchedule
value1Unit	1..1	UnitSymbol	inherited from: BasicIntervalSchedule
value2Unit	0..1	UnitSymbol	inherited from: BasicIntervalSchedule
description	0..1	String	inherited from: IdentifiedObject
mRID	1..1	String	inherited from: IdentifiedObject
name	1..1	String	inherited from: IdentifiedObject

Table 10 shows all association ends of TapSchedule with other classes.

Table 10 – Association ends of CoreEquipmentProfile::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	1..1	DayType	inherited from: SeasonDayTypeSchedule
0..*	Season	1..1	Season	inherited from: SeasonDayTypeSchedule

5.2.8 EnergySource

Inheritance path = EnergyConnection: ConductingEquipment: Equipment: PowerSystemResource: IdentifiedObject

A generic equivalent for an energy supplier on a transmission or distribution voltage level.

Table 11 shows all attributes of EnergySource.

Table 11 – Attributes of CoreEquipmentProfile::EnergySource

name	mult	type	description
nominalVoltage	0..1	Voltage	Phase-to-phase nominal voltage.
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
normallyInService	0..1	Boolean	inherited from: Equipment
description	0..1	String	inherited from: IdentifiedObject
mRID	1..1	String	inherited from: IdentifiedObject
name	1..1	String	inherited from: IdentifiedObject

Table 12 shows all association ends of EnergySource with other classes.

Table 12 – Association ends of CoreEquipmentProfile::EnergySource with other classes

mult from	name	mult to	type	description
0..*	EnergySchedulingType	0..1	EnergySchedulingType	Energy Scheduling Type of an Energy Source.
0..*	BaseVoltage	0..1	BaseVoltage	inherited from: ConductingEquipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment

5.2.9 (abstract) Equipment

Inheritance path = PowerSystemResource: IdentifiedObject

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

Table 13 shows all attributes of Equipment.

Table 13 – Attributes of CoreEquipmentProfile::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.
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.
description	0..1	String	inherited from: IdentifiedObject
mRID	1..1	String	inherited from: IdentifiedObject
name	1..1	String	inherited from: IdentifiedObject

Table 14 shows all association ends of Equipment with other classes.

Table 14 – Association ends of CoreEquipmentProfile::Equipment with other classes

mult from	name	mult to	type	description
0..*	EquipmentContainer	0..1	EquipmentContainer	Container of this equipment.

5.2.10 (abstract) EquipmentContainer

Inheritance path = ConnectivityNodeContainer: PowerSystemResource: IdentifiedObject

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

Table 15 shows all attributes of EquipmentContainer.

Table 15 – Attributes of CoreEquipmentProfile::EquipmentContainer

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

5.2.11 (abstract) ACDCConverter

Inheritance path = ConductingEquipment: Equipment: PowerSystemResource: IdentifiedObject

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 16 shows all attributes of ACDCConverter.

Table 16 – Attributes of CoreEquipmentProfile::ACDCConverter

name	mult	type	description
baseS	0..1	ApparentPower	Base apparent power of the converter pole. The attribute shall be a positive value.
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.
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.

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

Table 17 shows all association ends of ACDCConverter with other classes.

**Table 17 – Association ends of CoreEquipmentProfile::
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.
0..*	BaseVoltage	0..1	BaseVoltage	inherited from: ConductingEquipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment

5.2.12 ACDCConverterDCTerminal

Inheritance path = DCBaseTerminal: ACDCTerminal: IdentifiedObject

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 18 shows all attributes of ACDCConverterDCTerminal.

Table 18 – Attributes of CoreEquipmentProfile::ACDCConverterDCTerminal

name	mult	type	description
polarity	1..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".
sequenceNumber	1..1	Integer	inherited from: ACDCTerminal
description	0..1	String	inherited from: IdentifiedObject
mRID	1..1	String	inherited from: IdentifiedObject
name	1..1	String	inherited from: IdentifiedObject

Table 19 shows all association ends of ACDCConverterDCTerminal with other classes.

Table 19 – Association ends of CoreEquipmentProfile:: 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..*	DCNode	0..1	DCNode	inherited from: DCBaseTerminal
1..*	BusNameMarker	0..1	BusNameMarker	inherited from: ACDCTerminal

5.2.13 (abstract) ACDCTerminal

Inheritance path = IdentifiedObject

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

Table 20 shows all attributes of ACDCTerminal.

Table 20 – Attributes of CoreEquipmentProfile::ACDCTerminal

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

Table 21 shows all association ends of ACDCTerminal with other classes.

Table 21 – Association ends of CoreEquipmentProfile:: 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).

5.2.14 ACLineSegment

Inheritance path = Conductor: ConductingEquipment: Equipment: PowerSystemResource: IdentifiedObject

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 22 shows all attributes of ACLineSegment.

Table 22 – Attributes of CoreEquipmentProfile::ACLineSegment

name	mult	type	description
bch	1..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.
gch	0..1	Conductance	Positive sequence shunt (charging) conductance, uniformly distributed, of the entire line section.
r	1..1	Resistance	Positive sequence series resistance of the entire line section.
x	1..1	Reactance	Positive sequence series reactance of the entire line section.
length	0..1	Length	inherited from: Conductor
aggregate	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
description	0..1	String	inherited from: IdentifiedObject
mRID	1..1	String	inherited from: IdentifiedObject
name	1..1	String	inherited from: IdentifiedObject

Table 23 shows all association ends of ACLineSegment with other classes.

Table 23 – Association ends of CoreEquipmentProfile:: ACLineSegment with other classes

mult from	name	mult to	type	description
0..*	BaseVoltage	0..1	BaseVoltage	inherited from: ConductingEquipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment

5.2.15 ActivePowerLimit

Inheritance path = OperationalLimit: IdentifiedObject

Limit on active power flow.

Table 24 shows all attributes of ActivePowerLimit.

Table 24 – Attributes of CoreEquipmentProfile::ActivePowerLimit

name	mult	type	description
normalValue	1..1	ActivePower	The normal value of active power limit. The attribute shall be a positive value or zero.
description	0..1	String	inherited from: IdentifiedObject
mRID	1..1	String	inherited from: IdentifiedObject
name	1..1	String	inherited from: IdentifiedObject

Table 25 shows all association ends of ActivePowerLimit with other classes.

Table 25 – Association ends of CoreEquipmentProfile:: ActivePowerLimit with other classes

mult from	name	mult to	type	description
1..*	OperationalLimitType	1..1	OperationalLimitType	inherited from: OperationalLimit
1..*	OperationalLimitSet	1..1	OperationalLimitSet	inherited from: OperationalLimit

5.2.16 ApparentPowerLimit

Inheritance path = OperationalLimit: IdentifiedObject

Apparent power limit.

Table 26 shows all attributes of ApparentPowerLimit.

Table 26 – Attributes of CoreEquipmentProfile::ApparentPowerLimit

name	mult	type	description
normalValue	1..1	ApparentPower	The normal apparent power limit. The attribute shall be a positive value or zero.
description	0..1	String	inherited from: IdentifiedObject
mRID	1..1	String	inherited from: IdentifiedObject
name	1..1	String	inherited from: IdentifiedObject

Table 27 shows all association ends of ApparentPowerLimit with other classes.

Table 27 – Association ends of CoreEquipmentProfile:: ApparentPowerLimit with other classes

mult from	name	mult to	type	description
1..*	OperationalLimitType	1..1	OperationalLimitType	inherited from: OperationalLimit
1..*	OperationalLimitSet	1..1	OperationalLimitSet	inherited from: OperationalLimit

5.2.17 AsynchronousMachine

Inheritance path = RotatingMachine: RegulatingCondEq: EnergyConnection: ConductingEquipment: Equipment: PowerSystemResource: IdentifiedObject

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 28 shows all attributes of AsynchronousMachine.

Table 28 – Attributes of CoreEquipmentProfile::AsynchronousMachine

name	mult	type	description
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.
ratedPowerFactor	0..1	Float	inherited from: RotatingMachine
ratedS	0..1	ApparentPower	inherited from: RotatingMachine
ratedU	0..1	Voltage	inherited from: RotatingMachine
aggregate	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
description	0..1	String	inherited from: IdentifiedObject
mRID	1..1	String	inherited from: IdentifiedObject
name	1..1	String	inherited from: IdentifiedObject

Table 29 shows all association ends of AsynchronousMachine with other classes.

Table 29 – Association ends of CoreEquipmentProfile:: AsynchronousMachine with other classes

mult from	name	mult to	type	description
1..*	GeneratingUnit	0..1	GeneratingUnit	inherited from: RotatingMachine
0..*	RegulatingControl	0..1	RegulatingControl	inherited from: RegulatingCondEq
0..*	BaseVoltage	0..1	BaseVoltage	inherited from: ConductingEquipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment

5.2.18 (abstract) AuxiliaryEquipment

Inheritance path = Equipment: PowerSystemResource: IdentifiedObject

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 30 shows all attributes of AuxiliaryEquipment.

Table 30 – Attributes of CoreEquipmentProfile::AuxiliaryEquipment

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

Table 31 shows all association ends of AuxiliaryEquipment with other classes.

Table 31 – Association ends of CoreEquipmentProfile::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..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment

5.2.19 BaseVoltage

Inheritance path = IdentifiedObject

Defines a system base voltage which is referenced.

Table 32 shows all attributes of BaseVoltage.

Table 32 – Attributes of CoreEquipmentProfile::BaseVoltage

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

5.2.20 (abstract) BasicIntervalSchedule

Inheritance path = IdentifiedObject

Schedule of values at points in time.

Table 33 shows all attributes of BasicIntervalSchedule.

Table 33 – Attributes of CoreEquipmentProfile::BasicIntervalSchedule

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

5.2.21 BatteryUnit

Inheritance path = PowerElectronicsUnit: Equipment: PowerSystemResource: IdentifiedObject

An electrochemical energy storage device.

Table 34 shows all attributes of BatteryUnit.

Table 34 – Attributes of CoreEquipmentProfile::BatteryUnit

name	mult	type	description
ratedE	1..1	RealEnergy	Full energy storage capacity of the battery. The attribute shall be a positive value.
maxP	0..1	ActivePower	inherited from: PowerElectronicsUnit
minP	0..1	ActivePower	inherited from: PowerElectronicsUnit
aggregate	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
description	0..1	String	inherited from: IdentifiedObject
mRID	1..1	String	inherited from: IdentifiedObject
name	1..1	String	inherited from: IdentifiedObject

Table 35 shows all association ends of BatteryUnit with other classes.

Table 35 – Association ends of CoreEquipmentProfile::BatteryUnit with other classes

mult from	name	mult to	type	description
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment

5.2.22 Bay

Inheritance path = EquipmentContainer: ConnectivityNodeContainer: PowerSystemResource: IdentifiedObject

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.

Table 36 shows all attributes of Bay.

Table 36 – Attributes of CoreEquipmentProfile::Bay

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

Table 37 shows all association ends of Bay with other classes.

Table 37 – Association ends of CoreEquipmentProfile::Bay with other classes

mult from	name	mult to	type	description
0..*	VoltageLevel	1..1	VoltageLevel	The voltage level containing this bay.

5.2.23 Breaker

Inheritance path = ProtectedSwitch: Switch: ConductingEquipment: Equipment: PowerSystemResource: IdentifiedObject

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 38 shows all attributes of Breaker.

Table 38 – Attributes of CoreEquipmentProfile::Breaker

name	mult	type	description
normalOpen	1..1	Boolean	inherited from: Switch
ratedCurrent	0..1	CurrentFlow	inherited from: Switch
retained	1..1	Boolean	inherited from: Switch
aggregate	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
description	0..1	String	inherited from: IdentifiedObject
mRID	1..1	String	inherited from: IdentifiedObject
name	1..1	String	inherited from: IdentifiedObject

Table 39 shows all association ends of Breaker with other classes.

Table 39 – Association ends of CoreEquipmentProfile::Breaker with other classes

mult from	name	mult to	type	description
0..*	BaseVoltage	0..1	BaseVoltage	inherited from: ConductingEquipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment

5.2.24 BusbarSection

Inheritance path = Connector: ConductingEquipment: Equipment: PowerSystemResource: IdentifiedObject

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 40 shows all attributes of BusbarSection.

Table 40 – Attributes of CoreEquipmentProfile::BusbarSection

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

Table 41 shows all association ends of BusbarSection with other classes.

Table 41 – Association ends of CoreEquipmentProfile:: BusbarSection with other classes

mult from	name	mult to	type	description
0..*	BaseVoltage	0..1	BaseVoltage	inherited from: ConductingEquipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment

5.2.25 BusNameMarker

Inheritance path = IdentifiedObject

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 42 shows all attributes of BusNameMarker.

Table 42 – Attributes of CoreEquipmentProfile::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.
description	0..1	String	inherited from: IdentifiedObject
mRID	1..1	String	inherited from: IdentifiedObject
name	1..1	String	inherited from: IdentifiedObject

Table 43 shows all association ends of BusNameMarker with other classes.

Table 43 – Association ends of CoreEquipmentProfile:: BusNameMarker with other classes

mult from	name	mult to	type	description
0..*	ReportingGroup	0..1	ReportingGroup	The reporting group to which this bus name marker belongs.

5.2.26 CAESPlant

Inheritance path = PowerSystemResource: IdentifiedObject

Compressed air energy storage plant.

Table 44 shows all attributes of CAESPlant.

Table 44 – Attributes of CoreEquipmentProfile::CAESPlant

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

5.2.27 Clamp

Inheritance path = ConductingEquipment: Equipment: PowerSystemResource: IdentifiedObject

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 45 shows all attributes of Clamp.

Table 45 – Attributes of CoreEquipmentProfile::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
normallyInService	0..1	Boolean	inherited from: Equipment
description	0..1	String	inherited from: IdentifiedObject
mRID	1..1	String	inherited from: IdentifiedObject
name	1..1	String	inherited from: IdentifiedObject

Table 46 shows all association ends of Clamp with other classes.

Table 46 – Association ends of CoreEquipmentProfile::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
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment

5.2.28 ConformLoadSchedule

Inheritance path = SeasonDayTypeSchedule: RegularIntervalSchedule: BasicIntervalSchedule: IdentifiedObject

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 47 shows all attributes of ConformLoadSchedule.

Table 47 – Attributes of CoreEquipmentProfile::ConformLoadSchedule

name	mult	type	description
timeStep	1..1	Seconds	inherited from: RegularIntervalSchedule
endTime	1..1	DateTime	inherited from: RegularIntervalSchedule
startTime	1..1	DateTime	inherited from: BasicIntervalSchedule
value1Unit	1..1	UnitSymbol	inherited from: BasicIntervalSchedule
value2Unit	0..1	UnitSymbol	inherited from: BasicIntervalSchedule
description	0..1	String	inherited from: IdentifiedObject
mRID	1..1	String	inherited from: IdentifiedObject
name	1..1	String	inherited from: IdentifiedObject

Table 48 shows all association ends of ConformLoadSchedule with other classes.

Table 48 – Association ends of CoreEquipmentProfile::ConformLoadSchedule with other classes

mult from	name	mult to	type	description
0..*	ConformLoadGroup	1..1	ConformLoadGroup	The ConformLoadGroup where the ConformLoadSchedule belongs.
0..*	DayType	1..1	DayType	inherited from: SeasonDayTypeSchedule
0..*	Season	1..1	Season	inherited from: SeasonDayTypeSchedule

5.2.29 CogenerationPlant

Inheritance path = PowerSystemResource: IdentifiedObject

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 49 shows all attributes of CogenerationPlant.

Table 49 – Attributes of CoreEquipmentProfile::CogenerationPlant

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

5.2.30 CombinedCyclePlant

Inheritance path = PowerSystemResource: IdentifiedObject

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 50 shows all attributes of CombinedCyclePlant.

Table 50 – Attributes of CoreEquipmentProfile::CombinedCyclePlant

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

5.2.31 (abstract) ConductingEquipment

Inheritance path = Equipment: PowerSystemResource: IdentifiedObject

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

Table 51 shows all attributes of ConductingEquipment.

Table 51 – Attributes of CoreEquipmentProfile::ConductingEquipment

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

Table 52 shows all association ends of ConductingEquipment with other classes.

Table 52 – Association ends of CoreEquipmentProfile::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.
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment

5.2.32 (abstract) Conductor

Inheritance path = ConductingEquipment: Equipment: PowerSystemResource: IdentifiedObject

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

Table 53 shows all attributes of Conductor.

Table 53 – Attributes of CoreEquipmentProfile::Conductor

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

Table 54 shows all association ends of Conductor with other classes.

Table 54 – Association ends of CoreEquipmentProfile::Conductor with other classes

mult from	name	mult to	type	description
0..*	BaseVoltage	0..1	BaseVoltage	inherited from: ConductingEquipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment

5.2.33 ConformLoad

Inheritance path = EnergyConsumer: EnergyConnection: ConductingEquipment: Equipment: PowerSystemResource: IdentifiedObject

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 55 shows all attributes of ConformLoad.

Table 55 – Attributes of CoreEquipmentProfile::ConformLoad

name	mult	type	description
pfixed	0..1	ActivePower	inherited from: EnergyConsumer
pfixedPct	0..1	PerCent	inherited from: EnergyConsumer
qfixed	0..1	ReactivePower	inherited from: EnergyConsumer
qfixedPct	0..1	PerCent	inherited from: EnergyConsumer
aggregate	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
description	0..1	String	inherited from: IdentifiedObject
mRID	1..1	String	inherited from: IdentifiedObject
name	1..1	String	inherited from: IdentifiedObject

Table 56 shows all association ends of ConformLoad with other classes.

Table 56 – Association ends of CoreEquipmentProfile::ConformLoad with other classes

mult from	name	mult to	type	description
1..*	LoadGroup	1..1	ConformLoadGroup	Group of this ConformLoad.
0..*	LoadResponse	0..1	LoadResponseCharacteristic	inherited from: EnergyConsumer
0..*	BaseVoltage	0..1	BaseVoltage	inherited from: ConductingEquipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment

5.2.34 ConformLoadGroup

Inheritance path = LoadGroup: IdentifiedObject

A group of loads conforming to an allocation pattern.

Table 57 shows all attributes of ConformLoadGroup.

Table 57 – Attributes of CoreEquipmentProfile::ConformLoadGroup

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

Table 58 shows all association ends of ConformLoadGroup with other classes.

Table 58 – Association ends of CoreEquipmentProfile:: ConformLoadGroup with other classes

mult from	name	mult to	type	description
1..*	SubLoadArea	1..1	SubLoadArea	inherited from: LoadGroup

5.2.35 ConnectivityNode

Inheritance path = IdentifiedObject

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

Table 59 shows all attributes of ConnectivityNode.

Table 59 – Attributes of CoreEquipmentProfile::ConnectivityNode

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

Table 60 shows all association ends of ConnectivityNode with other classes.

Table 60 – Association ends of CoreEquipmentProfile:: ConnectivityNode with other classes

mult from	name	mult to	type	description
0..*	ConnectivityNodeContainer	1..1	ConnectivityNodeContainer	Container of this connectivity node.

5.2.36 (abstract) ConnectivityNodeContainer

Inheritance path = PowerSystemResource: IdentifiedObject

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

Table 61 shows all attributes of ConnectivityNodeContainer.

Table 61 – Attributes of CoreEquipmentProfile::ConnectivityNodeContainer

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

5.2.37 (abstract) Connector

Inheritance path = ConductingEquipment: Equipment: PowerSystemResource: IdentifiedObject

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 62 shows all attributes of Connector.

Table 62 – Attributes of CoreEquipmentProfile::Connector

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

Table 63 shows all association ends of Connector with other classes.

Table 63 – Association ends of CoreEquipmentProfile::Connector with other classes

mult from	name	mult to	type	description
0..*	BaseVoltage	0..1	BaseVoltage	inherited from: ConductingEquipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment

5.2.38 ControlArea

Inheritance path = PowerSystemResource: IdentifiedObject

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 64 shows all attributes of ControlArea.

Table 64 – Attributes of CoreEquipmentProfile::ControlArea

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

Table 65 shows all association ends of ControlArea with other classes.

Table 65 – Association ends of CoreEquipmentProfile::ControlArea with other classes

mult from	name	mult to	type	description
0..1	EnergyArea	1..1	EnergyArea	The energy area that is forecast from this control area specification.

5.2.39 ControlAreaGeneratingUnit

Inheritance path = IdentifiedObject

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 66 shows all attributes of ControlAreaGeneratingUnit.

Table 66 – Attributes of CoreEquipmentProfile::ControlAreaGeneratingUnit

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

Table 67 shows all association ends of ControlAreaGeneratingUnit with other classes.

Table 67 – Association ends of CoreEquipmentProfile:: ControlAreaGeneratingUnit with other classes

mult from	name	mult to	type	description
0..*	ControlArea	1..1	ControlArea	The parent control area for the generating unit specifications.
0..*	GeneratingUnit	1..1	GeneratingUnit	The generating unit specified for this control area. Note that a control area should include a GeneratingUnit only once.

5.2.40 CsConverter

Inheritance path = ACDCConverter: ConductingEquipment: Equipment: PowerSystemResource: IdentifiedObject

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 filter, 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 68 shows all attributes of CsConverter.

Table 68 – Attributes of CoreEquipmentProfile::CsConverter

name	mult	type	description
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.
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.
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.
baseS	0..1	ApparentPower	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
ratedUDC	0..1	Voltage	inherited from: ACDCConverter
resistiveLoss	0..1	Resistance	inherited from: ACDCConverter
switchingLoss	0..1	ActivePowerPerCurrentFlow	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
normallyInService	0..1	Boolean	inherited from: Equipment
description	0..1	String	inherited from: IdentifiedObject
mRID	1..1	String	inherited from: IdentifiedObject
name	1..1	String	inherited from: IdentifiedObject

Table 69 shows all association ends of CsConverter with other classes.

Table 69 – Association ends of CoreEquipmentProfile::CsConverter with other classes

mult from	name	mult to	type	description
0..*	PccTerminal	0..1	Terminal	inherited from: ACDCConverter
0..*	BaseVoltage	0..1	BaseVoltage	inherited from: ConductingEquipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment

5.2.41 CurrentLimit

Inheritance path = OperationalLimit: IdentifiedObject

Operational limit on current.

Table 70 shows all attributes of CurrentLimit.

Table 70 – Attributes of CoreEquipmentProfile::CurrentLimit

name	mult	type	description
normalValue	1..1	CurrentFlow	The normal value for limit on current flow. The attribute shall be a positive value or zero.
description	0..1	String	inherited from: IdentifiedObject
mRID	1..1	String	inherited from: IdentifiedObject
name	1..1	String	inherited from: IdentifiedObject

Table 71 shows all association ends of CurrentLimit with other classes.

Table 71 – Association ends of CoreEquipmentProfile::CurrentLimit with other classes

mult from	name	mult to	type	description
1..*	OperationalLimitType	1..1	OperationalLimitType	inherited from: OperationalLimit
1..*	OperationalLimitSet	1..1	OperationalLimitSet	inherited from: OperationalLimit

5.2.42 CurrentTransformer

Inheritance path = Sensor: AuxiliaryEquipment: Equipment: PowerSystemResource: IdentifiedObject

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 72 shows all attributes of CurrentTransformer.

Table 72 – Attributes of CoreEquipmentProfile::CurrentTransformer

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

Table 73 shows all association ends of CurrentTransformer with other classes.

Table 73 – Association ends of CoreEquipmentProfile:: CurrentTransformer with other classes

mult from	name	mult to	type	description
0..*	Terminal	1..1	Terminal	inherited from: AuxiliaryEquipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment

5.2.43 (abstract) Curve

Inheritance path = IdentifiedObject

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

Table 74 shows all attributes of Curve.

Table 74 – Attributes of CoreEquipmentProfile::Curve

name	mult	type	description
curveStyle	1..1	CurveStyle	The style or shape of the curve.
xUnit	1..1	UnitSymbol	The X-axis units of measure.
y1Unit	1..1	UnitSymbol	The Y1-axis units of measure.
y2Unit	0..1	UnitSymbol	The Y2-axis units of measure.
description	0..1	String	inherited from: IdentifiedObject
mRID	1..1	String	inherited from: IdentifiedObject
name	1..1	String	inherited from: IdentifiedObject

5.2.44 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 75 shows all attributes of CurveData.

Table 75 – Attributes of CoreEquipmentProfile::CurveData

name	mult	type	description
xvalue	1..1	Float	The data value of the X-axis variable, depending on the X-axis units.
y1value	1..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.

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

Table 76 – Association ends of CoreEquipmentProfile::CurveData with other classes

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

5.2.45 Cut

Inheritance path = Switch: ConductingEquipment: Equipment: PowerSystemResource: IdentifiedObject

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 77 shows all attributes of Cut.

Table 77 – Attributes of CoreEquipmentProfile::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	1..1	Boolean	inherited from: Switch
ratedCurrent	0..1	CurrentFlow	inherited from: Switch
retained	1..1	Boolean	inherited from: Switch
aggregate	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
description	0..1	String	inherited from: IdentifiedObject
mRID	1..1	String	inherited from: IdentifiedObject
name	1..1	String	inherited from: IdentifiedObject

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

Table 78 – Association ends of CoreEquipmentProfile::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.
0..*	BaseVoltage	0..1	BaseVoltage	inherited from: ConductingEquipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment

5.2.46 DayType

Inheritance path = IdentifiedObject

Group of similar days. For example it could be used to represent weekdays, weekend, or holidays.

Table 79 shows all attributes of DayType.

Table 79 – Attributes of CoreEquipmentProfile::DayType

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

5.2.47 (abstract) DCBaseTerminal

Inheritance path = ACDCTerminal: IdentifiedObject

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.

Table 80 shows all attributes of DCBaseTerminal.

Table 80 – Attributes of CoreEquipmentProfile::DCBaseTerminal

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

Table 81 shows all association ends of DCBaseTerminal with other classes.

Table 81 – Association ends of CoreEquipmentProfile:: DCBaseTerminal with other classes

mult from	name	mult to	type	description
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

5.2.48 DCBreaker

Inheritance path = DCSwitch: DCConductingEquipment: Equipment: PowerSystemResource: IdentifiedObject

A breaker within a DC system.

Table 82 shows all attributes of DCBreaker.

Table 82 – Attributes of CoreEquipmentProfile::DCBreaker

name	mult	type	description
ratedUDC	1..1	Voltage	inherited from: DCConductingEquipment
aggregate	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
description	0..1	String	inherited from: IdentifiedObject
mRID	1..1	String	inherited from: IdentifiedObject
name	1..1	String	inherited from: IdentifiedObject

Table 83 shows all association ends of DCBreaker with other classes.

Table 83 – Association ends of CoreEquipmentProfile::DCBreaker with other classes

mult from	name	mult to	type	description
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment

5.2.49 DCBusbar

Inheritance path = DCConductingEquipment: Equipment: PowerSystemResource: IdentifiedObject

A busbar within a DC system.

Table 84 shows all attributes of DCBusbar.

Table 84 – Attributes of CoreEquipmentProfile::DCBusbar

name	mult	type	description
ratedUDC	1..1	Voltage	inherited from: DCConductingEquipment
aggregate	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
description	0..1	String	inherited from: IdentifiedObject
mRID	1..1	String	inherited from: IdentifiedObject
name	1..1	String	inherited from: IdentifiedObject

Table 85 shows all association ends of DCBusbar with other classes.

Table 85 – Association ends of CoreEquipmentProfile::DCBusbar with other classes

mult from	name	mult to	type	description
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment

5.2.50 DCChopper

Inheritance path = DCConductingEquipment: Equipment: PowerSystemResource: IdentifiedObject

Low resistance equipment used in the internal DC circuit to balance voltages. It has typically positive and negative pole terminals and a ground.

Table 86 shows all attributes of DCChopper.

Table 86 – Attributes of CoreEquipmentProfile::DCChopper

name	mult	type	description
ratedUDC	1..1	Voltage	inherited from: DCConductingEquipment
aggregate	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
description	0..1	String	inherited from: IdentifiedObject
mRID	1..1	String	inherited from: IdentifiedObject
name	1..1	String	inherited from: IdentifiedObject

Table 87 shows all association ends of DCChopper with other classes.

Table 87 – Association ends of CoreEquipmentProfile::DCChopper with other classes

mult from	name	mult to	type	description
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment

5.2.51 (abstract) DCConductingEquipment

Inheritance path = Equipment: PowerSystemResource: IdentifiedObject

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

Table 88 shows all attributes of DCConductingEquipment.

Table 88 – Attributes of CoreEquipmentProfile::DCConductingEquipment

name	mult	type	description
ratedUDC	1..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
normallyInService	0..1	Boolean	inherited from: Equipment
description	0..1	String	inherited from: IdentifiedObject
mRID	1..1	String	inherited from: IdentifiedObject
name	1..1	String	inherited from: IdentifiedObject

Table 89 shows all association ends of DCConductingEquipment with other classes.

Table 89 – Association ends of CoreEquipmentProfile:: DCConductingEquipment with other classes

mult from	name	mult to	type	description
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment

5.2.52 DCConverterUnit

Inheritance path = DCEquipmentContainer: EquipmentContainer: ConnectivityNodeContainer: PowerSystemResource: IdentifiedObject

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 90 shows all attributes of DCConverterUnit.

Table 90 – Attributes of CoreEquipmentProfile::DCConverterUnit

name	mult	type	description
operationMode	1..1	DCConverterOperatingModeKind	The operating mode of an HVDC bipole (bipolar, monopolar metallic return, etc).
description	0..1	String	inherited from: IdentifiedObject
mRID	1..1	String	inherited from: IdentifiedObject
name	1..1	String	inherited from: IdentifiedObject

Table 91 shows all association ends of DCConverterUnit with other classes.

Table 91 – Association ends of CoreEquipmentProfile:: DCConverterUnit with other classes

mult from	name	mult to	type	description
0..*	Substation	0..1	Substation	The containing substation of the DC converter unit.

5.2.53 DCDisconnector

Inheritance path = DCSwitch: DCConductingEquipment: Equipment: PowerSystemResource: IdentifiedObject

A disconnector within a DC system.

Table 92 shows all attributes of DCDisconnector.

Table 92 – Attributes of CoreEquipmentProfile::DCDisconnector

name	mult	type	description
ratedUDC	1..1	Voltage	inherited from: DCConductingEquipment
aggregate	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
description	0..1	String	inherited from: IdentifiedObject
mRID	1..1	String	inherited from: IdentifiedObject
name	1..1	String	inherited from: IdentifiedObject

Table 93 shows all association ends of DCDisconnector with other classes.

Table 93 – Association ends of CoreEquipmentProfile:: DCDisconnector with other classes

mult from	name	mult to	type	description
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment

5.2.54 (abstract) DCEquipmentContainer

Inheritance path = EquipmentContainer: ConnectivityNodeContainer: PowerSystemResource: IdentifiedObject

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 94 shows all attributes of DCEquipmentContainer.

Table 94 – Attributes of CoreEquipmentProfile::DCEquipmentContainer

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

5.2.55 DCGround

Inheritance path = DCConductingEquipment: Equipment: PowerSystemResource: IdentifiedObject

A ground within a DC system.

Table 95 shows all attributes of DCGround.

Table 95 – Attributes of CoreEquipmentProfile::DCGround

name	mult	type	description
inductance	0..1	Inductance	Inductance to ground.
r	0..1	Resistance	Resistance to ground.
ratedUDC	1..1	Voltage	inherited from: DCConductingEquipment
aggregate	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
description	0..1	String	inherited from: IdentifiedObject
mRID	1..1	String	inherited from: IdentifiedObject
name	1..1	String	inherited from: IdentifiedObject

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

Table 96 – Association ends of CoreEquipmentProfile::DCGround with other classes

mult from	name	mult to	type	description
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment

5.2.56 DCLine

Inheritance path = DCEquipmentContainer: EquipmentContainer: ConnectivityNodeContainer: PowerSystemResource: IdentifiedObject

Overhead lines and/or cables connecting two or more HVDC substations.

Table 97 shows all attributes of DCLine.

Table 97 – Attributes of CoreEquipmentProfile::DCLine

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

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

Table 98 – Association ends of CoreEquipmentProfile::DCLine with other classes

mult from	name	mult to	type	description
0..*	Region	0..1	SubGeographicalRegion	The SubGeographicalRegion containing the DC line.

5.2.57 DCLineSegment

Inheritance path = DCConductingEquipment: Equipment: PowerSystemResource: IdentifiedObject

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 99 shows all attributes of DCLineSegment.

Table 99 – Attributes of CoreEquipmentProfile::DCLineSegment

name	mult	type	description
capacitance	1..1	Capacitance	Capacitance of the DC line segment. Significant for cables only.
inductance	1..1	Inductance	Inductance of the DC line segment. Negligible compared with DCSeriesDevice used for smoothing.
resistance	1..1	Resistance	Resistance of the DC line segment.
length	0..1	Length	Segment length for calculating line section capabilities.
ratedUDC	1..1	Voltage	inherited from: DCConductingEquipment
aggregate	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
description	0..1	String	inherited from: IdentifiedObject
mRID	1..1	String	inherited from: IdentifiedObject
name	1..1	String	inherited from: IdentifiedObject

Table 100 shows all association ends of DCLineSegment with other classes.

Table 100 – Association ends of CoreEquipmentProfile:: DCLineSegment with other classes

mult from	name	mult to	type	description
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment

5.2.58 DCNode

Inheritance path = IdentifiedObject

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

Table 101 shows all attributes of DCNode.

Table 101 – Attributes of CoreEquipmentProfile::DCNode

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

Table 102 shows all association ends of DCNode with other classes.

Table 102 – Association ends of CoreEquipmentProfile::DCNode with other classes

mult from	name	mult to	type	description
0..*	DCEquipmentContainer	1..1	DCEquipmentContainer	The DC container for the DC nodes.

5.2.59 RegulationSchedule

Inheritance path = SeasonDayTypeSchedule: RegularIntervalSchedule: BasicIntervalSchedule: IdentifiedObject

A pre-established pattern over time for a controlled variable, e.g., busbar voltage.

Table 103 shows all attributes of RegulationSchedule.

Table 103 – Attributes of CoreEquipmentProfile::RegulationSchedule

name	mult	type	description
timeStep	1..1	Seconds	inherited from: RegularIntervalSchedule
endTime	1..1	DateTime	inherited from: RegularIntervalSchedule
startTime	1..1	DateTime	inherited from: BasicIntervalSchedule
value1Unit	1..1	UnitSymbol	inherited from: BasicIntervalSchedule
value2Unit	0..1	UnitSymbol	inherited from: BasicIntervalSchedule
description	0..1	String	inherited from: IdentifiedObject
mRID	1..1	String	inherited from: IdentifiedObject
name	1..1	String	inherited from: IdentifiedObject

Table 104 shows all association ends of RegulationSchedule with other classes.

Table 104 – Association ends of CoreEquipmentProfile:: RegulationSchedule with other classes

mult from	name	mult to	type	description
0..*	RegulatingControl	1..1	RegulatingControl	Regulating controls that have this schedule.
0..*	DayType	1..1	DayType	inherited from: SeasonDayTypeSchedule
0..*	Season	1..1	Season	inherited from: SeasonDayTypeSchedule

5.2.60 DCSeriesDevice

Inheritance path = DCConductingEquipment: Equipment: PowerSystemResource: IdentifiedObject

A series device within the DC system, typically a reactor used for filtering or smoothing. Needed for transient and short circuit studies.

Table 105 shows all attributes of DCSeriesDevice.

Table 105 – Attributes of CoreEquipmentProfile::DCSeriesDevice

name	mult	type	description
inductance	1..1	Inductance	Inductance of the device.
resistance	1..1	Resistance	Resistance of the DC device.
ratedUDC	1..1	Voltage	inherited from: DCConductingEquipment
aggregate	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
description	0..1	String	inherited from: IdentifiedObject
mRID	1..1	String	inherited from: IdentifiedObject
name	1..1	String	inherited from: IdentifiedObject

Table 106 shows all association ends of DCSeriesDevice with other classes.

Table 106 – Association ends of CoreEquipmentProfile:: DCSeriesDevice with other classes

mult from	name	mult to	type	description
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment

5.2.61 DCShunt

Inheritance path = DCConductingEquipment: Equipment: PowerSystemResource: IdentifiedObject

A shunt device within the DC system, typically used for filtering. Needed for transient and short circuit studies.

Table 107 shows all attributes of DCShunt.

Table 107 – Attributes of CoreEquipmentProfile::DCShunt

name	mult	type	description
capacitance	1..1	Capacitance	Capacitance of the DC shunt.
resistance	1..1	Resistance	Resistance of the DC device.
ratedUDC	1..1	Voltage	inherited from: DCConductingEquipment
aggregate	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
description	0..1	String	inherited from: IdentifiedObject
mRID	1..1	String	inherited from: IdentifiedObject
name	1..1	String	inherited from: IdentifiedObject

Table 108 shows all association ends of DCShunt with other classes.

Table 108 – Association ends of CoreEquipmentProfile::DCShunt with other classes

mult from	name	mult to	type	description
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment

5.2.62 DCSwitch

Inheritance path = DCConductingEquipment: Equipment: PowerSystemResource: IdentifiedObject

A switch within the DC system.

Table 109 shows all attributes of DCSwitch.

Table 109 – Attributes of CoreEquipmentProfile::DCSwitch

name	mult	type	description
ratedUDC	1..1	Voltage	inherited from: DCConductingEquipment
aggregate	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
description	0..1	String	inherited from: IdentifiedObject
mRID	1..1	String	inherited from: IdentifiedObject
name	1..1	String	inherited from: IdentifiedObject

Table 110 shows all association ends of DCSwitch with other classes.

Table 110 – Association ends of CoreEquipmentProfile::DCSwitch with other classes

mult from	name	mult to	type	description
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment

5.2.63 DCTerminal

Inheritance path = DCBaseTerminal: ACDCTerminal: IdentifiedObject

An electrical connection point to generic DC conducting equipment.

Table 111 shows all attributes of DCTerminal.

Table 111 – Attributes of CoreEquipmentProfile::DCTerminal

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

Table 112 shows all association ends of DCTerminal with other classes.

Table 112 – Association ends of CoreEquipmentProfile::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..*	DCNode	0..1	DCNode	inherited from: DCBaseTerminal
1..*	BusNameMarker	0..1	BusNameMarker	inherited from: ACDCTerminal

5.2.64 Disconnector

Inheritance path = Switch: ConductingEquipment: Equipment: PowerSystemResource: IdentifiedObject

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 113 shows all attributes of Disconnector.

Table 113 – Attributes of CoreEquipmentProfile::Disconnector

name	mult	type	description
normalOpen	1..1	Boolean	inherited from: Switch
ratedCurrent	0..1	CurrentFlow	inherited from: Switch
retained	1..1	Boolean	inherited from: Switch
aggregate	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
description	0..1	String	inherited from: IdentifiedObject
mRID	1..1	String	inherited from: IdentifiedObject
name	1..1	String	inherited from: IdentifiedObject

Table 114 shows all association ends of Disconnector with other classes.

Table 114 – Association ends of CoreEquipmentProfile:: Disconnector with other classes

mult from	name	mult to	type	description
0..*	BaseVoltage	0..1	BaseVoltage	inherited from: ConductingEquipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment

5.2.65 DisconnectingCircuitBreaker

Inheritance path = Breaker: ProtectedSwitch: Switch: ConductingEquipment: Equipment: PowerSystemResource: IdentifiedObject

A circuit breaking device including disconnecting function, eliminating the need for separate disconnectors.

Table 115 shows all attributes of DisconnectingCircuitBreaker.

Table 115 – Attributes of CoreEquipmentProfile::DisconnectingCircuitBreaker

name	mult	type	description
normalOpen	1..1	Boolean	inherited from: Switch
ratedCurrent	0..1	CurrentFlow	inherited from: Switch
retained	1..1	Boolean	inherited from: Switch
aggregate	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
description	0..1	String	inherited from: IdentifiedObject
mRID	1..1	String	inherited from: IdentifiedObject
name	1..1	String	inherited from: IdentifiedObject

Table 116 shows all association ends of DisconnectingCircuitBreaker with other classes.

Table 116 – Association ends of CoreEquipmentProfile:: DisconnectingCircuitBreaker with other classes

mult from	name	mult to	type	description
0..*	BaseVoltage	0..1	BaseVoltage	inherited from: ConductingEquipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment

5.2.66 EquivalentBranch

Inheritance path = EquivalentEquipment: ConductingEquipment: Equipment: PowerSystemResource: IdentifiedObject

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 117 shows all attributes of EquivalentBranch.

Table 117 – Attributes of CoreEquipmentProfile::EquivalentBranch

name	mult	type	description
r	1..1	Resistance	Positive sequence series resistance of the reduced branch.
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	1..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.
aggregate	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
description	0..1	String	inherited from: IdentifiedObject
mRID	1..1	String	inherited from: IdentifiedObject
name	1..1	String	inherited from: IdentifiedObject

Table 118 shows all association ends of EquivalentBranch with other classes.

Table 118 – Association ends of CoreEquipmentProfile:: 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
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment

5.2.67 (abstract) EquivalentEquipment

Inheritance path = ConductingEquipment: Equipment: PowerSystemResource: IdentifiedObject

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 119 shows all attributes of EquivalentEquipment.

Table 119 – Attributes of CoreEquipmentProfile::EquivalentEquipment

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

Table 120 shows all association ends of EquivalentEquipment with other classes.

Table 120 – Association ends of CoreEquipmentProfile:: 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
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment

5.2.68 EquivalentInjection

Inheritance path = EquivalentEquipment: ConductingEquipment: Equipment: PowerSystemResource: IdentifiedObject

This class represents equivalent injections (generation or load). Voltage regulation is allowed only at the point of connection.

Table 121 shows all attributes of EquivalentInjection.

Table 121 – Attributes of CoreEquipmentProfile::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.
regulationCapability	1..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.
aggregate	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
description	0..1	String	inherited from: IdentifiedObject
mRID	1..1	String	inherited from: IdentifiedObject
name	1..1	String	inherited from: IdentifiedObject

Table 122 shows all association ends of EquivalentInjection with other classes.

Table 122 – Association ends of CoreEquipmentProfile:: 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
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment

5.2.69 EquivalentNetwork

Inheritance path = ConnectivityNodeContainer: PowerSystemResource: IdentifiedObject

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 123 shows all attributes of EquivalentNetwork.

Table 123 – Attributes of CoreEquipmentProfile::EquivalentNetwork

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

5.2.70 EquivalentShunt

Inheritance path = EquivalentEquipment: ConductingEquipment: Equipment: PowerSystemResource: IdentifiedObject

The class represents equivalent shunts.

Table 124 shows all attributes of EquivalentShunt.

Table 124 – Attributes of CoreEquipmentProfile::EquivalentShunt

name	mult	type	description
b	1..1	Susceptance	Positive sequence shunt susceptance.
g	1..1	Conductance	Positive sequence shunt conductance.
aggregate	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
description	0..1	String	inherited from: IdentifiedObject
mRID	1..1	String	inherited from: IdentifiedObject
name	1..1	String	inherited from: IdentifiedObject

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

Table 125 – Association ends of CoreEquipmentProfile:: 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
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment

5.2.71 ExternalNetworkInjection

Inheritance path = RegulatingCondEq: EnergyConnection: ConductingEquipment: Equipment: PowerSystemResource: IdentifiedObject

This class represents the external network and it is used for IEC 60909 calculations.

Table 126 shows all attributes of ExternalNetworkInjection.

Table 126 – Attributes of CoreEquipmentProfile::ExternalNetworkInjection

name	mult	type	description
governorSCD	1..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.
maxP	1..1	ActivePower	Maximum active power of the injection.
maxQ	1..1	ReactivePower	Maximum reactive power limit. It is used for modelling of infeed for load flow exchange and not for short circuit modelling.
minP	1..1	ActivePower	Minimum active power of the injection.
minQ	1..1	ReactivePower	Minimum reactive power limit. It is used for modelling of infeed for load flow exchange and not for short circuit modelling.
aggregate	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
description	0..1	String	inherited from: IdentifiedObject
mRID	1..1	String	inherited from: IdentifiedObject
name	1..1	String	inherited from: IdentifiedObject

Table 127 shows all association ends of ExternalNetworkInjection with other classes.

Table 127 – Association ends of CoreEquipmentProfile:: 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
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment

5.2.72 FaultIndicator

Inheritance path = AuxiliaryEquipment: Equipment: PowerSystemResource: IdentifiedObject

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 128 shows all attributes of FaultIndicator.

Table 128 – Attributes of CoreEquipmentProfile::FaultIndicator

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

Table 129 shows all association ends of FaultIndicator with other classes.

Table 129 – Association ends of CoreEquipmentProfile::
FaultIndicator with other classes

mult from	name	mult to	type	description
0..*	Terminal	1..1	Terminal	inherited from: AuxiliaryEquipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment

5.2.73 FossilFuel

Inheritance path = IdentifiedObject

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 130 shows all attributes of FossilFuel.

Table 130 – Attributes of CoreEquipmentProfile::FossilFuel

name	mult	type	description
fossilFuelType	1..1	FuelType	The type of fossil fuel, such as coal, oil, or gas.
description	0..1	String	inherited from: IdentifiedObject
mRID	1..1	String	inherited from: IdentifiedObject
name	1..1	String	inherited from: IdentifiedObject

Table 131 shows all association ends of FossilFuel with other classes.

Table 131 – Association ends of CoreEquipmentProfile::FossilFuel with other classes

mult from	name	mult to	type	description
0..*	ThermalGeneratingUnit	1..1	ThermalGeneratingUnit	A thermal generating unit may have one or more fossil fuels.

5.2.74 Fuse

Inheritance path = Switch: ConductingEquipment: Equipment: PowerSystemResource: IdentifiedObject

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 132 shows all attributes of Fuse.

Table 132 – Attributes of CoreEquipmentProfile::Fuse

name	mult	type	description
normalOpen	1..1	Boolean	inherited from: Switch
ratedCurrent	0..1	CurrentFlow	inherited from: Switch
retained	1..1	Boolean	inherited from: Switch
aggregate	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
description	0..1	String	inherited from: IdentifiedObject
mRID	1..1	String	inherited from: IdentifiedObject
name	1..1	String	inherited from: IdentifiedObject

Table 133 shows all association ends of Fuse with other classes.

Table 133 – Association ends of CoreEquipmentProfile::Fuse with other classes

mult from	name	mult to	type	description
0..*	BaseVoltage	0..1	BaseVoltage	inherited from: ConductingEquipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment

5.2.75 GeneratingUnit

Inheritance path = Equipment: PowerSystemResource: IdentifiedObject

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 134 shows all attributes of GeneratingUnit.

Table 134 – Attributes of CoreEquipmentProfile::GeneratingUnit

name	mult	type	description
genControlSource	0..1	GeneratorControlSource	The source of controls for a generating unit. Defines the control status of the generating unit.
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.
longPF	0..1	Float	Generating unit long term economic participation factor.
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	1..1	ActivePower	This is the maximum operating active power limit the dispatcher can enter for this unit.
minOperatingP	1..1	ActivePower	This is the minimum operating active power limit the dispatcher can enter for this unit.
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.
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.
variableCost	0..1	Money	The variable cost component of production per unit of ActivePower.
startupTime	0..1	Seconds	Time it takes to get the unit on-line, from the time that the prime mover mechanical power is applied.
totalEfficiency	0..1	PerCent	The efficiency of the unit in converting the fuel into electrical energy.
aggregate	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
description	0..1	String	inherited from: IdentifiedObject
mRID	1..1	String	inherited from: IdentifiedObject
name	1..1	String	inherited from: IdentifiedObject

Table 135 shows all association ends of GeneratingUnit with other classes.

Table 135 – Association ends of CoreEquipmentProfile:: GeneratingUnit with other classes

mult from	name	mult to	type	description
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment

5.2.76 GeographicalRegion

Inheritance path = IdentifiedObject

A geographical region of a power system network model.

Table 136 shows all attributes of GeographicalRegion.

Table 136 – Attributes of CoreEquipmentProfile::GeographicalRegion

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

5.2.77 GrossToNetActivePowerCurve

Inheritance path = Curve: IdentifiedObject

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 137 shows all attributes of GrossToNetActivePowerCurve.

Table 137 – Attributes of CoreEquipmentProfile::GrossToNetActivePowerCurve

name	mult	type	description
curveStyle	1..1	CurveStyle	inherited from: Curve
xUnit	1..1	UnitSymbol	inherited from: Curve
y1Unit	1..1	UnitSymbol	inherited from: Curve
y2Unit	0..1	UnitSymbol	inherited from: Curve
description	0..1	String	inherited from: IdentifiedObject
mRID	1..1	String	inherited from: IdentifiedObject
name	1..1	String	inherited from: IdentifiedObject

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

Table 138 – Association ends of CoreEquipmentProfile:: 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.

5.2.78 Ground

Inheritance path = ConductingEquipment: Equipment: PowerSystemResource: IdentifiedObject

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 139 shows all attributes of Ground.

Table 139 – Attributes of CoreEquipmentProfile::Ground

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

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

Table 140 – Association ends of CoreEquipmentProfile::Ground with other classes

mult from	name	mult to	type	description
0..*	BaseVoltage	0..1	BaseVoltage	inherited from: ConductingEquipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment

5.2.79 GroundDisconnector

Inheritance path = Switch: ConductingEquipment: Equipment: PowerSystemResource: IdentifiedObject

A manually operated or motor operated mechanical switching device used for isolating a circuit or equipment from ground.

Table 141 shows all attributes of GroundDisconnector.

Table 141 – Attributes of CoreEquipmentProfile::GroundDisconnector

name	mult	type	description
normalOpen	1..1	Boolean	inherited from: Switch
ratedCurrent	0..1	CurrentFlow	inherited from: Switch
retained	1..1	Boolean	inherited from: Switch
aggregate	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
description	0..1	String	inherited from: IdentifiedObject
mRID	1..1	String	inherited from: IdentifiedObject
name	1..1	String	inherited from: IdentifiedObject

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

Table 142 – Association ends of CoreEquipmentProfile:: GroundDisconnector with other classes

mult from	name	mult to	type	description
0..*	BaseVoltage	0..1	BaseVoltage	inherited from: ConductingEquipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment

5.2.80 GroundingImpedance

Inheritance path = EarthFaultCompensator: ConductingEquipment: Equipment: PowerSystemResource: IdentifiedObject

A fixed impedance device used for grounding.

Table 143 shows all attributes of GroundingImpedance.

Table 143 – Attributes of CoreEquipmentProfile::GroundingImpedance

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

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

Table 144 – Association ends of CoreEquipmentProfile:: GroundingImpedance with other classes

mult from	name	mult to	type	description
0..*	BaseVoltage	0..1	BaseVoltage	inherited from: ConductingEquipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment

5.2.81 HydroGeneratingUnit

Inheritance path = GeneratingUnit: Equipment: PowerSystemResource: IdentifiedObject

A generating unit whose prime mover is a hydraulic turbine (e.g., Francis, Pelton, Kaplan).

Table 145 shows all attributes of HydroGeneratingUnit.

Table 145 – Attributes of CoreEquipmentProfile::HydroGeneratingUnit

name	mult	type	description
energyConversionCapability	0..1	HydroEnergyConversionKind	Energy conversion capability for generating.
dropHeight	0..1	Length	The height water drops from the reservoir mid-point to the turbine.
turbineType	0..1	HydroTurbineKind	Type of turbine.
genControlSource	0..1	GeneratorControlSource	inherited from: GeneratingUnit
governorSCD	0..1	PerCent	inherited from: GeneratingUnit
longPF	0..1	Float	inherited from: GeneratingUnit
maximumAllowableSpinningReserve	0..1	ActivePower	inherited from: GeneratingUnit
maxOperatingP	1..1	ActivePower	inherited from: GeneratingUnit
minOperatingP	1..1	ActivePower	inherited from: GeneratingUnit
nominalP	0..1	ActivePower	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
variableCost	0..1	Money	inherited from: GeneratingUnit
startupTime	0..1	Seconds	inherited from: GeneratingUnit
totalEfficiency	0..1	PerCent	inherited from: GeneratingUnit
aggregate	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
description	0..1	String	inherited from: IdentifiedObject
mRID	1..1	String	inherited from: IdentifiedObject
name	1..1	String	inherited from: IdentifiedObject

Table 146 shows all association ends of HydroGeneratingUnit with other classes.

Table 146 – Association ends of CoreEquipmentProfile:: HydroGeneratingUnit with other classes

mult from	name	mult to	type	description
0..*	HydroPowerPlant	0..1	HydroPowerPlant	The hydro generating unit belongs to a hydro power plant.
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment

5.2.82 HydroPowerPlant

Inheritance path = PowerSystemResource: IdentifiedObject

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 147 shows all attributes of HydroPowerPlant.

Table 147 – Attributes of CoreEquipmentProfile::HydroPowerPlant

name	mult	type	description
hydroPlantStorageType	1..1	HydroPlantStorageKind	The type of hydro power plant water storage.
description	0..1	String	inherited from: IdentifiedObject
mRID	1..1	String	inherited from: IdentifiedObject
name	1..1	String	inherited from: IdentifiedObject

5.2.83 HydroPump

Inheritance path = Equipment: PowerSystemResource: IdentifiedObject

A synchronous motor-driven pump, typically associated with a pumped storage plant.

Table 148 shows all attributes of HydroPump.

Table 148 – Attributes of CoreEquipmentProfile::HydroPump

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

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

Table 149 – Association ends of CoreEquipmentProfile::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.
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment

5.2.84 (abstract) IdentifiedObject root class

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

Table 150 shows all attributes of IdentifiedObject.

Table 150 – Attributes of CoreEquipmentProfile::IdentifiedObject

name	mult	type	description
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	1..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	1..1	String	The name is any free human readable and possibly non unique text naming the object.

5.2.85 Jumper

Inheritance path = Switch: ConductingEquipment: Equipment: PowerSystemResource: IdentifiedObject

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 151 shows all attributes of Jumper.

Table 151 – Attributes of CoreEquipmentProfile::Jumper

name	mult	type	description
normalOpen	1..1	Boolean	inherited from: Switch
ratedCurrent	0..1	CurrentFlow	inherited from: Switch
retained	1..1	Boolean	inherited from: Switch
aggregate	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
description	0..1	String	inherited from: IdentifiedObject
mRID	1..1	String	inherited from: IdentifiedObject
name	1..1	String	inherited from: IdentifiedObject

Table 152 shows all association ends of Jumper with other classes.

Table 152 – Association ends of CoreEquipmentProfile::Jumper with other classes

mult from	name	mult to	type	description
0..*	BaseVoltage	0..1	BaseVoltage	inherited from: ConductingEquipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment

5.2.86 Junction

Inheritance path = Connector: ConductingEquipment: Equipment: PowerSystemResource: IdentifiedObject

A point where one or more conducting equipments are connected with zero resistance.

Table 153 shows all attributes of Junction.

Table 153 – Attributes of CoreEquipmentProfile::Junction

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

Table 154 shows all association ends of Junction with other classes.

Table 154 – Association ends of CoreEquipmentProfile::Junction with other classes

mult from	name	mult to	type	description
0..*	BaseVoltage	0..1	BaseVoltage	inherited from: ConductingEquipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment

5.2.87 Line

Inheritance path = EquipmentContainer: ConnectivityNodeContainer: PowerSystemResource: IdentifiedObject

Contains equipment beyond a substation belonging to a power transmission line.

Table 155 shows all attributes of Line.

Table 155 – Attributes of CoreEquipmentProfile::Line

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

Table 156 shows all association ends of Line with other classes.

Table 156 – Association ends of CoreEquipmentProfile::Line with other classes

mult from	name	mult to	type	description
0..*	Region	0..1	SubGeographicalRegion	The sub-geographical region of the line.

5.2.88 LinearShuntCompensator

Inheritance path = ShuntCompensator: RegulatingCondEq: EnergyConnection: ConductingEquipment: Equipment: PowerSystemResource: IdentifiedObject

A linear shunt compensator has banks or sections with equal admittance values.

Table 157 shows all attributes of LinearShuntCompensator.

Table 157 – Attributes of CoreEquipmentProfile::LinearShuntCompensator

name	mult	type	description
bPerSection	1..1	Susceptance	Positive sequence shunt (charging) susceptance per section.
gPerSection	1..1	Conductance	Positive sequence shunt (charging) conductance per section.
aVRDelay	0..1	Seconds	inherited from: ShuntCompensator
grounded	0..1	Boolean	inherited from: ShuntCompensator
maximumSections	1..1	Integer	inherited from: ShuntCompensator
nomU	1..1	Voltage	inherited from: ShuntCompensator
normalSections	1..1	Integer	inherited from: ShuntCompensator
voltageSensitivity	0..1	VoltagePerReactivePower	inherited from: ShuntCompensator
aggregate	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
description	0..1	String	inherited from: IdentifiedObject
mRID	1..1	String	inherited from: IdentifiedObject
name	1..1	String	inherited from: IdentifiedObject

Table 158 shows all association ends of LinearShuntCompensator with other classes.

Table 158 – Association ends of CoreEquipmentProfile:: LinearShuntCompensator 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
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment

5.2.89 LoadArea

Inheritance path = EnergyArea: IdentifiedObject

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 159 shows all attributes of LoadArea.

Table 159 – Attributes of CoreEquipmentProfile::LoadArea

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

5.2.90 LoadBreakSwitch

Inheritance path = ProtectedSwitch: Switch: ConductingEquipment: Equipment: PowerSystemResource: IdentifiedObject

A mechanical switching device capable of making, carrying, and breaking currents under normal operating conditions.

Table 160 shows all attributes of LoadBreakSwitch.

Table 160 – Attributes of CoreEquipmentProfile::LoadBreakSwitch

name	mult	type	description
normalOpen	1..1	Boolean	inherited from: Switch
ratedCurrent	0..1	CurrentFlow	inherited from: Switch
retained	1..1	Boolean	inherited from: Switch
aggregate	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
description	0..1	String	inherited from: IdentifiedObject
mRID	1..1	String	inherited from: IdentifiedObject
name	1..1	String	inherited from: IdentifiedObject

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

Table 161 – Association ends of CoreEquipmentProfile:: LoadBreakSwitch with other classes

mult from	name	mult to	type	description
0..*	BaseVoltage	0..1	BaseVoltage	inherited from: ConductingEquipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment

5.2.91 (abstract) LoadGroup

Inheritance path = IdentifiedObject

The class is the third level in a hierarchical structure for grouping of loads for the purpose of load flow load scaling.

Table 162 shows all attributes of LoadGroup.

Table 162 – Attributes of CoreEquipmentProfile::LoadGroup

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

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

Table 163 – Association ends of CoreEquipmentProfile::LoadGroup with other classes

mult from	name	mult to	type	description
1..*	SubLoadArea	1..1	SubLoadArea	The SubLoadArea where the Loadgroup belongs.

5.2.92 LoadResponseCharacteristic

Inheritance path = IdentifiedObject

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

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 164 shows all attributes of LoadResponseCharacteristic.

Table 164 – Attributes of CoreEquipmentProfile::LoadResponseCharacteristic

name	mult	type	description
exponentModel	1..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 consist of the attributes: – pVoltageExponent – qVoltageExponent – pFrequencyExponent – qFrequencyExponent. The coefficient model consist 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.
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.
description	0..1	String	inherited from: IdentifiedObject
mRID	1..1	String	inherited from: IdentifiedObject
name	1..1	String	inherited from: IdentifiedObject

5.2.93 NonConformLoad

Inheritance path = EnergyConsumer: EnergyConnection: ConductingEquipment: Equipment: PowerSystemResource: IdentifiedObject

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 165 shows all attributes of NonConformLoad.

Table 165 – Attributes of CoreEquipmentProfile::NonConformLoad

name	mult	type	description
pfixed	0..1	ActivePower	inherited from: EnergyConsumer
pfixedPct	0..1	PerCent	inherited from: EnergyConsumer
qfixed	0..1	ReactivePower	inherited from: EnergyConsumer
qfixedPct	0..1	PerCent	inherited from: EnergyConsumer
aggregate	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
description	0..1	String	inherited from: IdentifiedObject
mRID	1..1	String	inherited from: IdentifiedObject
name	1..1	String	inherited from: IdentifiedObject

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

Table 166 – Association ends of CoreEquipmentProfile:: NonConformLoad with other classes

mult from	name	mult to	type	description
1..*	LoadGroup	1..1	NonConformLoadGroup	Group of this ConformLoad.
0..*	LoadResponse	0..1	LoadResponseCharacteristic	inherited from: EnergyConsumer
0..*	BaseVoltage	0..1	BaseVoltage	inherited from: ConductingEquipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment

5.2.94 NonConformLoadGroup

Inheritance path = LoadGroup: IdentifiedObject

Loads that do not follow a daily and seasonal load variation pattern.

Table 167 shows all attributes of NonConformLoadGroup.

Table 167 – Attributes of CoreEquipmentProfile::NonConformLoadGroup

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

Table 168 shows all association ends of NonConformLoadGroup with other classes.

Table 168 – Association ends of CoreEquipmentProfile:: NonConformLoadGroup with other classes

mult from	name	mult to	type	description
1..*	SubLoadArea	1..1	SubLoadArea	inherited from: LoadGroup

5.2.95 NonConformLoadSchedule

Inheritance path = SeasonDayTypeSchedule: RegularIntervalSchedule: BasicIntervalSchedule: IdentifiedObject

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 169 shows all attributes of NonConformLoadSchedule.

Table 169 – Attributes of CoreEquipmentProfile::NonConformLoadSchedule

name	mult	type	description
timeStep	1..1	Seconds	inherited from: RegularIntervalSchedule
endTime	1..1	DateTime	inherited from: RegularIntervalSchedule
startTime	1..1	DateTime	inherited from: BasicIntervalSchedule
value1Unit	1..1	UnitSymbol	inherited from: BasicIntervalSchedule
value2Unit	0..1	UnitSymbol	inherited from: BasicIntervalSchedule
description	0..1	String	inherited from: IdentifiedObject
mRID	1..1	String	inherited from: IdentifiedObject
name	1..1	String	inherited from: IdentifiedObject

Table 170 shows all association ends of NonConformLoadSchedule with other classes.

Table 170 – Association ends of CoreEquipmentProfile:: NonConformLoadSchedule with other classes

mult from	name	mult to	type	description
0..*	NonConformLoadGroup	1..1	NonConformLoadGroup	The NonConformLoadGroup where the NonConformLoadSchedule belongs.
0..*	DayType	1..1	DayType	inherited from: SeasonDayTypeSchedule
0..*	Season	1..1	Season	inherited from: SeasonDayTypeSchedule

5.2.96 NonlinearShuntCompensator

Inheritance path = ShuntCompensator: RegulatingCondEq: EnergyConnection: ConductingEquipment: Equipment: PowerSystemResource: IdentifiedObject

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 171 shows all attributes of NonlinearShuntCompensator.

Table 171 – Attributes of CoreEquipmentProfile::NonlinearShuntCompensator

name	mult	type	description
aVRDelay	0..1	Seconds	inherited from: ShuntCompensator
grounded	0..1	Boolean	inherited from: ShuntCompensator
maximumSections	1..1	Integer	inherited from: ShuntCompensator
nomU	1..1	Voltage	inherited from: ShuntCompensator
normalSections	1..1	Integer	inherited from: ShuntCompensator
voltageSensitivity	0..1	VoltagePerReactivePower	inherited from: ShuntCompensator
aggregate	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
description	0..1	String	inherited from: IdentifiedObject
mRID	1..1	String	inherited from: IdentifiedObject
name	1..1	String	inherited from: IdentifiedObject

Table 172 shows all association ends of NonlinearShuntCompensator with other classes.

Table 172 – Association ends of CoreEquipmentProfile:: NonlinearShuntCompensator 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
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment

5.2.97 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 173 shows all attributes of NonlinearShuntCompensatorPoint.

Table 173 – Attributes of CoreEquipmentProfile::NonlinearShuntCompensatorPoint

name	mult	type	description
b	1..1	Susceptance	Positive sequence shunt (charging) susceptance per section.
g	1..1	Conductance	Positive sequence shunt (charging) conductance per section.
sectionNumber	1..1	Integer	The number of the section.

Table 174 shows all association ends of NonlinearShuntCompensatorPoint with other classes.

Table 174 – Association ends of CoreEquipmentProfile:: NonlinearShuntCompensatorPoint with other classes

mult from	name	mult to	type	description
1..*	NonlinearShuntCompensator	1..1	NonlinearShuntCompensator	Non-linear shunt compensator owning this point.

5.2.98 NuclearGeneratingUnit

Inheritance path = GeneratingUnit: Equipment: PowerSystemResource: IdentifiedObject

A nuclear generating unit.

Table 175 shows all attributes of NuclearGeneratingUnit.

Table 175 – Attributes of CoreEquipmentProfile::NuclearGeneratingUnit

name	mult	type	description
genControlSource	0..1	GeneratorControlSource	inherited from: GeneratingUnit
governorSCD	0..1	PerCent	inherited from: GeneratingUnit
longPF	0..1	Float	inherited from: GeneratingUnit
maximumAllowableSpinningReserve	0..1	ActivePower	inherited from: GeneratingUnit
maxOperatingP	1..1	ActivePower	inherited from: GeneratingUnit
minOperatingP	1..1	ActivePower	inherited from: GeneratingUnit
nominalP	0..1	ActivePower	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
variableCost	0..1	Money	inherited from: GeneratingUnit
startupTime	0..1	Seconds	inherited from: GeneratingUnit
totalEfficiency	0..1	PerCent	inherited from: GeneratingUnit
aggregate	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
description	0..1	String	inherited from: IdentifiedObject
mRID	1..1	String	inherited from: IdentifiedObject
name	1..1	String	inherited from: IdentifiedObject

Table 176 shows all association ends of NuclearGeneratingUnit with other classes.

Table 176 – Association ends of CoreEquipmentProfile:: NuclearGeneratingUnit with other classes

mult from	name	mult to	type	description
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment

5.2.99 (abstract) OperationalLimit

Inheritance path = IdentifiedObject

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. It should be noted that 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 177 shows all attributes of OperationalLimit.

Table 177 – Attributes of CoreEquipmentProfile::OperationalLimit

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

Table 178 shows all association ends of OperationalLimit with other classes.

Table 178 – Association ends of CoreEquipmentProfile:: OperationalLimit with other classes

mult from	name	mult to	type	description
1..*	OperationalLimitType	1..1	OperationalLimitType	The limit type associated with this limit.
1..*	OperationalLimitSet	1..1	OperationalLimitSet	The limit set to which the limit values belong.

5.2.100 OperationalLimitSet

Inheritance path = IdentifiedObject

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 179 shows all attributes of OperationalLimitSet.

Table 179 – Attributes of CoreEquipmentProfile::OperationalLimitSet

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

Table 180 shows all association ends of OperationalLimitSet with other classes.

Table 180 – Association ends of CoreEquipmentProfile:: OperationalLimitSet with other classes

mult from	name	mult to	type	description
0..*	Equipment	0..1	Equipment	The equipment to which the limit set applies.
0..*	Terminal	1..1	ACDCTerminal	The terminal where the operational limit set apply.

5.2.101 OperationalLimitType

Inheritance path = IdentifiedObject

The operational meaning of a category of limits.

Table 181 shows all attributes of OperationalLimitType.

Table 181 – Attributes of CoreEquipmentProfile::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	1..1	OperationalLimitDirectionKind	The direction of the limit.
isInfiniteDuration	1..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.
description	0..1	String	inherited from: IdentifiedObject
mRID	1..1	String	inherited from: IdentifiedObject
name	1..1	String	inherited from: IdentifiedObject

5.2.102 PetersenCoil

Inheritance path = EarthFaultCompensator: ConductingEquipment: Equipment: PowerSystemResource: IdentifiedObject

A variable impedance device normally used to offset line charging during single line faults in an ungrounded section of network.

Table 182 shows all attributes of PetersenCoil.

Table 182 – Attributes of CoreEquipmentProfile::PetersenCoil

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

Table 183 shows all association ends of PetersenCoil with other classes.

Table 183 – Association ends of CoreEquipmentProfile::PetersenCoil with other classes

mult from	name	mult to	type	description
0..*	BaseVoltage	0..1	BaseVoltage	inherited from: ConductingEquipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment

5.2.103 (abstract) PhaseTapChanger

Inheritance path = TapChanger: PowerSystemResource: IdentifiedObject

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 184 shows all attributes of PhaseTapChanger.

Table 184 – Attributes of CoreEquipmentProfile::PhaseTapChanger

name	mult	type	description
highStep	1..1	Integer	inherited from: TapChanger
lowStep	1..1	Integer	inherited from: TapChanger
ltcFlag	1..1	Boolean	inherited from: TapChanger
neutralStep	1..1	Integer	inherited from: TapChanger
neutralU	1..1	Voltage	inherited from: TapChanger
normalStep	1..1	Integer	inherited from: TapChanger
description	0..1	String	inherited from: IdentifiedObject
mRID	1..1	String	inherited from: IdentifiedObject
name	1..1	String	inherited from: IdentifiedObject

Table 185 shows all association ends of PhaseTapChanger with other classes.

Table 185 – Association ends of CoreEquipmentProfile:: 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

5.2.104 PhaseTapChangerAsymmetrical

Inheritance path = PhaseTapChangerNonLinear: PhaseTapChanger: TapChanger: PowerSystemResource: IdentifiedObject

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 186 shows all attributes of PhaseTapChangerAsymmetrical.

Table 186 – Attributes of CoreEquipmentProfile::PhaseTapChangerAsymmetrical

name	mult	type	description
windingConnectionAngle	1..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	1..1	PerCent	inherited from: PhaseTapChangerNonLinear
xMax	1..1	Reactance	inherited from: PhaseTapChangerNonLinear
xMin	1..1	Reactance	(deprecated) inherited from: PhaseTapChangerNonLinear
highStep	1..1	Integer	inherited from: TapChanger
lowStep	1..1	Integer	inherited from: TapChanger
ltcFlag	1..1	Boolean	inherited from: TapChanger
neutralStep	1..1	Integer	inherited from: TapChanger
neutralU	1..1	Voltage	inherited from: TapChanger
normalStep	1..1	Integer	inherited from: TapChanger
description	0..1	String	inherited from: IdentifiedObject
mRID	1..1	String	inherited from: IdentifiedObject
name	1..1	String	inherited from: IdentifiedObject

Table 187 shows all association ends of PhaseTapChangerAsymmetrical with other classes.

Table 187 – Association ends of CoreEquipmentProfile:: 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

5.2.105 PhaseTapChangerLinear

Inheritance path = PhaseTapChanger: TapChanger: PowerSystemResource: IdentifiedObject

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 188 shows all attributes of PhaseTapChangerLinear.

Table 188 – Attributes of CoreEquipmentProfile::PhaseTapChangerLinear

name	mult	type	description
stepPhaseShiftIncrement	1..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	1..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	1..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.
highStep	1..1	Integer	inherited from: TapChanger
lowStep	1..1	Integer	inherited from: TapChanger
ltcFlag	1..1	Boolean	inherited from: TapChanger
neutralStep	1..1	Integer	inherited from: TapChanger
neutralU	1..1	Voltage	inherited from: TapChanger
normalStep	1..1	Integer	inherited from: TapChanger
description	0..1	String	inherited from: IdentifiedObject
mRID	1..1	String	inherited from: IdentifiedObject
name	1..1	String	inherited from: IdentifiedObject

Table 189 shows all association ends of PhaseTapChangerLinear with other classes.

Table 189 – Association ends of CoreEquipmentProfile:: 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

5.2.106 (abstract) PhaseTapChangerNonLinear

Inheritance path = PhaseTapChanger: TapChanger: PowerSystemResource: IdentifiedObject

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 190 shows all attributes of PhaseTapChangerNonLinear.

Table 190 – Attributes of CoreEquipmentProfile::PhaseTapChangerNonLinear

name	mult	type	description
voltageStepIncrement	1..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	1..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	1..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.
highStep	1..1	Integer	inherited from: TapChanger
lowStep	1..1	Integer	inherited from: TapChanger
ltcFlag	1..1	Boolean	inherited from: TapChanger
neutralStep	1..1	Integer	inherited from: TapChanger
neutralU	1..1	Voltage	inherited from: TapChanger
normalStep	1..1	Integer	inherited from: TapChanger
description	0..1	String	inherited from: IdentifiedObject
mRID	1..1	String	inherited from: IdentifiedObject
name	1..1	String	inherited from: IdentifiedObject

Table 191 shows all association ends of PhaseTapChangerNonLinear with other classes.

Table 191 – Association ends of CoreEquipmentProfile:: 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

5.2.107 PhaseTapChangerSymmetrical

Inheritance path = PhaseTapChangerNonLinear: PhaseTapChanger: TapChanger: PowerSystemResource: IdentifiedObject

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 192 shows all attributes of PhaseTapChangerSymmetrical.

Table 192 – Attributes of CoreEquipmentProfile::PhaseTapChangerSymmetrical

name	mult	type	description
voltageStepIncrement	1..1	PerCent	inherited from: PhaseTapChangerNonLinear
xMax	1..1	Reactance	inherited from: PhaseTapChangerNonLinear
xMin	1..1	Reactance	(deprecated) inherited from: PhaseTapChangerNonLinear
highStep	1..1	Integer	inherited from: TapChanger
lowStep	1..1	Integer	inherited from: TapChanger
ltcFlag	1..1	Boolean	inherited from: TapChanger
neutralStep	1..1	Integer	inherited from: TapChanger
neutralU	1..1	Voltage	inherited from: TapChanger
normalStep	1..1	Integer	inherited from: TapChanger
description	0..1	String	inherited from: IdentifiedObject
mRID	1..1	String	inherited from: IdentifiedObject
name	1..1	String	inherited from: IdentifiedObject

Table 193 shows all association ends of PhaseTapChangerSymmetrical with other classes.

Table 193 – Association ends of CoreEquipmentProfile:: 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

5.2.108 PhaseTapChangerTable

Inheritance path = IdentifiedObject

Describes a tabular curve for how the phase angle difference and impedance varies with the tap step.

Table 194 shows all attributes of PhaseTapChangerTable.

Table 194 – Attributes of CoreEquipmentProfile::PhaseTapChangerTable

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

5.2.109 PhaseTapChangerTablePoint

Inheritance path = TapChangerTablePoint

Describes each tap step in the phase tap changer tabular curve.

Table 195 shows all attributes of PhaseTapChangerTablePoint.

Table 195 – Attributes of CoreEquipmentProfile::PhaseTapChangerTablePoint

name	mult	type	description
angle	1..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	1..1	Integer	inherited from: TapChangerTablePoint
x	0..1	PerCent	inherited from: TapChangerTablePoint

Table 196 shows all association ends of PhaseTapChangerTablePoint with other classes.

Table 196 – Association ends of CoreEquipmentProfile:: PhaseTapChangerTablePoint with other classes

mult from	name	mult to	type	description
1..*	PhaseTapChangerTable	1..1	PhaseTapChangerTable	The table of this point.

5.2.110 PhaseTapChangerTabular

Inheritance path = PhaseTapChanger: TapChanger: PowerSystemResource: IdentifiedObject

Describes a tap changer with a table defining the relation between the tap step and the phase angle difference across the transformer.

Table 197 shows all attributes of PhaseTapChangerTabular.

Table 197 – Attributes of CoreEquipmentProfile::PhaseTapChangerTabular

name	mult	type	description
highStep	1..1	Integer	inherited from: TapChanger
lowStep	1..1	Integer	inherited from: TapChanger
ltcFlag	1..1	Boolean	inherited from: TapChanger
neutralStep	1..1	Integer	inherited from: TapChanger
neutralU	1..1	Voltage	inherited from: TapChanger
normalStep	1..1	Integer	inherited from: TapChanger
description	0..1	String	inherited from: IdentifiedObject
mRID	1..1	String	inherited from: IdentifiedObject
name	1..1	String	inherited from: IdentifiedObject

Table 198 shows all association ends of PhaseTapChangerTabular with other classes.

Table 198 – Association ends of CoreEquipmentProfile:: PhaseTapChangerTabular with other classes

mult from	name	mult to	type	description
0..*	PhaseTapChangerTable	1..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

5.2.111 PhotoVoltaicUnit

Inheritance path = PowerElectronicsUnit: Equipment: PowerSystemResource: IdentifiedObject

A photovoltaic device or an aggregation of such devices.

Table 199 shows all attributes of PhotoVoltaicUnit.

Table 199 – Attributes of CoreEquipmentProfile::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
normallyInService	0..1	Boolean	inherited from: Equipment
description	0..1	String	inherited from: IdentifiedObject
mRID	1..1	String	inherited from: IdentifiedObject
name	1..1	String	inherited from: IdentifiedObject

Table 200 shows all association ends of PhotoVoltaicUnit with other classes.

Table 200 – Association ends of CoreEquipmentProfile:: PhotoVoltaicUnit with other classes

mult from	name	mult to	type	description
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment

5.2.112 PostLineSensor

Inheritance path = Sensor: AuxiliaryEquipment: Equipment: PowerSystemResource: IdentifiedObject

A sensor used mainly in overhead distribution networks as the source of both current and voltage measurements.

Table 201 shows all attributes of PostLineSensor.

Table 201 – Attributes of CoreEquipmentProfile::PostLineSensor

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

Table 202 shows all association ends of PostLineSensor with other classes.

Table 202 – Association ends of CoreEquipmentProfile:: PostLineSensor with other classes

mult from	name	mult to	type	description
0..*	Terminal	1..1	Terminal	inherited from: AuxiliaryEquipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment

5.2.113 PotentialTransformer

Inheritance path = Sensor: AuxiliaryEquipment: Equipment: PowerSystemResource: IdentifiedObject

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 203 shows all attributes of PotentialTransformer.

Table 203 – Attributes of CoreEquipmentProfile::PotentialTransformer

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

Table 204 shows all association ends of PotentialTransformer with other classes.

Table 204 – Association ends of CoreEquipmentProfile::
PotentialTransformer with other classes

mult from	name	mult to	type	description
0..*	Terminal	1..1	Terminal	inherited from: AuxiliaryEquipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment

5.2.114 PowerElectronicsConnection

Inheritance path = RegulatingCondEq: EnergyConnection: ConductingEquipment: Equipment: PowerSystemResource: IdentifiedObject

A connection to the AC network for energy production or consumption that uses power electronics rather than rotating machines.

Table 205 shows all attributes of PowerElectronicsConnection.

Table 205 – Attributes of CoreEquipmentProfile::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.
aggregate	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
description	0..1	String	inherited from: IdentifiedObject
mRID	1..1	String	inherited from: IdentifiedObject
name	1..1	String	inherited from: IdentifiedObject

Table 206 shows all association ends of PowerElectronicsConnection with other classes.

Table 206 – Association ends of CoreEquipmentProfile:: PowerElectronicsConnection with other classes

mult from	name	mult to	type	description
1..1	PowerElectronicsUnit	1..1	PowerElectronicsUnit	An AC network connection may have several power electronics units connecting through it.
0..*	RegulatingControl	0..1	RegulatingControl	inherited from: RegulatingCondEq
0..*	BaseVoltage	0..1	BaseVoltage	inherited from: ConductingEquipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment

5.2.115 (abstract) PowerElectronicsUnit

Inheritance path = Equipment: PowerSystemResource: IdentifiedObject

A generating unit or battery or aggregation that connects to the AC network using power electronics rather than rotating machines.

Table 207 shows all attributes of PowerElectronicsUnit.

Table 207 – Attributes of CoreEquipmentProfile::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
normallyInService	0..1	Boolean	inherited from: Equipment
description	0..1	String	inherited from: IdentifiedObject
mRID	1..1	String	inherited from: IdentifiedObject
name	1..1	String	inherited from: IdentifiedObject

Table 208 shows all association ends of PowerElectronicsUnit with other classes.

Table 208 – Association ends of CoreEquipmentProfile:: PowerElectronicsUnit with other classes

mult from	name	mult to	type	description
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment

5.2.116 PowerElectronicsWindUnit

Inheritance path = PowerElectronicsUnit: Equipment: PowerSystemResource: IdentifiedObject

A wind generating unit that connects to the AC network with power electronics rather than rotating machines or an aggregation of such units.

Table 209 shows all attributes of PowerElectronicsWindUnit.

Table 209 – Attributes of CoreEquipmentProfile::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
normallyInService	0..1	Boolean	inherited from: Equipment
description	0..1	String	inherited from: IdentifiedObject
mRID	1..1	String	inherited from: IdentifiedObject
name	1..1	String	inherited from: IdentifiedObject

Table 210 shows all association ends of PowerElectronicsWindUnit with other classes.

Table 210 – Association ends of CoreEquipmentProfile:: PowerElectronicsWindUnit with other classes

mult from	name	mult to	type	description
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment

5.2.117 (abstract) PowerSystemResource

Inheritance path = IdentifiedObject

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 211 shows all attributes of PowerSystemResource.

Table 211 – Attributes of CoreEquipmentProfile::PowerSystemResource

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

5.2.118 PowerTransformer

Inheritance path = ConductingEquipment: Equipment: PowerSystemResource: IdentifiedObject

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 212 shows all attributes of PowerTransformer.

Table 212 – Attributes of CoreEquipmentProfile::PowerTransformer

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

Table 213 shows all association ends of PowerTransformer with other classes.

Table 213 – Association ends of CoreEquipmentProfile:: PowerTransformer with other classes

mult from	name	mult to	type	description
0..*	BaseVoltage	0..1	BaseVoltage	inherited from: ConductingEquipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment

5.2.119 PowerTransformerEnd

Inheritance path = TransformerEnd: IdentifiedObject

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 214 shows all attributes of PowerTransformerEnd.

Table 214 – Attributes of CoreEquipmentProfile::PowerTransformerEnd

name	mult	type	description
b	1..1	Susceptance	Magnetizing branch susceptance (B mag). The value can be positive or negative.
connectionKind	0..1	WindingConnection	Kind of connection.
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.
g	0..1	Conductance	Magnetizing branch conductance.
ratedU	1..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.
r	1..1	Resistance	Resistance (star-model) of the transformer end. The attribute shall be equal to or greater than zero for non-equivalent transformers.
x	1..1	Reactance	Positive sequence series reactance (star-model) of the transformer end.
endNumber	1..1	Integer	inherited from: TransformerEnd
description	0..1	String	inherited from: IdentifiedObject
mRID	1..1	String	inherited from: IdentifiedObject
name	1..1	String	inherited from: IdentifiedObject

Table 215 shows all association ends of PowerTransformerEnd with other classes.

Table 215 – Association ends of CoreEquipmentProfile:: PowerTransformerEnd with other classes

mult from	name	mult to	type	description
0..*	PowerTransformer	1..1	PowerTransformer	The power transformer of this power transformer end.
0..*	BaseVoltage	1..1	BaseVoltage	inherited from: TransformerEnd
0..*	Terminal	1..1	Terminal	inherited from: TransformerEnd

5.2.120 (abstract) ProtectedSwitch

Inheritance path = Switch: ConductingEquipment: Equipment: PowerSystemResource: IdentifiedObject

A ProtectedSwitch is a switching device that can be operated by ProtectionEquipment.

Table 216 shows all attributes of ProtectedSwitch.

Table 216 – Attributes of CoreEquipmentProfile::ProtectedSwitch

name	mult	type	description
normalOpen	1..1	Boolean	inherited from: Switch
ratedCurrent	0..1	CurrentFlow	inherited from: Switch
retained	1..1	Boolean	inherited from: Switch
aggregate	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
description	0..1	String	inherited from: IdentifiedObject
mRID	1..1	String	inherited from: IdentifiedObject
name	1..1	String	inherited from: IdentifiedObject

Table 217 shows all association ends of ProtectedSwitch with other classes.

Table 217 – Association ends of CoreEquipmentProfile::ProtectedSwitch with other classes

mult from	name	mult to	type	description
0..*	BaseVoltage	0..1	BaseVoltage	inherited from: ConductingEquipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment

5.2.121 RatioTapChanger

Inheritance path = TapChanger: PowerSystemResource: IdentifiedObject

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 218 shows all attributes of RatioTapChanger.

Table 218 – Attributes of CoreEquipmentProfile::RatioTapChanger

name	mult	type	description
stepVoltageIncrement	1..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.
highStep	1..1	Integer	inherited from: TapChanger
lowStep	1..1	Integer	inherited from: TapChanger
ltcFlag	1..1	Boolean	inherited from: TapChanger
neutralStep	1..1	Integer	inherited from: TapChanger
neutralU	1..1	Voltage	inherited from: TapChanger
normalStep	1..1	Integer	inherited from: TapChanger
description	0..1	String	inherited from: IdentifiedObject
mRID	1..1	String	inherited from: IdentifiedObject
name	1..1	String	inherited from: IdentifiedObject

Table 219 shows all association ends of RatioTapChanger with other classes.

Table 219 – Association ends of CoreEquipmentProfile:: RatioTapChanger with other classes

mult from	name	mult to	type	description
0..1	TransformerEnd	1..1	TransformerEnd	Transformer end to which this ratio tap changer belongs.
0..*	RatioTapChangerTable	0..1	RatioTapChangerTable	The tap ratio table for this ratio tap changer.
1..*	TapChangerControl	0..1	TapChangerControl	inherited from: TapChanger

5.2.122 RatioTapChangerTable

Inheritance path = IdentifiedObject

Describes a curve for how the voltage magnitude and impedance varies with the tap step.

Table 220 shows all attributes of RatioTapChangerTable.

Table 220 – Attributes of CoreEquipmentProfile::RatioTapChangerTable

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

5.2.123 RatioTapChangerTablePoint

Inheritance path = TapChangerTablePoint

Describes each tap step in the ratio tap changer tabular curve.

Table 221 shows all attributes of RatioTapChangerTablePoint.

Table 221 – Attributes of CoreEquipmentProfile::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	1..1	Integer	inherited from: TapChangerTablePoint
x	0..1	PerCent	inherited from: TapChangerTablePoint

Table 222 shows all association ends of RatioTapChangerTablePoint with other classes.

Table 222 – Association ends of CoreEquipmentProfile:: RatioTapChangerTablePoint with other classes

mult from	name	mult to	type	description
1..*	RatioTapChangerTable	1..1	RatioTapChangerTable	Table of this point.

5.2.124 ReactiveCapabilityCurve

Inheritance path = Curve: IdentifiedObject

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 223 shows all attributes of ReactiveCapabilityCurve.

Table 223 – Attributes of CoreEquipmentProfile::ReactiveCapabilityCurve

name	mult	type	description
curveStyle	1..1	CurveStyle	inherited from: Curve
xUnit	1..1	UnitSymbol	inherited from: Curve
y1Unit	1..1	UnitSymbol	inherited from: Curve
y2Unit	0..1	UnitSymbol	inherited from: Curve
description	0..1	String	inherited from: IdentifiedObject
mRID	1..1	String	inherited from: IdentifiedObject
name	1..1	String	inherited from: IdentifiedObject

5.2.125 (abstract) RegulatingCondEq

Inheritance path = EnergyConnection: ConductingEquipment: Equipment: PowerSystemResource: IdentifiedObject

A type of conducting equipment that can regulate a quantity (i.e. voltage or flow) at a specific point in the network.

Table 224 shows all attributes of RegulatingCondEq.

Table 224 – Attributes of CoreEquipmentProfile::RegulatingCondEq

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

Table 225 shows all association ends of RegulatingCondEq with other classes.

Table 225 – Association ends of CoreEquipmentProfile:: 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
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment

5.2.126 RegulatingControl

Inheritance path = PowerSystemResource: IdentifiedObject

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 to 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.

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 226 shows all attributes of RegulatingControl.

Table 226 – Attributes of CoreEquipmentProfile::RegulatingControl

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

Table 227 shows all association ends of RegulatingControl with other classes.

Table 227 – Association ends of CoreEquipmentProfile:: RegulatingControl with other classes

mult from	name	mult to	type	description
0..*	Terminal	1..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.

5.2.127 RegularTimePoint root class

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

Table 228 shows all attributes of RegularTimePoint.

Table 228 – Attributes of CoreEquipmentProfile::RegularTimePoint

name	mult	type	description
sequenceNumber	1..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	1..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 229 shows all association ends of RegularTimePoint with other classes.

Table 229 – Association ends of CoreEquipmentProfile:: RegularTimePoint with other classes

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

5.2.128 (abstract) RegularIntervalSchedule

Inheritance path = BasicIntervalSchedule: IdentifiedObject

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

Table 230 shows all attributes of RegularIntervalSchedule.

Table 230 – Attributes of CoreEquipmentProfile::RegularIntervalSchedule

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

5.2.129 ReportingGroup

Inheritance path = IdentifiedObject

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

Table 231 shows all attributes of ReportingGroup.

Table 231 – Attributes of CoreEquipmentProfile::ReportingGroup

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

5.2.130 (abstract) RotatingMachine

Inheritance path = RegulatingCondEq: EnergyConnection: ConductingEquipment: Equipment: PowerSystemResource: IdentifiedObject

A rotating machine which may be used as a generator or motor.

Table 232 shows all attributes of RotatingMachine.

Table 232 – Attributes of CoreEquipmentProfile::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.
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.
aggregate	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
description	0..1	String	inherited from: IdentifiedObject
mRID	1..1	String	inherited from: IdentifiedObject
name	1..1	String	inherited from: IdentifiedObject

Table 233 shows all association ends of RotatingMachine with other classes.

Table 233 – Association ends of CoreEquipmentProfile:: RotatingMachine with other classes

mult from	name	mult to	type	description
1..*	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
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment

5.2.131 Season

Inheritance path = IdentifiedObject

A specified time period of the year.

Table 234 shows all attributes of Season.

Table 234 – Attributes of CoreEquipmentProfile::Season

name	mult	type	description
endDate	1..1	MonthDay	Date season ends.
startDate	1..1	MonthDay	Date season starts.
description	0..1	String	inherited from: IdentifiedObject
mRID	1..1	String	inherited from: IdentifiedObject
name	1..1	String	inherited from: IdentifiedObject

5.2.132 (abstract) Sensor

Inheritance path = AuxiliaryEquipment: Equipment: PowerSystemResource: IdentifiedObject

This class describes devices that transform a measured quantity into signals that can be presented at displays, used in control or be recorded.

Table 235 shows all attributes of Sensor.

Table 235 – Attributes of CoreEquipmentProfile::Sensor

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

Table 236 shows all association ends of Sensor with other classes.

Table 236 – Association ends of CoreEquipmentProfile::Sensor with other classes

mult from	name	mult to	type	description
0..*	Terminal	1..1	Terminal	inherited from: AuxiliaryEquipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment

5.2.133 (abstract) SeasonDayTypeSchedule

Inheritance path = RegularIntervalSchedule: BasicIntervalSchedule: IdentifiedObject

A time schedule covering a 24 hour period, with curve data for a specific type of season and day.

Table 237 shows all attributes of SeasonDayTypeSchedule.

Table 237 – Attributes of CoreEquipmentProfile::SeasonDayTypeSchedule

name	mult	type	description
timeStep	1..1	Seconds	inherited from: RegularIntervalSchedule
endTime	1..1	DateTime	inherited from: RegularIntervalSchedule
startTime	1..1	DateTime	inherited from: BasicIntervalSchedule
value1Unit	1..1	UnitSymbol	inherited from: BasicIntervalSchedule
value2Unit	0..1	UnitSymbol	inherited from: BasicIntervalSchedule
description	0..1	String	inherited from: IdentifiedObject
mRID	1..1	String	inherited from: IdentifiedObject
name	1..1	String	inherited from: IdentifiedObject

Table 238 shows all association ends of SeasonDayTypeSchedule with other classes.

Table 238 – Association ends of CoreEquipmentProfile::SeasonDayTypeSchedule with other classes

mult from	name	mult to	type	description
0..*	DayType	1..1	DayType	DayType for the Schedule.
0..*	Season	1..1	Season	Season for the Schedule.

5.2.134 SeriesCompensator

Inheritance path = ConductingEquipment: Equipment: PowerSystemResource: IdentifiedObject

A Series Compensator is a series capacitor or reactor or an AC transmission line without charging susceptance. It is a two terminal device.

Table 239 shows all attributes of SeriesCompensator.

Table 239 – Attributes of CoreEquipmentProfile::SeriesCompensator

name	mult	type	description
r	1..1	Resistance	Positive sequence resistance.
x	1..1	Reactance	Positive sequence reactance.
aggregate	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
description	0..1	String	inherited from: IdentifiedObject
mRID	1..1	String	inherited from: IdentifiedObject
name	1..1	String	inherited from: IdentifiedObject

Table 240 shows all association ends of SeriesCompensator with other classes.

Table 240 – Association ends of CoreEquipmentProfile::SeriesCompensator with other classes

mult from	name	mult to	type	description
0..*	BaseVoltage	0..1	BaseVoltage	inherited from: ConductingEquipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment

5.2.135 (abstract) ShuntCompensator

Inheritance path = RegulatingCondEq: EnergyConnection: ConductingEquipment: Equipment: PowerSystemResource: IdentifiedObject

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 241 shows all attributes of ShuntCompensator.

Table 241 – Attributes of CoreEquipmentProfile::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	1..1	Integer	The maximum number of sections that may be switched in.
nomU	1..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	1..1	Integer	The normal number of sections switched in. The value shall be between zero and ShuntCompensator.maximumSections.
voltageSensitivity	0..1	VoltagePerReactivePower	Voltage sensitivity required for the device to regulate the bus voltage, in voltage/reactive power.
aggregate	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
description	0..1	String	inherited from: IdentifiedObject
mRID	1..1	String	inherited from: IdentifiedObject
name	1..1	String	inherited from: IdentifiedObject

Table 242 shows all association ends of ShuntCompensator with other classes.

Table 242 – Association ends of CoreEquipmentProfile:: ShuntCompensator 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
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment

5.2.136 SolarGeneratingUnit

Inheritance path = GeneratingUnit: Equipment: PowerSystemResource: IdentifiedObject

A solar thermal generating unit, connected to the grid by means of a rotating machine. This class does not represent photovoltaic (PV) generation.

Table 243 shows all attributes of SolarGeneratingUnit.

Table 243 – Attributes of CoreEquipmentProfile::SolarGeneratingUnit

name	mult	type	description
genControlSource	0..1	GeneratorControlSource	inherited from: GeneratingUnit
governorSCD	0..1	PerCent	inherited from: GeneratingUnit
longPF	0..1	Float	inherited from: GeneratingUnit
maximumAllowableSpinningReserve	0..1	ActivePower	inherited from: GeneratingUnit
maxOperatingP	1..1	ActivePower	inherited from: GeneratingUnit
minOperatingP	1..1	ActivePower	inherited from: GeneratingUnit
nominalP	0..1	ActivePower	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
variableCost	0..1	Money	inherited from: GeneratingUnit
startupTime	0..1	Seconds	inherited from: GeneratingUnit
totalEfficiency	0..1	PerCent	inherited from: GeneratingUnit
aggregate	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
description	0..1	String	inherited from: IdentifiedObject
mRID	1..1	String	inherited from: IdentifiedObject
name	1..1	String	inherited from: IdentifiedObject

Table 244 shows all association ends of SolarGeneratingUnit with other classes.

Table 244 – Association ends of CoreEquipmentProfile:: SolarGeneratingUnit with other classes

mult from	name	mult to	type	description
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment

5.2.137 StaticVarCompensator

Inheritance path = RegulatingCondEq: EnergyConnection: ConductingEquipment: Equipment: PowerSystemResource: IdentifiedObject

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 245 shows all attributes of StaticVarCompensator.

Table 245 – Attributes of CoreEquipmentProfile::StaticVarCompensator

name	mult	type	description
capacitiveRating	1..1	Reactance	Capacitive reactance at maximum capacitive reactive power. Shall always be positive.
inductiveRating	1..1	Reactance	Inductive reactance at maximum inductive reactive power. Shall always be negative.
slope	1..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.
sVCControlMode	0..1	SVCControlMode	(deprecated) SVC control mode.
voltageSetPoint	0..1	Voltage	(deprecated) 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.
aggregate	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
description	0..1	String	inherited from: IdentifiedObject
mRID	1..1	String	inherited from: IdentifiedObject
name	1..1	String	inherited from: IdentifiedObject

Table 246 shows all association ends of StaticVarCompensator with other classes.

Table 246 – Association ends of CoreEquipmentProfile:: StaticVarCompensator 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
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment

5.2.138 StationSupply

Inheritance path = EnergyConsumer: EnergyConnection: ConductingEquipment: Equipment: PowerSystemResource: IdentifiedObject

Station supply with load derived from the station output.

Table 247 shows all attributes of StationSupply.

Table 247 – Attributes of CoreEquipmentProfile::StationSupply

name	mult	type	description
pfixed	0..1	ActivePower	inherited from: EnergyConsumer
pfixedPct	0..1	PerCent	inherited from: EnergyConsumer
qfixed	0..1	ReactivePower	inherited from: EnergyConsumer
qfixedPct	0..1	PerCent	inherited from: EnergyConsumer
aggregate	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
description	0..1	String	inherited from: IdentifiedObject
mRID	1..1	String	inherited from: IdentifiedObject
name	1..1	String	inherited from: IdentifiedObject

Table 248 shows all association ends of StationSupply with other classes.

Table 248 – Association ends of CoreEquipmentProfile:: StationSupply with other classes

mult from	name	mult to	type	description
0..*	LoadResponse	0..1	LoadResponseCharacteristic	inherited from: EnergyConsumer
0..*	BaseVoltage	0..1	BaseVoltage	inherited from: ConductingEquipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment

5.2.139 SubGeographicalRegion

Inheritance path = IdentifiedObject

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

Table 249 shows all attributes of SubGeographicalRegion.

Table 249 – Attributes of CoreEquipmentProfile::SubGeographicalRegion

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

Table 250 shows all association ends of SubGeographicalRegion with other classes.

Table 250 – Association ends of CoreEquipmentProfile:: SubGeographicalRegion with other classes

mult from	name	mult to	type	description
0..*	Region	1..1	GeographicalRegion	The geographical region which this sub-geographical region is within.

5.2.140 SubLoadArea

Inheritance path = EnergyArea: IdentifiedObject

The class is the second level in a hierarchical structure for grouping of loads for the purpose of load flow load scaling.

Table 251 shows all attributes of SubLoadArea.

Table 251 – Attributes of CoreEquipmentProfile::SubLoadArea

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

Table 252 shows all association ends of SubLoadArea with other classes.

Table 252 – Association ends of CoreEquipmentProfile:: SubLoadArea with other classes

mult from	name	mult to	type	description
1..*	LoadArea	1..1	LoadArea	The LoadArea where the SubLoadArea belongs.

5.2.141 Substation

Inheritance path = EquipmentContainer: ConnectivityNodeContainer: PowerSystemResource: IdentifiedObject

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 253 shows all attributes of Substation.

Table 253 – Attributes of CoreEquipmentProfile::Substation

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

Table 254 shows all association ends of Substation with other classes.

Table 254 – Association ends of CoreEquipmentProfile::Substation with other classes

mult from	name	mult to	type	description
0..*	Region	1..1	SubGeographicalRegion	The SubGeographicalRegion containing the substation.

5.2.142 SurgeArrester

Inheritance path = AuxiliaryEquipment: Equipment: PowerSystemResource: IdentifiedObject

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 255 shows all attributes of SurgeArrester.

Table 255 – Attributes of CoreEquipmentProfile::SurgeArrester

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

Table 256 shows all association ends of SurgeArrester with other classes.

Table 256 – Association ends of CoreEquipmentProfile:: SurgeArrester with other classes

mult from	name	mult to	type	description
0..*	Terminal	1..1	Terminal	inherited from: AuxiliaryEquipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment

5.2.143 Switch

Inheritance path = ConductingEquipment: Equipment: PowerSystemResource: IdentifiedObject

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.

Table 257 shows all attributes of Switch.

Table 257 – Attributes of CoreEquipmentProfile::Switch

name	mult	type	description
normalOpen	1..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.
retained	1..1	Boolean	Branch is retained in the topological solution. The flow through retained switches will normally be calculated in power flow.

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

Table 258 shows all association ends of Switch with other classes.

Table 258 – Association ends of CoreEquipmentProfile::Switch with other classes

mult from	name	mult to	type	description
0..*	BaseVoltage	0..1	BaseVoltage	inherited from: ConductingEquipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment

5.2.144 SwitchSchedule

Inheritance path = SeasonDayTypeSchedule: RegularIntervalSchedule: BasicIntervalSchedule: IdentifiedObject

A schedule of switch positions. If RegularTimePoint.value1 is 0, the switch is open. If 1, the switch is closed.

Table 259 shows all attributes of SwitchSchedule.

Table 259 – Attributes of CoreEquipmentProfile::SwitchSchedule

name	mult	type	description
timeStep	1..1	Seconds	inherited from: RegularIntervalSchedule
endTime	1..1	DateTime	inherited from: RegularIntervalSchedule
startTime	1..1	DateTime	inherited from: BasicIntervalSchedule
value1Unit	1..1	UnitSymbol	inherited from: BasicIntervalSchedule
value2Unit	0..1	UnitSymbol	inherited from: BasicIntervalSchedule
description	0..1	String	inherited from: IdentifiedObject
mRID	1..1	String	inherited from: IdentifiedObject
name	1..1	String	inherited from: IdentifiedObject

Table 260 shows all association ends of SwitchSchedule with other classes.

Table 260 – Association ends of CoreEquipmentProfile:: 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	1..1	DayType	inherited from: SeasonDayTypeSchedule
0..*	Season	1..1	Season	inherited from: SeasonDayTypeSchedule

5.2.145 SynchronousMachine

Inheritance path = RotatingMachine: RegulatingCondEq: EnergyConnection: ConductingEquipment: Equipment: PowerSystemResource: IdentifiedObject

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 261 shows all attributes of SynchronousMachine.

Table 261 – Attributes of CoreEquipmentProfile::SynchronousMachine

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.
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.
type	1..1	SynchronousMachineKind	Modes that this synchronous machine can operate in.
ratedPowerFactor	0..1	Float	inherited from: RotatingMachine
ratedS	0..1	ApparentPower	inherited from: RotatingMachine
ratedU	0..1	Voltage	inherited from: RotatingMachine
aggregate	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
description	0..1	String	inherited from: IdentifiedObject
mRID	1..1	String	inherited from: IdentifiedObject
name	1..1	String	inherited from: IdentifiedObject

Table 262 shows all association ends of SynchronousMachine with other classes.

Table 262 – Association ends of CoreEquipmentProfile:: 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..*	GeneratingUnit	0..1	GeneratingUnit	inherited from: RotatingMachine
0..*	RegulatingControl	0..1	RegulatingControl	inherited from: RegulatingCondEq
0..*	BaseVoltage	0..1	BaseVoltage	inherited from: ConductingEquipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment

5.2.146 (abstract) TapChanger

Inheritance path = PowerSystemResource: IdentifiedObject

Mechanism for changing transformer winding tap positions.

Table 263 shows all attributes of TapChanger.

Table 263 – Attributes of CoreEquipmentProfile::TapChanger

name	mult	type	description
highStep	1..1	Integer	Highest possible tap step position, advance from neutral. The attribute shall be greater than lowStep.
lowStep	1..1	Integer	Lowest possible tap step position, retard from neutral.
ltcFlag	1..1	Boolean	Specifies whether or not a TapChanger has load tap changing capabilities.
neutralStep	1..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	1..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	1..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.
description	0..1	String	inherited from: IdentifiedObject
mRID	1..1	String	inherited from: IdentifiedObject
name	1..1	String	inherited from: IdentifiedObject

Table 264 shows all association ends of TapChanger with other classes.

Table 264 – Association ends of CoreEquipmentProfile::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.

5.2.147 TapChangerControl

Inheritance path = RegulatingControl: PowerSystemResource: IdentifiedObject

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 265 shows all attributes of TapChangerControl.

Table 265 – Attributes of CoreEquipmentProfile::TapChangerControl

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

Table 266 shows all association ends of TapChangerControl with other classes.

Table 266 – Association ends of CoreEquipmentProfile::TapChangerControl with other classes

mult from	name	mult to	type	description
0..*	Terminal	1..1	Terminal	inherited from: RegulatingControl

5.2.148 (abstract) TapChangerTablePoint root class

Describes each tap step in the tabular curve.

Table 267 shows all attributes of TapChangerTablePoint.

Table 267 – Attributes of CoreEquipmentProfile::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.
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.

name	mult	type	description
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	1..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.

5.2.149 Terminal

Inheritance path = ACDCTerminal: IdentifiedObject

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

Table 268 shows all attributes of Terminal.

Table 268 – Attributes of CoreEquipmentProfile::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.
sequenceNumber	1..1	Integer	inherited from: ACDCTerminal
description	0..1	String	inherited from: IdentifiedObject
mRID	1..1	String	inherited from: IdentifiedObject
name	1..1	String	inherited from: IdentifiedObject

Table 269 shows all association ends of Terminal with other classes.

Table 269 – Association ends of CoreEquipmentProfile::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.
1..*	BusNameMarker	0..1	BusNameMarker	inherited from: ACDCTerminal

5.2.150 ThermalGeneratingUnit

Inheritance path = GeneratingUnit: Equipment: PowerSystemResource: IdentifiedObject

A generating unit whose prime mover could be a steam turbine, combustion turbine, or diesel engine.

Table 270 shows all attributes of ThermalGeneratingUnit.

Table 270 – Attributes of CoreEquipmentProfile::ThermalGeneratingUnit

name	mult	type	description
genControlSource	0..1	GeneratorControlSource	inherited from: GeneratingUnit
governorSCD	0..1	PerCent	inherited from: GeneratingUnit
longPF	0..1	Float	inherited from: GeneratingUnit
maximumAllowableSpinningReserve	0..1	ActivePower	inherited from: GeneratingUnit
maxOperatingP	1..1	ActivePower	inherited from: GeneratingUnit
minOperatingP	1..1	ActivePower	inherited from: GeneratingUnit
nominalP	0..1	ActivePower	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
variableCost	0..1	Money	inherited from: GeneratingUnit
startupTime	0..1	Seconds	inherited from: GeneratingUnit
totalEfficiency	0..1	PerCent	inherited from: GeneratingUnit
aggregate	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
description	0..1	String	inherited from: IdentifiedObject
mRID	1..1	String	inherited from: IdentifiedObject
name	1..1	String	inherited from: IdentifiedObject

Table 271 shows all association ends of ThermalGeneratingUnit with other classes.

Table 271 – Association ends of CoreEquipmentProfile::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.
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment

5.2.151 TieFlow

Inheritance path = IdentifiedObject

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 272 shows all attributes of TieFlow.

Table 272 – Attributes of CoreEquipmentProfile::TieFlow

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

Table 273 shows all association ends of TieFlow with other classes.

Table 273 – Association ends of CoreEquipmentProfile::TieFlow with other classes

mult from	name	mult to	type	description
0..*	ControlArea	1..1	ControlArea	The control area of the tie flows.
0..2	Terminal	1..1	Terminal	The terminal to which this tie flow belongs.

5.2.152 (abstract) TransformerEnd

Inheritance path = IdentifiedObject

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 274 shows all attributes of TransformerEnd.

Table 274 – Attributes of CoreEquipmentProfile::TransformerEnd

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

Table 275 shows all association ends of TransformerEnd with other classes.

Table 275 – Association ends of CoreEquipmentProfile:: TransformerEnd with other classes

mult from	name	mult to	type	description
0..*	BaseVoltage	1..1	BaseVoltage	Base voltage of the transformer end. This is essential for PU calculation.
0..*	Terminal	1..1	Terminal	Terminal of the power transformer to which this transformer end belongs.

5.2.153 VoltageLevel

Inheritance path = EquipmentContainer: ConnectivityNodeContainer: PowerSystemResource: IdentifiedObject

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 276 shows all attributes of VoltageLevel.

Table 276 – Attributes of CoreEquipmentProfile::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.

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

Table 277 shows all association ends of VoltageLevel with other classes.

Table 277 – Association ends of CoreEquipmentProfile::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..*	Substation	1..1	Substation	The substation of the voltage level.

5.2.154 VoltageLimit

Inheritance path = OperationalLimit: IdentifiedObject

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 278 shows all attributes of VoltageLimit.

Table 278 – Attributes of CoreEquipmentProfile::VoltageLimit

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

Table 279 shows all association ends of VoltageLimit with other classes.

Table 279 – Association ends of CoreEquipmentProfile::VoltageLimit with other classes

mult from	name	mult to	type	description
1..*	OperationalLimitType	1..1	OperationalLimitType	inherited from: OperationalLimit
1..*	OperationalLimitSet	1..1	OperationalLimitSet	inherited from: OperationalLimit

5.2.155 VsCapabilityCurve

Inheritance path = Curve: IdentifiedObject

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 280 shows all attributes of VsCapabilityCurve.

Table 280 – Attributes of CoreEquipmentProfile::VsCapabilityCurve

name	mult	type	description
curveStyle	1..1	CurveStyle	inherited from: Curve
xUnit	1..1	UnitSymbol	inherited from: Curve
y1Unit	1..1	UnitSymbol	inherited from: Curve
y2Unit	0..1	UnitSymbol	inherited from: Curve
description	0..1	String	inherited from: IdentifiedObject
mRID	1..1	String	inherited from: IdentifiedObject
name	1..1	String	inherited from: IdentifiedObject

5.2.156 VsConverter

Inheritance path = ACDCConverter: ConductingEquipment: Equipment: PowerSystemResource: IdentifiedObject

DC side of the voltage source converter (VSC).

Table 281 shows all attributes of VsConverter.

Table 281 – Attributes of CoreEquipmentProfile::VsConverter

name	mult	type	description
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.
baseS	0..1	ApparentPower	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
ratedUDC	0..1	Voltage	inherited from: ACDCConverter
resistiveLoss	0..1	Resistance	inherited from: ACDCConverter
switchingLoss	0..1	ActivePowerPerCurrentFlow	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
normallyInService	0..1	Boolean	inherited from: Equipment
description	0..1	String	inherited from: IdentifiedObject
mRID	1..1	String	inherited from: IdentifiedObject
name	1..1	String	inherited from: IdentifiedObject

Table 282 shows all association ends of VsConverter with other classes.

Table 282 – Association ends of CoreEquipmentProfile::VsConverter with other classes

mult from	name	mult to	type	description
0..*	CapabilityCurve	0..1	VsCapabilityCurve	Capability curve of this converter.
0..*	PccTerminal	0..1	Terminal	inherited from: ACDCConverter
0..*	BaseVoltage	0..1	BaseVoltage	inherited from: ConductingEquipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment

5.2.157 WaveTrap

Inheritance path = AuxiliaryEquipment: Equipment: PowerSystemResource: IdentifiedObject

Line traps are devices that impede high frequency power line carrier signals yet present a negligible impedance at the main power frequency.

Table 283 shows all attributes of WaveTrap.

Table 283 – Attributes of CoreEquipmentProfile::WaveTrap

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

Table 284 shows all association ends of WaveTrap with other classes.

Table 284 – Association ends of CoreEquipmentProfile::WaveTrap with other classes

mult from	name	mult to	type	description
0..*	Terminal	1..1	Terminal	inherited from: AuxiliaryEquipment
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment

5.2.158 WindGeneratingUnit

Inheritance path = GeneratingUnit: Equipment: PowerSystemResource: IdentifiedObject

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 285 shows all attributes of WindGeneratingUnit.

Table 285 – Attributes of CoreEquipmentProfile::WindGeneratingUnit

name	mult	type	description
windGenUnitType	1..1	WindGenUnitKind	The kind of wind generating unit.
genControlSource	0..1	GeneratorControlSource	inherited from: GeneratingUnit
governorSCD	0..1	PerCent	inherited from: GeneratingUnit
longPF	0..1	Float	inherited from: GeneratingUnit
maximumAllowableSpinningReserve	0..1	ActivePower	inherited from: GeneratingUnit
maxOperatingP	1..1	ActivePower	inherited from: GeneratingUnit
minOperatingP	1..1	ActivePower	inherited from: GeneratingUnit
nominalP	0..1	ActivePower	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
variableCost	0..1	Money	inherited from: GeneratingUnit
startupTime	0..1	Seconds	inherited from: GeneratingUnit
totalEfficiency	0..1	PerCent	inherited from: GeneratingUnit
aggregate	0..1	Boolean	inherited from: Equipment
normallyInService	0..1	Boolean	inherited from: Equipment
description	0..1	String	inherited from: IdentifiedObject
mRID	1..1	String	inherited from: IdentifiedObject
name	1..1	String	inherited from: IdentifiedObject

Table 286 shows all association ends of WindGeneratingUnit with other classes.

Table 286 – Association ends of CoreEquipmentProfile::WindGeneratingUnit with other classes

mult from	name	mult to	type	description
0..*	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment

5.2.159 ControlAreaTypeKind enumeration

The type of control area.

Table 287 shows all literals of ControlAreaTypeKind.

Table 287 – Literals of CoreEquipmentProfile::ControlAreaTypeKind

literal	value	description
AGC		Used for automatic generation control.
Forecast		Used for load forecast.
Interchange		Used for interchange specification or control.

5.2.160 Currency enumeration

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

Table 288 shows all literals of Currency.

Table 288 – Literals of CoreEquipmentProfile::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).
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.

literal	value	description
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.
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.

literal	value	description
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.
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.

literal	value	description
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.
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.

5.2.161 CurveStyle enumeration

Style or shape of curve.

Table 289 shows all literals of CurveStyle.

Table 289 – Literals of CoreEquipmentProfile::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.

5.2.162 DCConverterOperatingModeKind enumeration

The operating mode of an HVDC bipole.

Table 290 shows all literals of DCConverterOperatingModeKind.

Table 290 – Literals of CoreEquipmentProfile::DCConverterOperatingModeKind

literal	value	description
bipolar		Bipolar operation.
monopolarMetallicReturn		Monopolar operation with metallic return.
monopolarGroundReturn		Monopolar operation with ground return.

5.2.163 DCPolarityKind enumeration

Polarity for DC circuits.

Table 291 shows all literals of DCPolarityKind.

Table 291 – Literals of CoreEquipmentProfile::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.

5.2.164 FuelType enumeration

Type of fuel.

Table 292 shows all literals of FuelType.

Table 292 – Literals of CoreEquipmentProfile::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.

5.2.165 GeneratorControlSource enumeration

The source of controls for a generating unit.

Table 293 shows all literals of GeneratorControlSource.

Table 293 – Literals of CoreEquipmentProfile::GeneratorControlSource

literal	value	description
unavailable		Not available.
offAGC		Off of automatic generation control (AGC).
onAGC		On automatic generation control (AGC).
plantControl		Plant is controlling.

5.2.166 HydroEnergyConversionKind enumeration

Specifies the capability of the hydro generating unit to convert energy as a generator or pump.

Table 294 shows all literals of HydroEnergyConversionKind.

Table 294 – Literals of CoreEquipmentProfile::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.

5.2.167 HydroPlantStorageKind enumeration

The type of hydro power plant.

Table 295 shows all literals of HydroPlantStorageKind.

Table 295 – Literals of CoreEquipmentProfile::HydroPlantStorageKind

literal	value	description
runOfRiver		Run of river.
pumpedStorage		Pumped storage.
storage		Storage.

5.2.168 HydroTurbineKind enumeration

Type of turbine.

Table 296 shows all literals of HydroTurbineKind.

Table 296 – Literals of CoreEquipmentProfile::HydroTurbineKind

literal	value	description
francis		Francis.
pelton		Pelton.
kaplan		Kaplan.

5.2.169 OperationalLimitDirectionKind enumeration

The direction attribute describes the side of a limit that is a violation.

Table 297 shows all literals of OperationalLimitDirectionKind.

Table 297 – Literals of CoreEquipmentProfile::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.

5.2.170 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 298 shows all literals of PhaseCode.

Table 298 – Literals of CoreEquipmentProfile::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.
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.

5.2.171 RegulatingControlModeKind enumeration

The kind of regulation model. For example regulating voltage, reactive power, active power, etc.

Table 299 shows all literals of RegulatingControlModeKind.

Table 299 – Literals of CoreEquipmentProfile::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.

5.2.172 SynchronousMachineKind enumeration

Synchronous machine type.

Table 300 shows all literals of SynchronousMachineKind.

Table 300 – Literals of CoreEquipmentProfile::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.

5.2.173 (deprecated) SVCControlMode enumeration

Static VAr Compensator control mode.

Table 301 shows all literals of SVCControlMode.

Table 301 – Literals of CoreEquipmentProfile::SVCControlMode

literal	value	description
reactivePower		Reactive power control.
voltage		Voltage control.

5.2.174 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 302 shows all literals of UnitMultiplier.

Table 302 – Literals of CoreEquipmentProfile::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.

5.2.175 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 303 shows all literals of UnitSymbol.

Table 303 – Literals of CoreEquipmentProfile::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 (m2/m2).
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.

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/m2).
W	38	Real power in watts (J/s). Electrical power may have real and reactive components. The real portion of electrical power (I^2R 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).

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 = 3 600 s.
min	85	Time in minutes, minute = 60 s.
Q	100	Quantity power, Q.

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 = dm3 = m3/1 000.
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.

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" (1 000 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).

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).

5.2.176 WindGenUnitKind enumeration

Kind of wind generating unit.

Table 304 shows all literals of WindGenUnitKind.

Table 304 – Literals of CoreEquipmentProfile::WindGenUnitKind

literal	value	description
offshore		The wind generating unit is located offshore.
onshore		The wind generating unit is located onshore.

5.2.177 WindingConnection enumeration

Winding connection type.

Table 305 shows all literals of WindingConnection.

Table 305 – Literals of CoreEquipmentProfile::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.

5.2.178 ActivePower datatype

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

Table 306 shows all attributes of ActivePower.

Table 306 – Attributes of CoreEquipmentProfile::ActivePower

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

5.2.179 ActivePowerPerCurrentFlow datatype

Active power variation with current flow.

Table 307 shows all attributes of ActivePowerPerCurrentFlow.

Table 307 – Attributes of CoreEquipmentProfile::ActivePowerPerCurrentFlow

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

5.2.180 ActivePowerPerFrequency datatype

Active power variation with frequency.

Table 308 shows all attributes of ActivePowerPerFrequency.

Table 308 – Attributes of CoreEquipmentProfile::ActivePowerPerFrequency

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

5.2.181 AngleDegrees datatype

Measurement of angle in degrees.

Table 309 shows all attributes of AngleDegrees.

Table 309 – Attributes of CoreEquipmentProfile::AngleDegrees

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

5.2.182 ApparentPower datatype

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

Table 310 shows all attributes of ApparentPower.

Table 310 – Attributes of CoreEquipmentProfile::ApparentPower

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

5.2.183 Capacitance datatype

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

Table 311 shows all attributes of Capacitance.

Table 311 – Attributes of CoreEquipmentProfile::Capacitance

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

5.2.184 Conductance datatype

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

Table 312 shows all attributes of Conductance.

Table 312 – Attributes of CoreEquipmentProfile::Conductance

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

5.2.185 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 313 shows all attributes of CurrentFlow.

Table 313 – Attributes of CoreEquipmentProfile::CurrentFlow

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

5.2.186 Frequency datatype

Cycles per second.

Table 314 shows all attributes of Frequency.

Table 314 – Attributes of CoreEquipmentProfile::Frequency

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

5.2.187 Inductance datatype

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

Table 315 shows all attributes of Inductance.

Table 315 – Attributes of CoreEquipmentProfile::Inductance

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

5.2.188 Length datatype

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

Table 316 shows all attributes of Length.

Table 316 – Attributes of CoreEquipmentProfile::Length

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

5.2.189 Money datatype

Amount of money.

Table 317 shows all attributes of Money.

Table 317 – Attributes of CoreEquipmentProfile::Money

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

5.2.190 PerCent datatype

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

Table 318 shows all attributes of PerCent.

Table 318 – Attributes of CoreEquipmentProfile::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)

5.2.191 Reactance datatype

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

Table 319 shows all attributes of Reactance.

Table 319 – Attributes of CoreEquipmentProfile::Reactance

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

5.2.192 ReactivePower datatype

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

Table 320 shows all attributes of ReactivePower.

Table 320 – Attributes of CoreEquipmentProfile::ReactivePower

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

5.2.193 RealEnergy datatype

Real electrical energy.

Table 321 shows all attributes of RealEnergy.

Table 321 – Attributes of CoreEquipmentProfile::RealEnergy

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

5.2.194 Resistance datatype

Resistance (real part of impedance).

Table 322 shows all attributes of Resistance.

Table 322 – Attributes of CoreEquipmentProfile::Resistance

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

5.2.195 RotationSpeed datatype

Number of revolutions per second.

Table 323 shows all attributes of RotationSpeed.

Table 323 – Attributes of CoreEquipmentProfile::RotationSpeed

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

5.2.196 Seconds datatype

Time, in seconds.

Table 324 shows all attributes of Seconds.

Table 324 – Attributes of CoreEquipmentProfile::Seconds

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

5.2.197 Susceptance datatype

Imaginary part of admittance.

Table 325 shows all attributes of Susceptance.

Table 325 – Attributes of CoreEquipmentProfile::Susceptance

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

5.2.198 Voltage datatype

Electrical voltage, can be both AC and DC.

Table 326 shows all attributes of Voltage.

Table 326 – Attributes of CoreEquipmentProfile::Voltage

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

5.2.199 VoltagePerReactivePower datatype

Voltage variation with reactive power.

Table 327 shows all attributes of VoltagePerReactivePower.

Table 327 – Attributes of CoreEquipmentProfile::VoltagePerReactivePower

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

5.2.200 Boolean primitive

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

5.2.201 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".

5.2.202 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.

5.2.203 Decimal primitive

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

5.2.204 Float primitive

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

5.2.205 Integer primitive

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

5.2.206 MonthDay primitive

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

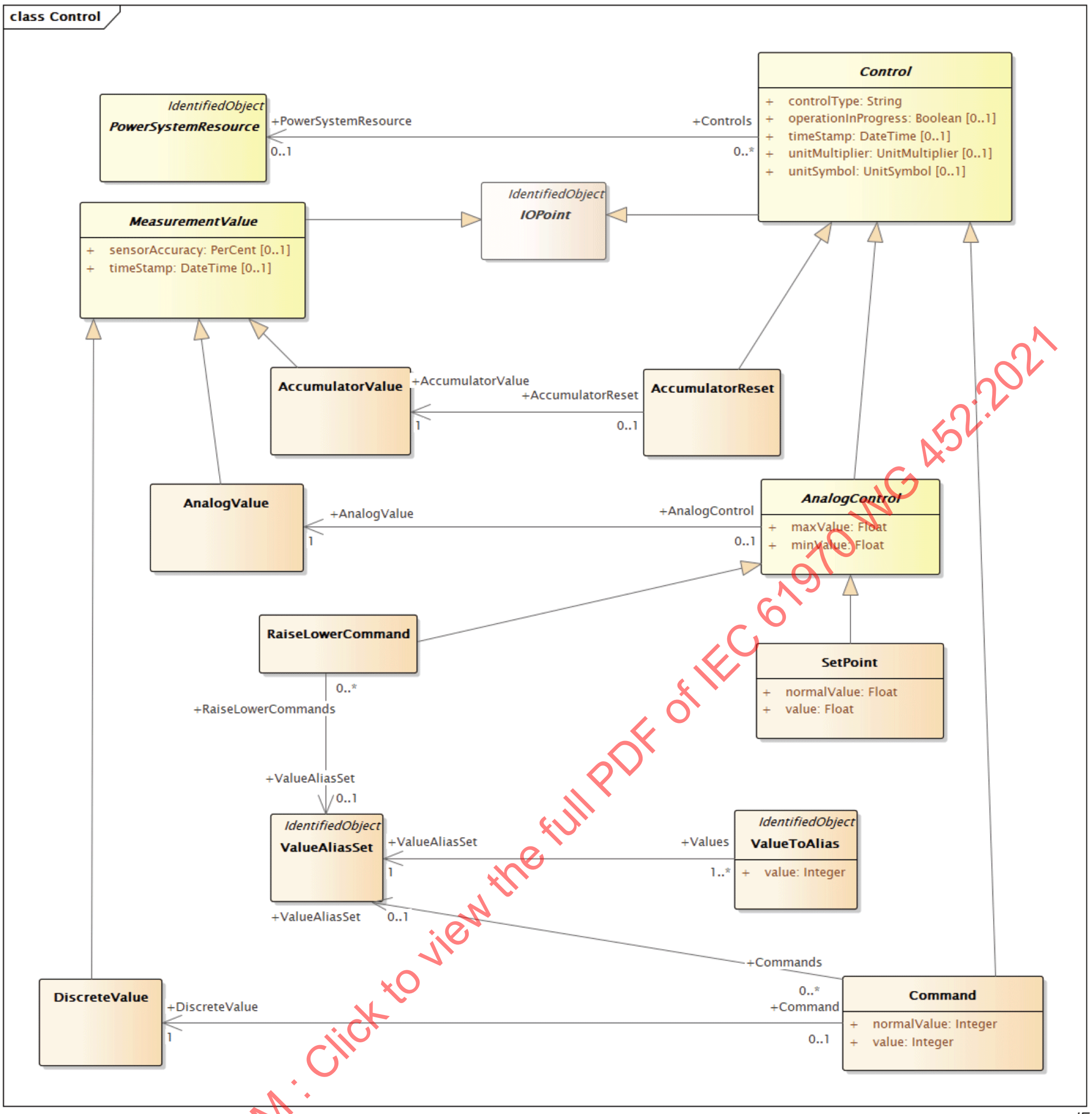
5.2.207 String primitive

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

5.3 Operation Profile

5.3.1 General

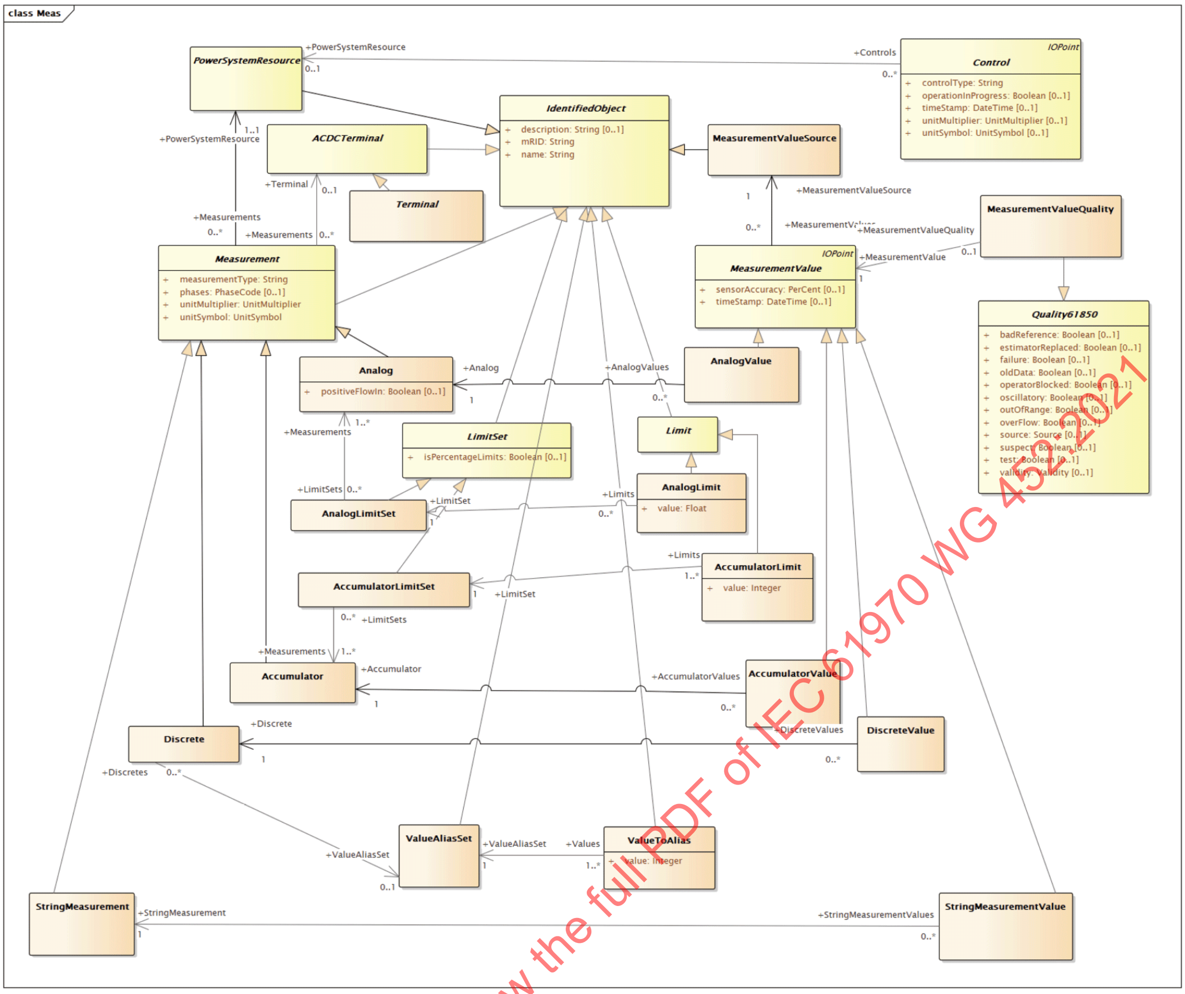
This is the IEC 61970-452 operation profile.



IEC

Figure 28 – Class diagram OperationProfile::Control

Figure 28: This diagram shows control related classes included in the Meas package.



IEC

Figure 29 – Class diagram OperationProfile::Meas

Figure 29: This diagram shows measurement related classes included in the Meas package.

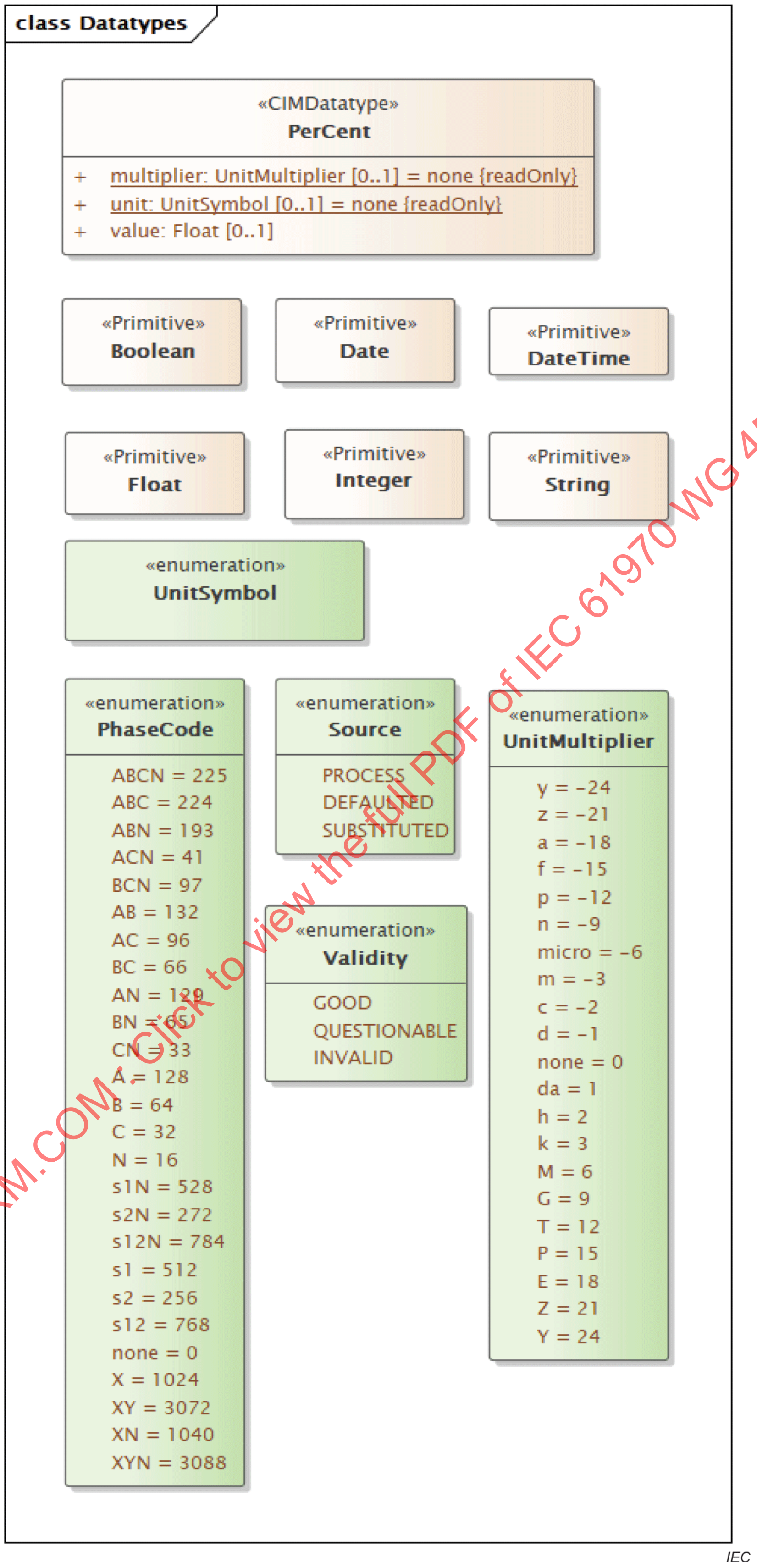


Figure 30 – Class diagram OperationProfile::Datatypes

Figure 30: The diagram shows datatypes that are used by classes in the profile. 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.

5.3.2 Accumulator

Inheritance path = Measurement: IdentifiedObject

Accumulator represents an accumulated (counted) Measurement, e.g. an energy value.

Table 328 shows all attributes of Accumulator.

Table 328 – Attributes of OperationProfile::Accumulator

name	mult	type	description
measurementType	1..1	String	inherited from: Measurement
phases	0..1	PhaseCode	inherited from: Measurement
unitMultiplier	1..1	UnitMultiplier	inherited from: Measurement
unitSymbol	1..1	UnitSymbol	inherited from: Measurement
description	0..1	String	inherited from: IdentifiedObject
mRID	1..1	String	inherited from: IdentifiedObject
name	1..1	String	inherited from: IdentifiedObject

Table 329 shows all association ends of Accumulator with other classes.

Table 329 – Association ends of OperationProfile::Accumulator with other classes

mult from	name	mult to	type	description
0..*	Terminal	0..1	ACDCTerminal	inherited from: Measurement
0..*	PowerSystemResource	1..1	PowerSystemResource	inherited from: Measurement

5.3.3 AccumulatorLimit

Inheritance path = Limit: IdentifiedObject

Limit values for Accumulator measurements.

Table 330 shows all attributes of AccumulatorLimit.

Table 330 – Attributes of OperationProfile::AccumulatorLimit

name	mult	type	description
value	1..1	Integer	The value to supervise against. The value is positive.
description	0..1	String	inherited from: IdentifiedObject
mRID	1..1	String	inherited from: IdentifiedObject
name	1..1	String	inherited from: IdentifiedObject

Table 331 shows all association ends of AccumulatorLimit with other classes.

Table 331 – Association ends of OperationProfile::AccumulatorLimit with other classes

mult from	name	mult to	type	description
1..*	LimitSet	1..1	AccumulatorLimitSet	The set of limits.

5.3.4 AccumulatorLimitSet

Inheritance path = LimitSet: IdentifiedObject

An AccumulatorLimitSet specifies a set of Limits that are associated with an Accumulator measurement.

Table 332 shows all attributes of AccumulatorLimitSet.

Table 332 – Attributes of OperationProfile::AccumulatorLimitSet

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

Table 333 shows all association ends of AccumulatorLimitSet with other classes.

Table 333 – Association ends of OperationProfile:: AccumulatorLimitSet with other classes

mult from	name	mult to	type	description
0..*	Measurements	1..*	Accumulator	The Measurements using the LimitSet.

5.3.5 AccumulatorReset

Inheritance path = Control: IOPoint: IdentifiedObject

This command resets the counter value to zero.

Table 334 shows all attributes of AccumulatorReset.

Table 334 – Attributes of OperationProfile::AccumulatorReset

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

Table 335 shows all association ends of AccumulatorReset with other classes.

Table 335 – Association ends of OperationProfile::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

5.3.6 AccumulatorValue

Inheritance path = MeasurementValue: IOPoint: IdentifiedObject

AccumulatorValue represents an accumulated (counted) MeasurementValue.

Table 336 shows all attributes of AccumulatorValue.

Table 336 – Attributes of OperationProfile::AccumulatorValue

name	mult	type	description
timeStamp	0..1	DateTime	inherited from: MeasurementValue
sensorAccuracy	0..1	PerCent	inherited from: MeasurementValue
description	0..1	String	inherited from: IdentifiedObject
mRID	1..1	String	inherited from: IdentifiedObject
name	1..1	String	inherited from: IdentifiedObject

Table 337 shows all association ends of AccumulatorValue with other classes.

Table 337 – Association ends of OperationProfile::AccumulatorValue with other classes

mult from	name	mult to	type	description
0..*	Accumulator	1..1	Accumulator	Measurement to which this value is connected.
0..*	MeasurementValueSource	1..1	MeasurementValueSource	inherited from: MeasurementValue

5.3.7 (abstract) ACDCTerminal

Inheritance path = IdentifiedObject

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

Table 338 shows all attributes of ACDCTerminal.

Table 338 – Attributes of OperationProfile::ACDCTerminal

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

5.3.8 Analog

Inheritance path = Measurement: IdentifiedObject

Analog represents an analog Measurement.

Table 339 shows all attributes of Analog.

Table 339 – Attributes of OperationProfile::Analog

name	mult	type	description
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	1..1	String	inherited from: Measurement
phases	0..1	PhaseCode	inherited from: Measurement
unitMultiplier	1..1	UnitMultiplier	inherited from: Measurement
unitSymbol	1..1	UnitSymbol	inherited from: Measurement
description	0..1	String	inherited from: IdentifiedObject
mRID	1..1	String	inherited from: IdentifiedObject
name	1..1	String	inherited from: IdentifiedObject

Table 340 shows all association ends of Analog with other classes.

Table 340 – Association ends of OperationProfile::Analog with other classes

mult from	name	mult to	type	description
0..*	Terminal	0..1	ACDCTerminal	inherited from: Measurement
0..*	PowerSystemResource	1..1	PowerSystemResource	inherited from: Measurement

5.3.9 (abstract) AnalogControl

Inheritance path = Control: IOPoint: IdentifiedObject

An analog control used for supervisory control.

Table 341 shows all attributes of AnalogControl.

Table 341 – Attributes of OperationProfile::AnalogControl

name	mult	type	description
maxValue	1..1	Float	Normal value range maximum for any of the Control.value. Used for scaling, e.g. in bar graphs.
minValue	1..1	Float	Normal value range minimum for any of the Control.value. Used for scaling, e.g. in bar graphs.
controlType	1..1	String	inherited from: Control
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
description	0..1	String	inherited from: IdentifiedObject
mRID	1..1	String	inherited from: IdentifiedObject
name	1..1	String	inherited from: IdentifiedObject

Table 342 shows all association ends of AnalogControl with other classes.

Table 342 – Association ends of OperationProfile::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

5.3.10 AnalogLimit

Inheritance path = Limit: IdentifiedObject

Limit values for Analog measurements.

Table 343 shows all attributes of AnalogLimit.

Table 343 – Attributes of OperationProfile::AnalogLimit

name	mult	type	description
value	1..1	Float	The value to supervise against.
description	0..1	String	inherited from: IdentifiedObject
mRID	1..1	String	inherited from: IdentifiedObject
name	1..1	String	inherited from: IdentifiedObject

Table 344 shows all association ends of AnalogLimit with other classes.

Table 344 – Association ends of OperationProfile::AnalogLimit with other classes

mult from	name	mult to	type	description
0..*	LimitSet	1..1	AnalogLimitSet	The set of limits.

5.3.11 AnalogLimitSet

Inheritance path = LimitSet: IdentifiedObject

An AnalogLimitSet specifies a set of Limits that are associated with an Analog measurement.

Table 345 shows all attributes of AnalogLimitSet.

Table 345 – Attributes of OperationProfile::AnalogLimitSet

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

Table 346 shows all association ends of AnalogLimitSet with other classes.

Table 346 – Association ends of OperationProfile::AnalogLimitSet with other classes

mult from	name	mult to	type	description
0..*	Measurements	1..*	Analog	The Measurements using the LimitSet.

5.3.12 AnalogValue

Inheritance path = MeasurementValue: IOPoint: IdentifiedObject

AnalogValue represents an analog MeasurementValue.

Table 347 shows all attributes of AnalogValue.

Table 347 – Attributes of OperationProfile::AnalogValue

name	mult	type	description
timeStamp	0..1	DateTime	inherited from: MeasurementValue
sensorAccuracy	0..1	PerCent	inherited from: MeasurementValue
description	0..1	String	inherited from: IdentifiedObject
mRID	1..1	String	inherited from: IdentifiedObject
name	1..1	String	inherited from: IdentifiedObject

Table 348 shows all association ends of AnalogValue with other classes.

Table 348 – Association ends of OperationProfile::AnalogValue with other classes

mult from	name	mult to	type	description
0..*	Analog	1..1	Analog	Measurement to which this value is connected.
0..*	MeasurementValueSource	1..1	MeasurementValueSource	inherited from: MeasurementValue

5.3.13 Command

Inheritance path = Control: IOPoint: IdentifiedObject

A Command is a discrete control used for supervisory control.

Table 349 shows all attributes of Command.

Table 349 – Attributes of OperationProfile::Command

name	mult	type	description
normalValue	1..1	Integer	Normal value for Control.value e.g. used for percentage scaling.
value	1..1	Integer	The value representing the actuator output.
controlType	1..1	String	inherited from: Control
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
description	0..1	String	inherited from: IdentifiedObject
mRID	1..1	String	inherited from: IdentifiedObject
name	1..1	String	inherited from: IdentifiedObject

Table 350 shows all association ends of Command with other classes.

Table 350 – Association ends of OperationProfile::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

5.3.14 (abstract) Control

Inheritance path = IOPoint: IdentifiedObject

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 351 shows all attributes of Control.

Table 351 – Attributes of OperationProfile::Control

name	mult	type	description
controlType	1..1	String	Specifies the type of Control. For example, this specifies if the Control represents BreakerOpen, BreakerClose, GeneratorVoltageSetPoint, GeneratorRaise, GeneratorLower, etc.
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.
description	0..1	String	inherited from: IdentifiedObject
mRID	1..1	String	inherited from: IdentifiedObject
name	1..1	String	inherited from: IdentifiedObject

Table 352 shows all association ends of Control with other classes.

Table 352 – Association ends of OperationProfile::Control with other classes

mult from	name	mult to	type	description
0..*	PowerSystemResource	0..1	PowerSystemResource	Regulating device governed by this control output.

5.3.15 Discrete

Inheritance path = Measurement: IdentifiedObject

Discrete represents a discrete Measurement, i.e. a Measurement representing discrete values, e.g. a Breaker position.

Table 353 shows all attributes of Discrete.

Table 353 – Attributes of OperationProfile::Discrete

name	mult	type	description
measurementType	1..1	String	inherited from: Measurement
phases	0..1	PhaseCode	inherited from: Measurement
unitMultiplier	1..1	UnitMultiplier	inherited from: Measurement
unitSymbol	1..1	UnitSymbol	inherited from: Measurement
description	0..1	String	inherited from: IdentifiedObject
mRID	1..1	String	inherited from: IdentifiedObject
name	1..1	String	inherited from: IdentifiedObject

Table 354 shows all association ends of Discrete with other classes.

Table 354 – Association ends of OperationProfile::Discrete with other classes

mult from	name	mult to	type	description
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	1..1	PowerSystemResource	inherited from: Measurement

5.3.16 DiscreteValue

Inheritance path = MeasurementValue: IOPoint: IdentifiedObject

DiscreteValue represents a discrete MeasurementValue.

Table 355 shows all attributes of DiscreteValue.

Table 355 – Attributes of OperationProfile::DiscreteValue

name	mult	type	description
timeStamp	0..1	DateTime	inherited from: MeasurementValue
sensorAccuracy	0..1	PerCent	inherited from: MeasurementValue
description	0..1	String	inherited from: IdentifiedObject
mRID	1..1	String	inherited from: IdentifiedObject
name	1..1	String	inherited from: IdentifiedObject

Table 356 shows all association ends of DiscreteValue with other classes.

Table 356 – Association ends of OperationProfile::DiscreteValue with other classes

mult from	name	mult to	type	description
0..*	Discrete	1..1	Discrete	Measurement to which this value is connected.
0..*	MeasurementValueSource	1..1	MeasurementValueSource	inherited from: MeasurementValue

5.3.17 (abstract) IdentifiedObject root class

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

Table 357 shows all attributes of IdentifiedObject.

Table 357 – Attributes of OperationProfile::IdentifiedObject

name	mult	type	description
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	1..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	1..1	String	The name is any free human readable and possibly non unique text naming the object.

5.3.18 (abstract) IOPoint

Inheritance path = IdentifiedObject

The class describe a measurement or control value. The purpose is to enable having attributes and associations common for measurement and control.

Table 358 shows all attributes of IOPoint.

Table 358 – Attributes of OperationProfile::IOPoint

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

5.3.19 (abstract) Limit

Inheritance path = IdentifiedObject

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 359 shows all attributes of Limit.

Table 359 – Attributes of OperationProfile::Limit

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

5.3.20 (abstract) LimitSet

Inheritance path = IdentifiedObject

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 360 shows all attributes of LimitSet.

Table 360 – Attributes of OperationProfile::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.
description	0..1	String	inherited from: IdentifiedObject
mRID	1..1	String	inherited from: IdentifiedObject
name	1..1	String	inherited from: IdentifiedObject

5.3.21 (abstract) Measurement

Inheritance path = IdentifiedObject

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 361 shows all attributes of Measurement.

Table 361 – Attributes of OperationProfile::Measurement

name	mult	type	description
measurementType	1..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	1..1	UnitMultiplier	The unit multiplier of the measured quantity.
unitSymbol	1..1	UnitSymbol	The unit of measure of the measured quantity.
description	0..1	String	inherited from: IdentifiedObject
mRID	1..1	String	inherited from: IdentifiedObject
name	1..1	String	inherited from: IdentifiedObject

Table 362 shows all association ends of Measurement with other classes.

Table 362 – Association ends of OperationProfile::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	1..1	PowerSystemResource	The power system resource that contains the measurement.

5.3.22 (abstract) MeasurementValue

Inheritance path = IOPoint: IdentifiedObject

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 363 shows all attributes of MeasurementValue.

Table 363 – Attributes of OperationProfile::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.
description	0..1	String	inherited from: IdentifiedObject
mRID	1..1	String	inherited from: IdentifiedObject
name	1..1	String	inherited from: IdentifiedObject

Table 364 shows all association ends of MeasurementValue with other classes.

Table 364 – Association ends of OperationProfile:: MeasurementValue with other classes

mult from	name	mult to	type	description
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.

5.3.23 MeasurementValueQuality

Inheritance path = Quality61850

Measurement quality flags. Bits 0 to 10 are defined for substation automation in IEC 61850-7-3. Bits 11 to 15 are reserved for future expansion by that document. Bits 16-31 are reserved for EMS applications.

Table 365 shows all attributes of MeasurementValueQuality.

Table 365 – Attributes of OperationProfile::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 366 shows all association ends of MeasurementValueQuality with other classes.

Table 366 – Association ends of OperationProfile:: 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.

5.3.24 MeasurementValueSource

Inheritance path = IdentifiedObject

MeasurementValueSource describes the alternative sources updating a MeasurementValue. User conventions for how to use the MeasurementValueSource attributes are defined in IEC 61970-301.

Table 367 shows all attributes of MeasurementValueSource.

Table 367 – Attributes of OperationProfile::MeasurementValueSource

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

5.3.25 (abstract) PowerSystemResource

Inheritance path = IdentifiedObject

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 368 shows all attributes of PowerSystemResource.

Table 368 – Attributes of OperationProfile::PowerSystemResource

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

5.3.26 (abstract) 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 369 shows all attributes of Quality61850.

Table 369 – Attributes of OperationProfile::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.

5.3.27 RaiseLowerCommand

Inheritance path = AnalogControl: Control: IOPoint: IdentifiedObject

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 370 shows all attributes of RaiseLowerCommand.

Table 370 – Attributes of OperationProfile::RaiseLowerCommand

name	mult	type	description
maxValue	1..1	Float	inherited from: AnalogControl
minValue	1..1	Float	inherited from: AnalogControl
controlType	1..1	String	inherited from: Control
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
description	0..1	String	inherited from: IdentifiedObject
mRID	1..1	String	inherited from: IdentifiedObject
name	1..1	String	inherited from: IdentifiedObject

Table 371 shows all association ends of RaiseLowerCommand with other classes.

Table 371 – Association ends of OperationProfile:: 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

5.3.28 SetPoint

Inheritance path = AnalogControl: Control: IOPoint: IdentifiedObject

An analog control that issues a set point value.

Table 372 shows all attributes of SetPoint.

Table 372 – Attributes of OperationProfile::SetPoint

name	mult	type	description
normalValue	1..1	Float	Normal value for Control.value e.g. used for percentage scaling.
value	1..1	Float	The value representing the actuator output.
maxValue	1..1	Float	inherited from: AnalogControl
minValue	1..1	Float	inherited from: AnalogControl
controlType	1..1	String	inherited from: Control
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
description	0..1	String	inherited from: IdentifiedObject
mRID	1..1	String	inherited from: IdentifiedObject

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

Table 373 shows all association ends of SetPoint with other classes.

Table 373 – Association ends of OperationProfile::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

5.3.29 StringMeasurement

Inheritance path = Measurement: IdentifiedObject

StringMeasurement represents a measurement with values of type string.

Table 374 shows all attributes of StringMeasurement.

Table 374 – Attributes of OperationProfile::StringMeasurement

name	mult	type	description
measurementType	1..1	String	inherited from: Measurement
phases	0..1	PhaseCode	inherited from: Measurement
unitMultiplier	1..1	UnitMultiplier	inherited from: Measurement
unitSymbol	1..1	UnitSymbol	inherited from: Measurement
description	0..1	String	inherited from: IdentifiedObject
mRID	1..1	String	inherited from: IdentifiedObject
name	1..1	String	inherited from: IdentifiedObject

Table 375 shows all association ends of StringMeasurement with other classes.

Table 375 – Association ends of OperationProfile:: StringMeasurement with other classes

mult from	name	mult to	type	description
0..*	Terminal	0..1	ACDCTerminal	inherited from: Measurement
0..*	PowerSystemResource	1..1	PowerSystemResource	inherited from: Measurement

5.3.30 StringMeasurementValue

Inheritance path = MeasurementValue: IOPoint: IdentifiedObject

StringMeasurementValue represents a measurement value of type string.

Table 376 shows all attributes of StringMeasurementValue.

Table 376 – Attributes of OperationProfile::StringMeasurementValue

name	mult	type	description
timeStamp	0..1	DateTime	inherited from: MeasurementValue
sensorAccuracy	0..1	PerCent	inherited from: MeasurementValue
description	0..1	String	inherited from: IdentifiedObject
mRID	1..1	String	inherited from: IdentifiedObject
name	1..1	String	inherited from: IdentifiedObject

Table 377 shows all association ends of StringMeasurementValue with other classes.

Table 377 – Association ends of OperationProfile:: StringMeasurementValue with other classes

mult from	name	mult to	type	description
0..*	StringMeasurement	1..1	StringMeasurement	Measurement to which this value is connected.
0..*	MeasurementValueSource	1..1	MeasurementValueSource	inherited from: MeasurementValue

5.3.31 (abstract) Terminal

Inheritance path = ACDCTerminal: IdentifiedObject

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

Table 378 shows all attributes of Terminal.

Table 378 – Attributes of OperationProfile::Terminal

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

5.3.32 ValueAliasSet

Inheritance path = IdentifiedObject

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 379 shows all attributes of ValueAliasSet.

Table 379 – Attributes of OperationProfile::ValueAliasSet

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

5.3.33 ValueToAlias

Inheritance path = IdentifiedObject

Describes the translation of one particular value into a name, e.g. 1 as "Open".

Table 380 shows all attributes of ValueToAlias.

Table 380 – Attributes of OperationProfile::ValueToAlias

name	mult	type	description
value	1..1	Integer	The value that is mapped.
description	0..1	String	inherited from: IdentifiedObject
mRID	1..1	String	inherited from: IdentifiedObject
name	1..1	String	inherited from: IdentifiedObject

Table 381 shows all association ends of ValueToAlias with other classes.

Table 381 – Association ends of OperationProfile::ValueToAlias with other classes

mult from	name	mult to	type	description
1..*	ValueAliasSet	1..1	ValueAliasSet	The ValueAliasSet having the ValueToAlias mappings.

5.3.34 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 382 shows all literals of PhaseCode.

Table 382 – Literals of OperationProfile::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.
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.

5.3.35 Source enumeration

Source gives information related to the origin of a value.

Table 383 shows all literals of Source.

Table 383 – Literals of OperationProfile::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.

5.3.36 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 384 shows all literals of UnitMultiplier.

Table 384 – Literals of OperationProfile::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.

5.3.37 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 385 shows all literals of UnitSymbol.

Table 385 – Literals of OperationProfile::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 (m2/m2).
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.