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INTERNATIONAL STANDARD

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Energy management system application program interface (EMS-API) – Part 452: CIM model exchange specification

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

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FOREWORD

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The present part of International Standard IEC 61970 has been prepared by IEC technical committee 57: Power systems management and associated information exchange.

This second edition cancels and replaces the first edition published in 2013. This edition constitutes a technical revision.

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

a) subclause 3.3, Transformer modeling – Updated description of transformer modelling to reflect changes in the modelling of transformers to work for both transmission and distribution systems;
b) subclause 3.5.1, Use of measurement classes – General – Updated to reflect changes to the measurement model;

c) subclause 3.5.2, ICCP data exchange – Updated to reflect changes to the use of identification in the model (IdentifiedObject, Name, and NameType);

d) the following detailed changes were made to Clause 4, CIM Equipment Profile:

- Added Measurement.unitMultiplier and Measurement.unitSymbol to replace association to class Unit.
- Added PowerTransformerEnd to replace TransformerWinding.
- Made PhaseTapChanger not concrete (abstract) and added PhaseTapChangerNonLinear (also not concrete), PhaseTapChangerSymetrical, PhaseTapChangerAsymetrical, and PhaseTapChangerLinear.
- Added PhaseTapChanger.TransformerEnd to replace PhaseTapChanger.TransformerWinding.
- Added RatioTapChanger.TransformerEnd to replace RatioTapChanger.TransformerWinding.
- Added TapChangerControl class to replace direct link TapChanger.RegulatingControl.
- Added RatioTapChanger.stepVoltageIncrement to replace TapChanger.stepVoltageIncrement.
- Added PhaseTapChangerTabular, PhaseTapChangerTabularPoint, RatioTapChangerTabular, and RatioTapChangerTabularPoint to replace ImpedanceVariationCurve, PhaseVariationCurve, and RatioVariationCurve.
- Added Switch.ratedCurrent as optional attribute.
- Changed all attributes of LoadResponseCharacteristic to optional except for exponentModel.
- Changed CurveData.y2Value to optional.
- Added PowerTransformer.vectorGroup as optional attribute.
- Added note to OperationalLimitSet stating that “Either an association to Equipment or an association to Terminal must be supplied, but not both.”
- Added SeriesCompensator.r0 and x0 as optional attributes.
- Added attributes for PhaseTapChangerTabularPoint and RatioTapChangerTabularPoint.
- Added RotatingMachine to the profile so that ratedS can be inherited by SynchronousMachine as an optional attribute.
- Changed association between RegulatingCondEq and RegulatingControl to be optional.
- Made OperationalLimitType attributes direction and acceptableDuration optional.
- Added classes Name and NameType to profile.
- Removed PowerTransformer.vectorGroup from the profile.
- Added PowerTransformerEnd.phaseAngleClock as an optional attribute.
- Made attributes RegulatingControl.targetRange and targetValue optional and added a note stating that they are not required if a RegulationSchedule is provided.
- Added TransformerEnd.endNumber to the profile for use with PowerTransformerEnd.phaseAngleClock.
- Added association OperationalLimt.OperationalLimitSet.
- Added association Name.IdentifiedObject.
- Updated PowerTransformer profile description to also refer to Terminals.
- Changed reference to association RegulatingControl.RegulationSchedule to use RegulationSchedule.RegulatingControl instead.

- Changed TapChanger attributes highStep, lowStep, neutralStep and normalStep to optional, because they are not required if the ltcFlag is false.
- Changed BasicIntervalSchedule.value2Unit and RegularTimePoint.value2 to optional, because they are not required for RegulationSchedule, TapSchedule or SwitchSchedule.
- Changed Analog.positiveFlowIn to be optional, because not all analogs have a flow direction (voltage, for instance).
- Added PowerTransformerEnd.g as optional attribute.
- Added SynchronousMachine.referencePriority as optional attribute.
- Added profile description for AccumulatorValue, AnalogValue, and DiscreteValue explaining that the classes are only used to define measurements available via ICCP, not to supply values for those measurements.
- Added attribute Switch.retained as required.
- Added association TransformerEnd.BaseVoltage as optional.
- Made association ControlArea.energyArea optional.

The text of this standard is based on the following documents:

CDV	Report on voting
57/1451/CDV	57/1503/RVC

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

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

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 publication will remain unchanged until the stability date indicated on the IEC web site under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

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

A bilingual version of this publication may be issued at a later date.

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INTRODUCTION

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

The IEC 61970-3x series of documents specify 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 61970-4x series of Component Interface Standards (CIS). The IEC 61970-3x series includes IEC 61970-301, *Common Information Model (CIM) base* and draft standard IEC 61970-302, *Common Information Model (CIM) Financial, EnergyScheduling and Reservations.*

This standard is one of the IEC 61970-4x series of Compoment 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 IEC 61970-5.

This part of IEC 61970 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 a interconnected power system, such that all parties have access to the modeling of their neighbor's systems that is necessary to execute state estimation or power flow applications. Currently only one profile, the Equipment Profile, has 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 which 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 model exchange specification

1 Scope

This part of IEC 61970 is a member 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 centers and/or control center components.

The purpose of this document is to rigorously define the subset of classes, class attributes, and roles 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 Modeling group (CPSM) produced the original data requirements, which are shown in Annex C. 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 to facilitate a model exchange that includes parameters common to breaker-oriented applications. Where necessary this document establishes conventions, shown in Clause 5, with which an XML data file must comply in order to be considered valid for exchange of models.

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, the 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 standard 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. All classes, attributes, and associations not explicitly labeled as recommended or conditionally required should be considered required with the following caveat. Consider, as an example, the situation in which an exporter produces an XML data file describing a small section of the exporter's network that happens to contain no breakers. The resulting XML data file should, therefore, not contain an instance of the Breaker class. On the other hand, if the section of the exporter's network does contain breakers, the resulting data file should contain instances of the Breaker class that include, at a minimum, the attributes and roles described herein for Breakers. Furthermore, it should be noted that an exporter may, at his or her discretion, produce an XML data file containing additional class data described by the CIM RDF Schema but not required by this document provided these data adhere to the conventions established in Clause 5.

From the standpoint of the model import used by a data recipient, the document describes a subset of the CIM that importing software must be able to interpret in order to import exported models. As mentioned above, data providers are free to exceed the minimum requirements described herein as long as their resulting data files are compliant with the CIM RDF 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 labeled as recommended or as not required 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 RDF Schema.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. 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 60050, *International Electrotechnical Vocabulary*.

IEC 61970-301:2013, *Energy management system application program interface (EMS-API) – Part 301: Common information model (CIM) base*

IEC 61970-501, *Energy management system application program interface (EMS-API) – Part 501: Common Information Model Resource Description Framework (CIM RDF) schema*

3 Overview of data requirements

3.1 Overview

An extensive discussion of the model exchange use cases can be found in Annex A. In all cases, the purpose of this standard is:

- 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 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.

3.2 General requirements

The following requirements are general in nature or involve multiple classes. Additional requirements are defined in the sections for the individual classes.

– The cardinality defined in the CIM model shall be followed, unless a different 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.

– Associations between classes referenced in this document and classes not referenced here are not required regardless of cardinality. For instance, the CIM requires that a HydroGeneratingUnit be associated with a HydroPowerPlant. Because the HydroPowerPlant class is not included in this document the association to HydroPowerPlant is not considered mandatory in this context.

– The attribute "name" inherited by many classes from the abstract class IdentifiedObject is not required to be unique. The RDF ID 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. The additional attribute of IdentifiedObject, aliasName, is not required.

– Although not defined within this profile, the IdentifiedObject.mRID attribute should be used as the RDF ID. The RDF ID can not begin with a number. An underscore should be added as the first character if necessary. The RDF ID shall be globally unique. A prefix may be added, if necessary, to ensure global uniqueness, but the RDF ID including the prefix shall be within the maximum character limit specified below.

– The maximum character length of names and identifiers are listed below.
  - rdf:ID – 60 characters maximum
  - IdentifiedObject.name – 32 characters maximum
  - IdentifiedObject.aliasname – 40 characters maximum
– To maintain a consistent naming hierarchy, each Substation shall be contained by a SubGeographicalRegion and each SubGeographicalRegion shall be contained by one and only one GeographicalRegion.
– Equipment defined without connectivity, because the associated Terminal(s) are not connected to ConnectivityNodes is allowed, for instance a ShuntCompensator whose Terminal is not associated to a ConnectivityNode.
– UTF-8 is the standard for file encoding. UTF-16 is not supported.
– Instance data to be exchanged shall make use of the most detailed class possible. 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.

3.3 Transformer modeling

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.

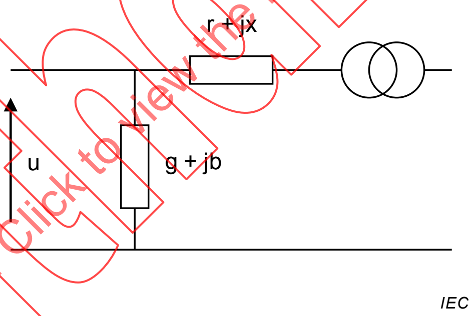

Figure 1 – Two winding transformer impedance

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.

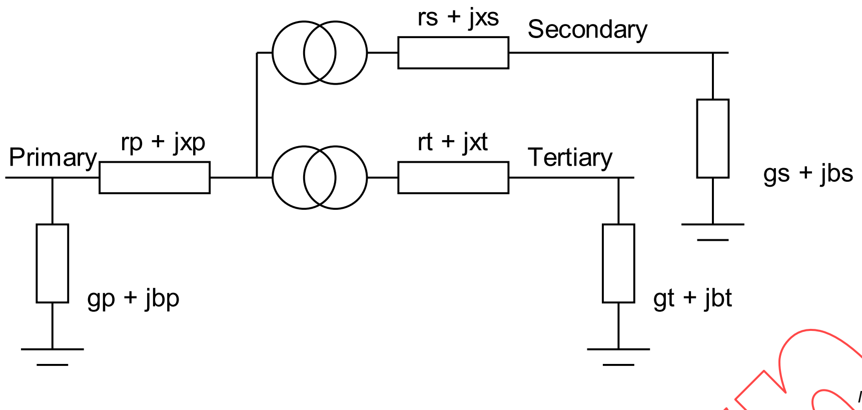

Figure 2 – Three winding transformer impedance

Additional requirements related to transformer modeling are listed below.

- Each PowerTransformer and its associated PowerTransformerEnds and tap changers (RatioTapChanger, PhaseTapChangerLinear, PhaseTapChangerSymetrical, and PhaseTapChangerAsymetrical) shall be contained within one substation. For the case of a transformer that connects two substations, however, the terminal of one of the PowerTransformerEnds can be connected to a ConnectivityNode defined in another substation. In this case, the PowerTransformer, the PowerTransformerEnds, the tap changers are still all defined in one substation.
- A PowerTransformer shall be contained by a Substation. A PowerTransformerEnd shall be contained by a PowerTransformer. A RatioTapChanger, PhaseTapChangerLinear, PhaseTapChangerSymetrical, and PhaseTapChangerAsymetrical shall be contained by a PowerTransformerEnd.
- Each PowerTransformer shall have at least two and no more than three PowerTransformerEnds. Each PowerTransformerEnd can have at most one tap changer (RatioTapChanger, PhaseTapChangerLinear, PhaseTapChangerSymetrical, or PhaseTapChangerAsymetrical). 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, PhaseTapChangerSymetrical class, or PhaseTapChangerAsymetrical class. Each of these classes are subtypes of the TapChanger class. The use of the various subtypes is explained in IEC 61970-301.

3.4 Modeling 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 modeling 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 modeling entities are involved, each modeled 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.

3.5 Use of measurement classes

3.5.1 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, PhaseTapChangerSymetrical or PhaseTapChangerAsymetrical). 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 a 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 1.

Table 1 – Valid measurementTypes

Measurement Subclass	measurementType
Analog	ThreePhasePower
	ThreePhaseActivePower
	ThreePhaseReactivePower
	LineCurrent
	PhaseVoltage
	LineToLineVoltage
	Angle
	TapPosition
Accumulator	ApparentEnergy
	ReactiveEnergy
	ActiveEnergy
	SwitchPosition
Discrete	

3.5.2 ICCP data exchange

In the context of this data exchange profile, ICCP Data Exchange is only for the purpose of defining input measurements for use by State Estimator. It is not meant to be used to configure bidirectional ICCP exchange.

ICCP (known officially as IEC 60870-6 TASE.2) data is exchanged using the Measurement classes (Analog, Discrete, and Accumulator), the MeasurementValue classes (AnalogValue, DiscreteValue, and AccumulatorValue), and the MeasurementValueSource class. The MeasurementValueSource class is used to define the control center supplying the ICCP data. The MeasurementValueSource shall be associated with an instance of Name where the attribute Name.name holds the name of the supplying control center. The instance of NameType associated with the control center Name shall have the NameType.name attribute set to “ICCP Provider ID”.

The MeasurementValue classes are used to specify the ICCP ID. The MeasurementValue shall be associated with an instance of Name where the attribute Name.name holds the ICCP ID. The instance of NameType associated with the ICCP ID Name shall have the NameType.name attribute set to “ICCP ID”. The MeasurementValue.name attribute holds the SCADA point name. Each MeasurementValue will be associated with one Measurement. Each MeasurementValue being supplied via ICCP shall also have an association to a MeasurementValueSource.

To clearly specify the point in the system being measured, the Measurement should be associated with a Terminal. For a switch status measurement, however, the association to the appropriate PowerSystemResource representing the switch would be sufficient.

3.6 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, ShuntCompensator, StaticVarCompensator, RatioTapChanger, PhaseTapChangerLinear, PhaseTapChangerSymetrical, or PhaseTapChangerAsymetrical) 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 Terminal defines the point of regulation. The association between RegulatingControl or TapChangerControl and Terminal is required to define regulation of voltage or active power. For a SynchronousMachine, ShuntCompensator, StaticVarCompensator RatioTapChanger, PhaseTapChangerLinear, PhaseTapChangerSymetrical or PhaseTapChangerAsymetrical that is not regulating, the association to RegulatingControl or TapChangerControl is not required.

3.7 Use of curves

3.7.1 General

The use of the Curve and CurveData attributes will differ for the different types of curves derived from Curve. To define a Y value that does not change, the curveStyle attribute should be set to “constantYValue”. In this case, only one instance of CurveData should be included defining the single point for the curve. Because the Y value is constant, the CurveData.xvalue value will be ignored, if it is supplied at all. A curve should never have multiple instances of CurveData where the xvalue value is repeated.

3.7.2 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.

3.8 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.

4 CIM Equipment Profile

4.1 CIM Equipment Profile General

This chapter 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 profiles and associated URIs are listed in Table 2.

Table 2 – Profiles defined in this document

Name	Version	URI	Revision date
Equipment	2	http://iec.ch/TC57/61970-452/Equipment/2	2011-05-17

4.2 Concrete Classes

4.2.1 Accumulator

Meas

Accumulator represents a accumulated (counted) Measurement, e.g. an energy value.

– The association to Terminal may not be required depending on how the Measurement is being used. See section Use of Measurement Class for details.
– The measurementType attribute is used to define the quantity being measured (Voltage, ThreePhaseActivePower, etc.) by a Measurement. The valid values for measurementType are defined in Normative String Tables.

Inherited Members

measurementType	1..1	string	see Measurement
unitMultiplier	1..1	UnitMultiplier	see Measurement
unitSymbol	1..1	UnitSymbol	see Measurement
PowerSystemResource	1..1	PowerSystemResource	see Measurement
Terminal	0..1	Terminal	see Measurement

aliasName	0..1	string	see IdentifiedObject
name	1..1	string	see IdentifiedObject

4.2.2 AccumulatorValue

Meas

AccumulatorValue represents an accumulated (counted) MeasurementValue.

In the context of this profile this class is only used to define measurements that are available via ICCP. It is not used to supply values for those measurements. Consequently the value attribute is not included in this profile.

Native Members

Accumulator	1..1	Accumulator	Measurement to which this value is connected.

Inherited Members

MeasurementValueSource	1..1	MeasurementValueSource	see MeasurementValue

aliasName	0..1	string	see IdentifiedObject
name	1..1	string	see IdentifiedObject

4.2.3 ACLineSegment

Wires

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 3ph 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.

– Each ACLineSegment is required to have an association to a BaseVoltage. The association to Line is not required.

– Using the EquipmentContainer association, an ACLineSegment can only be contained by a Line, but the association to Line is not required.

Native Members

b0ch	0..1	Susceptance	Zero sequence shunt (charging) susceptance, uniformly distributed, of the entire line section.
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.
g0ch	0..1	Conductance	Zero sequence shunt (charging) conductance, uniformly distributed, of the entire line section.
gch	0..1	Conductance	Positive sequence shunt (charging) conductance, uniformly distributed, of the entire line section.
r	1..1	Resistance	Positive sequence series resistance of the entire line section.
r0	0..1	Resistance	Zero sequence series resistance of the entire line section.
x	1..1	Reactance	Positive sequence series reactance of the entire line section.
x0	0..1	Reactance	Zero sequence series reactance of the entire line section.

Inherited Members

length	0..1	Length	see Conductor

BaseVoltage	0..1	BaseVoltage	see ConductingEquipment

aggregate	0..1	boolean	see Equipment
EquipmentContainer	0..1	EquipmentContainer	see Equipment

aliasName	0..1	string	see IdentifiedObject
name	1..1	string	see IdentifiedObject

4.2.4 ActivePowerLimit

OperationalLimits

Limit on active power flow.

Native Members

value	1..1	ActivePower	Value of active power limit.

Inherited Members

OperationalLimitSet	1..1	OperationalLimitSet	see OperationalLimit
OperationalLimitType	1..1	OperationalLimitType	see OperationalLimit

aliasName	0..1	string	see IdentifiedObject
name	1..1	string	see IdentifiedObject

4.2.5 Analog

Meas

Analog represents an analog Measurement.

- The positiveFlowIn attribute is only required if the Measurement measures a directional flow of power.
- The association to Terminal may not be required depending on how the Measurement is being used. See section Use of Measurement Class for details.
- The measurementType attribute is used to define the quantity being measured (Voltage, ThreePhaseActivePower, etc.) by a Measurement. The valid values for measurementType are defined in Normative String Tables.

Native Members

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

Inherited Members

measurementType	1..1	string	see Measurement
unitMultiplier	1..1	UnitMultiplier	see Measurement
unitSymbol	1..1	UnitSymbol	see Measurement
PowerSystemResource	1..1	PowerSystemResource	see Measurement
Terminal	0..1	Terminal	see Measurement

aliasName	0..1	string	see IdentifiedObject
name	1..1	string	see IdentifiedObject

4.2.6 AnalogValue

Meas

AnalogValue represents an analog MeasurementValue.

In the context of this profile this class is only used to define measurements that are available via ICCP. It is not used to supply values for those measurements. Consequently the value attribute is not included in this profile.

Native Members

Analog	1..1	Analog	Measurement to which this value is connected.

Inherited Members

MeasurementValueSource	1..1	MeasurementValueSource	see MeasurementValue

aliasName	0..1	string	see IdentifiedObject
name	1..1	string	see IdentifiedObject

4.2.7 ApparentPowerLimit

OperationalLimits

Apparent power limit.

Native Members

value	1..1	ApparentPower	The apparent power limit.

Inherited Members

OperationalLimitSet	1..1	OperationalLimitSet	see OperationalLimit
OperationalLimitType	1..1	OperationalLimitType	see OperationalLimit

aliasName	0..1	string	see IdentifiedObject
name	1..1	string	see IdentifiedObject

4.2.8 BaseVoltage

Core

Defines a system base voltage which is referenced.

Native Members

nominalVoltage	1..1	Voltage	The power system resource's base voltage.

Inherited Members

aliasName	0..1	string	see IdentifiedObject
name	1..1	string	see IdentifiedObject

4.2.9 Bay

Core

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.

– The Bay class is used as a container for Switches. Switches can either be contained by Bays or by VoltageLevels. If Switches are contained by VoltageLevels rather than by Bays in the sending system, then Bays are not required.

Native Members

VoltageLevel	1..1	VoltageLevel	The voltage level containing this bay.

Inherited Members

aliasName	0..1	string	see IdentifiedObject
name	1..1	string	see IdentifiedObject

4.2.10 Breaker

Wires

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.

Inherited Members

normalOpen	1..1	boolean	see Switch
ratedCurrent	0..1	CurrentFlow	see Switch
retained	1..1	boolean	see Switch

BaseVoltage	0..1	BaseVoltage	see ConductingEquipment

aggregate	0..1	boolean	see Equipment
EquipmentContainer	0..1	EquipmentContainer	see Equipment

aliasName	0..1	string	see IdentifiedObject
name	1..1	string	see IdentifiedObject

4.2.11 BusbarSection

Wires

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 VoltageTransformers 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.

Inherited Members

BaseVoltage	0..1	BaseVoltage	see ConductingEquipment

aggregate	0..1	boolean	see Equipment
EquipmentContainer	0..1	EquipmentContainer	see Equipment

aliasName	0..1	string	see IdentifiedObject
name	1..1	string	see IdentifiedObject

4.2.12 ConformLoad

LoadModel

ConformLoad represent loads that follow a daily load change pattern where the pattern can be used to scale the load with a system load.

- The definition of the real and reactive power injections for an EnergyConsumer can be done using different sets of attributes. In the simplest case, the injections can be defined directly using only the attributes fixed and qfixed.
- The injections for a ConformLoad can be defined as a percentage of the ConformLoadGroup with the attributes pfixedPct and qfixedPct. In this case, the associated ConformLoadGroup would have to have an associated ConformLoadSchedule.
- See EnergyConsumer for specific notes about inherited attributes.

Native Members

LoadGroup	1..1	ConformLoadGroup	Group of this ConformLoad

Inherited Members

pfixed	0..1	ActivePower	see EnergyConsumer
pfixedPct	0..1	PerCent	see EnergyConsumer
qfixed	0..1	ReactivePower	see EnergyConsumer
qfixedPct	0..1	PerCent	see EnergyConsumer
LoadResponse	0..1	LoadResponseCharacteristic	see EnergyConsumer

BaseVoltage	0..1	BaseVoltage	see ConductingEquipment

aggregate	0..1	boolean	see Equipment
EquipmentContainer	0..1	EquipmentContainer	see Equipment

aliasName	0..1	string	see IdentifiedObject
name	1..1	string	see IdentifiedObject

4.2.13 ConformLoadGroup

LoadModel

A group of loads conforming to an allocation pattern.

Inherited Members

SubLoadArea	1..1	SubLoadArea	see LoadGroup

aliasName	0..1	string	see IdentifiedObject
name	1..1	string	see IdentifiedObject

4.2.14 ConformLoadSchedule

LoadModel

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.

– Because value1 will always be specified in MW and value2 will always be specified in MVAr, the value1Multiplier and value2Multiplier attributes do not need to be specified.

Native Members

ConformLoadGroup	1..1	ConformLoadGroup	The ConformLoadGroup where the ConformLoadSchedule belongs.

Inherited Members

DayType	1..1	DayType	see SeasonDayTypeSchedule
Season	1..1	Season	see SeasonDayTypeSchedule

endTime	1..1	dateTime	see RegularIntervalSchedule
timeStep	1..1	Seconds	see RegularIntervalSchedule

startTime	1..1	dateTime	see BasicIntervalSchedule
value1Unit	1..1	UnitSymbol	see BasicIntervalSchedule
value2Unit	0..1	UnitSymbol	see BasicIntervalSchedule

aliasName	0..1	string	see IdentifiedObject
name	1..1	string	see IdentifiedObject

4.2.15 ConnectivityNode

Core

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

– By convention, ConnectivityNodes may only be placed within VoltageLevels.

Native Members

ConnectivityNodeContainer	1..1	ConnectivityNodeContainer	Container of this connectivity node.

Inherited Members

aliasName	0..1	string	see IdentifiedObject
name	1..1	string	see IdentifiedObject

4.2.16 ControlArea

ControlArea

A **control area** is a grouping of **generating units** and/or loads and a cutset of tie lines (as **terminals**) which may be used for a variety of purposes including automatic generation control, powerflow solution area interchange control specification, and input to load forecasting. Note that any number of overlapping control area specifications can be superimposed on the physical model.

Native Members

netInterchange	1..1	ActivePower	The specified positive net interchange into the control area.
pTolerance	0..1	ActivePower	Active power net interchange tolerance
type	1..1	ControlAreaTypeKind	The type of control area defintion used to determine if this is used for automatic generation control, for planning interchange control, or other purposes.
EnergyArea	0..1	EnergyArea	The energy area that is forecast from this control area specification.

Inherited Members

aliasName	0..1	string	see IdentifiedObject
name	1..1	string	see IdentifiedObject

4.2.17 ControlAreaGeneratingUnit

ControlArea

A control area generating unit. This class is needed so that alternate control area definitions may include the same generating unit. Note only one instance within a control area should reference a specific generating unit.

Native Members

ControlArea	1..1	ControlArea	The parent control area for the generating unit specifications.
GeneratingUnit	1..1	GeneratingUnit	The generating unit specified for this control area. Note that a control area should include a GeneratingUnit only once.

4.2.18 CurrentLimit

OperationalLimits

Operational limit on current.

Native Members

value	1..1	CurrentFlow	Limit on current flow.

Inherited Members

OperationalLimitSet	1..1	OperationalLimitSet	see OperationalLimit
OperationalLimitType	1..1	OperationalLimitType	see OperationalLimit

aliasName	0..1	string	see IdentifiedObject
name	1..1	string	see IdentifiedObject

4.2.19 CurveData

Core

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.

Native Members

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.
Curve	1..1	Curve	The curve of this curve data point.

4.2.20 DayType

LoadModel

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

- The name attribute indicates the days of the week that a given DayType represents.
- 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.

Inherited Members

aliasName	0..1	string	see IdentifiedObject
name	1..1	string	see IdentifiedObject

4.2.21 Disconnector

Wires

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.

Inherited Members

normalOpen	1..1	Boolean	see Switch
ratedCurrent	0..1	CurrentFlow	see Switch
retained	1..1	boolean	see Switch

BaseVoltage	0..1	BaseVoltage	see ConductingEquipment

aggregate	0..1	boolean	see Equipment
EquipmentContainer	0..1	EquipmentContainer	see Equipment

aliasName	0..1	string	see IdentifiedObject
name	1..1	string	see IdentifiedObject

4.2.22 Discrete

Meas

Discrete represents a discrete Measurement, i.e. a Measurement reprsenting discrete values, e.g. a Breaker position.

- The association to Terminal may not be required depending on how the Measurement is being used. See section Use of Measurement Class for details.
- The measurementType attribute is used to define the quantity being measured (Voltage, ThreePhaseActivePower, etc.) by a Measurement. The valid values for the measurementType are defined in Normative String Tables.

Inherited Members

measurementType	1..1	string	see Measurement
unitMultiplier	1..1	UnitMultiplier	see Measurement
unitSymbol	1..1	UnitSymbol	see Measurement
PowerSystemResource	1..1	PowerSystemResource	see Measurement
Terminal	0..1	Terminal	see Measurement

aliasName	0..1	string	see IdentifiedObject
name	1..1	string	see IdentifiedObject

4.2.23 DiscreteValue

Meas

DiscreteValue represents a discrete MeasurementValue.

In the context of this profile this class is only used to define measurements that are available via ICCP. It is not used to supply values for those measurements. Consequently the value attribute is not included in this profile.

Native Members

Discrete	1..1	Discrete	Measurement to which this value is connected.

Inherited Members

MeasurementValueSource	1..1	MeasurementValueSource	see MeasurementValue

aliasName	0..1	string	see IdentifiedObject
name	1..1	string	see IdentifiedObject

4.2.24 EnergyConsumer

Wires

Generic user of energy – a point of consumption on the power system model.

– The definition of the real and reactive power injections for an EnergyConsumer can be done using different sets of attributes. In the simplest case, the injections can be defined directly using only the attributes fixed and qfixed.

– To specify conforming and nonconforming loads, the classes ConformLoad, NonConformLoad, or their subtypes should be used.

– The attributes defining the affect of voltage and frequency on the injection defined by an associated LoadResponseCharacteristic should be supplied, if they are available, but are not required.

Native Members

pfixed	0..1	ActivePower	Active power of the load that is a fixed quantity. Load sign convention is used, i.e. positive sign means flow out from a

			node.
pfixedPct	0..1	PerCent	Fixed active power as per cent of load group fixed active power. Load sign convention is used, i.e. positive sign means flow out from a node.
qfixed	0..1	ReactivePower	Reactive power of the load that is a fixed quantity. Load sign convention is used, i.e. positive sign means flow out from a node.
qfixedPct	0..1	PerCent	Fixed reactive power as per cent of load group fixed reactive power. Load sign convention is used, i.e. positive sign means flow out from a node.
LoadResponse	0..1	LoadResponseCharacteristic	The load response characteristic of this load. If missing, this load is assumed to be constant power.

Inherited Members

BaseVoltage	0..1	BaseVoltage	see ConductingEquipment
aggregate	0..1	boolean	see Equipment
EquipmentContainer	0..1	EquipmentContainer	see Equipment
aliasName	0..1	string	see IdentifiedObject
name	1..1	string	see IdentifiedObject

4.2.25 EquivalentBranch

Equivalents

The class represents equivalent branches.

Native Members

r	1..1	Resistance	Positive sequence series resistance of the reduced branch.
x	1..1	Reactance	Positive sequence series reactance of the reduced branch.

Inherited Members

EquivalentNetwork	1..1	EquivalentNetwork	see

			EquivalentEquipment

BaseVoltage	0..1	BaseVoltage	see ConductingEquipment

aggregate	0..1	boolean	see Equipment
EquipmentContainer	0..1	EquipmentContainer	see Equipment

aliasName	0..1	string	see IdentifiedObject
name	1..1	string	see IdentifiedObject

4.2.26 EquivalentInjection

Equivalents

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

Native Members

maxP	1..1	ActivePower	Minimum active power of the injection.
minP	1..1	ActivePower	Maximum active power of the injection.
regulationCapability	1..1	boolean	Specifies whether or not the EquivalentInjection has the capability to regulate the local voltage.
regulationStatus	1..1	boolean	Specifies the default regulation status of the EquivalentInjection. True is regulating. False is not regulating.
regulationTarget	1..1	Voltage	The target voltage for voltage regulation.

Inherited Members

EquivalentNetwork	1..1	EquivalentNetwork	see EquivalentEquipment

BaseVoltage	0..1	BaseVoltage	see ConductingEquipment

aggregate	0..1	boolean	see Equipment
EquipmentContainer	0..1	EquipmentContainer	see Equipment

aliasName	0..1	string	see IdentifiedObject
name	1..1	string	see IdentifiedObject

4.2.27 EquivalentNetwork

Equivalents

A class that represents an external meshed network that has been reduced to an electrically equivalent model. 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.

Inherited Members

aliasName	0..1	string	see IdentifiedObject
name	1..1	string	see IdentifiedObject

4.2.28 EquivalentShunt

Equivalents

The class represents equivalent shunts.

Native Members

b	1..1	Susceptance	Positive sequence shunt susceptance.
g	1..1	Conductance	Positive sequence shunt conductance.

Inherited Members

EquivalentNetwork	1..1	EquivalentNetwork	see EquivalentEquipment

BaseVoltage	0..1	BaseVoltage	see ConductingEquipment

aggregate	0..1	boolean	see Equipment
EquipmentContainer	0..1	EquipmentContainer	see Equipment

aliasName	0..1	string	see IdentifiedObject
name	1..1	string	see IdentifiedObject

4.2.29 FossilFuel

Production

The fossil fuel consumed by the non-nuclear thermal generating unit. For example, coal, oil, gas, etc. This a the specific fuels that that the generating unit can consume.

Native Members

fossilFuelType	1..1	FuelType	The type of fossil fuel, such as coal, oil, or gas.
ThermalGeneratingUnit	1..1	ThermalGeneratingUnit	A thermal generating unit may have one or more fossil fuels.

Inherited Members

aliasName	0..1	string	see IdentifiedObject
name	1..1	string	see IdentifiedObject

4.2.30 GeneratingUnit

Production

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.

- To define a GeneratingUnit requires defining the initial real power injection, net real power limits, and the status of the unit. The initial injection is defined using the attribute initialP.
- The net real power limits 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.
- The control status of the unit is defined with the attribute genControlSource, but it is not required. The participation factor attributes longPF, normalPF, and shortPF are not required.
- The GeneratingUnit class should only be used in cases where the more specific classes, HydroGeneratingUnit and ThermalGeneratingUnit, do not apply.
- The attributes governorSCD, maximumAllowableSpinningReserve, nominalP, startupCost, and variableCost are not required.

Native Members

genControlSource	0..1	GeneratorControlSource	The source of controls for a 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.
initialP	1..1	ActivePower	Default initial active power which is used to store a powerflow result for the initial active power for this unit in this network configuration.

longPF	0..1	float	Generating unit long term economic participation factor.
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 govenor speed change droop (governorSCD attribute).
normalPF	0..1	float	Generating unit economic participation factor.
ratedGrossMaxP	0..1	ActivePower	The unit's gross rated maximum capacity (book 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.
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.
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.

Inherited Members

aggregate	0..1	boolean	see Equipment
EquipmentContainer	0..1	EquipmentContainer	see Equipment

aliasName	0..1	string	see IdentifiedObject
name	1..1	string	see IdentifiedObject

4.2.31 GeographicalRegion

Core

A geographical region of a power system network model.

Inherited Members

aliasName	0..1	string	see IdentifiedObject
name	1..1	string	see IdentifiedObject

4.2.32 GrossToNetActivePowerCurve

Production

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 modeled, should be treated as non-conforming bus loads. There may be more than one curve, depending on the auxiliary equipment that is in service.

– Because the x and y values will always be specified in MW, the xMultiplier and y1Multiplier attributes do not need to be supplied.

Native Members

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.

Inherited Members

curveStyle	1..1	CurveStyle	see Curve
xUnit	1..1	UnitSymbol	see Curve
y1Unit	1..1	UnitSymbol	see Curve
y2Unit	0..1	UnitSymbol	see Curve

aliasName	0..1	string	see IdentifiedObject
name	1..1	string	see IdentifiedObject

4.2.33 HydroGeneratingUnit

Production

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

– The attributes governorSCD, maximumAllowableSpinningReserve, nominalP, startupCost, and variableCost are not required.

Inherited Members

genControlSource	0..1	GeneratorControlSource	see GeneratingUnit
governorSCD	0..1	PerCent	see GeneratingUnit
initialP	1..1	ActivePower	see GeneratingUnit
longPF	0..1	float	see GeneratingUnit
maximumAllowableSpinningReserve	0..1	ActivePower	see GeneratingUnit
maxOperatingP	1..1	ActivePower	see GeneratingUnit
minOperatingP	1..1	ActivePower	see GeneratingUnit
nominalP	0..1	ActivePower	see GeneratingUnit
normalPF	0..1	float	see GeneratingUnit
ratedGrossMaxP	0..1	ActivePower	see GeneratingUnit
ratedGrossMinP	0..1	ActivePower	see GeneratingUnit
ratedNetMaxP	0..1	ActivePower	see GeneratingUnit
shortPF	0..1	Float	see GeneratingUnit
startupCost	0..1	Money	see GeneratingUnit
variableCost	0..1	Money	see GeneratingUnit

aggregate	0..1	boolean	see Equipment
EquipmentContainer	0..1	EquipmentContainer	see Equipment

aliasName	0..1	string	see IdentifiedObject
name	1..1	string	see IdentifiedObject

4.2.34 HydroPump

Production

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

Native Members

SynchronousMachine	1..1	SynchronousMachine	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.

Inherited Members

aliasName	0..1	string	see IdentifiedObject

name	1..1	string	see IdentifiedObject

4.2.35 IEC61970CIMVersion

This is the IEC 61970 CIM version number assigned to this UML model.

– The two IEC61970CIMVersion attributes should be assigned the values defined as the initial values in the CIM UML. Currently the initial value for version is IEC61970CIM15v32. The current initial value for date is 2011-08-10.

Native Members

date	1..1	date	Form is YYYY-MM-DD for example for January 5, 2009 it is 2009-01-05.
version	1..1	string	Form is IEC61970CIMXXvYY where XX is the major CIM package version and the YY is the minor version. For example IEC61970CIM13v18.

4.2.36 Line

Wires

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

– Use of the Line class is not required. If used, it can only be used as a container for ACLineSegments and SeriesCompensators.

– A Line is not required to be associated with a SubGeographicalRegion.

Native Members

Region	0..1	SubGeographicalRegion	The sub-geographical region of the line.

Inherited Members

aliasName	0..1	string	see IdentifiedObject
name	1..1	string	see IdentifiedObject

4.2.37 LoadArea

LoadModel

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

Inherited Members

aliasName	0..1	string	see IdentifiedObject
name	1..1	string	see IdentifiedObject

4.2.38 LoadBreakSwitch

Wires

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

Inherited Members

normalOpen	1..1	boolean	see Switch
ratedCurrent	0..1	CurrentFlow	see Switch
retained	1..1	boolean	see Switch

BaseVoltage	0..1	BaseVoltage	see ConductingEquipment

aggregate	0..1	boolean	see Equipment
EquipmentContainer	0..1	EquipmentContainer	see Equipment

aliasName	0..1	string	see IdentifiedObject
name	1..1	string	see IdentifiedObject

4.2.39 LoadResponseCharacteristic

LoadModel

Models the characteristic response of the load demand due to to changes in system conditions such as voltage and frequency. This is not related to demand response.

If LoadResponseCharacteristic.exponentModel is True, the voltage exponents are specified and used as to calculate:

– Active power component = Pnominal * (Voltage/cim:BaseVoltage.nominalVoltage) ** cim:LoadResponseCharacteristic.pVoltageExponent

– Reactive power component = Qnominal * (Voltage/cim:BaseVoltage.nominalVoltage) ** cim:LoadResponseCharacteristic.qVoltageExponent

Where * means "multiply" and ** is "raised to power of".

Native Members

exponentModel	1..1	boolean	Indicates the exponential voltage dependency model (pVoltateExponent and qVoltageExponent) is to be used. If false, the coeficient model (consisting of pConstantImpedance, pConstantCurrent, pConstantPower, qConstantImpedance, qConstantCurrent, and qConstantPower) is to be used.
pConstantCurrent	0..1	float	Portion of active

			power load modeled as constant current. Used only if the useExponentModel is false. This value is noralized against the sum of pZ, pI, and pP.
pConstantImpedance	0..1	float	Portion of active power load modeled as constant impedance. Used only if the useExponentModel is false. This value is noralized against the sum of pZ, pI, and pP.
pConstantPower	0..1	float	Portion of active power load modeled as constant power. Used only if the useExponentModel is false. This value is noralized against the sum of pZ, pI, and pP.
pFrequencyExponent	0..1	float	Exponent of per unit frequency effecting active power.
pVoltageExponent	0..1	float	Exponent of per unit voltage effecting real power. This model used only when "useExponentModel" is true.
qConstantCurrent	0..1	float	Portion of reactive power load modeled as constant current. Used only if the useExponentModel is false. This value is noralized against the sum of qZ, qI, and qP.
qConstantImpedance	0..1	float	Portion of reactive power load modeled real as constant impedance. Used only if the useExponentModel is false. This value is noralized against the sum of qZ, qI, and qP.
qConstantPower	0..1	float	Portion of reactive power load modeled as constant power. Used only if the useExponentModel is false. This value is noralized against the sum of qZ, qI, and qP.
qFrequencyExponent	0..1	float	Exponent of per unit frequency effecting reactive power.

qVoltageExponent	0..1	float	Exponent of per unit voltage effecting reactive power. This model used only when "useExponentModel" is true.

Inherited Members

aliasName	0..1	string	see IdentifiedObject
name	1..1	string	see IdentifiedObject

4.2.40 MeasurementValueSource

Meas

MeasurementValueSource describes the alternative sources updating a MeasurementValue. User conventions for how to use the MeasurementValueSource attributes are described in the introduction to IEC 61970-301.

Inherited Members

aliasName	0..1	string	see IdentifiedObject
name	1..1	string	see IdentifiedObject

4.2.41 MutualCoupling

Wires

This class represents the zero sequence line mutual coupling.

Native Members

b0ch	1..1	Susceptance	Zero sequence mutual coupling shunt (charging) susceptance, uniformly distributed, of the entire line section.
distance11	1..1	Length	Distance to the start of the coupled region from the first line's terminal having sequence number equal to 1.
distance12	1..1	Length	Distance to the end of the coupled region from the first line's terminal with sequence number equal to 1.
distance21	1..1	Length	Distance to the start of coupled region from the second line's terminal with sequence number equal to 1.

distance22	1..1	Length	Distance to the end of coupled region from the second line's terminal with squence number equal to 1.
g0ch	1..1	Conductance	Zero sequence mutual coupling shunt (charging) conductance, uniformly distributed, of the entire line section.
r0	1..1	Resistance	Zero sequence branch-to-branch mutual impedance coupling, resistance.
x0	1..1	Reactance	Zero sequence branch-to-branch mutual impedance coupling, reactance.
First_Terminal	1..1	Terminal	The starting terminal for the calculation of distances along the first branch of the mutual coupling. Normally MutualCoupling would only be used for terminals of AC line segments. The first and second terminals of a mutual coupling should point to different AC line segments.
Second_Terminal	1..1	Terminal	The starting terminal for the calculation of distances along the second branch of the mutual coupling.

Inherited Members

aliasName	0..1	string	see IdentifiedObject
name	1..1	string	see IdentifiedObject

4.2.42 Name

Core

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

Native Members

name	1..1	string	Any free text that name the object.
IdentifiedObject	1..1	IdentifiedObject	Identified object that this name designates.

NameType	1..1	NameType	Type of this name.

4.2.43 NameType

Core

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

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

Native Members

name	1..1	string	Name of the name type.

4.2.44 NonConformLoad

LoadModel

NonConformLoad represent loads that do not follow a daily load change pattern and changes are not correlated with the daily load change pattern.

- The definition of the real and reactive power injections for an EnergyConsumer can be done using different sets of attributes. In the simplest case, the injections can be defined directly using only the attributes pfixed and qfixed.
- The injections for a NonConformLoad can be defined as a percentage of the NonConformLoadGroup with the attributes pfixedPct and qfixedPct. In this case, the associated NonConformLoadGroup would have to have an associated NonConformLoadSchedule.
- The attributes defining the affect of voltage and frequency on the injection defined by an associated LoadResponseCharacteristic should be supplied, if they are available, but are not required.

Native Members

LoadGroup	1..1	NonConformLoadGroup	Group of this ConformLoad.

Inherited Members

pfixed	0..1	ActivePower	see EnergyConsumer
pfixedPct	0..1	PerCent	see EnergyConsumer
qfixed	0..1	ReactivePower	see EnergyConsumer
qfixedPct	0..1	PerCent	see EnergyConsumer
LoadResponse	0..1	LoadResponseCharacteristic	see EnergyConsumer

BaseVoltage	0..1	BaseVoltage	see ConductingEquipment

aggregate	0..1	boolean	see Equipment
EquipmentContainer	0..1	EquipmentContainer	see Equipment

aliasName	0..1	string	see IdentifiedObject
name	1..1	string	see IdentifiedObject

4.2.45 NonConformLoadGroup

LoadModel

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

Inherited Members

SubLoadArea	1..1	SubLoadArea	see LoadGroup

aliasName	0..1	string	see IdentifiedObject
name	1..1	string	see IdentifiedObject

4.2.46 NonConformLoadSchedule

LoadModel

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 modeled).

– Because value1 will always be specified in MW and value2 will always be specified in MVAr, the value1Multiplier and value2Multiplier attributes do not need to be specified.

Native Members

NonConformLoadGroup	1..1	NonConformLoadGroup	The NonConformLoadGroup where the NonConformLoadSchedule belongs.

Inherited Members

DayType	1..1	DayType	see SeasonDayTypeSchedule
Season	1..1	Season	see SeasonDayTypeSchedule

endTime	1..1	dateTime	see RegularIntervalSchedule
timeStep	1..1	Seconds	see RegularIntervalSchedule

startTime	1..1	dateTime	see BasicIntervalSchedule
value1Unit	1..1	UnitSymbol	see BasicIntervalSchedule

value2Unit	0..1	UnitSymbol	see BasicIntervalSchedule

aliasName	0..1	string	see IdentifiedObject
name	1..1	string	see IdentifiedObject

4.2.47 NuclearGeneratingUnit

Production

A nuclear generating unit.

Inherited Members

genControlSource	0..1	GeneratorControlSource	see GeneratingUnit
governorSCD	0..1	PerCent	see GeneratingUnit
initialP	1..1	ActivePower	see GeneratingUnit
longPF	0..1	float	see GeneratingUnit
maximumAllowableSpinningReserve	0..1	ActivePower	see GeneratingUnit
maxOperatingP	1..1	ActivePower	see GeneratingUnit
minOperatingP	1..1	ActivePower	see GeneratingUnit
nominalP	0..1	ActivePower	see GeneratingUnit
normalPF	0..1	float	see GeneratingUnit
ratedGrossMaxP	0..1	ActivePower	see GeneratingUnit
ratedGrossMinP	0..1	ActivePower	see GeneratingUnit
ratedNetMaxP	0..1	ActivePower	see GeneratingUnit
shortPF	0..1	float	see GeneratingUnit
startupCost	0..1	Money	see GeneratingUnit
variableCost	0..1	Money	see GeneratingUnit

aggregate	0..1	boolean	see Equipment
EquipmentContainer	0..1	EquipmentContainer	see Equipment

aliasName	0..1	string	see IdentifiedObject
name	1..1	string	see IdentifiedObject

4.2.48 OperationalLimitSet

OperationalLimits

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.

– Either an association to Equipment or an association to Terminal shall be supplied, but not both.

Native Members

Equipment	0..1	Equipment	The equipment to which the limit set applies.
Terminal	0..1	Terminal	The terminal specifically

			associated to this operational limit set. If no terminal is associated, all terminals of the equipment are implied.

Inherited Members

aliasName	0..1	string	see IdentifiedObject
name	1..1	string	see IdentifiedObject

4.2.49 OperationalLimitType

OperationalLimits

The operational meaning of a category of limits.

Native Members

acceptableDuration	0..1	Seconds	The nominal acceptable duration of the limit. Limits are commonly expressed in terms of the a 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.
direction	0..1	OperationalLimitDirectionKind	The direction of the limit.

Inherited Members

aliasName	0..1	string	see IdentifiedObject
name	1..1	string	see IdentifiedObject

4.2.50 PhaseTapChangerAsymetrical

Wires

Describes the tap model for an asymmetrical phase shifting tranformer in which the difference voltage vector adds to the primary side voltage. The angle between the primary side voltage and the difference voltage is named the winding connection angle. The phase shift depends on both the difference voltage magnitude and the winding connection angle.

Native Members

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 symmemtrical transformer.

Inherited Members

voltageStepIncrement	1..1	PerCent	see PhaseTapChangerNonLinear
xMax	1..1	Reactance	see PhaseTapChangerNonLinear
xMedian	1..1	Reactance	see PhaseTapChangerNonLinear

PhaseTapChangerTabular	0..1	PhaseTapChangerTabular	see PhaseTapChanger
TransformerEnd	1..1	TransformerEnd	see PhaseTapChanger

highStep	0..1	integer	see TapChanger
lowStep	0..1	integer	see TapChanger
ltcFlag	1..1	boolean	see TapChanger
neutralStep	0..1	integer	see TapChanger
neutralU	1..1	Voltage	see TapChanger
normalStep	0..1	integer	see TapChanger
regulationStatus	0..1	boolean	see TapChanger
TapChangerControl	0..1	TapChangerControl	see TapChanger

aliasName	0..1	string	see IdentifiedObject
name	1..1	string	see IdentifiedObject

4.2.51 PhaseTapChangerLinear

Wires

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.

Native Members

stepPhaseShiftIncrement	1..1	AngleDegrees	Phase shift per step position. A positive value indicates a positive phase shift from the winding where the tap is located to the other winding (for a two-

			winding 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.

Inherited Members

PhaseTapChangerTabular	0..1	PhaseTapChangerTabular	see PhaseTapChanger
TransformerEnd	1..1	TransformerEnd	see PhaseTapChanger

highStep	0..1	integer	see TapChanger
lowStep	0..1	integer	see TapChanger
ltcFlag	1..1	boolean	see TapChanger
neutralStep	0..1	integer	see TapChanger
neutralU	1..1	Voltage	see TapChanger
normalStep	0..1	integer	see TapChanger
regulationStatus	0..1	boolean	see TapChanger
TapChangerControl	0..1	TapChangerControl	see TapChanger

aliasName	0..1	string	see IdentifiedObject
name	1..1	string	see IdentifiedObject

4.2.52 PhaseTapChangerSymetrical

Wires

Describes a symmetrical phase shifting transformer tap model in which the secondary side voltage magnitude is the same as at the primary side. 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.

Inherited Members

voltageStepIncrement	1..1	PerCent	see PhaseTapChangerNonLinear
xMax	1..1	Reactance	see PhaseTapChangerNonLinear
xMedian	1..1	Reactance	see PhaseTapChangerNonLinear

PhaseTapChangerTabular	0..1	PhaseTapChangerTabular	see PhaseTapChanger
TransformerEnd	1..1	TransformerEnd	see PhaseTapChanger

highStep	0..1	integer	see TapChanger

lowStep	0..1	integer	see TapChanger
ltcFlag	1..1	boolean	see TapChanger
neutralStep	0..1	integer	see TapChanger
neutralU	1..1	Voltage	see TapChanger
normalStep	0..1	integer	see TapChanger
regulationStatus	0..1	boolean	see TapChanger
TapChangerControl	0..1	TapChangerControl	see TapChanger

aliasName	0..1	string	see IdentifiedObject
name	1..1	string	see IdentifiedObject

4.2.53 PhaseTapChangerTabular

Wires

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

Inherited Members

aliasName	0..1	string	see IdentifiedObject
name	1..1	string	see IdentifiedObject

4.2.54 PhaseTapChangerTabularPoint

Wires

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

Native Members

angle	0..1	AngleDegrees	The angle difference in degrees.
b	0..1	PerCent	The magnetizing branch susceptance deviation in percent 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 in percent of nominal value. The actual conductance is calculated as follows: calculated magnetizing conductance = b(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 in percent of nominal value. The actual resistance 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.
step	1..1	integer	The tap step.
x	0..1	PerCent	The series reactance deviation in percent 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.
PhaseTapChangerTabular	1..1	PhaseTapChangerTabular	The table of this point.

4.2.55 PowerTransformer

Wires

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.

A PowerTransformer can be either two winding or three winding.

– A two winding transformer has two PowerTransformerEnds and two associated Terminals.
– A three winding transformer has three PowerTransformerEnds and three associated Terminals.

Inherited Members

aggregate	0..1	boolean	see Equipment
EquipmentContainer	0..1	EquipmentContainer	see Equipment

aliasName	0..1	string	see IdentifiedObject
name	1..1	string	see IdentifiedObject

4.2.56 PowerTransformerEnd

Wires

A PowerTransformerEnd is associated with each Terminal of a PowerTransformer.

The impdedance values r, r0, x, and x0 of a PowerTransformerEnd represents a star equivalent as follows

1) for a two Terminal PowerTransformer the high voltage PowerTransformerEnd has non zero values on r, r0, x, and x0 while the low voltage PowerTransformerEnd has zero values for r, r0, x, and x0.
2) for a three Terminal PowerTransformer the three PowerTransformerEnds represents a star equivalent with each leg in the star represented by r, r0, x, and x0 values.
3) 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 shall 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).
   – The attributes ratedS, b0, g0, r0, x0, and connectionKind are not required.

Native Members

b	1..1	Susceptance	Magnetizing branch susceptance (B mag).

			The value can be positive or negative.
b0	0..1	Susceptance	Zero sequence magnetizing branch susceptance.
connectionKind	0..1	WindingConnection	Kind of connection.
g	0..1	Conductance	Magnetizing branch conductance.
g0	0..1	Conductance	Zero sequence magnetizing branch conductance (star-model).
phaseAngleClock	0..1	integer	Terminal voltage phase angle displacement where 360 degrees are represented with clock hours. The valid values are 0 to 11. For example, for the secondary side end of a transformer with vector group code of 'Dyn11', specify the connection kind as wye with neutral and specify the phase angle of the clock as 11. The clock value of the transformer end number specified as 1, is assumed to be zero. Note the transformer end number is not assumed to be the same as the terminal sequence number.
r	1..1	Resistance	Resistance (star-model) of the transformer end.
r0	0..1	Resistance	Zero sequence series resistance (star-model) of the transformer end.
ratedS	0..1	ApparentPower	Normal apparent power rating.
ratedU	1..1	Voltage	Rated voltage: phase-phase for three-phase windings, and either phase-phase or phase-neutral for single-phase windings.
x	1..1	Reactance	Positive sequence series reactance (star-model) of the transformer end.
x0	0..1	Reactance	Zero sequence series reactance of the

			transformer end.
PowerTransformer	1..1	PowerTransformer	The power transformer of this power transformer end.

Inherited Members

endNumber	1..1	integer	see TransformerEnd
rground	0..1	Resistance	see TransformerEnd
xground	0..1	Reactance	see TransformerEnd
BaseVoltage	0..1	BaseVoltage	see TransformerEnd
Terminal	1..1	Terminal	see TransformerEnd

aliasName	0..1	string	see IdentifiedObject
name	1..1	string	see IdentifiedObject

4.2.57 RatioTapChanger

Wires

A tap changer that changes the voltage ratio impacting the voltage magnitude but not the phase angle across the transformer.

– The attribute TapChanger.ltcflag specifies whether or not a TapChanger has load tap changing capabilities. If the ltcFlag is true, the attribute stepVoltageIncrement is required.

Native Members

stepVoltageIncrement	0..1	PerCent	Tap step increment, in per cent of nominal voltage, per step position.
tculControlMode	1..1	TransformerControlMode	Specifies the regulation control mode (voltage or reactive) of the RatioTapChanger.
RatioTapChangerTabular	0..1	RatioTapChangerTabular	The tap ratio table for this ratio tap changer.
TransformerEnd	1..1	TransformerEnd	Transformer end to which this ratio tap changer belongs.

Inherited Members

highStep	0..1	integer	see TapChanger
lowStep	0..1	integer	see TapChanger
ltcFlag	1..1	boolean	see TapChanger
neutralStep	0..1	integer	see TapChanger
neutralU	1..1	Voltage	see TapChanger
normalStep	0..1	integer	see TapChanger
regulationStatus	0..1	boolean	see TapChanger
TapChangerControl	0..1	TapChangerControl	see TapChanger

aliasName	0..1	string	see IdentifiedObject
name	1..1	string	see IdentifiedObject

4.2.58 RatioTapChangerTabular

Wires

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

Inherited Members

aliasName	0..1	string	see IdentifiedObject
name	1..1	string	see IdentifiedObject

4.2.59 RatioTapChangerTabularPoint

Wires

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

Native Members

b	0..1	PerCent	The magnetizing branch susceptance deviation in percent 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 in percent 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 in percent of nominal value. The actual reactance is calculated as follows: calculated resistance = r(nominal) * (1 + r(from this class)/100). The r(nominal) is defined as the static resistance on the associated power transformer end or ends. This model assumes the star impedance (pi model) form.
ratio	0..1	float	The voltage ratio in per unit. Hence this is a value close to one.
step	1..1	integer	The tap step.
x	0..1	PerCent	The series reactance deviation in percent 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.
RatioTapChangerTabular	1..1	RatioTapChangerTabular	Table of this point.

4.2.60 ReactiveCapabilityCurve

Wires

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.

– ReactiveCapabilityCurves are not required if the reactive power limits of the SynchronousMachine do not vary with real power output.
– By convention, the Y1 axis values represent reactive minimum and the Y2 axis values represent reactive maximum.
– Because the x value will always be specified in MW and the y values will always be specified in MVAr, the xMultiplier, y1Multiplier, and y2Multiplier attributes do not need to be supplied.

Inherited Members

curveStyle	1..1	CurveStyle	see Curve
xUnit	1..1	UnitSymbol	see Curve
y1Unit	1..1	UnitSymbol	see Curve
y2Unit	0..1	UnitSymbol	see Curve

aliasName	0..1	string	see IdentifiedObject
name	1..1	string	see IdentifiedObject

4.2.61 RegularTimePoint

Core

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

– The first SequenceNumber for a schedule is 1. 0 is not an allowed value. The first time point is defined with SequenceNumber = 1.

Native Members

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.
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.

IntervalSchedule	1..1	RegularIntervalSchedule	Regular interval schedule containing this time point.

4.2.62 RegulatingControl

Wires

Specifies a set of equipment that works together to control a power system quantity such as voltage or flow.

The attributes targetRange and targetValue are not required if an associated RegulationSchedule is provided.

Native Members

discrete	1..1	boolean	The regulation is performed in a discrete mode.
mode	1..1	RegulatingControlModeKind	The regulating control mode presently available. This specifications allows for determining the kind of regualation without need for obtaining the units from a schedule.
targetRange	0..1	float	This is the case input target range. This performs the same function as the value2 attribute on the regulation schedule in the case that schedules are not used. The units of those appropriate for the mode.
targetValue	0..1	float	The target value specified for case input. This value can be used for the target value wihout the use of schedules. The value has the units appropriate to the mode attribute.
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 (bus in bus-branch model) or a connectivity node

			(detailed switch model). Sometimes it is useful to model regulation at a terminal of a bus bar object since the bus bar can be present in both a bus-branch model or a model with switch detail.

Inherited Members

aliasName	0..1	string	see IdentifiedObject
name	1..1	string	see IdentifiedObject

4.2.63 RegulationSchedule

Wires

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

– By convention, value1 represents the target voltage or real power. value2 is the deviation. A value1 of 100 and value2 of 1 means regulating to 100 kV plus or minus 1 kV. The range would be from 99 kV to 101 kV. Because the regulation values will be specified in either kV for voltage or MW for real power, the value1Multiplier and value2Multiplier attributes do not need to be specified.

Native Members

RegulatingControl	1..1	RegulatingControl	Regulating controls that have this Schedule.

Inherited Members

DayType	1..1	DayType	see SeasonDayTypeSchedule
Season	1..1	Season	see SeasonDayTypeSchedule

endTime	1..1	dateTime	see RegularIntervalSchedule
timeStep	1..1	Seconds	see RegularIntervalSchedule

startTime	1..1	dateTime	see BasicIntervalSchedule
value1Unit	1..1	UnitSymbol	see BasicIntervalSchedule
value2Unit	0..1	UnitSymbol	see BasicIntervalSchedule

aliasName	0..1	string	see IdentifiedObject
name	1..1	string	see IdentifiedObject

4.2.64 Season

LoadModel

A specified time period of the year.

– To specify a relative date as the startDate or endDate for a Season, the year component of the ISO 8601 date format (YYYY-MM-DD) can be omitted. The resulting format would be MM-DD.

Native Members

endDate	1..1	dateTime	Date season ends.
name	1..1	SeasonName	Name of the season.
startDate	1..1	dateTime	Date season starts.

4.2.65 SeriesCompensator

Wires

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

Native Members

r	1..1	Resistance	Positive sequence resistance.
r0	0..1	Resistance	Zero sequence resistance.
x	1..1	Reactance	Positive sequence reactance.
x0	0..1	Reactance	Zero sequence reactance.

Inherited Members

BaseVoltage	0..1	BaseVoltage	see ConductingEquipment

aggregate	0..1	boolean	see Equipment
EquipmentContainer	0..1	EquipmentContainer	see Equipment

aliasName	0..1	string	see IdentifiedObject
name	1..1	string	see IdentifiedObject

4.2.66 ShuntCompensator

Wires

A shunt capacitor or reactor or switchable bank of shunt capacitors or reactors. A section of a shunt compensator is an individual capacitor or reactor. A negative value for reactivePerSection indicates that the compensator is a reactor. ShuntCompensator is a single terminal device. Ground is implied.

– If the reactivePerSection attribute is positive, the Compensator is a capacitor. If the value is negative, the Compensator is a reactor.

– Attributes b0PerSection and g0PerSection are not required.

Native Members

b0PerSection	0..1	Susceptance	Zero sequence shunt (charging) susceptance per section
bPerSection	1..1	Susceptance	Positive sequence shunt (charging) susceptance per section
g0PerSection	0..1	Conductance	Zero sequence shunt (charging) conductance per section
gPerSection	1..1	Conductance	Positive sequence shunt (charging) conductance per section
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

Inherited Members

RegulatingControl	0..1	RegulatingControl	see RegulatingCondEq

BaseVoltage	0..1	BaseVoltage	see ConductingEquipment

aggregate	0..1	boolean	see Equipment
EquipmentContainer	0..1	EquipmentContainer	see Equipment

aliasName	0..1	string	see IdentifiedObject
name	1..1	string	see IdentifiedObject

4.2.67 StaticVarCompensator

Wires

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.

– The value of the inductiveRating attribute shall always be negative.

– The value of the capactiveRating attribute shall always be positive.

Native Members

capacitiveRating	1..1	Reactance	Maximum available capacitive reactance.
inductiveRating	1..1	Reactance	Maximum available inductive reactance.
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.
sVCControlMode	1..1	SVCControlMode	SVC control mode.
voltageSetPoint	1..1	Voltage	The reactive power output of the SVC is proportional to the difference between the voltage at the regulated bus and the voltage setpoint. When the regulated bus voltage is equal to the voltage setpoint, the reactive power output is zero.

Inherited Members

RegulatingControl	0..1	RegulatingControl	see RegulatingCondEq

BaseVoltage	0..1	BaseVoltage	see ConductingEquipment

aggregate	0..1	boolean	see Equipment
EquipmentContainer	0..1	EquipmentContainer	see Equipment

aliasName	0..1	string	see IdentifiedObject
name	1..1	string	see IdentifiedObject

4.2.68 StationSupply

LoadModel

Station supply with load derived from the station output.

– See EnergyConsumer for specific notes about inherited attributes.

Inherited Members

pfixed	0..1	ActivePower	see EnergyConsumer
pfixedPct	0..1	PerCent	see EnergyConsumer
qfixed	0..1	ReactivePower	see EnergyConsumer
qfixedPct	0..1	PerCent	see EnergyConsumer
LoadResponse	0..1	LoadResponseCharacteristic	see EnergyConsumer

BaseVoltage	0..1	BaseVoltage	see ConductingEquipment

aggregate	0..1	boolean	see Equipment
EquipmentContainer	0..1	EquipmentContainer	see Equipment

aliasName	0..1	string	see IdentifiedObject
name	1..1	string	see IdentifiedObject

4.2.69 SubGeographicalRegion

Core

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

Native Members

Region	1..1	GeographicalRegion	The geographical region to which this sub-geographical region is within.

Inherited Members

aliasName	0..1	string	see IdentifiedObject
name	1..1	string	see IdentifiedObject

4.2.70 SubLoadArea

LoadModel

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

Native Members

LoadArea	1..1	LoadArea	The LoadArea where the SubLoadArea belongs.

Inherited Members

aliasName	0..1	string	see IdentifiedObject
name	1..1	string	see IdentifiedObject

4.2.71 Substation

Core

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.

Native Members

Region	1..1	SubGeographicalRegion	The sub-geographical containing the the substation.

Inherited Members

aliasName	0..1	string	see IdentifiedObject
name	1..1	string	see IdentifiedObject

4.2.72 Switch

Wires

A generic device designed to close, or open, or both, one or more electric circuits.

Native Members

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 measurment 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.
retained	1..1	boolean	Branch is retained in a bus branch model.

Inherited Members

BaseVoltage	0..1	BaseVoltage	see ConductingEquipment

aggregate	0..1	boolean	see Equipment
EquipmentContainer	0..1	EquipmentContainer	see Equipment

aliasName	0..1	string	see IdentifiedObject
name	1..1	string	see IdentifiedObject

4.2.73 SwitchSchedule

Wires

A schedule of switch positions. If RegularTimePoint.value1 is 0, the switch is open. If 1, the switch is closed.

Native Members

Switch	1..1	Switch	A SwitchSchedule is associated with a Switch.

Inherited Members

DayType	1..1	DayType	see SeasonDayTypeSchedule
Season	1..1	Season	see SeasonDayTypeSchedule

endTime	1..1	dateTime	see RegularIntervalSchedule
timeStep	1..1	Seconds	see RegularIntervalSchedule

startTime	1..1	dateTime	see BasicIntervalSchedule
value1Unit	1..1	UnitSymbol	see BasicIntervalSchedule
value2Unit	0..1	UnitSymbol	see BasicIntervalSchedule

aliasName	0..1	string	see IdentifiedObject
name	1..1	string	see IdentifiedObject

4.2.74 SynchronousMachine

Wires

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.

- If a SynchronousMachine is not associated with a ReactiveCapabilityCurve, then the minQ and maxQ attributes will be used.
- If a ReactiveCapabilityCurve is supplied, then the minQ and maxQ attributes are not required.
- If a synchronous condenser is being modeled so that there is no capability for real power output, the SynchronousMachine is not required to be associated with a GeneratingUnit. In this case, the type and operatingMode attributes shall both be set to condenser.
- Attributes qPercent, r, r0, r2, x, x0, x2, ratedS and referencePriority are not required.

Native Members

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.
operatingMode	1..1	SynchronousMachine OperatingMode	Current mode of operation.
qPercent	0..1	PerCent	Percent of the coordinated reactive control that comes from this machine.
r	0..1	Resistance	Positive sequence resistance of the synchronous machine.
r0	0..1	Resistance	Zero sequence resistance of the synchronous machine.
r2	0..1	Resistance	Negative sequence resistance.
referencePriority	0..1	integer	Priority of unit for use as powerflow voltage phase angle reference bus selection. 0 = don t care (default) 1 = highest priority. 2 is less than 1 and so on.
type	1..1	SynchronousMachine Type	Modes that this synchronous machine can operate in.
x	0..1	Reactance	Positive sequence reactance of the synchronous machine.
x0	0..1	Reactance	Zero sequence reactance of the synchronous machine.
x2	0..1	Reactance	Negative sequence reactance.
GeneratingUnit	0..1	GeneratingUnit	A synchronous machine may operate as a generator and as such becomes a member of a generating unit.
InitialReactiveCapabilityCurve	0..1	ReactiveCapabilityCurve	The default reactive capability curve for use by a synchronous machine.

Inherited Members

ratedS	0..1	ApparentPower	see RotatingMachine

RegulatingControl	0..1	RegulatingControl	see RegulatingCondEq

BaseVoltage	0..1	BaseVoltage	see ConductingEquipment

aggregate	0..1	boolean	see Equipment
EquipmentContainer	0..1	EquipmentContainer	see Equipment

aliasName	0..1	string	see IdentifiedObject
name	1..1	string	see IdentifiedObject

4.2.75 TapChangerControl

Wires

Discribes 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.

Inherited Members

discrete	1..1	boolean	see RegulatingControl
mode	1..1	RegulatingControlModeKind	see RegulatingControl
targetRange	0..1	float	see RegulatingControl
targetValue	0..1	float	see RegulatingControl
Terminal	1..1	Terminal	see RegulatingControl

aliasName	0..1	string	see IdentifiedObject
name	1..1	string	see IdentifiedObject

4.2.76 TapSchedule

Wires

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

Native Members

TapChanger	1..1	TapChanger	A TapSchedule is associated with a TapChanger.

Inherited Members

DayType	1..1	DayType	see SeasonDayTypeSchedule
Season	1..1	Season	see SeasonDayTypeSchedule

endTime	1..1	dateTime	see RegularIntervalSchedule
timeStep	1..1	Seconds	see RegularIntervalSchedule

startTime	1..1	dateTime	see

			BasicIntervalSchedule
value1Unit	1..1	UnitSymbol	see BasicIntervalSchedule
value2Unit	0..1	UnitSymbol	see BasicIntervalSchedule

aliasName	0..1	string	see IdentifiedObject
name	1..1	string	see IdentifiedObject

4.2.77 Terminal

Core

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

Native Members

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.
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.
ConnectivityNode	1..1	ConnectivityNode	The connectivity node to which this terminal connects with zero impedance.

Inherited Members

aliasName	0..1	string	see IdentifiedObject
name	1..1	string	see IdentifiedObject

4.2.78 ThermalGeneratingUnit

Production

A generating unit whose prime mover could be a steam turbine, combustion turbine, or diesel engine.

Inherited Members

genControlSource	0..1	GeneratorControlSource	see GeneratingUnit
governorSCD	0..1	PerCent	see GeneratingUnit
initialP	1..1	ActivePower	see GeneratingUnit
longPF	0..1	float	see GeneratingUnit
maximumAllowableSpinningReserve	0..1	ActivePower	see GeneratingUnit
maxOperatingP	1..1	ActivePower	see GeneratingUnit
minOperatingP	1..1	ActivePower	see GeneratingUnit
nominalP	0..1	ActivePower	see GeneratingUnit
normalPF	0..1	float	see GeneratingUnit
ratedGrossMaxP	0..1	ActivePower	see GeneratingUnit
ratedGrossMinP	0..1	ActivePower	see GeneratingUnit
ratedNetMaxP	0..1	ActivePower	see GeneratingUnit
shortPF	0..1	float	see GeneratingUnit
startupCost	0..1	Money	see GeneratingUnit
variableCost	0..1	Money	see GeneratingUnit

aggregate	0..1	boolean	see Equipment
EquipmentContainer	0..1	EquipmentContainer	see Equipment

aliasName	0..1	string	see IdentifiedObject
name	1..1	string	see IdentifiedObject

4.2.79 TieFlow

ControlArea

A flow specification in terms of location and direction for a control area.

Native Members

positiveFlowIn	1..1	boolean	The flow is positive into the terminal. A flow is positive if it is an import into the control area.
ControlArea	1..1	ControlArea	The control area of the tie flows.
Terminal	1..1	Terminal	The terminal to which this tie flow belongs.

4.2.80 VoltageLevel

Core

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

– The attributes highVoltageLimit and lowVoltageLimit are not required.

Native Members

highVoltageLimit	0..1	Voltage	The bus bar's high voltage limit.
lowVoltageLimit	0..1	Voltage	The bus bar's low voltage limit.
BaseVoltage	1..1	BaseVoltage	The base voltage used for all equipment within the voltage level.
Substation	1..1	Substation	The substation of the voltage level.

Inherited Members

aliasName	0..1	string	see IdentifiedObject
name	1..1	string	see IdentifiedObject

4.2.81 VoltageLimit

OperationalLimits

Operational limit applied to voltage.

Native Members

value	1..1	Voltage	Limit on voltage. High or low limit nature of the limit depends upon the properties of the operational limit type.

Inherited Members

OperationalLimitSet	1..1	OperationalLimitSet	see OperationalLimit
OperationalLimitType	1..1	OperationalLimitType	see OperationalLimit

aliasName	0..1	string	see IdentifiedObject
name	1..1	string	see IdentifiedObject

4.2.82 WindGeneratingUnit

Production

A wind driven generating unit.

Inherited Members

genControlSource	0..1	GeneratorControlSource	see GeneratingUnit
governorSCD	0..1	PerCent	see GeneratingUnit
initialP	1..1	ActivePower	see GeneratingUnit
longPF	0..1	float	see GeneratingUnit
maximumAllowableSpinningReserve	0..1	ActivePower	see GeneratingUnit
maxOperatingP	1..1	ActivePower	see GeneratingUnit
minOperatingP	1..1	ActivePower	see GeneratingUnit
nominalP	0..1	ActivePower	see GeneratingUnit

normalPF	0..1	float	see GeneratingUnit
ratedGrossMaxP	0..1	ActivePower	see GeneratingUnit
ratedGrossMinP	0..1	ActivePower	see GeneratingUnit
ratedNetMaxP	0..1	ActivePower	see GeneratingUnit
shortPF	0..1	float	see GeneratingUnit
startupCost	0..1	Money	see GeneratingUnit
variableCost	0..1	Money	see GeneratingUnit

aggregate	0..1	boolean	see Equipment
EquipmentContainer	0..1	EquipmentContainer	see Equipment

aliasName	0..1	string	see IdentifiedObject
name	1..1	string	see IdentifiedObject

4.3 Abstract Classes

4.3.1 BasicIntervalSchedule

Core

Schedule of values at points in time.

Native Members

startTime	1..1	dateTime	The time for the first time point.
value1Unit	1..1	UnitSymbol	Value1 units of measure.
value2Unit	0..1	UnitSymbol	Value2 units of measure.

Inherited Members

aliasName	0..1	string	see IdentifiedObject
name	1..1	string	see IdentifiedObject

4.3.2 ConductingEquipment

Core

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

Native Members

BaseVoltage	0..1	BaseVoltage	Base voltage of this conducting equipment. Use only when there is no voltage level container used and only one base vltage applies. For example, not used for transformers.

Inherited Members

aggregate	0..1	boolean	see Equipment
EquipmentContainer	0..1	EquipmentContainer	see Equipment

aliasName	0..1	string	see IdentifiedObject
name	1..1	string	see IdentifiedObject

4.3.3 Conductor

Wires

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

Native Members

length	0..1	Length	Segment length for calculating line section capabilities

Inherited Members

BaseVoltage	0..1	BaseVoltage	see ConductingEquipment

aggregate	0..1	boolean	see Equipment
EquipmentContainer	0..1	EquipmentContainer	see Equipment

aliasName	0..1	string	see IdentifiedObject
name	1..1	string	see IdentifiedObject

4.3.4 ConnectivityNodeContainer

Core

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

Inherited Members

aliasName	0..1	string	see IdentifiedObject
name	1..1	string	see IdentifiedObject

4.3.5 Curve

Core

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

Native Members

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.

Inherited Members

aliasName	0..1	string	see IdentifiedObject
name	1..1	string	see IdentifiedObject

4.3.6 EnergyArea

LoadModel

The class describes an area having energy production or consumption.

Inherited Members

aliasName	0..1	string	see IdentifiedObject
name	1..1	string	see IdentifiedObject

4.3.7 Equipment

Core

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

Native Members

aggregate	0..1	boolean	The single instance of equipment represents multiple pieces of equipment that have been modeled together as an aggregate. Examples would be power transformers or sychronous machines operating in parallel modeled as a single aggregate power transformer or aggregate synchronous machine. This is not to be used to indicate equipment that is part of a group of interdependent equipment produced by a network production program.
EquipmentContainer	0..1	EquipmentContainer	Container of this equipment.

Inherited Members

aliasName	0..1	string	see IdentifiedObject
name	1..1	string	see IdentifiedObject

4.3.8 EquipmentContainer

Core

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

Inherited Members

aliasName	0..1	string	see IdentifiedObject
name	1..1	string	see IdentifiedObject

4.3.9 EquivalentEquipment

Equivalents

The class represents equivalent objects that are the result of a network reduction. The class is the base for equivalent objects of different types.

Native Members

EquivalentNetwork	1..1	EquivalentNetwork	The equivalent where the reduced model belongs.

Inherited Members

BaseVoltage	0..1	BaseVoltage	see ConductingEquipment

aggregate	0..1	boolean	see Equipment
EquipmentContainer	0..1	EquipmentContainer	see Equipment

aliasName	0..1	string	see IdentifiedObject
name	1..1	string	see IdentifiedObject

4.3.10 IdentifiedObject

Core

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

Native Members

aliasName	0..1	string	The aliasName is free text human readable name of the object alternative to IdentifiedObject.name. It may be non unique and may not correlate to a naming hierarchy. The attribute aliasName is retained because of

			backwards compatibility between CIM relases. It is however recommended to replace aliasName with the Name class as aliasName is planned for retirement at a future time.
name	1..1	string	The name is any free human readable and possibly non unique text naming the object.

4.3.11 LoadGroup

LoadModel

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

Native Members

SubLoadArea	1..1	SubLoadArea	The SubLoadArea where the Loadgroup belongs.

Inherited Members

aliasName	0..1	string	see IdentifiedObject
name	1..1	string	see IdentifiedObject

4.3.12 Measurement

Meas

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 leafs, 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 (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.

Native Members

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.
unitMultiplier	1..1	UnitMultiplier	The unit multiplier of the measured quantity.
unitSymbol	1..1	UnitSymbol	The unit of measure of the measured quantity.
PowerSystemResource	1..1	PowerSystemResource	The power system resource that contains the measurement.
Terminal	0..1	Terminal	One or more measurements may be associated with a terminal in the network.

Inherited Members

aliasName	0..1	string	see IdentifiedObject
name	1..1	string	see IdentifiedObject

4.3.13 MeasurementValue

Meas

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.

Native Members

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.

Inherited Members

aliasName	0..1	string	see IdentifiedObject
name	1..1	string	see IdentifiedObject

4.3.14 OperationalLimit

OperationalLimits

A value associated with a specific kind of limit.

Native Members

OperationalLimitSet	1..1	OperationalLimitSet	The limit set to which the limit values belong.
OperationalLimitType	1..1	OperationalLimitType	The limit type associated with this limit.

Inherited Members

aliasName	0..1	string	see IdentifiedObject
name	1..1	string	see IdentifiedObject

4.3.15 PhaseTapChanger

Wires

A transformer phase shfiting tap model that controls the phase angle difference across the power transformer and potentially the activer power flow through the power transformer. This phase tap model may also impact the voltage magnitude.

Native Members

PhaseTapChangerTabular	0..1	PhaseTapChangerTabular	The phase tap changer table for this phase tap changer.
TransformerEnd	1..1	TransformerEnd	Transformer end to which this phase tap changer belongs.

Inherited Members

highStep	0..1	integer	see TapChanger
lowStep	0..1	integer	see TapChanger
ltcFlag	1..1	boolean	see TapChanger
neutralStep	0..1	integer	see TapChanger
neutralU	1..1	Voltage	see TapChanger
normalStep	0..1	integer	see TapChanger
regulationStatus	0..1	boolean	see TapChanger
TapChangerControl	0..1	TapChangerControl	see TapChanger

aliasName	0..1	string	see IdentifiedObject
name	1..1	string	see IdentifiedObject

4.3.16 PhaseTapChangerNonLinear

Wires

The non-linear phase tap changer describes the non-linear behavior 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.

Native Members

voltageStepIncrement	1..1	PerCent	The voltage step increment on the out of phase winding specified in percent of nominal voltage of the transformer end.
xMax	1..1	Reactance	The reactance at the maximum tap step.
xMedian	1..1	Reactance	The reactance at the mid tap step.

Inherited Members

PhaseTapChangerTabular	0..1	PhaseTapChangerTabular	see PhaseTapChanger
TransformerEnd	1..1	TransformerEnd	see PhaseTapChanger

highStep	0..1	integer	see TapChanger
lowStep	0..1	integer	see TapChanger
ltcFlag	1..1	boolean	see TapChanger
neutralStep	0..1	integer	see TapChanger
neutralU	1..1	Voltage	see TapChanger
normalStep	0..1	integer	see TapChanger
regulationStatus	0..1	boolean	see TapChanger
TapChangerControl	0..1	TapChangerControl	see TapChanger

aliasName	0..1	string	see IdentifiedObject
name	1..1	string	see IdentifiedObject

4.3.17 PowerSystemResource

Core

A power system resource 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.

Inherited Members

aliasName	0..1	string	see IdentifiedObject
name	1..1	string	see IdentifiedObject

4.3.18 RegularIntervalSchedule

Core

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

Native Members

endTime	1..1	dateTime	The time for the last time point.
timeStep	1..1	Seconds	The time between each pair of subsequent regular time points in sequence order.

Inherited Members

startTime	1..1	dateTime	see BasicIntervalSchedule
value1Unit	1..1	UnitSymbol	see BasicIntervalSchedule
value2Unit	0..1	UnitSymbol	see BasicIntervalSchedule

aliasName	0..1	string	see IdentifiedObject
name	1..1	string	see IdentifiedObject

4.3.19 RegulatingCondEq

Wires

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

Native Members

RegulatingControl	0..1	RegulatingControl	The regulating control scheme in which this equipment participates.

Inherited Members

BaseVoltage	0..1	BaseVoltage	see ConductingEquipment

aggregate	0..1	boolean	see Equipment
EquipmentContainer	0..1	EquipmentContainer	see Equipment

aliasName	0..1	string	see IdentifiedObject
name	1..1	string	see IdentifiedObject

4.3.20 RotatingMachine

Wires

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

Native Members

ratedS	0..1	ApparentPower	Nameplate apparent power rating for the

			unit.

Inherited Members

RegulatingControl	0..1	RegulatingControl	see RegulatingCondEq
BaseVoltage	0..1	BaseVoltage	see ConductingEquipment
aggregate	0..1	boolean	see Equipment
EquipmentContainer	0..1	EquipmentContainer	see Equipment
aliasName	0..1	string	see IdentifiedObject
name	1..1	string	see IdentifiedObject

4.3.21 SeasonDayTypeSchedule

LoadModel

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

Native Members

DayType	1..1	DayType	DayType for the Schedule.
Season	1..1	Season	Season for the Schedule.

Inherited Members

endTime	1..1	dateTime	see RegularIntervalSchedule
timeStep	1..1	Seconds	see RegularIntervalSchedule
startTime	1..1	dateTime	see BasicIntervalSchedule
value1Unit	1..1	UnitSymbol	see BasicIntervalSchedule
value2Unit	0..1	UnitSymbol	see BasicIntervalSchedule
aliasName	0..1	string	see IdentifiedObject
name	1..1	string	see IdentifiedObject

4.3.22 TapChanger

Wires

Mechanism for changing transformer winding tap positions.

– The attribute ltcflag specifies whether or not a TapChanger has load tap changing capabilities. If the ltcFlag is true, the attributes highStep, lowStep, neutralStep, and normalStep are all required.

Native Members

highStep	0..1	integer	Highest possible tap step position, advance from neutral
lowStep	0..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	0..1	integer	The neutral tap step position for this winding
neutralU	1..1	Voltage	Voltage at which the winding operates at the neutral tap setting
normalStep	0..1	integer	The tap step position used in "normal" network operation for this winding. For a "Fixed" tap changer indicates the current physical tap setting
regulationStatus	0..1	boolean	Specifies the default regulation status of the TapChanger. True is regulating. False is not regulating
TapChangerControl	0..1	TapChangerControl	The regulating control scheme in which this tap changer participates

Inherited Members

aliasName	0..1	string	see IdentifiedObject
name	1..1	string	see IdentifiedObject

4.3.23 TransformerEnd

Wires

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.

– The attributes rground and xground are not required.

Native Members

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.
rground	0..1	Resistance	(for Yn and Zn connections) Resistance part of neutral impedance where 'grounded' is true.
xground	0..1	Reactance	(for Yn and Zn connections) Reactive part of neutral impedance where 'grounded' is true.
BaseVoltage	0..1	BaseVoltage	Base voltage of the transformer end. This is essential for PU calculation.
Terminal	1..1	Terminal	Terminal of the power transformer to which this transformer end belongs.

Inherited Members

aliasName	0..1	string	see IdentifiedObject
name	1..1	string	see IdentifiedObject

4.4 Enumerations

4.4.1 ControlAreaTypeKind

ControlArea

The type of control area.

AGC	Used for automatic generatoin control.
Forecast	Used for load forecast.
Interchange	Used for interchange specification or control.

4.4.2 CurveStyle

Core

Style or shape of curve.

constantYValue	The Y-axis values are assumed constant until the next curve point and prior to the first curve point.
formula	An unspecified formula is assumed to compute the Y-axis value between points.
rampYValue	The Y-axis values are assumed to ramp between points.
straightLineYValues	The Y-axis values are assumed to be a straight line between values. Also known as linear interpolation.

4.4.3 FuelType

Production

Type of fuel.

coal	Generic coal, not including lignite type.
gas	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.
oil	Oil.

4.4.4 GeneratorControlSource

Production

The source of controls for a generating unit.

offAGC	Off of automatic generation control (AGC).
onAGC	On automatic generation control (AGC).
plantControl	Plant is controlling
unavailable	Not available

4.4.5 OperationalLimitDirectionKind

OperationalLimits

The direction of an operational limit.

absoluteValue	If the absolute value of the monitored value is above the limit value, the limit is violated. In effect, the limit is both a high limit and its negative a low limit.
high	The limit is a high limit. If applied to a terminal flow, the positive direction is into the terminal.
low	The limit is a low limit. If applied to a terminal flow, the positive direction is into the terminal.

4.4.6 RegulatingControlModeKind

Wires

The kind of regulation model. For example regulating voltage, reactive power, active power, etc.

activePower	Active power is specified.
admittance	Admittance is specified.
currentFlow	Current flow is specified.
fixed	The regulation mode is fixed, and thus not regulating.
powerFactor	Power factor is specified.
reactivePower	Reactive power is specified.
temperature	Control switches on/off based on the local temperature (i.e., a thermostat).
timeScheduled	Control switches on/off by time of day. The times may change on the weekend, or in different seasons.
voltage	Voltage is specified.

4.4.7 SeasonName

LoadModel

Name of season.

fall	Fall.
spring	Spring.
summer	Summer.
winter	Winter.

4.4.8 SVCControlMode

Wires

Static VAr Compensator control mode.

off
reactivePower
voltage

4.4.9 SynchronousMachineOperatingMode

Wires

Synchronous machine operating mode.

condenser
generator

4.4.10 SynchronousMachineType

Wires

Synchronous machine type.

condenser
generator
generator_or_condenser

4.4.11 TapChangerKind

Wires

Transformer tap changer type. Indicates the capabilities of the tap changer independent of the operating mode.

fixed	Not capable of control. This is also indicated by by no association of TapChanger to a RegulatingControl.
phaseControl	Capable of phase control.
voltageAndPhaseControl	Capable of voltage and phase control.
voltageControl	Capable of voltage control.

4.4.12 TransformerControlMode

Wires

Control modes for a transformer.

reactive	Reactive power flow control
volt	Voltage control

4.4.13 UnitSymbol

Domain

The units defiend for usage in the CIM.

A	Current in ampere.
F	Capacitance in farad.
H	Inductance in henry.
Hz	Frequency in hertz.
J	Energy in joule.
N	Force in newton.
Pa	Pressure in pascal (n/m2).
S	Conductance in siemens.
V	Voltage in volt.
VA	Apparent power in volt ampere.
VAh	Apparent energy in volt ampere hours.
VAr	Reactive power in volt ampere reactive.
VArh	Reactive energy in volt ampere reactive hours.
W	Active power in watt.