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**Schnittstelle für Anwendungsprogramme für Netzführungssysteme
(EMS-API) –****Teil 452: CIM-Statische-Übertragungsnetzwerk-Modell-Profile
(IEC 61970-452:2013);****Englische Fassung EN 61970-452:2013**

Energy management system application program interface (EMS-API) –

Part 452: CIM Static transmission network model profiles

(IEC 61970-452:2013);

English version EN 61970-452:2013

Interface de programmation d'application pour système de gestion d'énergie (EMS-API) –

Partie 452: Profils du modèle de réseau de transport statique CIM

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English version

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Comité Européen de Normalisation Electrotechnique
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Foreword

The text of document 57/1366/FDIS, future edition 1 of IEC 61970-452, prepared by IEC/TC 57 "Power systems management and associated information exchange" was submitted to the IEC-CENELEC parallel vote and approved by CENELEC as EN 61970-452:2013.

The following dates are fixed:

- latest date by which the document has to be implemented at national level by publication of an identical national standard or by endorsement (dop) 2014-06-20
- latest date by which the national standards conflicting with the document have to be withdrawn (dow) 2016-09-16

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Endorsement notice

The text of the International Standard IEC 61970-452:2013 was approved by CENELEC as a European Standard without any modification.

In the official version, for Bibliography, the following note has to be added for the standard indicated :

IEC 61970-552 NOTE Harmonised as EN 61970-552.

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INTRODUCTION

This international standard is one of the IEC 61970 series that define an application program interface (API¹) for an energy management system (EMS²).

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 (CIM³) base, and draft standard IEC 61970-302: Common Information Model (CIM) Financial, EnergyScheduling, and Reservation.

This standard is one of the IEC 61970-4x series of Component Interface Standards that specify the functional requirements for interfaces that a component (or application) shall implement to exchange information with other components (or applications) and/or to access publicly available data in a standard way. The component interfaces describe the specific message contents and services that can be used by applications for this purpose. The implementation of these messages in a particular technology is described in IEC 61970-5.

This standard 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, 61970-552⁴, 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 61970-452 profile.

¹ Footnote 1 applies to the French version only.

² Footnote 2 applies to the French version only.

³ Footnote 3 applies to the French version only.

⁴ To be published.

1 Scope

This part of IEC 61970 forms part of the IEC 61907-450 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 0, 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 0.

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 0. 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.

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 the International Electrotechnical Vocabulary, IEC 60050.

IEC 61970-1, *Energy management system application program interface (EMS-API) – Part 1: Guidelines and general requirements*

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

IEC 61970-301, *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*

Overview of data requirements

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.

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 attributes of IdentifiedObject (aliasName, description, and pathName) are not required. If the pathName attribute is supplied it shall be constructed from the names in the GeographicalRegion / SubGeographicalRegion / Substation / VoltageLevel / ... hierarchy. A forward slash, “/”, shall be used as the separator between names.
- Although not defined within this profile, the IdentifiedObject.mRID attribute should be used as the RDF ID. The RDF ID cannot 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
 - IdentifiedObject.description – 256 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, Disconnecter, etc.) is not available.

Transformer modeling

A two winding PowerTransformer has two TransformerWindings. This gives the option to specify the impedance values for the equivalent pi-model completely at one of the windings or split them over the two windings. The impedances shall be specified at the primary voltage side as shown in Figure 1.

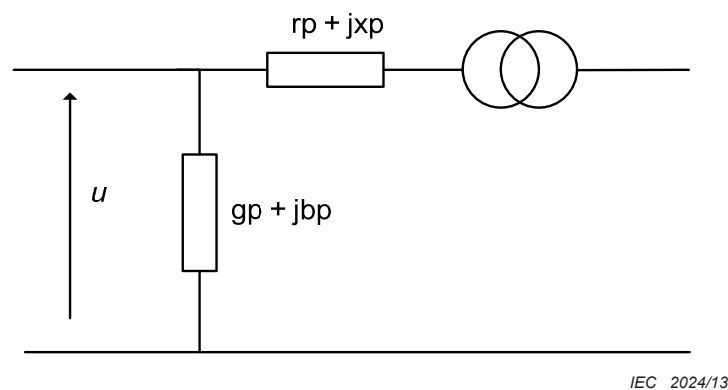


Figure 1 – Two winding transformer impedance

A three winding PowerTransformer has three TransformerWindings. The equivalent pi-model corresponds to three TransformerWindings 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 windings has series impedances $r_n + jx_n$ and shunt $g_n + jb_n$ where n is: p for primary, s for secondary and t for tertiary as shown in Figure 2.

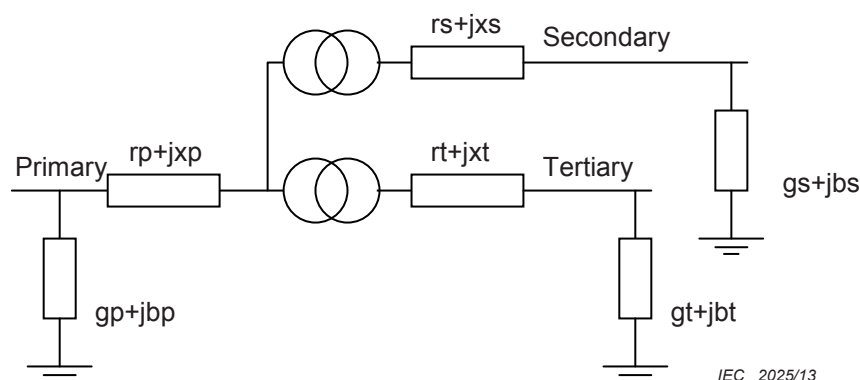


Figure 2 – Three winding transformer impedance

Additional requirements related to transformer modeling are listed below.

- Each PowerTransformer and its associated TransformerWindings, RatioTapChangers and PhaseTapChangers shall be contained within one substation. For the case of a transformer that connects two substations, however, the terminal of one of the TransformerWindings can be connected to a ConnectivityNode defined in another substation. In this case, the PowerTransformer, the TransformerWindings, the RatioTapChangers and the PhaseTapChangers are still all defined in one substation.
- A PowerTransformer shall be contained by a Substation. A TransformerWinding shall be contained by a PowerTransformer. A RatioTapChanger and a PhaseTapChanger shall be contained by a TransformerWinding.
- Each PowerTransformer shall have at least two and no more than three TransformerWindings. Each TransformerWinding can have at most one RatioTapChanger or PhaseTapChanger. If a TransformerWinding does not have an associated RatioTapChanger or PhaseTapChanger, the winding 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 either the RatioTapChanger class or the PhaseTapChanger class. Both of these classes are subtypes of the TapChanger class. The use of the various subtypes is explained in IEC 61970-301.

Modeling authorities

From the use cases for model exchange detailed in Annex A, it is clear that most situations involve multiple entities that must 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 the CIM includes classes called ModelingAuthority and ModelingAuthoritySet. 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.

For purposes of data exchange, the use of explicit associations between ModelingAuthoritySets and the objects in the model would create an unnecessary burden because of the potential file sizes and additional processing necessary. To avoid this situation, when using ModelingAuthoritySets, a single file shall contain only data objects associated with a single ModelingAuthoritySet.

Use of measurement classes

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 RatioTapChanger or with a PhaseTapChanger. 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, TransformerWinding, 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
Discrete	SwitchPosition

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 Name attribute is set to "ICCP" and the pathName holds the name of the supplying control center.

The MeasurementValue classes are used to specify the ICCP ID. The aliasName attribute is used to hold the ICCP ID and the 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.

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 or PhaseTapChanger) and an instance of RegulatingControl. The RegulatingControl shall be associated with a Terminal. The RegulatingControl for a piece of regulating equipment can refer to a Terminal associated with another PowerSystemResource. For instance, for voltage

regulation purposes the `RegulatingControl` for a `SynchronousMachine` could refer to a `Terminal` associated with a `BusbarSection`. The `Terminal` defines the point of regulation. The association between `RegulatingControl` and `Terminal` is required to define regulation of voltage or active power. For a `SynchronousMachine`, `ShuntCompensator`, `StaticVarCompensator`, `RatioTapChanger` or `PhaseTapChanger` that is not regulating, the association to `RegulatingControl` is not required.

Use of curves

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.

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.

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`.

CIM Equipment Profile

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	1	http://iec.ch/TC57/61970-452/Equipment/1	2010-05-24

Concrete Classes

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
PowerSystemResource	1..1	PowerSystemResource	see Measurement
Terminal	0..1	Terminal	see Measurement
Unit	1..1	Unit	see Measurement

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

AccumulatorValue

Meas

AccumulatorValue represents a accumulated (counted) MeasurementValue.

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
description	0..1	string	see IdentifiedObject
name	1..1	string	see IdentifiedObject
pathName	0..1	string	see IdentifiedObject

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.

- Each ACLineSegment is required to have an association to a BaseVoltage. The association to Line is not required.
- Using the MemberOf_EquipmentContainer association, an ACLineSegment can only be contained by a Line, but the association to Line is not required.
- Attributes b0ch, g0ch, gch, r0, and x0 are for short circuit only and are 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
description	0..1	string	see IdentifiedObject
name	1..1	string	see IdentifiedObject
pathName	0..1	string	see IdentifiedObject

ActivePowerLimit

OperationalLimits

Limit on active power flow.

Native Members

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

Inherited Members

type	1..1	string	see OperationalLimit
OperationalLimitSet	1..1	OperationalLimitSet	see OperationalLimit

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

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	1..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
PowerSystemResource	1..1	PowerSystemResource	see Measurement
Terminal	0..1	Terminal	see Measurement
Unit	1..1	Unit	see Measurement

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

AnalogValue

Meas

AnalogValue represents an analog MeasurementValue.

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
description	0..1	string	see IdentifiedObject
name	1..1	string	see IdentifiedObject
pathName	0..1	string	see IdentifiedObject

ApparentPowerLimit

OperationalLimits

Apparent power limit.

Native Members

value	1..1	ApparentPower	The apparent power limit.
-------	------	---------------	---------------------------

Inherited Members

type	1..1	string	see OperationalLimit
OperationalLimitSet	1..1	OperationalLimitSet	see OperationalLimit

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

BaseVoltage

Core

Defines a nominal base voltage which is referenced in the system.

Native Members

nominalVoltage	1..1	Voltage	The PowerSystemResource's base voltage.
----------------	------	---------	---

Inherited Members

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

Bay

Core

A collection of power system resources (within a given substation) including conducting equipment, protection relays, measurements, and telemetry.

- 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 association is used in the naming hierarchy.
--------------	------	--------------	--

Inherited Members

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

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.

Native Members

ratedCurrent	0..1	CurrentFlow	Fault interrupting current rating.
--------------	------	-------------	------------------------------------

Inherited Members

normalOpen	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
description	0..1	string	see IdentifiedObject
name	1..1	string	see IdentifiedObject
pathName	0..1	string	see IdentifiedObject

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
description	0..1	string	see IdentifiedObject
name	1..1	string	see IdentifiedObject
pathName	0..1	string	see IdentifiedObject

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 pfixed 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
description	0..1	string	see IdentifiedObject
name	1..1	string	see IdentifiedObject
pathName	0..1	string	see IdentifiedObject

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
description	0..1	string	see IdentifiedObject
name	1..1	string	see IdentifiedObject
pathName	0..1	string	see IdentifiedObject

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 MVA, 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	1..1	UnitSymbol	see BasicIntervalSchedule

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

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
description	0..1	string	see IdentifiedObject
name	1..1	string	see IdentifiedObject
pathName	0..1	string	see IdentifiedObject

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 definition used to determine if this is used for automatic generation control, for planning interchange control, or other purposes.
EnergyArea	1..1	EnergyArea	The energy area that is forecast from this control area specification.

Inherited Members

aliasName	0..1	string	see IdentifiedObject
-----------	------	--------	----------------------

description	0..1	string	see IdentifiedObject
name	1..1	string	see IdentifiedObject
pathName	0..1	string	see IdentifiedObject

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.

CurrentLimit

OperationalLimits

Operational limit on current.

Native Members

value	1..1	CurrentFlow	Limit on current flow.
-------	------	-------------	------------------------

Inherited Members

type	1..1	string	see OperationalLimit
OperationalLimitSet	1..1	OperationalLimitSet	see OperationalLimit
aliasName	0..1	string	see IdentifiedObject
description	0..1	string	see IdentifiedObject

name	1..1	string	see IdentifiedObject
pathName	0..1	string	see IdentifiedObject

CurveData

Core

Multi-purpose data points for defining a curve.

- The CurveData class is used to represent points for various curves that derive from the Curve class. The curves defined in this profile are:

GrossToNetActivePowerCurve

ReactiveCapabilityCurve

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	1..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 defined by this CurveData.

DayType

LoadModel

Group of similar days, e.g., Mon/Tue/Wed, Thu/Fri, Sat/Sun, Holiday1, Holiday2.

- 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
-----------	------	--------	----------------------

description	0..1	string	see IdentifiedObject
name	1..1	string	see IdentifiedObject
pathName	0..1	string	see IdentifiedObject

Disconnecter

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
------------	------	---------	------------

BaseVoltage	0..1	BaseVoltage	see ConductingEquipment
-------------	------	-------------	----------------------------

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

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

Discrete

Meas

Discrete represents a discrete Measurement, i.e. a Measurement representing 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
PowerSystemResource	1..1	PowerSystemResource	see Measurement
Terminal	0..1	Terminal	see Measurement
Unit	1..1	Unit	see Measurement

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

DiscreteValue

Meas

DiscreteValue represents a discrete MeasurementValue.

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
description	0..1	string	see IdentifiedObject
name	1..1	string	see IdentifiedObject
pathName	0..1	string	see IdentifiedObject

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 pfixed 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.
pfixedPct	0..1	PerCent	Fixed active power as per cent of load group fixed active power
qfixed	0..1	ReactivePower	Reactive power of the load that is a fixed quantity.
qfixedPct	0..1	PerCent	Fixed reactive power as per cent of load group fixed reactive power.
LoadResponse	0..1	LoadResponseCharacteristic	The load response characteristic of this load.

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
description	0..1	string	see IdentifiedObject
name	1..1	string	see IdentifiedObject
pathName	0..1	string	see IdentifiedObject

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
description	0..1	string	see IdentifiedObject
name	1..1	string	see IdentifiedObject
pathName	0..1	string	see IdentifiedObject

EquivalentInjection

Equivalents

This class represents equivalent injections (generation or load). Voltage regulation is allowed only at the local connectivity node.

Native Members

maxP	1..1	ActivePower	Maximum active power of the injection.
------	------	-------------	--

minP	1..1	ActivePower	Minimum 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
description	0..1	string	see IdentifiedObject
name	1..1	string	see IdentifiedObject
pathName	0..1	string	see IdentifiedObject

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
description	0..1	string	see IdentifiedObject
name	1..1	string	see IdentifiedObject
pathName	0..1	string	see IdentifiedObject

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
description	0..1	string	see IdentifiedObject
name	1..1	string	see IdentifiedObject
pathName	0..1	string	see IdentifiedObject

FossilFuel

Production

The fossil fuel consumed by the non-nuclear thermal generating units, e.g., coal, oil, gas

Native Members

fossilFuelType	1..1	FuelType	The type of fossil fuel, such as coal, oil, or gas.
----------------	------	----------	---

Inherited Members

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

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 economic participation factor
maximumAllowableSpinningReserve	0..1	ActivePower	Maximum allowable spinning reserve. Spinning reserve will never be considered greater than this value regardless of the current operating point.
maxOperatingP	1..1	ActivePower	This is the maximum operating active power limit the dispatcher can enter for this unit
minOperatingP	1..1	ActivePower	This is the minimum operating active power limit the dispatcher can enter for this unit.
nominalP	0..1	ActivePower	The nominal power of the generating unit. Used to give precise meaning to percentage based attributes such as the governor speed change droop (governorSCD attribute).