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Ersatz für
DIN EN 61970-301:2004-11
Siehe Anwendungsbeginn

**Schnittstelle für Anwendungsprogramme für Netzführungssysteme
(EMS-API) –****Teil 301: Allgemeines Informationsmodell (CIM), Basismodell
(IEC 61970-301:2011);****Englische Fassung EN 61970-301:2011**

Energy management system application program interface (EMS-API) –
Part 301: Common information model (CIM) base
(IEC 61970-301:2011);
English version EN 61970-301:2011

Interface de programmation d'application pour système de gestion d'énergie (EMS-API) –
Partie 301: Base de modèle d'information commun (CIM)
(CEI 61970-301:2011);
Version anglaise EN 61970-301:2011

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Anwendungsbeginn

Anwendungsbeginn für die von CENELEC am 2011-09-30 angenommene Europäische Norm als DIN-Norm ist 2012-03-01.

Für DIN EN 61970-301:2004-11 gilt eine Übergangsfrist bis zum 2014-09-30.

Nationales Vorwort

Vorausgegangener Norm-Entwurf: E DIN EN 61970-301:2008-02.

Für diese Norm ist das nationale Arbeitsgremium K 952 „Netzleittechnik“ der DKE Deutsche Kommission Elektrotechnik Elektronik Informationstechnik im DIN und VDE (www.dke.de) zuständig.

Die enthaltene IEC-Publikation wurde vom TC 57 „Power systems management and associated information exchange“ erarbeitet.

Das IEC-Komitee hat entschieden, dass der Inhalt dieser Publikation bis zu dem Datum (stability date) unverändert bleiben soll, das auf der IEC-Website unter „<http://webstore.iec.ch>“ zu dieser Publikation angegeben ist. Zu diesem Zeitpunkt wird entsprechend der Entscheidung des Komitees die Publikation

- bestätigt,
- zurückgezogen,
- durch eine Folgeausgabe ersetzt oder
- geändert.

Für den Fall einer undatierten Verweisung im normativen Text (Verweisung auf eine Norm ohne Angabe des Ausgabedatums und ohne Hinweis auf eine Abschnittsnummer, eine Tabelle, ein Bild usw.) bezieht sich die Verweisung auf die jeweils neueste gültige Ausgabe der in Bezug genommenen Norm.

Für den Fall einer datierten Verweisung im normativen Text bezieht sich die Verweisung immer auf die in Bezug genommene Ausgabe der Norm.

Der Zusammenhang der zitierten Normen mit den entsprechenden Deutschen Normen ergibt sich, soweit ein Zusammenhang besteht, grundsätzlich über die Nummer der entsprechenden IEC-Publikation. Beispiel: IEC 60068 ist als EN 60068 als Europäische Norm durch CENELEC übernommen und als DIN EN 60068 ins Deutsche Normenwerk aufgenommen.

Das Präsidium des DIN hat mit Präsidialbeschluss 1/2004 festgelegt, dass DIN-Normen, deren Inhalt sich auf internationale Arbeitsergebnisse der Informationsverarbeitung gründet, unter bestimmten Bedingungen allein in englischer Sprache veröffentlicht werden dürfen. Diese Bedingungen sind für die vorliegende Norm erfüllt.

Da sich die Nutzer der vorliegenden Norm der englischen Sprache als Fachsprache bedienen, wird die englische Fassung der IEC 61970-301 veröffentlicht. Zu deren Abschnitt 3, der die Begriffe festlegt, wurde eine Übersetzung angefertigt und als Nationaler Anhang NA der vorliegenden Norm hinzugefügt. Diese Norm steht nicht in unmittelbarem Zusammenhang mit Rechtsvorschriften und ist nicht als Sicherheitsnorm anzusehen.

Änderungen

Gegenüber DIN EN 61970-301:2004-11 wurden folgende Änderungen vorgenommen:

- a) partielle Eigentumsbeschreibungen hinzugefügt;
- b) Nicht-SI-Einheiten wurden in SI-Einheiten geändert;
- c) verschiedene editorielle Änderungen zur Korrektur des UML-Modells vorgenommen;
- d) neue Äquivalent-Einheit zum Modell des Äquivalentnetzwerkes hinzugefügt;
- e) neuer Kontrollbereich mit Lastprognose hinzugefügt;
- f) Erweiterung zur Unterstützung des Energieflusses „case input“ hinzugefügt;
- g) neue Kontingenz-Einheit zum Behandeln der Kontingenz hinzugefügt.

Frühere Ausgaben

DIN EN 61970-301: 2004-11

Nationaler Anhang NA (informativ)

NA.3 Begriffe

Für die Anwendung dieser Norm gelten die Begriffe nach IEC 61970-2 sowie die folgenden.

ANMERKUNG Für allgemeine Glossardefinitionen siehe das Internationale Elektrotechnische Wörterbuch IEC 60050.

3.1

energy management system (Energiemanagementsystem) EMS

Computersystem, das eine Softwareplattform für die grundlegenden Supportdienstleistungen und eine Reihe von Anwendungen zur Sicherstellung der Funktionalität der elektrischen Energieerzeugung und der Übertragungseinrichtungen beinhaltet, um eine angemessene Sicherheit der Energieversorgung bei minimalen Kosten zu sichern

3.2

application program interface (Anwendungsprogramm-Schnittstelle) API

eine Menge von öffentlichen Funktionen, die von einer ausführbaren Komponente zum Aufruf durch andere Anwendungskomponenten zur Verfügung gestellt wird

**Energy management system application program interface (EMS-API) -
Part 301: Common information model (CIM) base
(IEC 61970-301:2011)**

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pour système de gestion d'énergie
(EMS-API) -
Part 301: Base de modèle d'information
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für Netzführungssysteme (EMS-API) -
Teil 301: Allgemeines Informationsmodell
(CIM), Basismodell
(IEC 61970-301:2011)

This European Standard was approved by CENELEC on 2011-09-30. CENELEC members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the CEN-CENELEC Management Centre or to any CENELEC member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CENELEC member into its own language and notified to the CEN-CENELEC Management Centre has the same status as the official versions.

CENELEC members are the national electrotechnical committees of Austria, Belgium, Bulgaria, Croatia, Cyprus, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and the United Kingdom.

CENELEC

European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
Europäisches Komitee für Elektrotechnische Normung

Management Centre: Avenue Marnix 17, B - 1000 Brussels

Foreword

The text of document 57/1136/FDIS, future edition 3 of IEC 61970-301, 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 61970-301:2011.

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) 2012-06-30
- latest date by which the national standards conflicting with the document have to be withdrawn (dow) 2014-09-30

This document supersedes EN 61970-301:2004.

EN 61970-301:2011 includes the following significant technical changes with respect to EN 61970-301:2004:

- regulation control models were added with a new `RegulatingControl` class which provides the capability to model multiple equipments participating in a regulation scheme;
- new "OperationalLimits" package for equipment ratings;
- partial ownership specification added;
- `LoadResponseCharacteristic` class was enhanced to better model the characteristic response of the load demand due to changes in system conditions such as voltage and frequency;
- new `ControlArea` package added with load forecast and area interchange specifications;
- EPRI CIM for Planning project proposals to support the exchange of planning models were incorporated;
- branch group "interface" monitoring specification was added;
- composite switch model was changed to better model distribution use cases;
- extensions were added to support powerflow "case input" so that profiles are not required to use time based schedules and detailed connectivity (via new bus-branch model);
- new `Equivalents` package added to model equivalent networks;
- new `Contingency` package added to handle contingencies;
- various editorial changes to cleanup UML model;
- non-SI units have been changed to SI units.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CENELEC [and/or CEN] shall not be held responsible for identifying any or all such patent rights.

Endorsement notice

The text of the International Standard IEC 61970-301:2011 was approved by CENELEC as a European Standard without any modification.

In the official version, for Bibliography, the following notes have to be added for the standards indicated:

IEC 61850-7-3	NOTE Harmonized as EN 61850-7-3.
IEC 61968-11:2010	NOTE Harmonized as EN 61968-11:2010 (not modified).
IEC 61970-501	NOTE Harmonized as EN 61970-501.

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INTRODUCTION

This standard is one of several parts of the IEC 61970 series which define an application program interface (API) for an energy management system (EMS). This standard was originally based upon the work of the EPRI control center API (CCAPI) research project (RP-3654-1). The principle objectives of the EPRI CCAPI project were to

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

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

The common information model (CIM) specifies the semantics for this API. The component interface specifications (CIS), which are contained in other parts of the IEC 61970 standards, specify the content of the messages exchanged.

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

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

This standard defines the CIM base set of packages which provide a logical view of the functional aspects of an energy management system including SCADA. Other functional areas are standardized in separate IEC documents that augment and reference this base CIM standard. For example, IEC 61968-11 addresses distribution models and references this base CIM standard. While there are multiple IEC standards dealing with different parts of the CIM, there is a single, unified normalized information model comprising the CIM behind all these individual standard documents.

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

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

Part 301: Common information model (CIM) base

1 Scope

This part of IEC 61970 deals with the common information model (CIM), an abstract model that represents all the major objects in an electric utility enterprise typically involved in utility operations.

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

By providing a standard way of representing power system resources as object classes and attributes, along with their relationships, the CIM facilitates the integration of energy management system (EMS) applications developed independently by different vendors, between entire EMS systems developed independently, or between an EMS system and other systems concerned with different aspects of power system operations, such as generation or distribution management. SCADA (supervisory control and data acquisition) is modeled to the extent necessary to support power system simulation and inter-control center communication. The CIM facilitates integration by defining a common language (i.e., semantics and syntax) based on the CIM to enable these applications or systems to access public data and exchange information independent of how such information is represented internally.

Due to the size of the complete CIM, the object classes contained in the CIM are grouped into a number of logical packages, each of which represents a certain part of the overall power system being modeled. Collections of these packages are progressed as separate International Standards. This particular International Standard specifies a base set of packages which provide a logical view of the functional aspects of energy management system (EMS) information within the electric utility enterprise that is shared between all applications. Other standards specify more specific parts of the model that are needed by only certain applications. Subclause 4.2 provides the current grouping of packages into standard documents.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 61850 (all parts), *Communication networks and systems in substations*

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

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

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

ISO 8601:2004, *Data elements and interchange formats – Information interchange – Representation of dates and times*

3 Terms and definitions

For the purposes of this document, the terms and definitions of IEC 61970-2 apply, as well as the following.

NOTE Refer to International Electrotechnical Vocabulary, IEC 60050, for general glossary definitions.

3.1

energy management system

EMS

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

3.2

application program interface

API

the set of public functions provided by an executable application component for use by other executable application components

4 CIM specification

4.1 CIM modeling notation

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

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

The UML notation is described in object management group (OMG) documents and several published textbooks.

4.2 CIM packages

4.2.1 CIM packages overview

The CIM is partitioned into a set of packages. A package is a general purpose means of grouping related model elements. There is no specific semantic meaning. The packages have been chosen to make the model easier to design, understand and review. The common information model consists of the complete set of packages. Entities may have associations that cross many package boundaries. Each application will use information represented in several packages.

The comprehensive CIM is partitioned into groups of packages for convenience in managing and maintaining them. These groups are assigned to different working groups within technical committee 57.

WG13 packages include:

a) IEC 61970-301 (this document) with the following packages:

- Domain
- Core
- OperationalLimits
- Topology
- Wires
- Generation

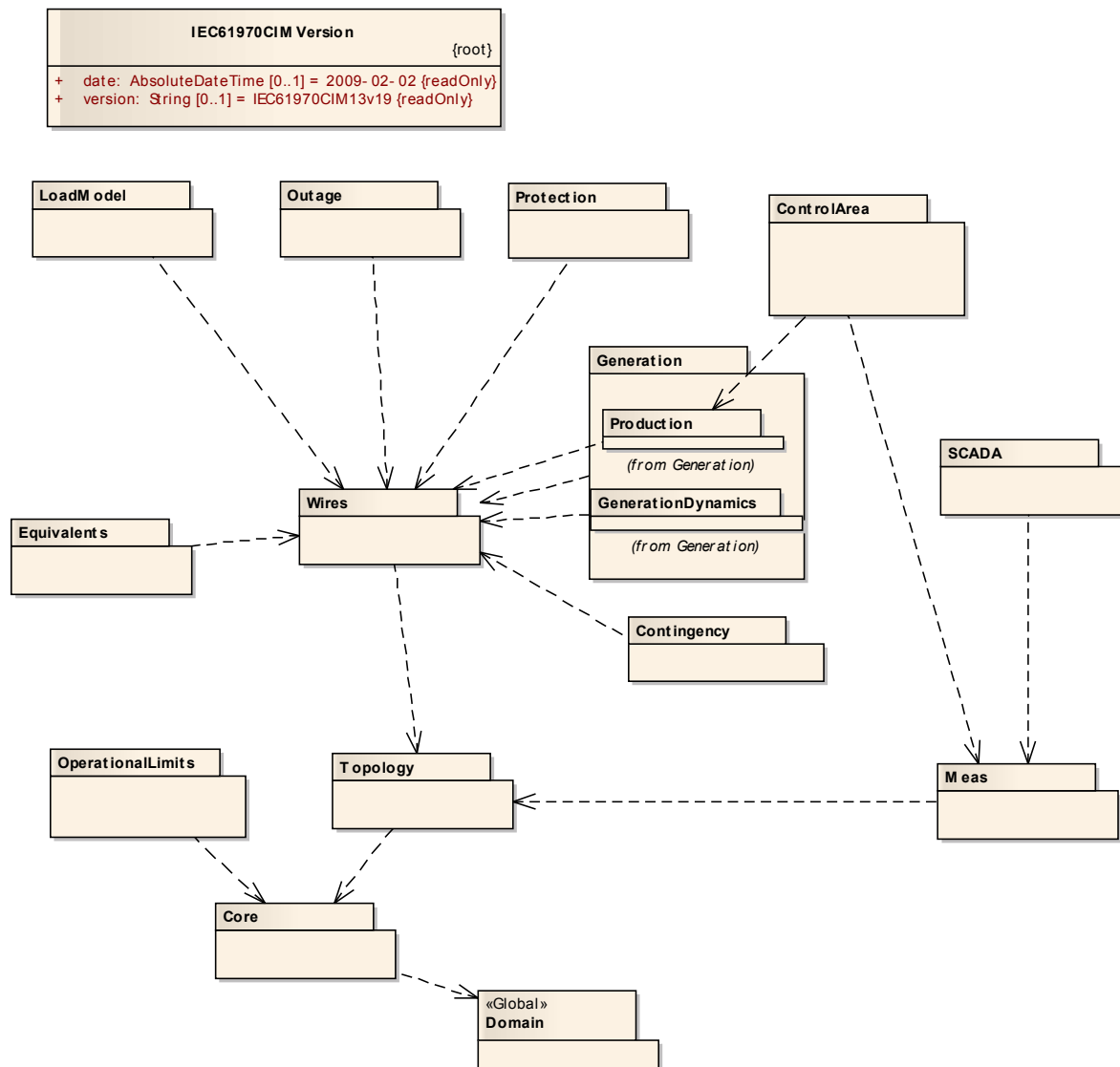
- Generation.GenerationDynamics
- Generation.Production
- LoadModel
- Outage
- Protection
- Equivalents
- Meas
- SCADA
- ControlArea
- Contingency

b) Packages dealing with market operations, such as energy scheduling, financial, and reservations.

WG14 packages in the IEC 61968 series of standards describe additional parts of the CIM that deal with other logical views of utility operations including include assets, location, activities, consumers, documentation, work management, and distribution-specific network models.

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

Figure 1 shows the packages defined for IEC 61970-301 CIM base and their dependency relationships. The dashed line indicates a dependency relationship, with the arrowhead pointing from the dependent package to the package on which it has a dependency.



IEC 1989/11

Figure 1 – CIM IEC 61970-301 package diagram

The subclauses below summarize the contents of each CIM package. Clause 6 contains the specification for each of the CIM packages.

NOTE The contents of the CIM defined in this specification were auto-generated from the CIM UML electronic model release IEC 61970CIM13v19, which is available at through the CIM users group.

4.2.2 Domain

The Domain package is a data dictionary of quantities and units that define datatypes for attributes (properties) that may be used by any class in any other package.

This package contains the definition of primitive datatypes, including units of measure and permissible values. Each datatype contains a value attribute and an optional unit of measure, which is specified as a static variable initialized to the textual description of the unit of measure. The value of the "units" string may be country or customer specific. Typical values are given. Permissible values for enumerations are listed in the documentation for the attribute using UML constraint syntax inside curly braces. Lengths of variable strings are listed in the descriptive text where required.

4.2.3 Core

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

4.2.4 OperationalLimits

The OperationalLimits package models a specification of limits associated with equipment and other operational entities.

4.2.5 Topology

An extension to the Core package that in association with the Terminal class, models Connectivity, that is the physical definition of how equipment is connected together. In addition it models Topology, that is the logical definition of how equipment is connected via closed switches. The Topology definition is independent of the other electrical characteristics.

4.2.6 Wires

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

4.2.7 Generation

Generation is divided into two separate packages, Production and Generation, which are described below.

4.2.7.1 Generation.Production

The Production package is responsible for classes which describe various kinds of generators. These classes also provide production costing information which is used to economically allocate demand among committed units and calculate reserve quantities.

4.2.7.2 Generation.GenerationDynamics

The GenerationDynamics package contains prime movers, such as turbines and boilers, which are needed for simulation and educational purposes.

4.2.8 LoadModel

This package is responsible for modeling the energy consumers and the system load as curves and associated curve data. Special circumstances that may affect the load, such as seasons and daytypes, are also included here.

This information is used by Load Forecasting and Load Management.

4.2.9 Outage

An extension to the Core and Wires packages that models information on the current and planned network configuration. These entities are optional within typical network applications.

4.2.10 Protection

An extension to the Core and Wires packages that models information for protection equipment such as relays. These entities are used within training simulators and distribution network fault location applications.

4.2.11 **Equivalents**

The equivalents package models equivalent networks.

4.2.12 **Meas**

Contains entities that describe dynamic measurement data exchanged between applications.

4.2.13 **SCADA**

Contains entities to model information used by supervisory control and data acquisition (SCADA) applications. Supervisory control supports operator control of equipment, such as opening or closing a breaker. Data acquisition gathers telemetered data from various sources. The subtypes of the Telemetry entity deliberately match the IEC 61850 definitions.

This package also supports alarm presentation but it is not expected to be used by other applications.

4.2.14 **ControlArea**

The ControlArea package models area specifications which can be used for a variety of purposes. The package as a whole models potentially overlapping control area specifications for the purpose of actual generation control, load forecast area load capture, or powerflow based analysis.

4.2.15 **Contingency**

Contingencies to be studied.

4.3 **CIM classes and relationships**

4.3.1 **Classes**

The class diagram(s) for each CIM package shows all the classes in the package and their relationships. Where relationships exist with classes in other packages, those classes are also shown with a note identifying the package which owns the class.

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

It should also be noted that the CIM is defined to facilitate data exchange. As defined in this document, CIM entities have no behavior. In order to make the CIM as generic as possible, it is highly desirable to make it easy to configure for specific implementations. In general, it is easier to change the value or domain of an attribute than to change a class definition. These principles imply that the CIM should avoid defining too many specific sub-types of classes. Instead, the CIM defines generic classes with attributes giving the type name. Applications may then use this information to instantiate specific object types as required. Applications may need additional information to define the set of valid types and relationships.

Classes have attributes that describe the characteristics of the objects. Each class in the CIM contains the attributes that describe and identify a specific instance of the class. Only the attributes that are of public interest to EMS applications are included in the class descriptions.

Each attribute has a type, which identifies what kind of attribute it is. Typical attributes are of type integer, float, boolean, string, and enumeration, which are called primitive types. However, many additional types are defined as part of the CIM specification. For example, ShuntCompensator has a "maxU" attribute of type Voltage. The definition of data types is contained in the Domain package described in Subclause 4.2.2. The

UML stereotypes of Primitive, enumeration, and Datatype are added to classes used as types. The Datatype stereotype is used with a specific CIM semantics for a triple of attributes {value, unit, multiplier}, which implies custom mapping to serialization artifacts such as RDFS, OWL, and XSD. Classes with these stereotypes do not participate in generalization or association relationships and are simply used as types for attributes.

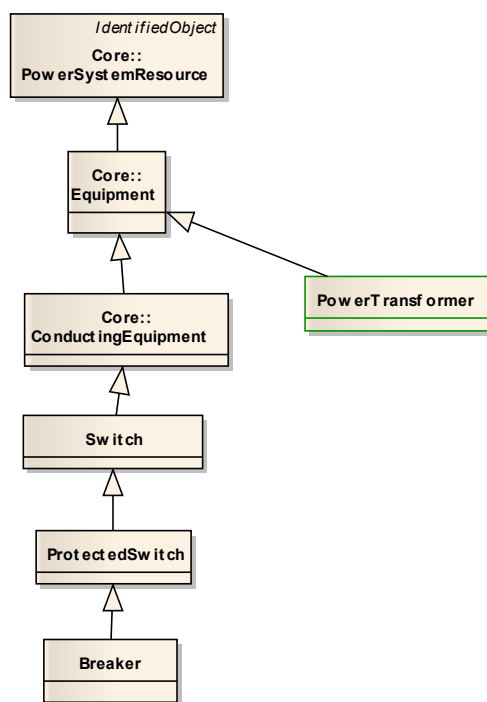
All CIM attributes are implicitly optional in the sense that profiles using the CIM may eliminate any attributes.

Relationships between classes reveal how they are structured in terms of each other. CIM classes are related in a variety of ways, as described in the subclauses below.

4.3.2 Generalization

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

Figure 2 is an example of generalization. In this example taken from the Wires package, a Breaker is a more specific type of ProtectedSwitch, which in turn is a more specific type of Switch, which is a more specific type of ConductingEquipment, etc. A PowerTransformer is another more specific type of Equipment. Note that PowerSystemResource inherits from class IdentifiedObject which is not on the diagram.



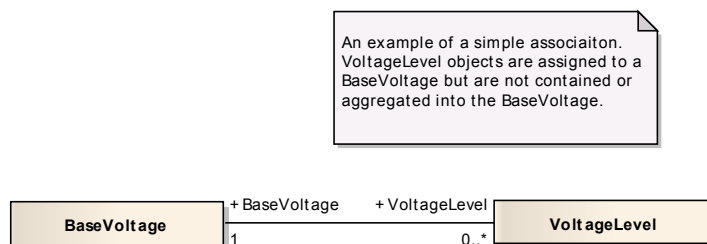
IEC 1990/11

Figure 2 – Example of generalization

4.3.3 Simple association

An association is a conceptual connection between classes. Each association has two “association ends”. The “association ends” were called “roles” prior to the UML 2.0 specification. Each association end describes the role the target class (i.e., the class the association end goes to) has in relation to the source class (i.e., the class the association end goes from). Association ends are usually given the name of the target class with or without a verb phrase. Each association end also has multiplicity/cardinality, which is an indication of how many objects may participate in the given relationship. In the CIM, associations are not named, only association ends are named. For example, in the CIM there is an association between a BaseVoltage and a VoltageLevel (See Figure 3 which is taken from the Wires package). Multiplicity is shown at both ends of the

association. In this example, a VoltageLevel object may reference 1 BaseVoltage, and a BaseVoltage may be referenced by 0 or more VoltageLevel objects.

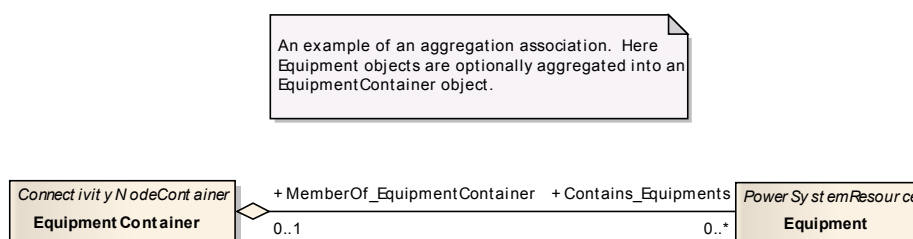


IEC 1991/11

Figure 3 – Example of simple association

4.3.4 Aggregation

Aggregation is a special case of association. Aggregation indicates that the relationship between the classes is some sort of whole-part relationship, where the whole class “consists of” or “contains” the part class, and the part class is “part of” the whole class. The part class does not inherit from the whole class as in generalization. Figure 4 illustrates an aggregation between the EquipmentContainer class and the Equipment class, which is taken from the Core package. As shown, an Equipment can be a member of zero or one EquipmentContainer objects, but an EquipmentContainer object can contain any number of Equipment objects.



IEC 1992/11

Figure 4 – Example of aggregation

4.4 CIM model concepts and examples

4.4.1 Concepts

The CIM classes, attributes, types, and relationships are specified in Clauses 5 and 6. Clause 6 comprises a complete description of the IEC 61970-301 CIM Base model. To help understand how to interpret the CIM, some key model concepts used in the CIM are introduced and described in the following subclauses.

4.4.2 Containment, equipment hierarchies and naming

4.4.2.1 Containment structure

Figure 5 shows the concept of equipment containers to form hierarchies in the CIM. Equipment containers represent ways of organizing and naming equipment typically found within a substation. As may be seen, there is some flexibility provided in which containers are used in a specific application of the CIM in order to accommodate different international practices as well as differences typically found between transmission and distribution substations. Bay, VoltageLevel, Substation, Line, and Plant are all types of EquipmentContainers. In general, a Bay is contained within a specific VoltageLevel, which in turn is contained within a Substation. Substations and Lines may be contained within SubGeographicRegions and GeographicRegions.

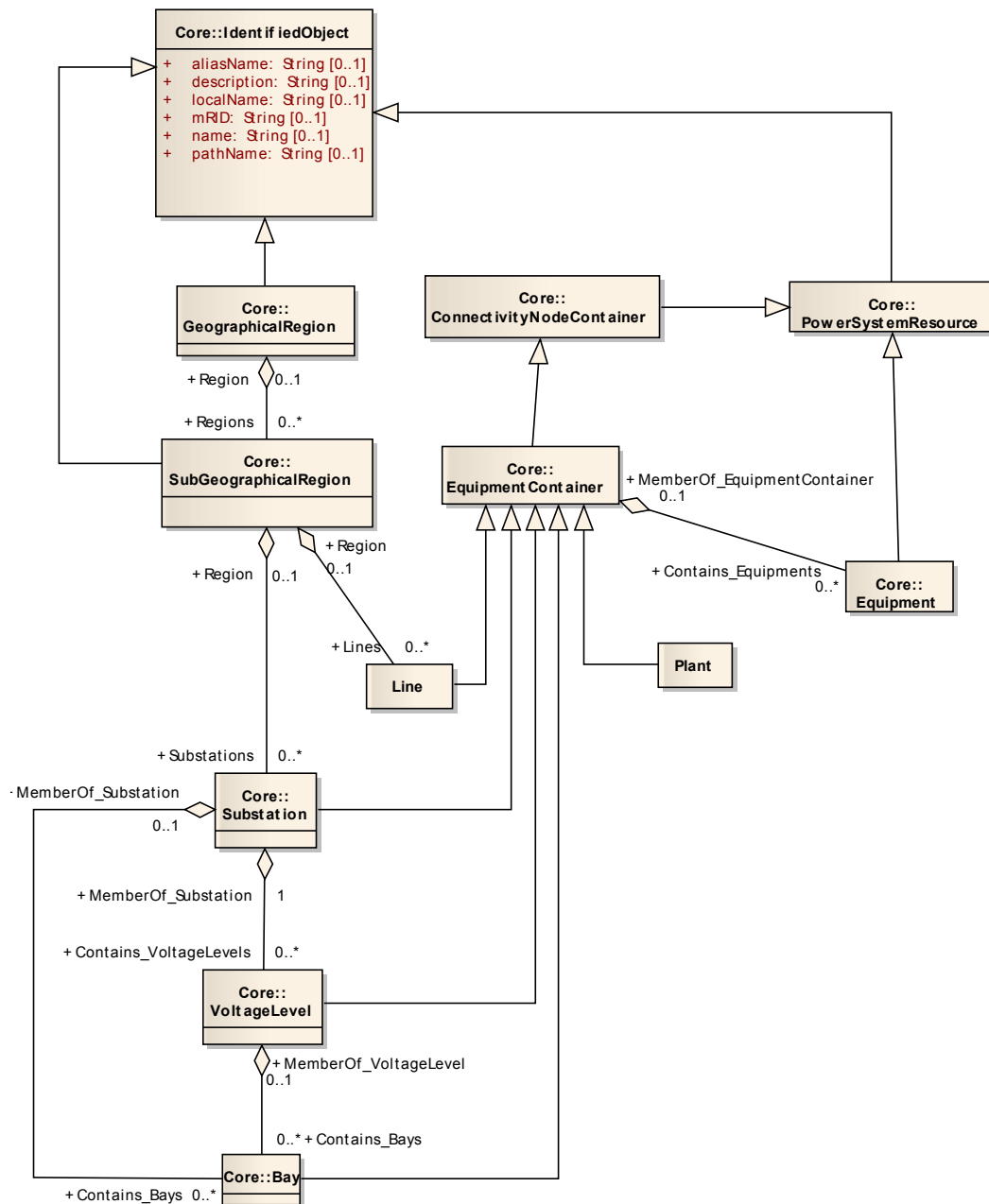
One containment hierarchy is used with the IdentifiedObject class to create hierarchical naming intended for human consumption. One hierarchy is specifically used to name equipment according to its function in the power system. This is the functional naming hierarchy. Other common identifications beside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

4.4.2.2 IdentifiedObject class

The IdentifiedObject class contained in the Core package is inherited by all PowerSystemResource and many other classes. This class contains six attributes to be used for naming all PowerSystemResource objects. It is intended that values should be assigned to each attribute in a manner consistent with the attribute definitions.

The following are definitions and conventions for how to use the IdentifiedObject attributes when naming PowerSystemResource objects (for more details, refer to documentation for IdentifiedObject and its attributes in Clause 6):

- name: A free text name.
- localName: A local short name of the instance. Objects that are structured in a functional naming hierarchy have this name local to each particular level in the hierarchy. The name shall be unique among objects contained by the same parent.
- pathName: Objects that are structured in a functional naming hierarchy have a pathName which contains all the IdentifiedObject.localNames from the object to the root. The pathName, then, is a concatenation of all these names from the leaf object up to the root of the containment hierarchy, similar to a file path name. For example, if node "A" contains node "B" that contains node "C", then the pathName for node "C" may look like "A.B.C". The type of delimiters used between localNames is not specified but is a local implementation issue.
- aliasName: A free text name of the instance. This attribute can also be used for localization.
- description: A free format description of the instance.
- mRID (Master Resource ID): A globally unique machine-readable identifier for an object instance.



IEC 1993/11

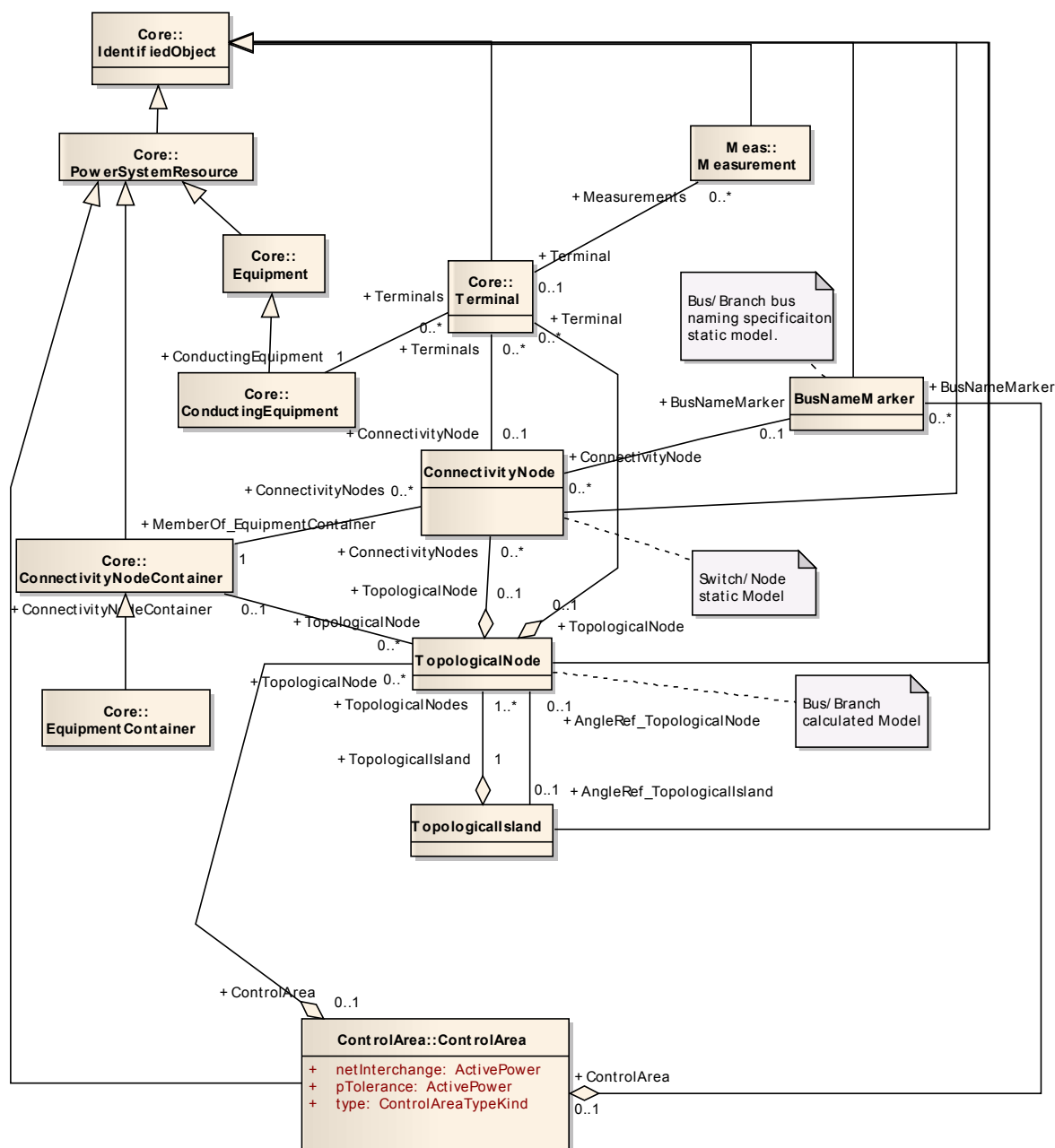
Figure 5 – Equipment containers

The diagrams NamingHierarchyPart1 and NamingHierarchyPart2 in the Wires package show the functional naming hierarchy (refer to the Wires package documentation in Clause 6 for the details).

4.4.3 Connectivity model

4.4.3.1 Connectivity description

Figure 6 shows the Topology class diagram which models connectivity between different types of ConductingEquipment. Also included is a portion of the Meas package class diagram dealing with measurements to illustrate how measurements are associated with conducting equipment.



IEC 1994/11

Figure 6 – Connectivity model

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

It is possible to exchange messages directly involving TopologicalNode and bypassing the ConnectivityNode details by using the TopologicalNode to Terminal association. This is often useful for exchanges involving bus/branch models which do not typically contain switch detail.

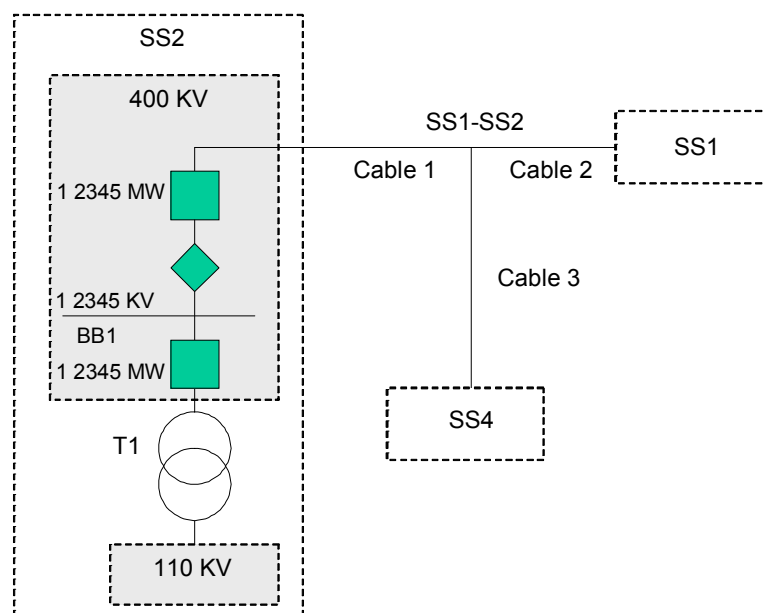
EquipmentContainers, which are a specialization of a ConnectivityNodeContainer, may contain zero or more ConnectivityNodes. The associations, ConductingEquipment – Terminal and Terminal – ConnectivityNode, capture the as built topology of an actual power system network. For each Terminal connected to a ConnectivityNode, the associations of the other Terminal(s) connected to the same ConnectivityNode identify the ConductingEquipment object(s) that are electrically connected. Similar connectivity at the “bus/branch” level of detail can be expressed using the TopologicalNode instead of the ConnectivityNode.

To model the analog values such as voltage and power, each Terminal has an association with a Measurement class from the Meas package. Although not shown in Figure 6, a Measurement object is associated with at least one MeasurementValue object. Each MeasurementValue object is an instance of a measurement from a specific source, for example, a telemetered measurement. In a study context, the measurement values would have a calculation source instead.

Clause 6 contains a complete description of each class in Figure 6 along with the definition of all the attributes and relationships supported in each class.

4.4.3.2 Connectivity and containment example

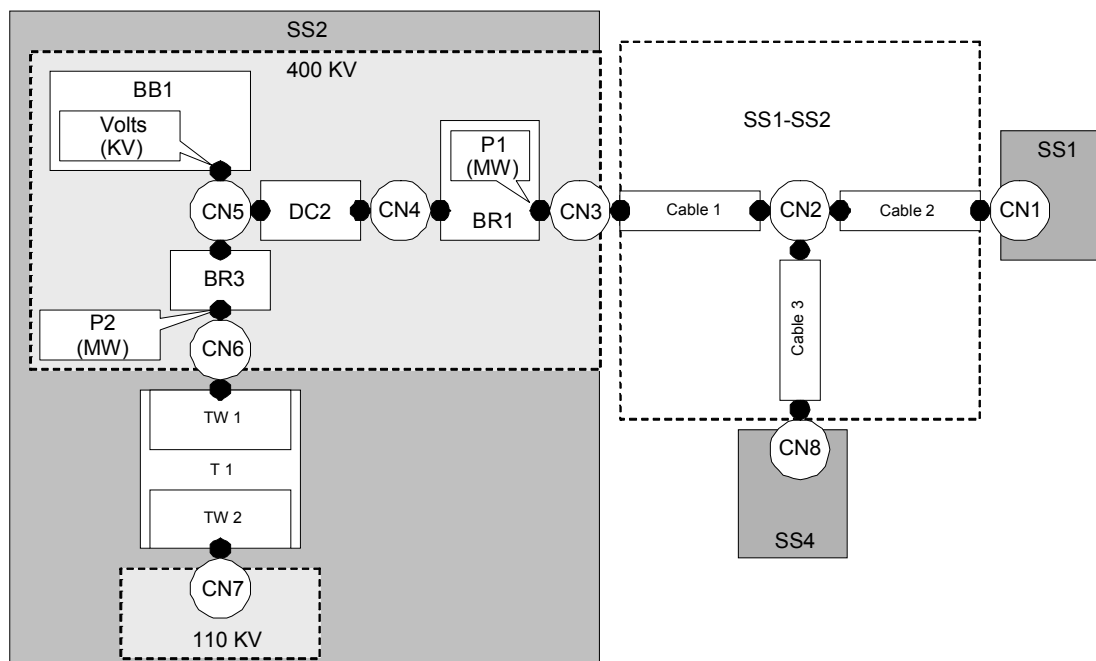
To illustrate how the connectivity model and containment model would appear as objects, a small example is presented in Figure 7. The example shows a transmission line with a T-junction spanning two substations and a substation having two voltage levels with a transformer between them. The transmission line consists of two different cables. One of the voltage levels is shown with a busbar section having a single busbar and two very simple switchgear bays connecting to the busbar.



IEC 1995/11

Figure 7 – Simple network example

Figure 8 shows how connectivity is modeled in the CIM as well as one way (but not necessarily the only way) containment is modeled for the diagram in Figure 8. The shaded square boxes represent EquipmentContainers, and the white square boxes represent ConductingEquipment. Darker shading indicates the EquipmentContainer is higher up in the containment hierarchy (i.e., Substation is highest, VoltageLevel next, etc.). White circles represent ConnectivityNodes, and black small circles represent Terminals. A Terminal belongs to a ConductingEquipment, and a ConnectivityNode belongs to an EquipmentContainer. This means that the borders (or contact points) between ConductingEquipment are their Terminals interconnected via ConnectivityNodes.



IEC 1996/11

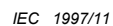
Figure 8 – Simple network connectivity modeled with CIM topology

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

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

4.4.4 Inheritance hierarchy

Figure 9 shows an overview of the inheritance hierarchy modeled in the CIM. This overview, which is included as one of the Wires package diagrams, actually spans most of the CIM packages.



4.4.5 Transformer model

As shown, a `PowerTransformer` is a specialized class of `Equipment`, which is a specialized class of a `PowerSystemResource`, as is `ConductingEquipment` and `TapChanger`. This is shown by the use of the generalization-type of relationship, which uses an arrow to point to the general class, and permits the `PowerTransformer` to inherit attributes from both `Equipment` and `PowerSystemResource`.

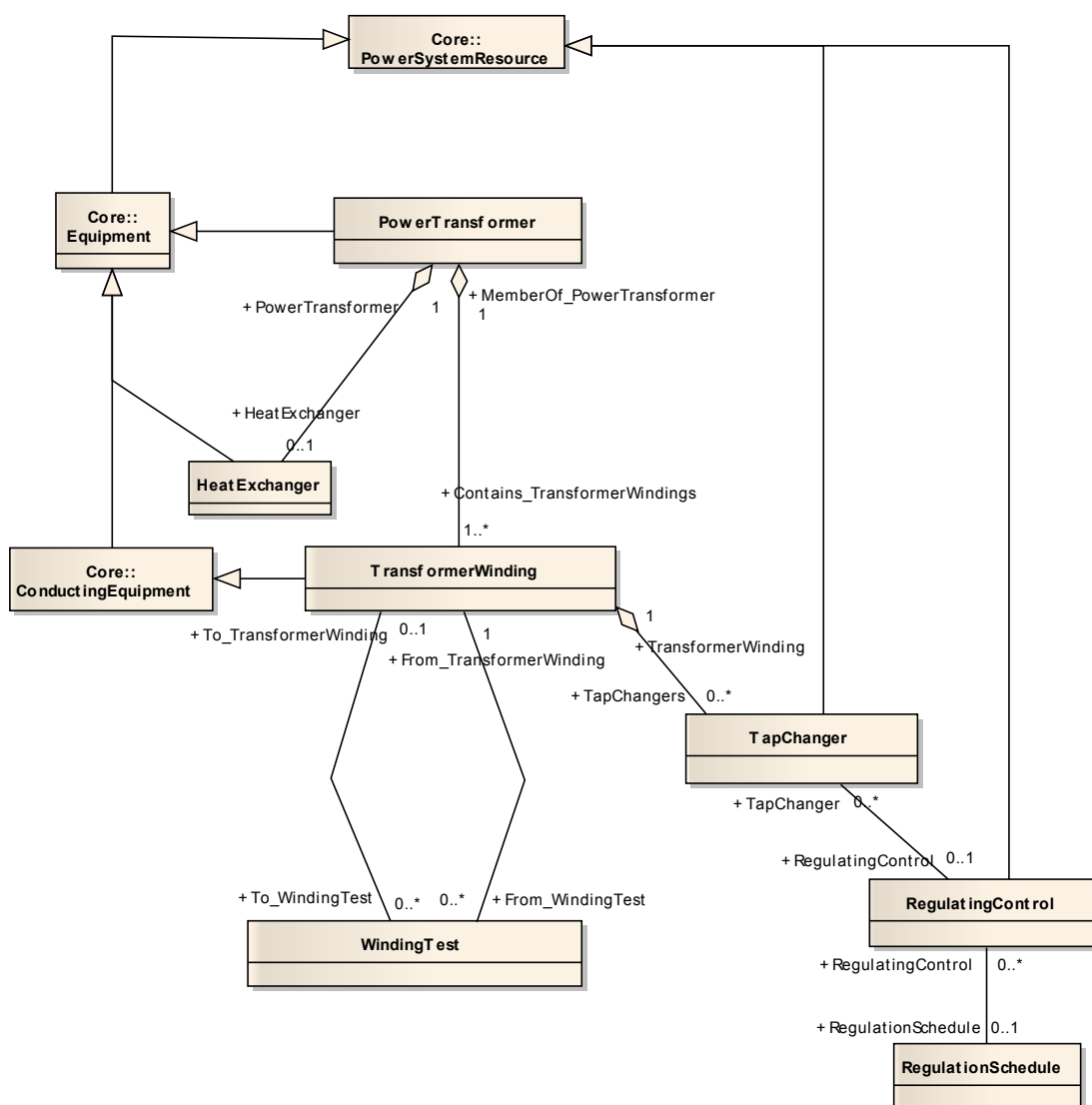
29

PowerTransformer may have (or contain) one or more TransformerWindings, but a TransformerWinding may belong to (or be a member of) only one PowerTransformer.

The TransformerWinding has other relationships as well:

- a generalization relationship with ConductingEquipment;
- an association relationship with the WindingTest class, such that a TransformerWinding object may be TestedFrom from 0, 1, or more WindingTest objects;
- an aggregation relationship with the TapChanger class, such that a TransformerWinding object may have 0, 1, or more TapChanger objects associated with it.

Clause 6 contains a complete description of each class in Figure 10 along with the definition of all the attributes and relationships supported in each class.



IEC 1998/11

Figure 10 – Transformer model

4.4.6 Measurements and controls

4.4.6.1 Measurement overview

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

The name "Measurement" would seem to indicate that all the state variables are measured. This is not always strictly the case as many measurements are calculated by SCADA or EMS/DMS functions, such as State Estimator or Power Flow calculations. As a consequence, a measurement may have a number of alternate values (e.g., manually supplied, telemetered, state estimated, optimized etc.). This is supported by the Measurement and MeasurementValue models in the Meas package.

4.4.6.2 Control overview

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

4.4.6.3 Use of measurement-related classes

A PowerSystemResource (PSR) may have zero to many measurements associated with it by containing one or more measurements. Each measurement may have one or more measurement values. Observing the following guidelines will enable applications to navigate and find the required measurement values in a consistent way (see Figure 11).

- a) Measurements of a PowerSystemResource are classified by MeasurementType.
- b) MeasurementValues of a Measurement are classified by MeasurementValueSource.
MeasurementType¹ inherits from IdentifiedObject. The values to be used for MeasurementType.name, MeasurementType.aliasName, and MeasurementType.description are specified in Table 1.
- c) MeasurementValueSource also inherits from IdentifiedObject. The values to be used for MeasurementValueSource.name and MeasurementValueSource.description are given in Table 2. This table provides a number of source names to be used where possible. However, the exact names to be used for specific applications are defined in related IEC 61970 component interface specifications (CIS).
- d) The tables may be extended for proprietary needs. The names added must start with a unique name (e.g. the company name) and an underscore. Example: xyz_AverageTemperature.
- e) The ValueAliasSet is used for discrete measurements and describes mappings from values to symbolic names. Different communication protocols (e.g. for RTUs and for control centers as ICCP or ELCOM) use different data encodings. A system may have a system wide mapping for all Discrete values or group the Discrete values and make a mapping per group. Creation of a single system wide mapping that covers existing communication protocols is outside the scope of this specification.

¹ MeasurementType is different from Unit, which is part of the Domain package described in 4.2.2. MeasurementType describes "what" is measured rather than the unit of measure including scaling, which is the purpose of Unit.

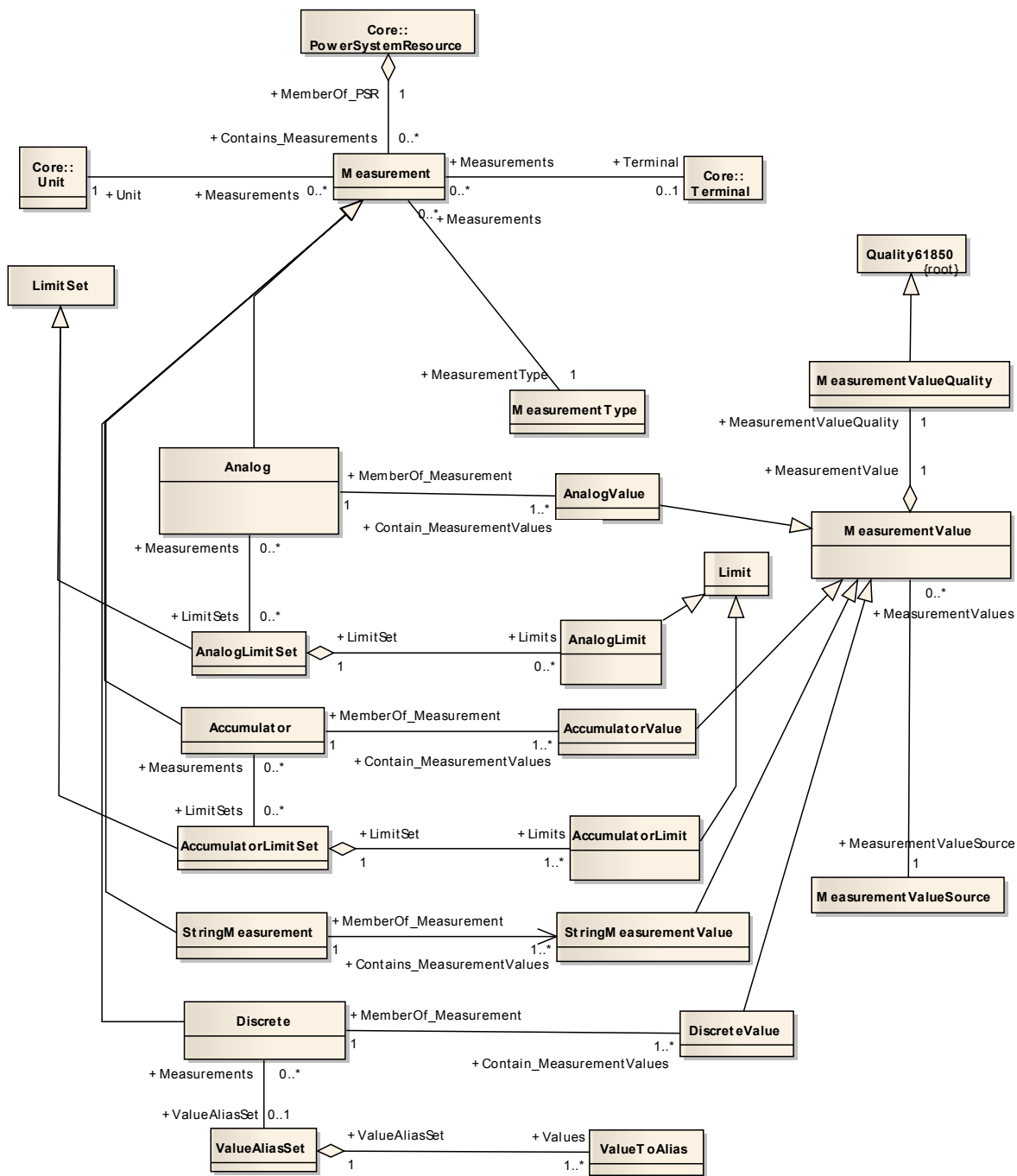


Figure 11 – Navigating from PSR to MeasurementValue

IEC 1999/11

Table 1 – MeasurementType naming conventions

name	aliasName	description
Current	Amp	Current (rms) of a non-three phase circuit
ThreePhaseCurrent	AvAmps	Total current (rms) in a three phase circuit
PhaseCurrent	A	Measured phase current
Frequency	Hz	Frequency
PowerFactor	PwrFact	Power factor not allocated to a phase
ThreePhasePowerFactor	TotPF	Average power factor in a three phase circuit
ThreePhaseApparentPower	TotVA	Total apparent power in a three phase circuit
ThreePhaseReactivePower	TotVAr	Total reactive power in a three phase circuit
ThreePhaseActivePower	TotW	Total real power in a three phase circuit
ApparentPower	VoltAmp	Apparent power in a non-three phase circuit
ReactivePower	VoltAmpr	Reactive power in a non-three phase circuit
Voltage	Vol	Voltage (rms) not allocated to a phase
ActivePower	Watt	Real power in a non-three phase circuit
Pressure	Pres	Pressure
Temperature	Tmp	Temperature
Angle	Ang	Angle between voltage and current
ApparentEnergy	TotVAh	Apparent energy
ReactiveEnergy	TotVArh	Reactive energy
ActiveEnergy	TotWh	Real energy
Automatic	Auto	Automatic operation (not manual)
LocalOperation	Loc	Local operation (not remote)
SwitchPosition	Pos	Switch position [2bits= intermediate,open,closed,ignore]
TapPosition	TapPos	Tap position of power transformer or phaseshifter
Operation Count	OperCnt	Operation count - typically for switches

Table 1 describes various types of measurements also defined in IEC 61850. The meaning of the columns in Table 1 are as follows:

- name (MeasurementType.name) is the IEC 61970 measurement type name.
- aliasName (MeasurementType.aliasName) is the name assigned to the data in IEC 61850. (Refer to Clause 6 of IEC 61850-7-4, data object name semantics).
- description (MeasurementType.description) of the data.

It shall be noted that Table 1 is a non exhaustive list and that the mapping between measurements as defined in a control center and a substation is non-trivial.

Table 2 – MeasurementValueSource naming conventions

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

Following these conventions:

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

4.4.6.4 Attachment of measurements

As mentioned in the previous subclause and as shown in Figure 11, Measurements are contained by a PowerSystemResource. This is sufficient for Measurements that are not related to connectivity, e.g. temperature, weight, size.

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

Figure 12 shows two examples of the placement of Measurements.

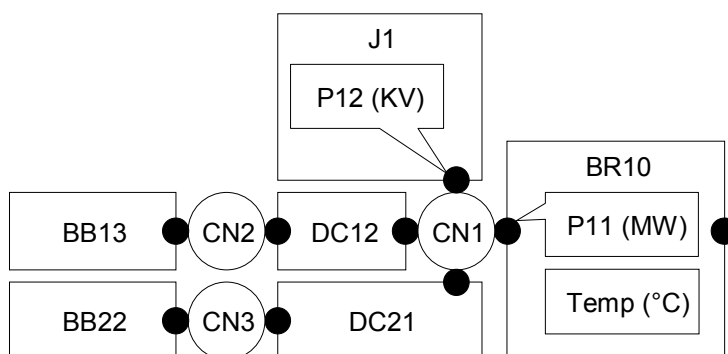


Figure 12 – Measurement placement

IEC 2000/11

P12 is a voltage Measurement that measures the voltage at the Junction J1. P12 is topologically related to the ConnectivityNode CN1 via the Terminal in Junction J1. P11 is a Measurement that measures the flow through Breaker BR10 at the side connected to the ConnectivityNode CN1. P11 is topologically related to the

ConnectivityNode CN1 via the left Terminal in Breaker BR10. Temp is a Measurement that measures the Breaker temperature. As a temperature is not related to connectivity, it has no relation to a Terminal - it just belongs to the Breaker BR10.

4.4.7 Regulating control models

Regulation control, such as automatic voltage control at generators or voltage tap control at transformers is modeled using a class named RegulationControl. The RegulationControl class provides the capability to model multiple equipment participating in a regulation scheme. These regulation schemes may be physical or manually implemented in actual power system operation, but are reflected in the models used for power system analysis purposes. Figure 13 shows how RegulatingCondEq and TapChanger classes can participate in regulation.

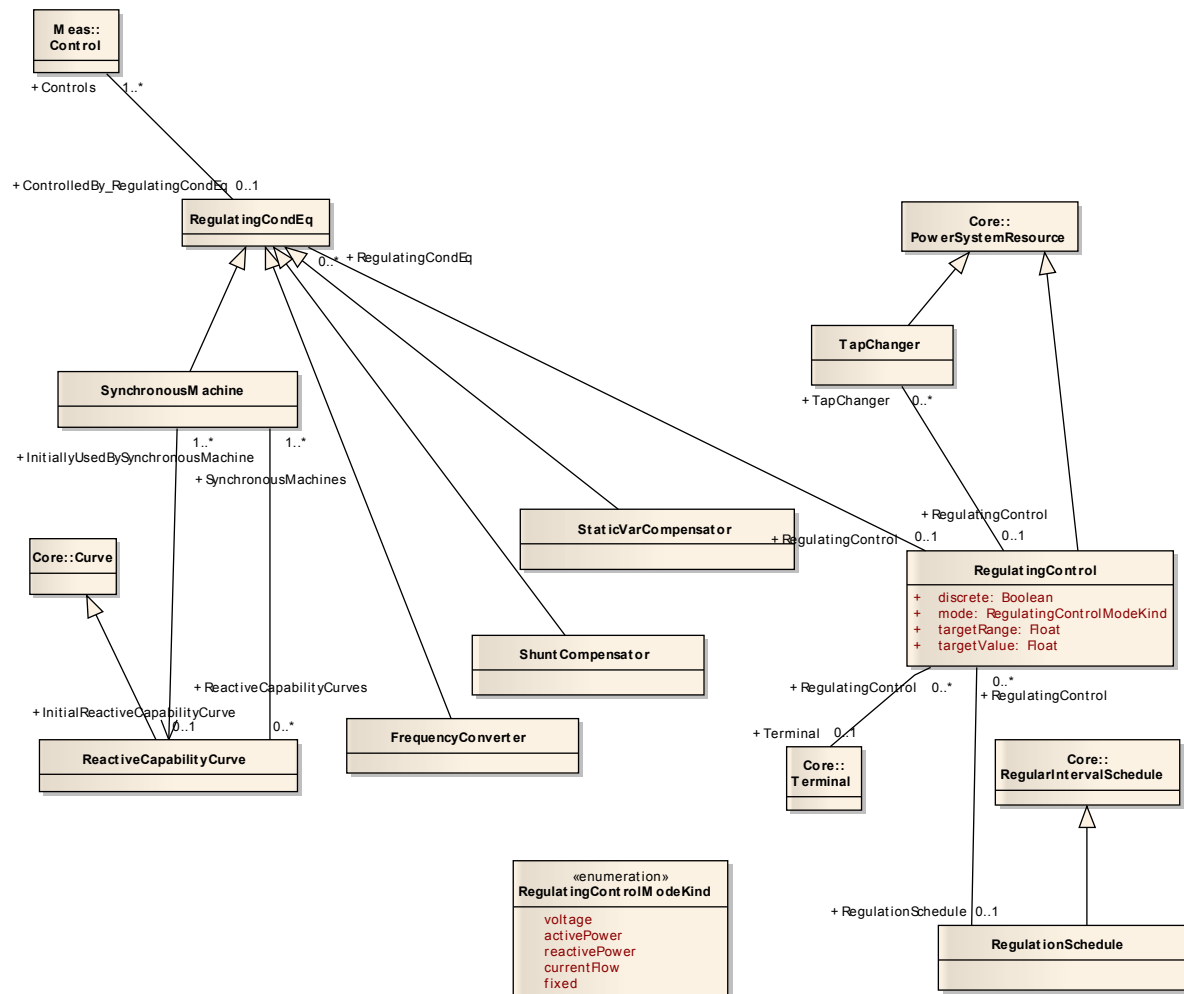


Figure 13 – Regulating control models

IEC 2001/11

4.5 Modeling guidelines

4.5.1 Modeling for change

The following subclauses provide guidelines on how to maintain and extend the CIM.

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

4.5.2 Process for amendments to the CIM

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

- a) Prepare a Use Case(s) to describe the desired changes. This should include proposed changes to the appropriate class diagrams showing new/revised classes, attributes, and associations.
- b) The Use Case(s) is then reviewed by the appropriate IEC working group to decide if the requested changes should be treated as revisions to the current CIM standard, or if they should be treated as private amendments, not requiring a change to the standard itself.
- c) Proposed amendments accepted by the working group will be added to a list of outstanding issues, and at the appropriate time, a new version of the CIM model will be prepared and an update made to the appropriate IEC CIM specification.

4.5.3 Changes to the CIM UML model

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

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

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

4.5.4 Changes to the CIM standards documents

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

4.5.5 CIM profiles

An implementation of the CIM need not include all classes, attributes, or associations in the standard CIM specification to be compliant with the CIM standard. Profiles may be defined to specify which elements shall be included (i.e., mandatory elements) in a particular use of the CIM, as well as which are optional. These profiles are defined in the Part 4xx series of standards.

An example is the profile for exchanging power system models. This profile specifies how the CIM is to be used for exchanging power system models in XML, and also specifies the mandatory and optional classes, attributes, and associations to be supported for this use of the CIM. Profiles can be maintained using tools such as the open source CIMTool, available at <http://www.CIMTool.org>.

4.6 Modeling tools

Previous editions of CIM were created and maintained using Rational ROSE², but this release was constructed using Enterprise Architect product. The entire CIM UML model exists as an Enterprise Architect3

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

project file and is viewable with that tool, including the class diagrams and descriptions of classes, attributes, types, and relationships. Viewing the CIM in this fashion provides a graphical navigation interface that permits all CIM specification data to be viewed via point-and-click from the class diagram in each package. A free viewer is available through Sparx Systems.

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

Clause 6 of this document was auto-generated using a publicly available tool called CIMinEA which uses the automation interfaces of Microsoft Word and Enterprise Architect and the standard IEC format and styles.

4.7 User implementation conventions

4.7.1 Conventions beyond UML

This following subclauses provide recommended user conventions when using the CIM in actual system implementations.

4.7.2 Number of Terminals for ConductingEquipment objects

The following ConductingEquipment classes have two terminals: ACLineSegment, DCLineSegment, Jumper, Fuse, Breaker, Disconnecter, LoadBreakSwitch, SeriesCompensator. All other ConductingEquipment leaf classes have a single terminal.

4.8 CIM modeling examples

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

It should be noted that an RDF schema version of the CIM is still metadata rather than an instantiation of an actual network. However, complete network model files with descriptions of all network elements and their electrical connectivity can be generated by system suppliers using proprietary export tools, and then imported by other systems via a similar import tool, which is used to populate a local network engineering tool database. Examples of such CIM XML models include the Siemens 100 bus model, the Areva 60 bus model, and the ABB 40 bus model files⁴ used for CIM XML interoperability testing.

5 Detailed model

5.1 Overview

The common information model (CIM) represents a comprehensive logical view of energy management system information. This definition includes the public classes and attributes, as well as the relationships

³ Enterprise Architect is the trade name of a product supplied by Sparx Systems. This information is given for the convenience of users of this document and does not constitute an endorsement by the IEC of the product named. Equivalent products may be used if they can be shown to lead to the same results.

⁴ Siemens100 bus model, Areva 60 bus model, and ABB 40 model are the trade names of products supplied by Siemens, Areva, and ABB. This information is given for the convenience of users of this document and does not constitute an endorsement by IEC of the product named. Equivalent products may be used if they can be shown to lead to the same results.

between them. The following subclauses describe how Clause 6 is structured. Clause 6 is automatically generated from the CIM model maintained with the tools described in 4.6.

5.2 Context

The CIM is partitioned into subpackages. The Domain package defines datatypes used by the other packages. The Generation package is subdivided into Production and GenerationDynamics packages. Classes within the packages are listed alphabetically. Native class attributes are listed first, followed by inherited attributes in order of depth of inheritance, then by attribute name. Native associations are listed first for each class, followed by inherited associations in order of depth of inheritance, then alphabetically by class name, then alphabetically by association end name. The associations are described according to the role of each class participating in the association. The association ends are listed under the class at each end of an association.

Figure 14 shows the top level packages included in this document.

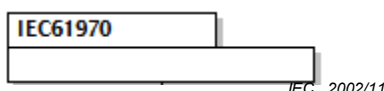


Figure 14 – CIM top level packages

For each package, the model information for each class is fully described. Attribute and association end information for native and inherited attributes is listed as below. For any inherited attributes or association ends the “note” column will contain text indicating the attributes is inherited from a specific class. The note column for native attributes and association ends contains the actual description.

Attributes

name	type	note
native1	Float	A floating point native attribute of the class is described here
native2	ActivePower	Documenation for another native attribute of type ActivePower
Name	Float	Inherited from class IdentifiedObject

In the Attributes table, in some cases, an attribute is a constant, in which case the phrase “(const)” is added in the name column of the attributes table. In such cases, the attribute normally has an initial value also which is preceded by an equal sign and appended to the attribute name.

Association ends

Mult from	[Mult] name (type)	note
1..*	[0..1] ModelingAuthoritySet (ModelingAuthoritySet)	inhertted from class IdentifiedObject
0..*	[0..*] OperatedBy_Companies (Company)	inherited from class PowerSystemResource
1	[0..*] Contains_Measurements (Measurement)	inherited from class PowerSystemResource
1	[0..*] OperatingShare (OperatingShare)	inhertted from class PowerSystemResource

In the Association Ends table, the first column describes the multiplicity at the other end of the association (i.e., the multiplicity of the class for which association ends are being described). The multiplicity of the association end itself is included in brackets. The association end name is listed in plain text. The class at the other end of the association is within the parentheses. A multiplicity of zero indicates an optional association. A multiplicity of “*” indicates any number is allowed. For example, a multiplicity of [1..*] indicates a range from 1 to any larger number is allowed.

In the case that a class is an enumeration, the Attributes table is replaced by the Enums table as shown below, since enumeration literals have no type. There are no inherited enumeration literals for an enumeration class.

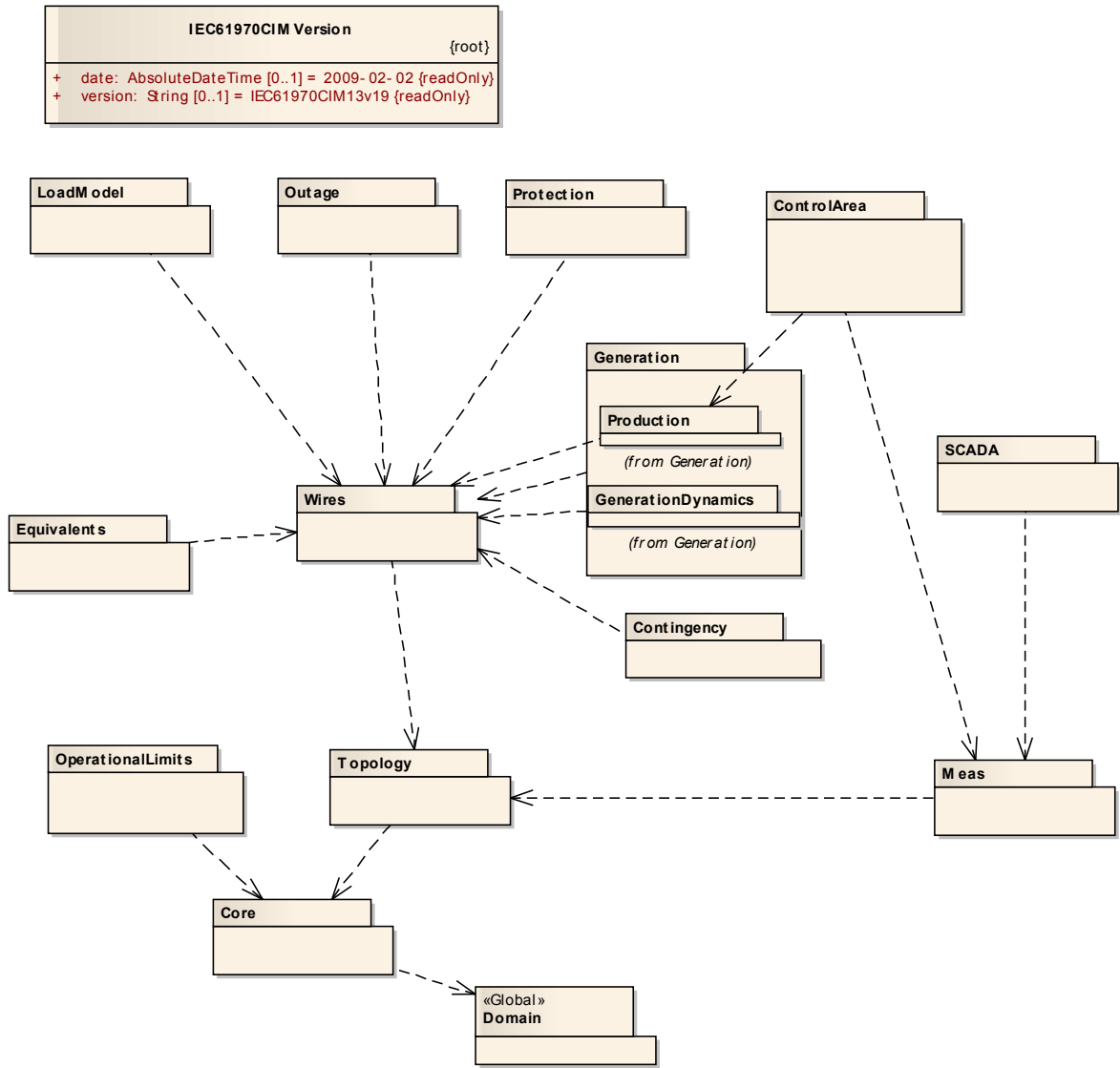
Enums

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

6 Package architecture (normative)

6.1 IEC 61970

6.1.1 IEC 61970 package summary



IEC 2003/11

Figure 15 – Main

Figure 15 is documented as follows. This diagram shows all 61970 packages and their logical dependencies.

6.1.2 IEC 61970CIMVersion

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

Attributes

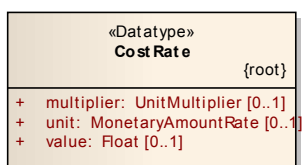
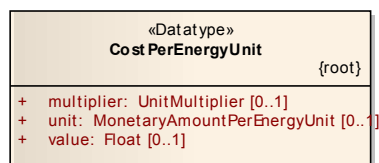
name	type	note
date=2009-02-02 (const)	AbsoluteDateTime	Form is YYYY-MM-DD for example for January 5, 2009 it is 2009-01-05.
version=IEC 61970CIM13v19 (const)	String	Form is IEC 61970CIMXXvYY where XX is the major CIM package version and the YY is the minor version. For example IEC 61970CIM13v18.

6.2 Domain

6.2.1 Domain package summary

The Domain package is a data dictionary of quantities and units that define datatypes for attributes (properties) that may be used by any class in any other package.

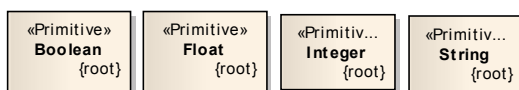
This package contains the definition of primitive datatypes, including units of measure and permissible values. Each datatype contains a value attribute and an optional unit of measure, which is specified as a static variable initialized to the textual description of the unit of measure. The value of the "units" string may be country or customer specific. Typical values are given. Permissible values for enumerations are listed in the documentation for the attribute using UML constraint syntax inside curly braces. Lengths of variable strings are listed in the descriptive text where required.



IEC 2004/11

Figure 16 – CombinedDatatypes

Figure 16 is documented as follows. This diagram includes the datatypes that are combined from datatypes in the other diagrams.



IEC 2005/11

Figure 17 – BasicDatatypes

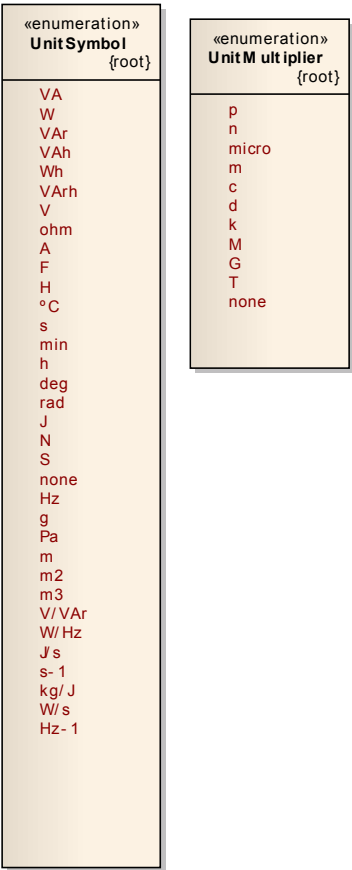
Figure 17 is documented as follows. This diagram shows basic datatypes that are the basis for all other datatypes.



IEC 2006/11

Figure 18 – ElectricityDatatypes

Figure 18 is documented as follows. This diagram shows electricity-related data types.



IEC 2007/11

Figure 19 – EnumeratedUnitDatatypes

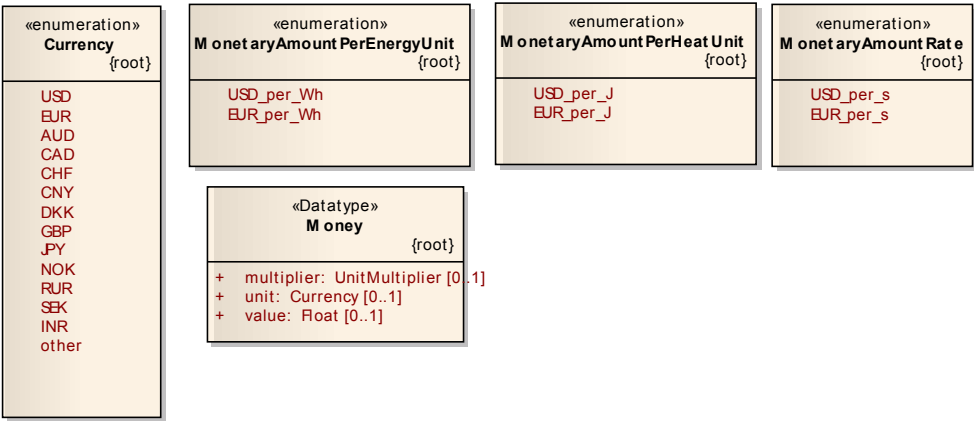
Figure 19 is documented as follows. This diagram shows enumerated data types related to the SI unit system.



IEC 2008/11

Figure 20 – GeneralDatatypes

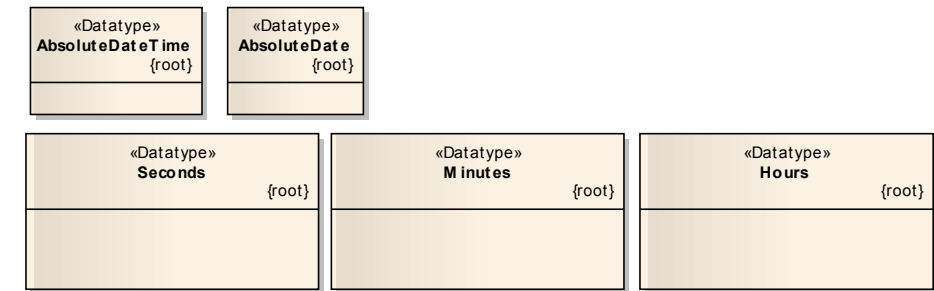
Figure 20 is documented as follows. This diagram shows general related data types.



IEC 2009/11

Figure 21 – MonetaryDatatypes

Figure 21 is documented as follows. This diagram shows monetary related data types.



IEC 2010/11

Figure 22 – TimeDatatypes

Figure 22 is documented as follows. This diagram shows time-related data types.

6.2.2 AbsoluteDate Datatype

Date and time as "yyyy-mm-dd", which conforms with ISO 8601. UTC time zone is specified as "yyyy-mm-dd".

Attributes

name	type	note
value	String	String representation of date, refer to description of the class.

6.2.3 AbsoluteDateTime Datatype

Date and time as "yyyy-mm-ddThh:mm:ss.sss", which conforms with ISO 8601. UTC time zone is specified as "yyyy-mm-ddThh:mm:ss.sssZ". A local timezone relative UTC is specified as "yyyy-mm-ddThh:mm:ss.sss-hh:mm".

AbsoluteDateTime can be used both for calendar time, e.g. 2007-02-07T10:30, and for relative time, e.g. 10:30.

Attributes

name	type	note
value	String	String representation of date and time, refer to description of the class.

6.2.4 ActivePower Datatype

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

Attributes

name	type	note
value	Float	
unit=W (const)	UnitSymbol	
multiplier	UnitMultiplier	

6.2.5 ActivePowerChangeRate Datatype

Attributes

name	type	note
value	Float	
unit=W/s (const)	UnitSymbol	
multiplier	UnitMultiplier	

6.2.6 Admittance Datatype

Ratio of current to voltage.

Attributes

name	type	note
value	Float	
unit=S (const)	UnitSymbol	
multiplier	UnitMultiplier	

6.2.7 AngleDegrees Datatype

Measurement of angle in degrees.

Attributes

name	type	note
value	Float	
unit=deg (const)	UnitSymbol	
multiplier=none (const)	UnitMultiplier	

6.2.8 AngleRadians Datatype

Phase angle in radians.

Attributes

name	type	note
value	Float	
unit=rad (const)	UnitSymbol	
multiplier=none (const)	UnitMultiplier	

6.2.9 ApparentPower Datatype

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

Attributes

name	type	note
value	Float	
unit=VA (const)	UnitSymbol	
multiplier	UnitMultiplier	

6.2.10 Boolean Primitive

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

6.2.11 Capacitance Datatype

A farad, the typical unit, is the capacitance in which a charge of 1 coulomb produces 1 V potential difference between its terminals.

Attributes

name	type	note
value	Float	
unit=F (const)	UnitSymbol	
multiplier	UnitMultiplier	

6.2.12 Conductance Datatype

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

Attributes

name	type	note
value	Float	
unit=S (const)	UnitSymbol	
multiplier	UnitMultiplier	

6.2.13 CostPerEnergyUnit Datatype

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

Attributes

name	type	note
value	Float	
unit	MonetaryAmountPerEnergyUnit	
multiplier	UnitMultiplier	

6.2.14 CostRate Datatype

Cost, in units of currency, per hour of elapsed time.

Attributes

name	type	note
value	Float	
unit	MonetaryAmountRate	
multiplier	UnitMultiplier	

6.2.15 Currency enumeration

Monetary currencies. Apologies for this list not being exhaustive.

Enums

name	note
USD	US dollar
EUR	European euro
AUD	Australian dollar
CAD	Canadian dollar
CHF	Swiss francs
CNY	Chinese yuan renminbi
DKK	Danish crown
GBP	British pound
JPY	Japanese yen
NOK	Norwegian crown
RUR	Russian ruble
SEK	Swedish crown
INR	India rupees
other	Another type of currency.

6.2.16 CurrentFlow Datatype

Electrical current (positive flow is out of the ConductingEquipment into the ConnectivityNode).

Attributes

name	type	note
value	Float	
unit=A (const)	UnitSymbol	
multiplier	UnitMultiplier	

6.2.17 Damping Datatype

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

Attributes

name	type	note
value	Float	
unit=Hz-1 (const)	UnitSymbol	
multiplier	UnitMultiplier	

6.2.18 Float Primitive

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

6.2.19 FloatQuantity Datatype

Quantity with Float value and associated unit information.

Attributes

name	type	note
value	Float	
unit	UnitSymbol	
multiplier	UnitMultiplier	

6.2.20 Frequency Datatype

Cycles per second.

Attributes

name	type	note
value	Float	
unit=Hz (const)	UnitSymbol	
multiplier	UnitMultiplier	

6.2.21 Hours Datatype

Time, in hours.

Attributes

name	type	note
value	Float	
unit=h (const)	UnitSymbol	
multiplier=none (const)	UnitMultiplier	

6.2.22 Impedance Datatype

Ratio of voltage to current.

Attributes

name	type	note
value	Float	
unit=ohm (const)	UnitSymbol	
multiplier	UnitMultiplier	

6.2.23 Inductance Datatype

Inductance.

Attributes

name	type	note
value	Float	
unit=H (const)	UnitSymbol	
multiplier	UnitMultiplier	

6.2.24 Integer Primitive

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

6.2.25 IntegerQuantity Datatype

Quantity with integer value and associated unit information.

Attributes

name	type	note
value	Integer	
unit	UnitSymbol	
multiplier	UnitMultiplier	

6.2.26 KWActivePower Datatype

Active power in kilowatts.

Attributes

name	type	note
value	Float	
unit=W (const)	UnitSymbol	
multiplier=k (const)	UnitMultiplier	

6.2.27 LongLength Datatype

Long unit of length.

Attributes

name	type	note
value	Float	
unit=m (const)	UnitSymbol	
multiplier=k (const)	UnitMultiplier	

6.2.28 Minutes Datatype

Time in minutes.

Attributes

name	type	note
value	Float	
unit=min (const)	UnitSymbol	
multiplier=none (const)	UnitMultiplier	

6.2.29 MonetaryAmountPerEnergyUnit enumeration

Monetary amount per energy unit.

Enums

name	note
USD_per_Wh	
EUR_per_Wh	

6.2.30 MonetaryAmountPerHeatUnit enumeration

Monetary amount per joule.

Enums

name	note
USD_per_J	
EUR_per_J	

6.2.31 MonetaryAmountRate enumeration

Monetary amount per second.

Enums

name	note
USD_per_s	
EUR_per_s	

6.2.32 Money Datatype

Amount of money.

Attributes

name	type	note
value	Float	
unit	Currency	
multiplier	UnitMultiplier	

6.2.33 PerCent Datatype

Normally 0 to 100 on a defined base.

Attributes

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

6.2.34 Pressure Datatype

Pressure in Pascal.

Attributes

name	type	note
value	Float	
unit=Pa (const)	UnitSymbol	
multiplier	UnitMultiplier	

6.2.35 PU Datatype

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

Attributes

name	type	note
value	Float	
unit=none (const)	UnitSymbol	
multiplier=none (const)	UnitMultiplier	

6.2.36 Reactance Datatype

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

Attributes

name	type	note
value	Float	
unit=ohm (const)	UnitSymbol	
multiplier	UnitMultiplier	

6.2.37 ReactivePower Datatype

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

Attributes

name	type	note
value	Float	
unit=VAr (const)	UnitSymbol	
multiplier	UnitMultiplier	

6.2.38 RealEnergy Datatype

Real electrical energy.

Attributes

name	type	note
value	Float	
unit=Wh (const)	UnitSymbol	
multiplier	UnitMultiplier	

6.2.39 Resistance Datatype

Resistance (real part of impedance).

Attributes

name	type	note
value	Float	
unit=ohm (const)	UnitSymbol	
multiplier	UnitMultiplier	

6.2.40 RotationSpeed Datatype

Number of revolutions per second.

Attributes

name	type	note
value	Float	
unit=s-1 (const)	UnitSymbol	
multiplier=none (const)	UnitMultiplier	

6.2.41 Seconds Datatype

Time, in seconds.

Attributes

name	type	note
value	Float	Time, in seconds
unit=s (const)	UnitSymbol	
multiplier=none (const)	UnitMultiplier	

6.2.42 ShortLength Datatype

Short unit of length.

Attributes

name	type	note
value	Float	
unit=m (const)	UnitSymbol	
multiplier=none (const)	UnitMultiplier	

6.2.43 String Primitive

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

6.2.44 StringQuantity Datatype

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

Attributes

name	type	note
value	String	
unit	UnitSymbol	
multiplier	UnitMultiplier	

6.2.45 Susceptance Datatype

Imaginary part of admittance.

Attributes

name	type	note
value	Float	
unit=S (const)	UnitSymbol	
multiplier	UnitMultiplier	

6.2.46 Temperature Datatype

Value of temperature in degrees Celsius.

Attributes

name	type	note
value	Float	
unit=°C (const)	UnitSymbol	
multiplier=none (const)	UnitMultiplier	

6.2.47 UnitMultiplier enumeration

The unit multipliers defined for the CIM.

Enums

name	note
p	Pico 10**−12
n	Nano 10**−9
micro	Micro 10**−6
m	Milli 10**−3
c	Centi 10**−2
d	Deci 10**−1
k	Kilo 10**3
M	Mega 10**6
G	Giga 10**9
T	Tera 10**12
None	

6.2.48 UnitSymbol enumeration

The units defined for usage in the CIM.

Enums

name	note
VA	Apparent power in volt ampere
W	Active power in watt
VA _r	Reactive power in volt ampere reactive
VA _h	Apparent energy in volt ampere hours
Wh	Real energy in what hours
VA _{rh}	Reactive energy in volt ampere reactive hours
V	Voltage in volt
ohm	Resistance in ohm
A	Current in ampere
F	Capacitance in farad
H	Inductance in henry
°C	Relative temperature in degrees Celsius
s	Time in seconds
min	Time in minutes

name	note
h	Time in hours
deg	Plane angle in degrees
rad	Plane angle in radians
J	Energy in joule
N	Force in newton
S	Conductance in siemens
none	Dimension less quantity, e.g. count, per unit, etc.
Hz	Frequency in hertz
g	Mass in gram
Pa	Pressure in pascal (n/m ²)
m	Length in meter
m ²	Area in square meters
m ³	Volume in cubic meters
V/VAr	Volt per volt ampere reactive
W/Hz	Watt per hertz
J/s	Joule per second
s ⁻¹	per second
kg/J	Mass per energy
W/s	Watt per second
Hz ⁻¹	per Hertz

6.2.49 Voltage Datatype

Electrical voltage.

Attributes

name	type	note
value	Float	
unit=V (const)	UnitSymbol	
multiplier	UnitMultiplier	

6.2.50 VoltagePerReactivePower Datatype

Voltage variation with reactive power.

Attributes

name	type	note
value	Float	
unit=V/VAr (const)	UnitSymbol	
multiplier	UnitMultiplier	

6.2.51 Volume Datatype

Volume.

Attributes

name	type	note
value	Float	
unit=m3 (const)	UnitSymbol	
multiplier	UnitMultiplier	

6.2.52 WaterLevel Datatype

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

Attributes

name	type	note
value	Float	
unit=m (const)	UnitSymbol	
multiplier	UnitMultiplier	

6.2.53 Weight Datatype

The weight of an object.

Attributes

name	type	note
value	Float	
unit=g (const)	UnitSymbol	
multiplier	UnitMultiplier	

6.3 Core

6.3.1 Core package summary

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

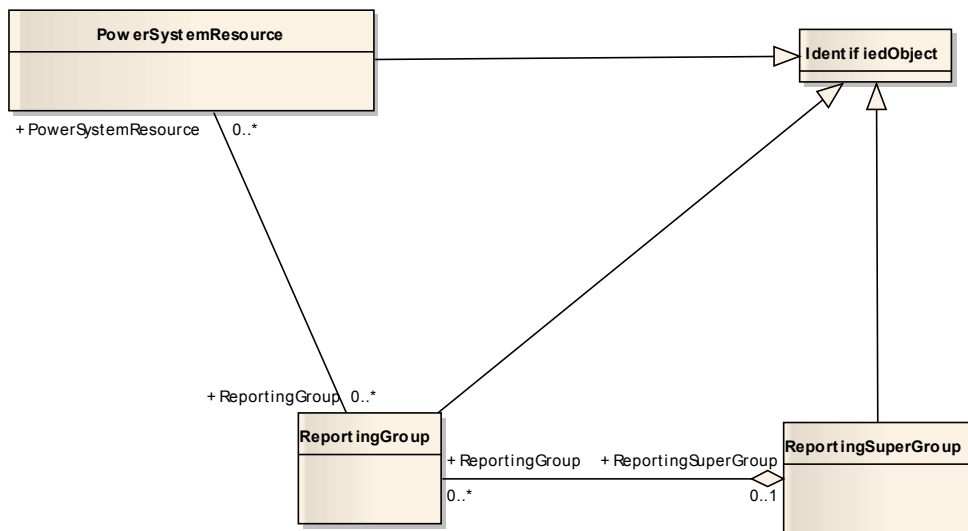
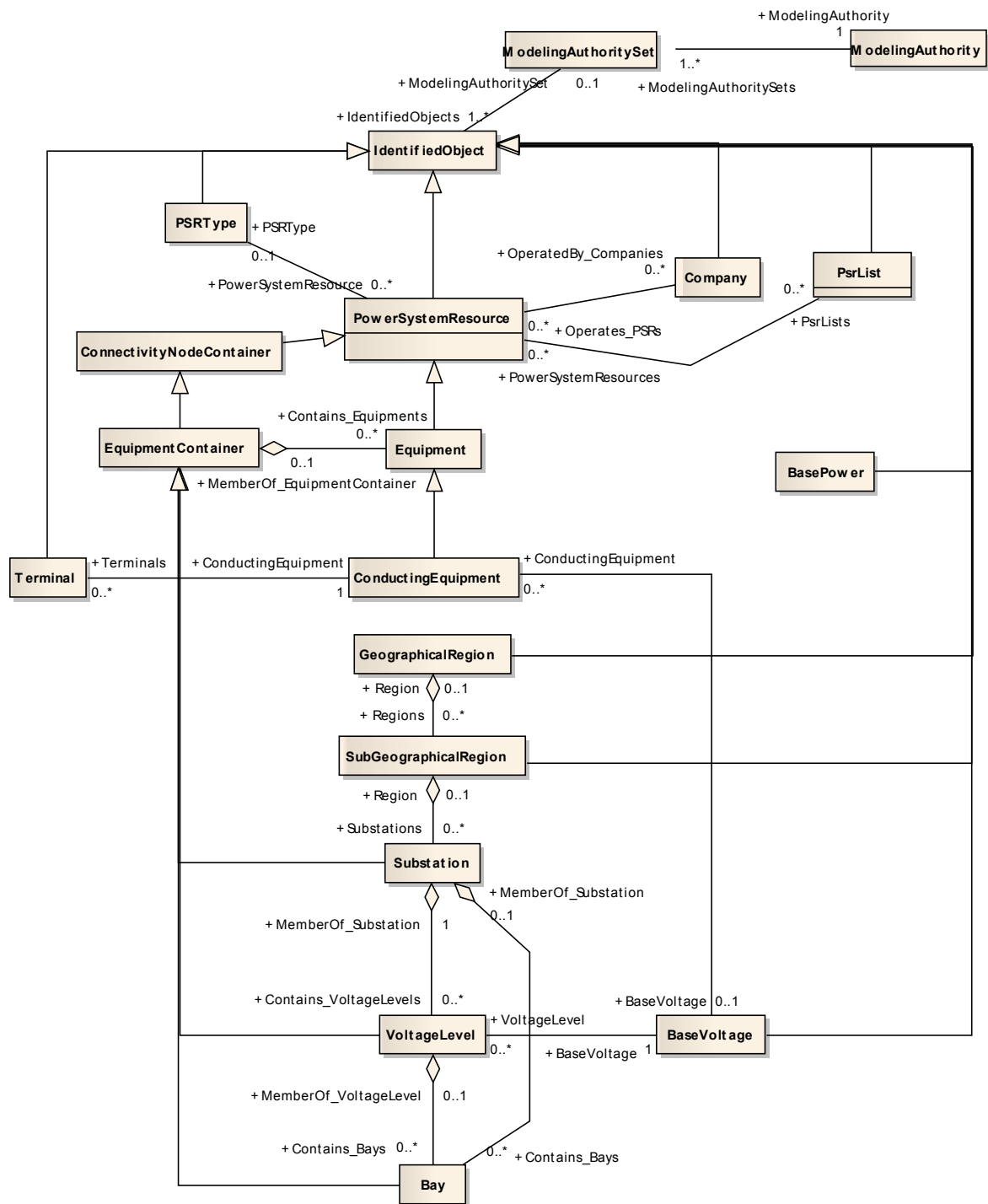


Figure 23 – Reporting

IEC 2011/11

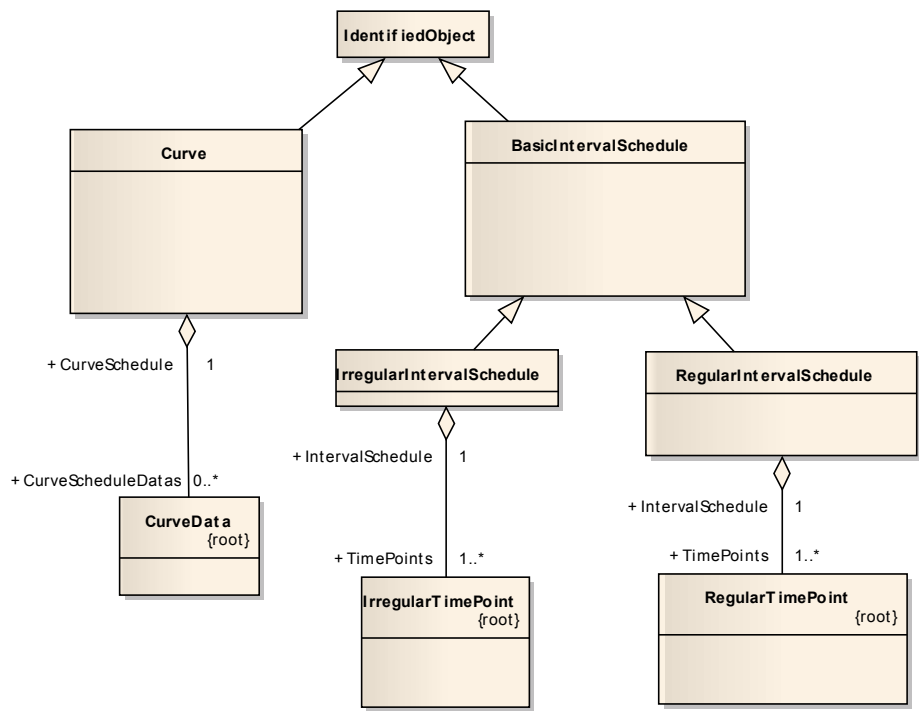
Figure 23 is not documented.



IEC 2012/11

Figure 24 – Main

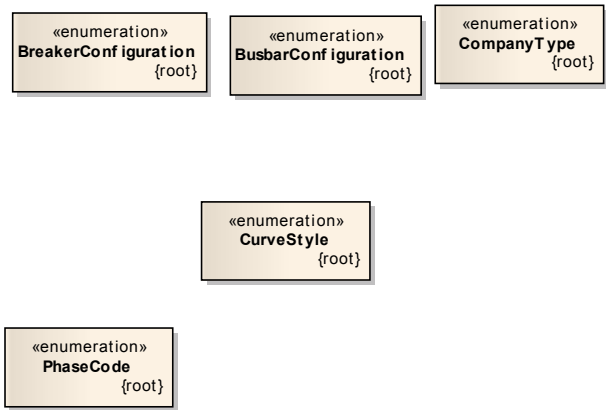
Figure 24 is documented as follows. This diagram is intended to show all classes needed for any application of the CIM for modeling transmission and generation systems.



IEC 2013/11

Figure 25 – CurveSchedule

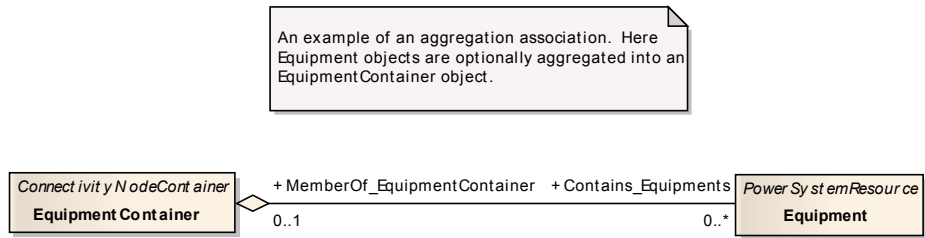
Figure 25 is not documented.



IEC 2014/11

Figure 26 – Datatypes

Figure 26 is documented as follows. This diagram shows the data types specific to the Core package.



IEC 2015/11

Figure 27 – DocumentationExampleAggregation

Figure 27 is not documented.

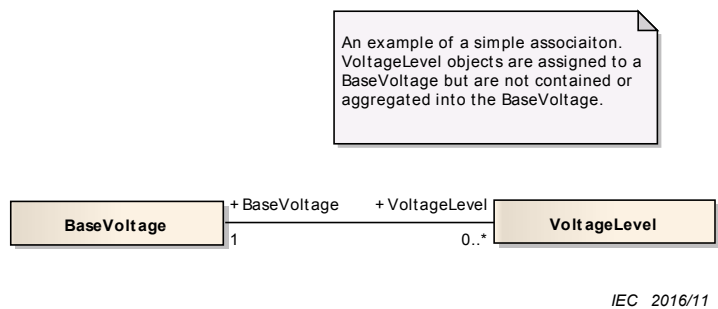


Figure 28 – DocumentationExampleAssociation

Figure 28 is documented as follows. This diagram is an example used for documentation purposes. It shows how a simple association and an aggregation association are expressed in UML diagrams.

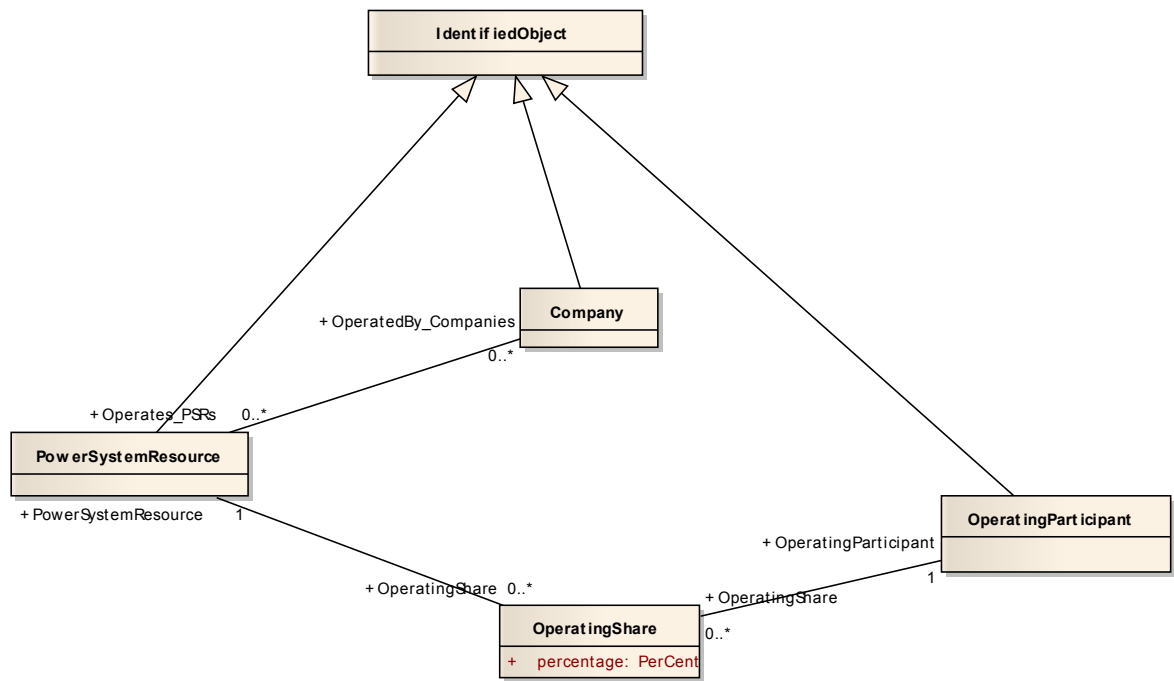


Figure 29 – Ownership

IEC 2017/11

Figure 29 is not documented.

6.3.2 BasePower

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

Attributes

name	type	note
basePower	ApparentPower	Definition of base power
mRID	String	inherited from: IdentifiedObject

name	String	inherited from: IdentifiedObject
localName	String	inherited from: IdentifiedObject
pathName	String	inherited from: IdentifiedObject
aliasName	String	inherited from: IdentifiedObject
description	String	inherited from: IdentifiedObject

Association ends

Mult from	[Mult] name (type)	note
1..*	[0..1] ModelingAuthoritySet (ModelingAuthoritySet)	inherited from: IdentifiedObject

6.3.3 BaseVoltage

Collection of BaseVoltages which is used to verify that the BusbarSection.BaseVoltage and other voltage attributes in the CIM are given a value existing in the collection.

Attributes

name	type	note
isDC	Boolean	If true, this is a direct current base voltage and items assigned to this base voltage are also associated with a direct current capabilities. False indicates alternating current.
nominalVoltage	Voltage	The PowerSystemResource's base voltage
mRID	String	inherited from: IdentifiedObject
name	String	inherited from: IdentifiedObject
localName	String	inherited from: IdentifiedObject
pathName	String	inherited from: IdentifiedObject
aliasName	String	inherited from: IdentifiedObject
description	String	inherited from: IdentifiedObject

Association ends

Mult from	[Mult] name (type)	note
0..1	[0..*] ConductingEquipment (ConductingEquipment)	Use association to ConductingEquipment only when there is no VoltageLevel container used.
1	[0..*] VoltageLevel (VoltageLevel)	The VoltageLevels having this BaseVoltage.
1..*	[0..1] ModelingAuthoritySet (ModelingAuthoritySet)	inherited from: IdentifiedObject

6.3.4 BasicIntervalSchedule

Schedule of values at points in time.

Attributes

name	type	note
startTime	AbsoluteDateTime	The time for the first time point
value1Unit	UnitSymbol	Value1 units of measure
value1Multiplier	UnitMultiplier	Multiplier for value1
value2Unit	UnitSymbol	Value2 units of measure
value2Multiplier	UnitMultiplier	Multiplier for value2

mRID	String	inherited from: IdentifiedObject
name	String	inherited from: IdentifiedObject
localName	String	inherited from: IdentifiedObject
pathName	String	inherited from: IdentifiedObject
aliasName	String	inherited from: IdentifiedObject
description	String	inherited from: IdentifiedObject

Association ends

Mult from	[Mult] name (type)	note
1..*	[0..1] ModelingAuthoritySet (ModelingAuthoritySet)	inherited from: IdentifiedObject

6.3.5 Bay

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

Attributes

name	type	note
bayEnergyMeasFlag	Boolean	Indicates the presence/absence of energy measurements.
bayPowerMeasFlag	Boolean	Indicates the presence/absence of active/reactive power measurements.
breakerConfiguration	BreakerConfiguration	Breaker configuration
busBarConfiguration	BusbarConfiguration	Bus bar configuration
mRID	String	inherited from: IdentifiedObject
name	String	inherited from: IdentifiedObject
localName	String	inherited from: IdentifiedObject
pathName	String	inherited from: IdentifiedObject
aliasName	String	inherited from: IdentifiedObject
description	String	inherited from: IdentifiedObject

Association ends

Mult from	[Mult] name (type)	note
0..*	[0..1] MemberOf_Substation (Substation)	The association is used in the naming hierarchy.
0..*	[0..1] MemberOf_VoltageLevel (VoltageLevel)	The association is used in the naming hierarchy.
0..1	[0..*] Contains_Equipments (Equipment)	inherited from: EquipmentContainer
1	[0..*] ConnectivityNodes (ConnectivityNode)	inherited from: ConnectivityNodeContainer
0..1	[0..*] TopologicalNode (TopologicalNode)	inherited from: ConnectivityNodeContainer
0..*	[0..*] OperatedBy_Companies (Company)	inherited from: PowerSystemResource
1	[0..*] Contains_Measurements (Measurement)	inherited from: PowerSystemResource
1	[0..*] OperatingShare (OperatingShare)	inherited from: PowerSystemResource
1	[0..1] OutageSchedule (OutageSchedule)	inherited from: PowerSystemResource
0..*	[0..*] PsrLists (PsrList)	inherited from: PowerSystemResource
0..*	[0..1] PSRTtype (PSRTtype)	inherited from: PowerSystemResource

Mult from	[Mult] name (type)	note
0..*	[0..*] ReportingGroup (ReportingGroup)	inherited from: PowerSystemResource
1..*	[0..1] ModelingAuthoritySet (ModelingAuthoritySet)	inherited from: IdentifiedObject

6.3.6 BreakerConfiguration Enumeration

Switching arrangement for Bay.

Enums

name	note
singleBreaker	
breakerAndAHalf	
doubleBreaker	
noBreaker	

6.3.7 BusbarConfiguration Enumeration

Busbar layout for Bay.

Enums

name	note
singleBus	
doubleBus	
mainWithTransfer	
ringBus	

6.3.8 Company

A company is a legal entity that owns and operates power system resources and is a party to interchange and transmission contracts.

Attributes

name	type	note
companyType	CompanyType	The type of company
mRID	String	inherited from: IdentifiedObject
name	String	inherited from: IdentifiedObject
localName	String	inherited from: IdentifiedObject
pathName	String	inherited from: IdentifiedObject
aliasName	String	inherited from: IdentifiedObject
description	String	inherited from: IdentifiedObject

Association ends

Mult from	[Mult] name (type)	note
0..*	[0..*] Operates_PSRs (PowerSystemResource)	PowerSystemResources the company operates
1..*	[0..1] ModelingAuthoritySet (ModelingAuthoritySet)	inherited from: IdentifiedObject

6.3.9 CompanyType enumeration

Type of company.

Enums

name	note
pool	
municipal	
isPrivate	

6.3.10 ConductingEquipment

The parts of the power system that are designed to carry current or that are conductively connected therewith. ConductingEquipment is contained within an EquipmentContainer that may be a Substation, or a VoltageLevel or a Bay within a Substation.

Attributes

name	type	note
phases	PhaseCode	Describes the phases carried by a conducting equipment
normalIyInService	Boolean	inherited from: Equipment
mRID	String	inherited from: IdentifiedObject
name	String	inherited from: IdentifiedObject
localName	String	inherited from: IdentifiedObject
pathName	String	inherited from: IdentifiedObject
aliasName	String	inherited from: IdentifiedObject
description	String	inherited from: IdentifiedObject

Association ends

Mult from	[Mult] name (type)	note
0..*	[0..1] BaseVoltage (BaseVoltage)	Use association to ConductingEquipment only when there is no VoltageLevel container used.
1	[0..*] ClearanceTags (ClearanceTag)	Conducting equipment may have multiple clearance tags for authorized field work.
0..*	[0..*] ProtectionEquipments (ProtectionEquipment)	Protection equipment may be used to protect specific Conducting Equipment. Multiple equipment may be protected or monitored by multiple protection equipment.
1	[0..*] Terminals (Terminal)	ConductingEquipment has 1 or 2 terminals that may be connected to other ConductingEquipment terminals via ConnectivityNodes.
1	[0..*] ContingencyEquipment (ContingencyEquipment)	inherited from: Equipment
0..*	[0..1] MemberOf_EquipmentContainer (EquipmentContainer)	inherited from: Equipment
1	[0..*] OperationalLimitSet (OperationalLimitSet)	inherited from: Equipment
0..*	[0..*] OperatedBy_Companies (Company)	inherited from: PowerSystemResource
1	[0..*] Contains_Measurements (Measurement)	inherited from: PowerSystemResource
1	[0..*] OperatingShare (OperatingShare)	inherited from: PowerSystemResource
1	[0..1] OutageSchedule (OutageSchedule)	inherited from: PowerSystemResource
0..*	[0..*] PsrLists (PsrList)	inherited from: PowerSystemResource

Mult from	[Mult] name (type)	note
0..*	[0..1] PSRTtype (PSRTtype)	inherited from: PowerSystemResource
0..*	[0..*] ReportingGroup (ReportingGroup)	inherited from: PowerSystemResource
1..*	[0..1] ModelingAuthoritySet (ModelingAuthoritySet)	inherited from: IdentifiedObject

6.3.11 ConnectivityNodeContainer

A base class for all objects that may contain ConnectivityNodes or TopologicalNodes.

Attributes

name	type	note
mRID	String	inherited from: IdentifiedObject
name	String	inherited from: IdentifiedObject
localName	String	inherited from: IdentifiedObject
pathName	String	inherited from: IdentifiedObject
aliasName	String	inherited from: IdentifiedObject
description	String	inherited from: IdentifiedObject

Association ends

Mult from	[Mult] name (type)	note
1	[0..*] ConnectivityNodes (ConnectivityNode)	Connectivity nodes contained by this container
0..1	[0..*] TopologicalNode (TopologicalNode)	The topological nodes which belong to this connectivity node container
0..*	[0..*] OperatedBy_Companies (Company)	inherited from: PowerSystemResource
1	[0..*] Contains_Measurements (Measurement)	inherited from: PowerSystemResource
1	[0..*] OperatingShare (OperatingShare)	inherited from: PowerSystemResource
1	[0..1] OutageSchedule (OutageSchedule)	inherited from: PowerSystemResource
0..*	[0..*] PsrLists (PsrList)	inherited from: PowerSystemResource
0..*	[0..1] PSRTtype (PSRTtype)	inherited from: PowerSystemResource
0..*	[0..*] ReportingGroup (ReportingGroup)	inherited from: PowerSystemResource
1..*	[0..1] ModelingAuthoritySet (ModelingAuthoritySet)	inherited from: IdentifiedObject

6.3.12 Curve

Relationship between an independent variable (X-axis) and one or two dependent variables (Y1-axis and Y2-axis). Curves can also serve as schedules.

Attributes

name	type	note
curveStyle	CurveStyle	The style or shape of the curve
xUnit	UnitSymbol	The X-axis units of measure
xMultiplier	UnitMultiplier	Multiplier for X-axis
y1Unit	UnitSymbol	The Y1-axis units of measure
y1Multiplier	UnitMultiplier	Multiplier for Y1-axis
y2Unit	UnitSymbol	The Y2-axis units of measure

y2Multiplier	UnitMultiplier	Multiplier for Y2-axis
mRID	String	inherited from: IdentifiedObject
name	String	inherited from: IdentifiedObject
localName	String	inherited from: IdentifiedObject
pathName	String	inherited from: IdentifiedObject
aliasName	String	inherited from: IdentifiedObject
description	String	inherited from: IdentifiedObject

Association ends

Mult from	[Mult] name (type)	note
1	[0..*] CurveScheduleDatas (CurveData)	The point data values that define a curve
1..*	[0..1] ModelingAuthoritySet (ModelingAuthoritySet)	inherited from: IdentifiedObject

6.3.13 CurveData

Data point values for defining a curve or schedule.

Attributes

name	type	note
xvalue	Float	The data value of the X-axis variable, depending on the X-axis units
y1value	Float	The data value of the first Y-axis variable, depending on the Y-axis units
y2value	Float	The data value of the second Y-axis variable (if present), depending on the Y-axis units

Association ends

Mult from	[Mult] name (type)	note
0..*	[1] CurveSchedule (Curve)	The Curve defined by this CurveData

6.3.14 CurveStyle enumeration

Style or shape of curve.

Enums

name	note
constantYValue	
straightLineYValues	
rampYValue	
formula	

6.3.15 Equipment

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

Attributes

name	type	note
normallyInService	Boolean	The equipment is normally in service
mRID	String	inherited from: IdentifiedObject
name	String	inherited from: IdentifiedObject
localName	String	inherited from: IdentifiedObject
pathName	String	inherited from: IdentifiedObject
aliasName	String	inherited from: IdentifiedObject
description	String	inherited from: IdentifiedObject

Association ends

Mult from	[Mult] name (type)	note
1	[0..*] ContingencyEquipment (ContingencyEquipment)	The contingency element associated with the equipment.
0..*	[0..1] MemberOf_EquipmentContainer (EquipmentContainer)	The association is used in the naming hierarchy.
1	[0..*] OperationalLimitSet (OperationalLimitSet)	The equipment limit sets associated with the equipment.
0..*	[0..*] OperatedBy_Companies (Company)	inherited from: PowerSystemResource
1	[0..*] Contains_Measurements (Measurement)	inherited from: PowerSystemResource
1	[0..*] OperatingShare (OperatingShare)	inherited from: PowerSystemResource
1	[0..1] OutageSchedule (OutageSchedule)	inherited from: PowerSystemResource
0..*	[0..*] PsrLists (PsrList)	inherited from: PowerSystemResource
0..*	[0..1] PSRType (PSRType)	inherited from: PowerSystemResource
0..*	[0..*] ReportingGroup (ReportingGroup)	inherited from: PowerSystemResource
1..*	[0..1] ModelingAuthoritySet (ModelingAuthoritySet)	inherited from: IdentifiedObject

6.3.16 EquipmentContainer

A modeling construct to provide a root class for all Equipment classes.

Attributes

name	type	note
mRID	String	inherited from: IdentifiedObject
name	String	inherited from: IdentifiedObject
localName	String	inherited from: IdentifiedObject
pathName	String	inherited from: IdentifiedObject
aliasName	String	inherited from: IdentifiedObject
description	String	inherited from: IdentifiedObject

Association ends

Mult from	[Mult] name (type)	note
0..1	[0..*] Contains_Equipments (Equipment)	The association is used in the naming hierarchy.
1	[0..*] ConnectivityNodes (ConnectivityNode)	inherited from: ConnectivityNodeContainer
0..1	[0..*] TopologicalNode (TopologicalNode)	inherited from: ConnectivityNodeContainer
0..*	[0..*] OperatedBy_Companies (Company)	inherited from: PowerSystemResource
1	[0..*] Contains_Measurements (Measurement)	inherited from: PowerSystemResource
1	[0..*] OperatingShare (OperatingShare)	inherited from: PowerSystemResource
1	[0..1] OutageSchedule (OutageSchedule)	inherited from: PowerSystemResource
0..*	[0..*] PsrLists (PsrList)	inherited from: PowerSystemResource
0..*	[0..1] PSRTtype (PSRTtype)	inherited from: PowerSystemResource
0..*	[0..*] ReportingGroup (ReportingGroup)	inherited from: PowerSystemResource
1..*	[0..1] ModelingAuthoritySet (ModelingAuthoritySet)	inherited from: IdentifiedObject

6.3.17 GeographicalRegion

A geographical region of a power system network model.

Attributes

name	type	note
mRID	String	inherited from: IdentifiedObject
name	String	inherited from: IdentifiedObject
localName	String	inherited from: IdentifiedObject
pathName	String	inherited from: IdentifiedObject
aliasName	String	inherited from: IdentifiedObject
description	String	inherited from: IdentifiedObject

Association ends

Mult from	[Mult] name (type)	note
0..1	[0..*] Regions (SubGeographicalRegion)	The association is used in the naming hierarchy.
1..*	[0..1] ModelingAuthoritySet (ModelingAuthoritySet)	inherited from: IdentifiedObject

6.3.18 IdentifiedObject

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

Attributes

name	type	note
mRID	String	A Model Authority issues mRIDs. Given that each Model Authority has a unique id and this id is part of the mRID, then the mRID is globally unique.
name	String	The name is a free text human readable name of the object. It may be non unique and may not correlate to a naming hierarchy.
localName	String	The localName is a human readable name of the

name	type	note
		object. It is only used with objects organized in a naming hierarchy. The simplest naming hierarchy has just one parent (the root) giving a flat naming hierarchy. However, the naming hierarchy usually has several levels, e.g. Substation, VoltageLevel, Equipment etc. Children of the same parent have names that are unique among them. If the uniqueness requirement cannot be met IdentifiedObject.localName shall not be used, use IdentifiedObject.name instead.
pathName	String	The pathname is a system unique name composed from all IdentifiedObject.localNames in a naming hierarchy path from the object to the root.
aliasName	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.
description	String	The description is a free human readable text describing or naming the object. It may be non unique and may not correlate to a naming hierarchy.

Association ends

Mult from	[Mult] name (type)	note
1..*	[0..1] ModelingAuthoritySet (ModelingAuthoritySet)	An IdentifiedObject belongs to a Modeling Authority Set for purposes of defining a group of data maintained by the same Modeling Authority.

6.3.19 IrregularIntervalSchedule

The schedule has TimePoints where the time between them varies.

Attributes

name	type	note
startTime	AbsoluteDateTime	inherited from: BasicIntervalSchedule
value1Unit	UnitSymbol	inherited from: BasicIntervalSchedule
value1Multiplier	UnitMultiplier	inherited from: BasicIntervalSchedule
value2Unit	UnitSymbol	inherited from: BasicIntervalSchedule
value2Multiplier	UnitMultiplier	inherited from: BasicIntervalSchedule
mRID	String	inherited from: IdentifiedObject
name	String	inherited from: IdentifiedObject
localName	String	inherited from: IdentifiedObject
pathName	String	inherited from: IdentifiedObject
aliasName	String	inherited from: IdentifiedObject
description	String	inherited from: IdentifiedObject

Association ends

Mult from	[Mult] name (type)	note
1	[1..*] TimePoints (IrregularTimePoint)	The point data values that define a curve
1..*	[0..1] ModelingAuthoritySet (ModelingAuthoritySet)	inherited from: IdentifiedObject

6.3.20 IrregularTimePoint

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

Attributes

name	type	note
time	Seconds	The time is relative the BasicTimeSchedule.startTime.
value1	Float	The first value at the time. The meaning of the value is defined by the class inhering the IrregularIntervalSchedule.
value2	Float	The second value at the time. The meaning of the value is defined by the class inhering the IrregularIntervalSchedule.

Association ends

Mult from	[Mult] name (type)	note
1..*	[1] IntervalSchedule (IrregularIntervalSchedule)	An IrregularTimePoint belongs to an IrregularIntervalSchedule.

6.3.21 ModelingAuthority

A modeling authority is an entity responsible for supplying and maintaining the data defining a specific set of objects in a network model.

Attributes

name	type	note
mRID	String	inherited from: IdentifiedObject
name	String	inherited from: IdentifiedObject
localName	String	inherited from: IdentifiedObject
pathName	String	inherited from: IdentifiedObject
aliasName	String	inherited from: IdentifiedObject
description	String	inherited from: IdentifiedObject

Association ends

Mult from	[Mult] name (type)	note
1	[1..*] ModelingAuthoritySets (ModelingAuthoritySet)	A modeling authority supplies and maintains the data for the objects in a Modeling Authority Set.
1..*	[0..1] ModelingAuthoritySet (ModelingAuthoritySet)	inherited from: IdentifiedObject

6.3.22 ModelingAuthoritySet

A modeling authority set is a group of objects in a network model where the data is supplied and maintained by the same modeling authority.

Attributes

name	type	note
mRID	String	inherited from: IdentifiedObject
name	String	inherited from: IdentifiedObject
localName	String	inherited from: IdentifiedObject
pathName	String	inherited from: IdentifiedObject
aliasName	String	inherited from: IdentifiedObject
description	String	inherited from: IdentifiedObject

Association ends

Mult from	[Mult] name (type)	note
0..1	[1..*] IdentifiedObjects (IdentifiedObject)	An IdentifiedObject belongs to a modeling authority set for purposes of defining a group of data maintained by the same modeling authority.
1..*	[1] ModelingAuthority (ModelingAuthority)	A modeling authority supplies and maintains the data for the objects in a Modeling Authority Set.
1..*	[0..1] ModelingAuthoritySet (ModelingAuthoritySet)	inherited from: IdentifiedObject

6.3.23 OperatingParticipant

An operator of multiple PowerSystemResource objects. Note multiple OperatingParticipants may operate the same PowerSystemResource object. This can be used for modeling jointly owned units where each owner operates as a contractual share.

Attributes

name	type	note
mRID	String	inherited from: IdentifiedObject
name	String	inherited from: IdentifiedObject
localName	String	inherited from: IdentifiedObject
pathName	String	inherited from: IdentifiedObject
aliasName	String	inherited from: IdentifiedObject
description	String	inherited from: IdentifiedObject

Association ends

Mult from	[Mult] name (type)	note
1	[0..*] OperatingShare (OperatingShare)	The operating shares of an operating participant. An operating participant can be reused for any number of PSR's.
1..*	[0..1] ModelingAuthoritySet (ModelingAuthoritySet)	inherited from: IdentifiedObject

6.3.24 OperatingShare

Specifies the contract relationship between a PowerSystemResource and a contract participant.

Attributes

name	type	note
percentage	PerCent	Percentage ownership for this device. The percentage indicates the percentage ownership of the PSROwner for the PowerSystemResource. The total percentage ownership for a PowerSystemResource should add to 100 %.

Association ends

Mult from	[Mult] name (type)	note
0..*	[1] OperatingParticipant (OperatingParticipant)	The linkage to an owner and its linkage attributes like percentage ownership. The ownership percentage should add to 100 % for all owners of a PowerSystemResource, but a PSROwner may own any percentage of any number of PowerSystemResource objects.
0..*	[1] PowerSystemResource (PowerSystemResource)	The PowerSystemResource to which the attributes apply. The percentage ownership of all owners of a PowerSystemResource should add to 100 %.

6.3.25 PhaseCode enumeration

Enumeration of phase identifiers.

Enums

name	note
ABCN	
ABC	
ABN	
ACN	
BCN	
AB	
AC	
BC	
AN	
BN	
CN	
A	
B	
C	
N	

6.3.26 PowerSystemResource

A power system resource can be an item of equipment such as a Switch, an EquipmentContainer containing many individual items of equipment such as a Substation, or an organizational entity such as Company or SubControlArea. This provides for the nesting of collections of PowerSystemResources within other PowerSystemResources. For example, a Switch could be a member of a Substation and a Substation could be a member of a division of a Company.

Attributes

name	type	note
mRID	String	inherited from: IdentifiedObject
name	String	inherited from: IdentifiedObject
localName	String	inherited from: IdentifiedObject
pathName	String	inherited from: IdentifiedObject
aliasName	String	inherited from: IdentifiedObject
description	String	inherited from: IdentifiedObject

Association ends

Mult from	[Mult] name (type)	note
0..*	[0..*] OperatedBy_Companies (Company)	A power system resource may be part of one or more companies.
1	[0..*] Contains_Measurements (Measurement)	The Measurements that are included in the naming hierarchy where the PSR is the containing object.
1	[0..*] OperatingShare (OperatingShare)	The linkage to any number of operating share objects.
1	[0..1] OutageSchedule (OutageSchedule)	A power system resource may have an outage schedule.
0..*	[0..*] PsrLists (PsrList)	
0..*	[0..1] PSRType (PSRType)	PSRType (custom classification) for this PowerSystemResource.
0..*	[0..*] ReportingGroup (ReportingGroup)	Reporting groups to which this PSR belongs.
1..*	[0..1] ModelingAuthoritySet (ModelingAuthoritySet)	inherited from: IdentifiedObject

6.3.27 PsrList

Arbitrary list of PowerSystemResources. Can be used for various purposes, including grouping for report generation.

Attributes

name	type	note
typePSRList	String	Type of power system resources in this list
mRID	String	inherited from: IdentifiedObject
name	String	inherited from: IdentifiedObject
localName	String	inherited from: IdentifiedObject
pathName	String	inherited from: IdentifiedObject
aliasName	String	inherited from: IdentifiedObject
description	String	inherited from: IdentifiedObject

Association ends

Mult from	[Mult] name (type)	note
0..*	[0..*] PowerSystemResources (PowerSystemResource)	
1..*	[0..1] ModelingAuthoritySet (ModelingAuthoritySet)	inherited from: IdentifiedObject

6.3.28 PSRType

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

Attributes

name	type	note
mRID	String	inherited from: IdentifiedObject
name	String	inherited from: IdentifiedObject
localName	String	inherited from: IdentifiedObject
pathName	String	inherited from: IdentifiedObject
aliasName	String	inherited from: IdentifiedObject
description	String	inherited from: IdentifiedObject

Association ends

Mult from	[Mult] name (type)	note
0..1	[0..*] PowerSystemResource (PowerSystemResource)	Power system resources classified with this PSRType
1..*	[0..1] ModelingAuthoritySet (ModelingAuthoritySet)	inherited from: IdentifiedObject

6.3.29 RegularIntervalSchedule

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

Attributes

name	type	note
timeStep	Seconds	The time between each pair of subsequent RegularTimePoints
endTime	AbsoluteDateTime	The time for the last time point
startTime	AbsoluteDateTime	inherited from: BasicIntervalSchedule
value1Unit	UnitSymbol	inherited from: BasicIntervalSchedule
value1Multiplier	UnitMultiplier	inherited from: BasicIntervalSchedule
value2Unit	UnitSymbol	inherited from: BasicIntervalSchedule
value2Multiplier	UnitMultiplier	inherited from: BasicIntervalSchedule
mRID	String	inherited from: IdentifiedObject
name	String	inherited from: IdentifiedObject
localName	String	inherited from: IdentifiedObject
pathName	String	inherited from: IdentifiedObject
aliasName	String	inherited from: IdentifiedObject
description	String	inherited from: IdentifiedObject

Association ends

Mult from	[Mult] name (type)	note
1	[1..*] TimePoints (RegularTimePoint)	The point data values that define a curve
1..*	[0..1] ModelingAuthoritySet (ModelingAuthoritySet)	inherited from: IdentifiedObject

6.3.30 RegularTimePoint

TimePoints for a schedule where the time between the points is constant.

Attributes

name	type	note
sequenceNumber	Integer	The position of the RegularTimePoint 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 RegularIntervalSchedule.timeStep with the RegularTimePoint.sequenceNumber and add the BasicIntervalSchedule.startTime.
value1	Float	The first value at the time. The meaning of the value is defined by the class inhering the RegularIntervalSchedule.
value2	Float	The second value at the time. The meaning of the value is defined by the class inhering the RegularIntervalSchedule.

Association ends

Mult from	[Mult] name (type)	note
1..*	[1] IntervalSchedule (RegularIntervalSchedule)	A RegularTimePoint belongs to a RegularIntervalSchedule.

6.3.31 ReportingGroup

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

Attributes

name	type	note
mRID	String	inherited from: IdentifiedObject
name	String	inherited from: IdentifiedObject
localName	String	inherited from: IdentifiedObject
pathName	String	inherited from: IdentifiedObject
aliasName	String	inherited from: IdentifiedObject
description	String	inherited from: IdentifiedObject

Association ends

Mult from	[Mult] name (type)	note
0..1	[0..*] BusNameMarker (BusNameMarker)	The BusNameMarkers that belong to this reporting group
0..*	[0..*] PowerSystemResource (PowerSystemResource)	PSR's which belong to this reporting group
0..*	[0..1] ReportingSuperGroup (ReportingSuperGroup)	Reporting super group to which this reporting group belongs
0..1	[0..*] TopologicalNode (TopologicalNode)	The topological nodes that belong to the reporting group
1..*	[0..1] ModelingAuthoritySet (ModelingAuthoritySet)	inherited from: IdentifiedObject

6.3.32 ReportingSuperGroup

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

Attributes

name	type	note
mRID	String	inherited from: IdentifiedObject
name	String	inherited from: IdentifiedObject
localName	String	inherited from: IdentifiedObject
pathName	String	inherited from: IdentifiedObject
aliasName	String	inherited from: IdentifiedObject
description	String	inherited from: IdentifiedObject

Association ends

Mult from	[Mult] name (type)	note
0..1	[0..*] ReportingGroup (ReportingGroup)	Reporting groups that are grouped under this group group
1..*	[0..1] ModelingAuthoritySet (ModelingAuthoritySet)	inherited from: IdentifiedObject

6.3.33 SubGeographicalRegion

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

Attributes

name	type	note
mRID	String	inherited from: IdentifiedObject
name	String	inherited from: IdentifiedObject
localName	String	inherited from: IdentifiedObject
pathName	String	inherited from: IdentifiedObject
aliasName	String	inherited from: IdentifiedObject
description	String	inherited from: IdentifiedObject

Association ends

Mult from	[Mult] name (type)	note
0..*	[0..1] Region (GeographicalRegion)	The association is used in the naming hierarchy.
0..1	[0..*] Lines (Line)	A Line can be contained by a SubGeographical Region.
0..1	[0..*] Substations (Substation)	The association is used in the naming hierarchy.
1..*	[0..1] ModelingAuthoritySet (ModelingAuthoritySet)	inherited from: IdentifiedObject

6.3.34 Substation

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

Attributes

name	type	note
mRID	String	inherited from: IdentifiedObject
name	String	inherited from: IdentifiedObject
localName	String	inherited from: IdentifiedObject
pathName	String	inherited from: IdentifiedObject
aliasName	String	inherited from: IdentifiedObject
description	String	inherited from: IdentifiedObject

Association ends

Mult from	[Mult] name (type)	note
0..1	[0..*] Contains_Bays (Bay)	The association is used in the naming hierarchy.
0..*	[0..1] Region (SubGeographicalRegion)	The association is used in the naming hierarchy.
1	[0..*] Contains_VoltageLevels (VoltageLevel)	The association is used in the naming hierarchy.
0..1	[0..*] Contains_Equipments (Equipment)	inherited from: EquipmentContainer
1	[0..*] ConnectivityNodes (ConnectivityNode)	inherited from: ConnectivityNodeContainer
0..1	[0..*] TopologicalNode (TopologicalNode)	inherited from: ConnectivityNodeContainer
0..*	[0..*] OperatedBy_Companies (Company)	inherited from: PowerSystemResource
1	[0..*] Contains_Measurements (Measurement)	inherited from: PowerSystemResource
1	[0..*] OperatingShare (OperatingShare)	inherited from: PowerSystemResource
1	[0..1] OutageSchedule (OutageSchedule)	inherited from: PowerSystemResource
0..*	[0..*] PsrLists (PsrList)	inherited from: PowerSystemResource
0..*	[0..1] PSRTYPE (PSRTYPE)	inherited from: PowerSystemResource
0..*	[0..*] ReportingGroup (ReportingGroup)	inherited from: PowerSystemResource
1..*	[0..1] ModelingAuthoritySet (ModelingAuthoritySet)	inherited from: IdentifiedObject

6.3.35 Terminal

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

Attributes

name	type	note
mRID	String	inherited from: IdentifiedObject
name	String	inherited from: IdentifiedObject
localName	String	inherited from: IdentifiedObject
pathName	String	inherited from: IdentifiedObject
aliasName	String	inherited from: IdentifiedObject
description	String	inherited from: IdentifiedObject

Association ends

Mult from	[Mult] name (type)	note
1	[0..*] BranchGroupTerminal (BranchGroupTerminal)	The directed branch group terminals for which the terminal is monitored.
0..*	[1] ConductingEquipment (ConductingEquipment)	ConductingEquipment has 1 or 2 terminals that may be connected to other ConductingEquipment terminals via ConnectivityNodes.
0..*	[0..1] ConnectivityNode (ConnectivityNode)	Terminals interconnect with zero impedance at a node. Measurements on a node apply to all of its terminals.
0..1	[0..*] Measurements (Measurement)	
1	[0..*] HasFirst_MutualCoupling (MutualCoupling)	Mutual couplings associated with the branch as the first branch.
1	[0..*] HasSecond_MutualCoupling (MutualCoupling)	Mutual couplings with the branch associated as the first branch.
0..1	[0..*] OperationalLimitSet (OperationalLimitSet)	The operational limits sets that apply specifically to this terminal. Other operational limits sets may apply to this terminal through the association to Equipment.
0..1	[0..*] RegulatingControl (RegulatingControl)	The terminal is regulated by a control.
1	[0..2] TieFlow (TieFlow)	The control area tie flows to which this terminal associates.
0..*	[0..1] TopologicalNode (TopologicalNode)	The topological node associated with the terminal. This can be used as an alternative to the connectivity node path to topological node, thus making it unnecessary to model connectivity nodes in some cases. Note that the if connectivity nodes are in the model, this association would probably not be used.
1..*	[0..1] ModelingAuthoritySet (ModelingAuthoritySet)	inherited from: IdentifiedObject

6.3.36 Unit

Quantity being measured. The Unit.name shall be unique among all specified quantities and describe the quantity. The Unit.aliasName is meant to be used for localization.

Attributes

name	type	note
mRID	String	inherited from: IdentifiedObject
name	String	inherited from: IdentifiedObject
localName	String	inherited from: IdentifiedObject
pathName	String	inherited from: IdentifiedObject
aliasName	String	inherited from: IdentifiedObject
description	String	inherited from: IdentifiedObject

Association ends

Mult from	[Mult] name (type)	note
1	[0..*] Controls (Control)	The Controls having the Unit.
1	[0..*] Measurements (Measurement)	The Measurements having the Unit
1	[0..*] ProtectionEquipments (ProtectionEquipment)	
1..*	[0..1] ModelingAuthoritySet (ModelingAuthoritySet)	inherited from: IdentifiedObject

6.3.37 VoltageLevel

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.

Attributes

name	type	note
highVoltageLimit	Voltage	The bus bar's high voltage limit
lowVoltageLimit	Voltage	The bus bar's low voltage limit
mRID	String	inherited from: IdentifiedObject
name	String	inherited from: IdentifiedObject
localName	String	inherited from: IdentifiedObject
pathName	String	inherited from: IdentifiedObject
aliasName	String	inherited from: IdentifiedObject
description	String	inherited from: IdentifiedObject

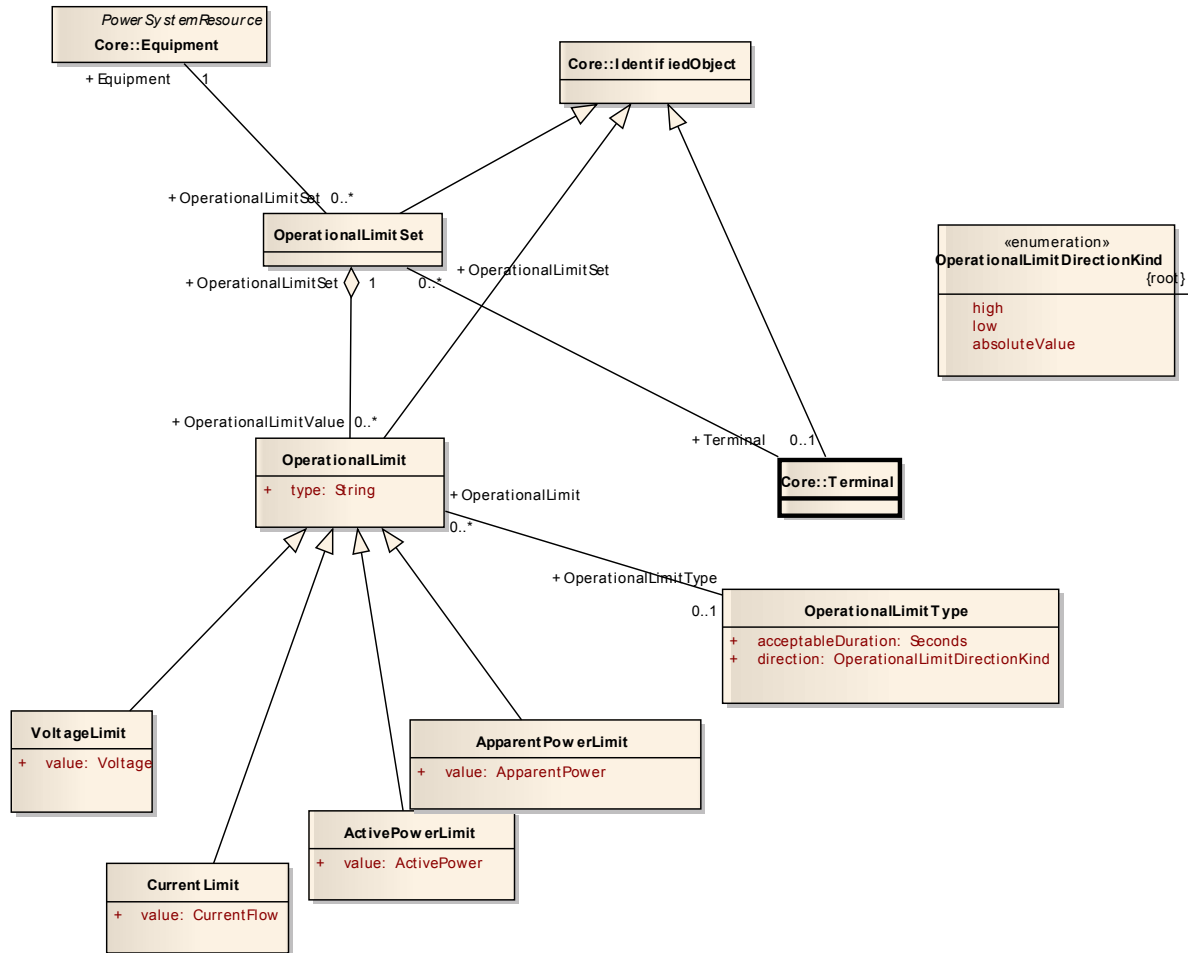
Association ends

Mult from	[Mult] name (type)	note
0..*	[1] BaseVoltage (BaseVoltage)	The base voltage used for all equipment within the VoltageLevel.
0..1	[0..*] Contains_Bays (Bay)	The association is used in the naming hierarchy.
0..*	[1] MemberOf_Substation (Substation)	The association is used in the naming hierarchy.
0..1	[0..*] Contains_Equipments (Equipment)	inherited from: EquipmentContainer
1	[0..*] ConnectivityNodes (ConnectivityNode)	inherited from: ConnectivityNodeContainer
0..1	[0..*] TopologicalNode (TopologicalNode)	inherited from: ConnectivityNodeContainer
0..*	[0..*] OperatedBy_Companies (Company)	inherited from: PowerSystemResource
1	[0..*] Contains_Measurements (Measurement)	inherited from: PowerSystemResource
1	[0..*] OperatingShare (OperatingShare)	inherited from: PowerSystemResource
1	[0..1] OutageSchedule (OutageSchedule)	inherited from: PowerSystemResource
0..*	[0..*] PsrLists (PsrList)	inherited from: PowerSystemResource
0..*	[0..1] PSRTYPE (PSRTYPE)	inherited from: PowerSystemResource
0..*	[0..*] ReportingGroup (ReportingGroup)	inherited from: PowerSystemResource
1..*	[0..1] ModelingAuthoritySet (ModelingAuthoritySet)	inherited from: IdentifiedObject

6.4 OperationalLimits

6.4.1 OperationalLimits package summary

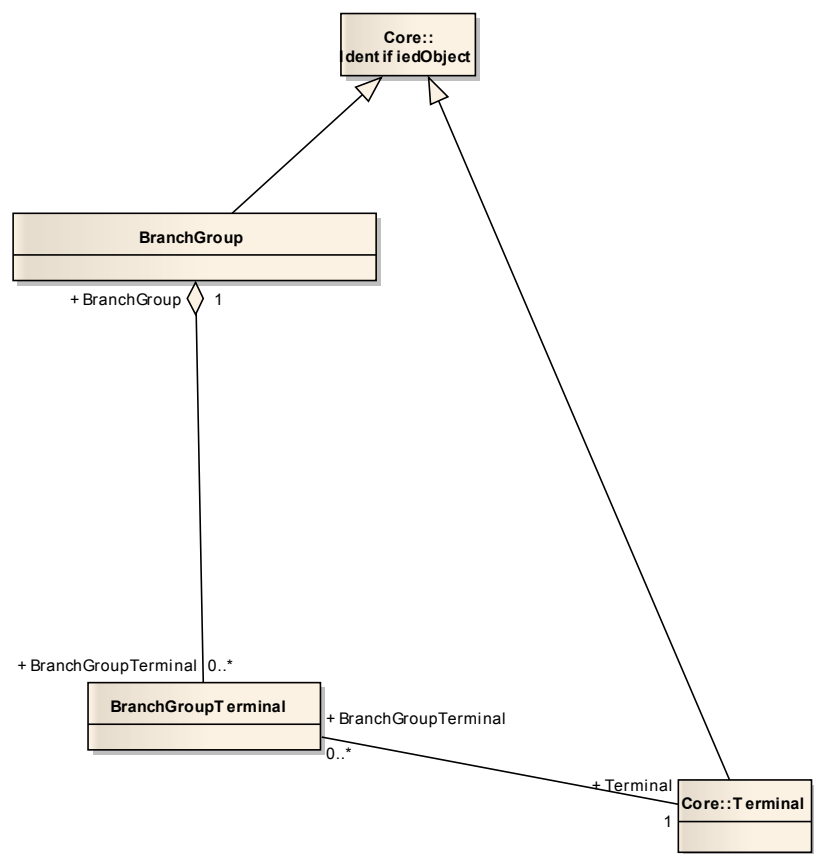
The OperationalLimits package models a specification of limits associated with equipment and other operational entities.



IEC 2018/11

Figure 30 – OperationalLimits

Figure 30 is documented as follows. Operational limits as they tie back into the core model.



IEC 2019/11

Figure 31 – BranchGroup

Figure 31 is not documented.

6.4.2 ActivePowerLimit

Limit on active power flow.

Attributes

name	type	note
value	ActivePower	Value of active power limit
type	String	inherited from: OperationalLimit
mRID	String	inherited from: IdentifiedObject
name	String	inherited from: IdentifiedObject
localName	String	inherited from: IdentifiedObject
pathName	String	inherited from: IdentifiedObject
aliasName	String	inherited from: IdentifiedObject
description	String	inherited from: IdentifiedObject

Association ends

Mult from	[Mult] name (type)	note
0..*	[1] OperationalLimitSet (OperationalLimitSet)	inherited from: OperationalLimit
0..*	[0..1] OperationalLimitType (OperationalLimitType)	inherited from: OperationalLimit
1..*	[0..1] ModelingAuthoritySet (ModelingAuthoritySet)	inherited from: IdentifiedObject

6.4.3 ApparentPowerLimit

Apparent power limit.

Attributes

name	type	note
value	ApparentPower	The apparent power limit
type	String	inherited from: OperationalLimit
mRID	String	inherited from: IdentifiedObject
name	String	inherited from: IdentifiedObject
localName	String	inherited from: IdentifiedObject
pathName	String	inherited from: IdentifiedObject
aliasName	String	inherited from: IdentifiedObject
description	String	inherited from: IdentifiedObject

Association ends

Mult from	[Mult] name (type)	note
0..*	[1] OperationalLimitSet (OperationalLimitSet)	inherited from: OperationalLimit
0..*	[0..1] OperationalLimitType (OperationalLimitType)	inherited from: OperationalLimit
1..*	[0..1] ModelingAuthoritySet (ModelingAuthoritySet)	inherited from: IdentifiedObject

6.4.4 BranchGroup

A group of branch terminals whose directed flow summation is to be monitored. A branch group need not form a cutset of the network.

Attributes

name	type	note
maximumActivePower	ActivePower	The maximum active power flow
maximumReactivePower	ReactivePower	The maximum reactive power flow
minimumActivePower	ActivePower	The minimum active power flow
minimumReactivePower	ReactivePower	The minimum reactive power flow
monitorActivePower	Boolean	Monitor the active power flow.
monitorReactivePower	Boolean	Monitor the reactive power flow
mRID	String	inherited from: IdentifiedObject
name	String	inherited from: IdentifiedObject
localName	String	inherited from: IdentifiedObject
pathName	String	inherited from: IdentifiedObject
aliasName	String	inherited from: IdentifiedObject
description	String	inherited from: IdentifiedObject

Association ends

Mult from	[Mult] name (type)	note
1	[0..*] BranchGroupTerminal (BranchGroupTerminal)	The directed branch group terminals to be summed
1..*	[0..1] ModelingAuthoritySet (ModelingAuthoritySet)	inherited from: IdentifiedObject

6.4.5 BranchGroupTerminal

A specific directed terminal flow for a branch group.

Attributes

name	type	note
positiveFlowIn	Boolean	The flow into the terminal is summed if set true. The flow out of the terminal is summed if set false.

Association ends

Mult from	[Mult] name (type)	note
0..*	[1] BranchGroup (BranchGroup)	The branch group to which the directed branch group terminals belong
0..*	[1] Terminal (Terminal)	The terminal to be summed

6.4.6 CurrentLimit

Operational limit on current.

Attributes

name	type	note
value	CurrentFlow	Limit on current flow
type	String	inherited from: OperationalLimit
mRID	String	inherited from: IdentifiedObject
name	String	inherited from: IdentifiedObject
localName	String	inherited from: IdentifiedObject
pathName	String	inherited from: IdentifiedObject
aliasName	String	inherited from: IdentifiedObject
description	String	inherited from: IdentifiedObject

Association ends

Mult from	[Mult] name (type)	note
0..*	[1] OperationalLimitSet (OperationalLimitSet)	inherited from: OperationalLimit
0..*	[0..1] OperationalLimitType (OperationalLimitType)	inherited from: OperationalLimit
1..*	[0..1] ModelingAuthoritySet (ModelingAuthoritySet)	inherited from: IdentifiedObject

6.4.7 OperationalLimit

A value associated with a specific kind of limit.

Attributes

name	type	note
type	String	Used to specify high/low and limit levels
mRID	String	inherited from: IdentifiedObject
name	String	inherited from: IdentifiedObject
localName	String	inherited from: IdentifiedObject
pathName	String	inherited from: IdentifiedObject
aliasName	String	inherited from: IdentifiedObject
description	String	inherited from: IdentifiedObject

Association ends

Mult from	[Mult] name (type)	note
0..*	[1] OperationalLimitSet (OperationalLimitSet)	The limit set to which the limit values belong
0..*	[0..1] OperationalLimitType (OperationalLimitType)	The limit type associated with this limit
1..*	[0..1] ModelingAuthoritySet (ModelingAuthoritySet)	inherited from: IdentifiedObject

6.4.8 OperationalLimitDirectionKind enumeration

The direction of an operational limit.

Enums

name	note
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.
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.

6.4.9 OperationalLimitSet

A set of limits associated with equipment. Sets of limits might apply to a specific temperature, or season for example. A set of limits may contain may different severiteis 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.

Attributes

name	type	note
mRID	String	inherited from: IdentifiedObject
name	String	inherited from: IdentifiedObject
localName	String	inherited from: IdentifiedObject
pathName	String	inherited from: IdentifiedObject
aliasName	String	inherited from: IdentifiedObject
description	String	inherited from: IdentifiedObject

Association ends

Mult from	[Mult] name (type)	note
0..*	[1] Equipment (Equipment)	The equipment to which the limit set applies.
1	[0..*] OperationalLimitValue (OperationalLimit)	Values of equipment limits.
0..*	[0..1] Terminal (Terminal)	The terminal specifically associated to this operational limit set. If no terminal is associated, all terminals of the equipment are implied.
1..*	[0..1] ModelingAuthoritySet (ModelingAuthoritySet)	inherited from: IdentifiedObject

6.4.10 OperationalLimitType

A type of limit. The meaning of a specific limit is described in this class.

Attributes

name	type	note
acceptableDuration	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	OperationalLimitDirectionKind	The direction of the limit.

Association ends

Mult from	[Mult] name (type)	note
0..1	[0..*] OperationalLimit (OperationalLimit)	The operational limits associated with this type of limit

6.4.11 VoltageLimit

Operational limit applied to voltage.

Attributes

name	type	note
value	Voltage	Limit on voltage. High or low limit depends on the OperationalLimit.limitKind
type	String	inherited from: OperationalLimit
mRID	String	inherited from: IdentifiedObject
name	String	inherited from: IdentifiedObject
localName	String	inherited from: IdentifiedObject
pathName	String	inherited from: IdentifiedObject
aliasName	String	inherited from: IdentifiedObject
description	String	inherited from: IdentifiedObject

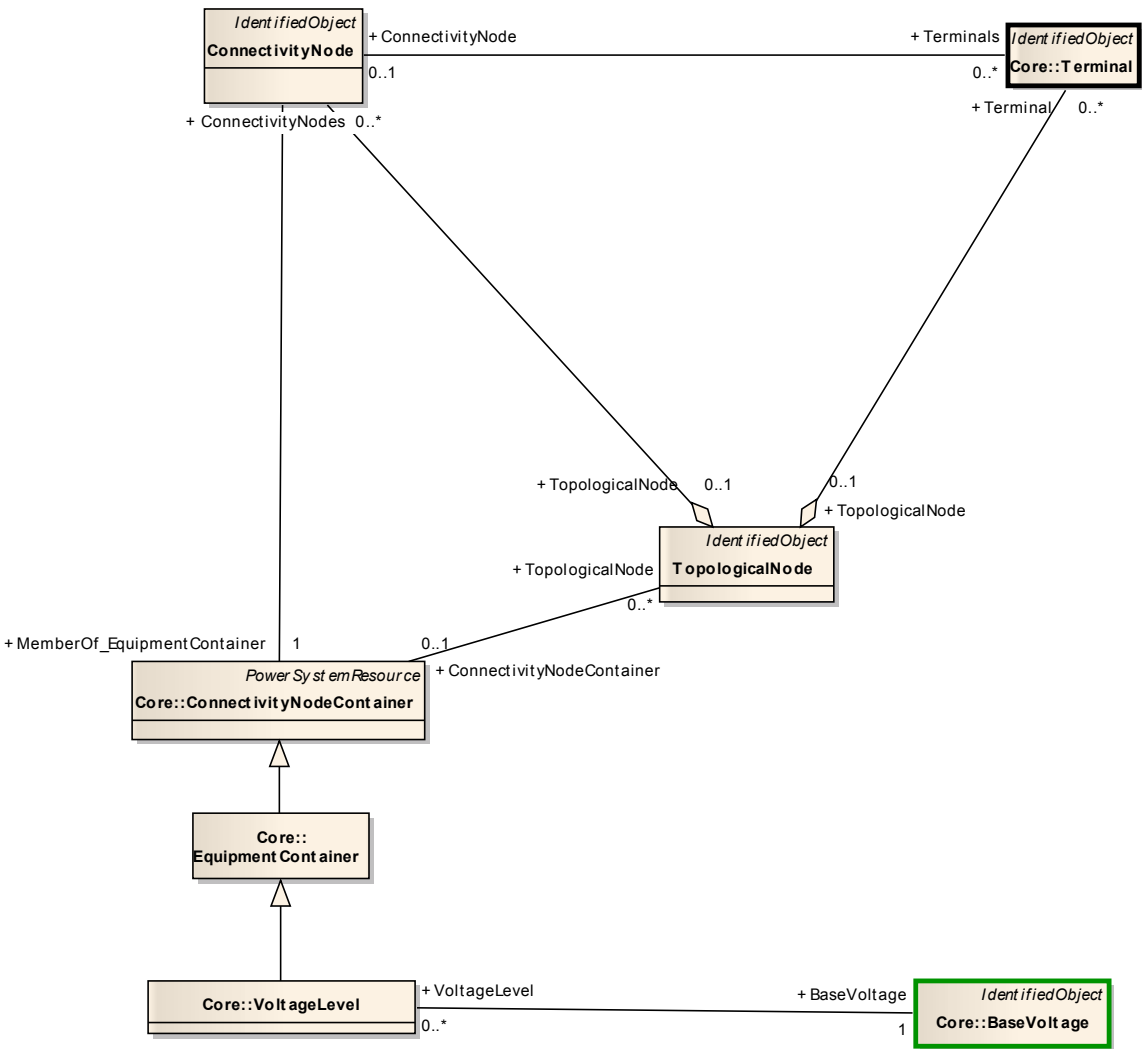
Association ends

Mult from	[Mult] name (type)	note
0..*	[1] OperationalLimitSet (OperationalLimitSet)	inherited from: OperationalLimit
0..*	[0..1] OperationalLimitType (OperationalLimitType)	inherited from: OperationalLimit
1..*	[0..1] ModelingAuthoritySet (ModelingAuthoritySet)	inherited from: IdentifiedObject

6.5 Topology

6.5.1 Topology package summary

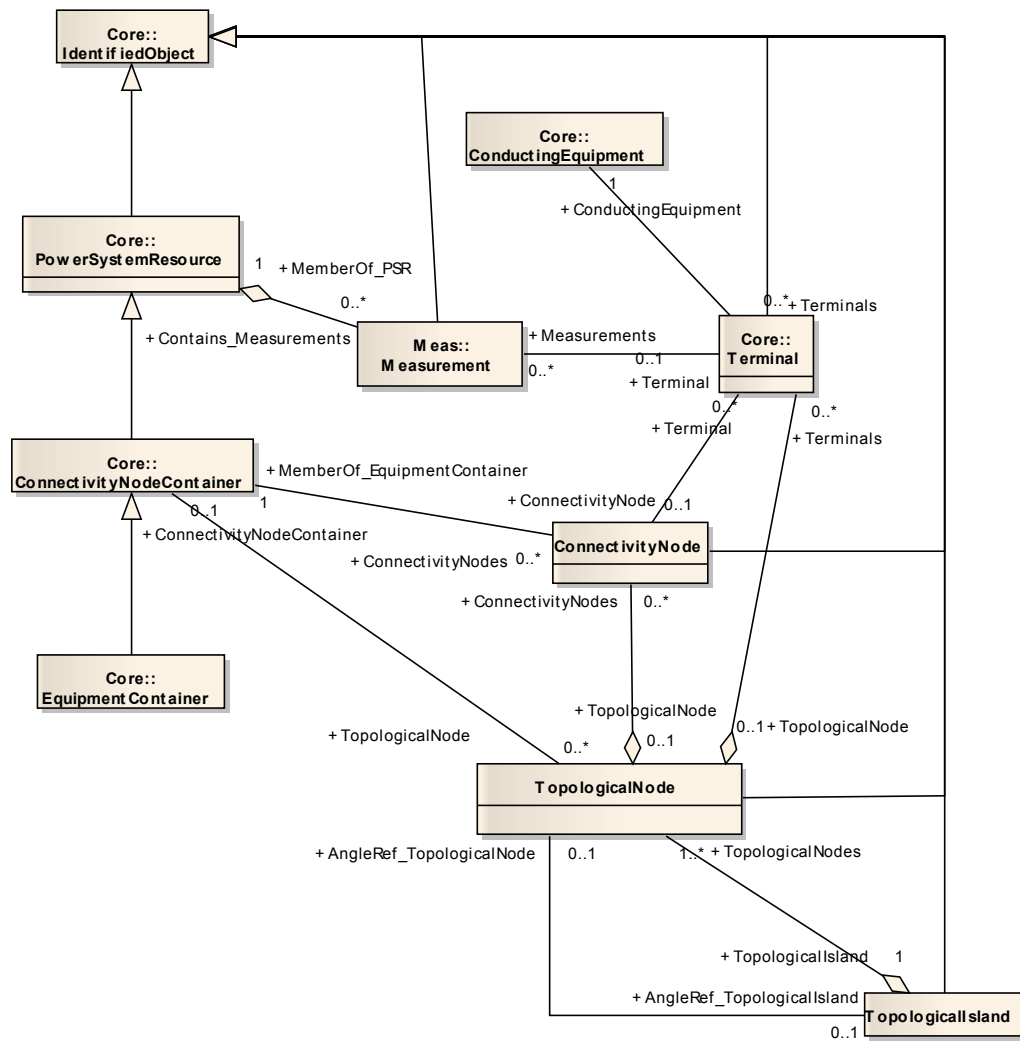
An extension to the Core package that in association with the Terminal class models Connectivity, that is the physical definition of how equipment is connected together. In addition it models Topology, that is the logical definition of how equipment is connected via closed switches. The Topology definition is independent of the other electrical characteristics.



IEC 2020/11

Figure 32 – TopologicalNodeTerminal

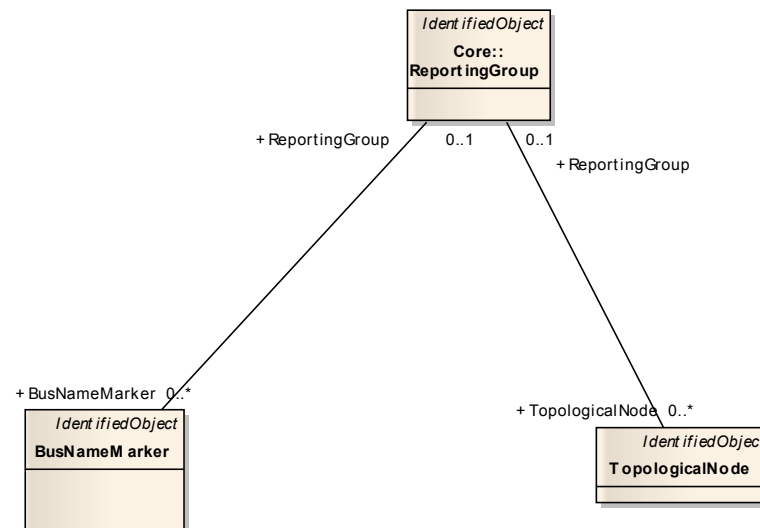
Figure 32 is not documented.



IEC 2021/11

Figure 33 – TopologyMeasRelations

Figure 33 is not documented.



IEC 2022/11

Figure 34 – TopologyReporting

Figure 34 is not documented.

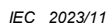


Figure 35 is documented as follows. This diagram shows all classes included in the Topology package as well as the key external classes that have associations with Topology classes.

Used to apply user standard names to topology buses. Typically used for "bus/branch" case generation. Associated with one or more ConnectivityNodes that are normally a part of the bus name. The associated ConnectivityNodes are to be connected by non-retained switches. For a ring bus station configuration, all busbar connectivity nodes in the ring are typically associated. For a breaker and a half scheme, both busbars would be associated. For a ring bus, all busbars would be associated. For a "straight" busbar configuration, only the main connectivity node at the busbar would be associated.

Attributes

name	type	note
mRID	String	inherited from: IdentifiedObject
name	String	inherited from: IdentifiedObject
localName	String	inherited from: IdentifiedObject
pathName	String	inherited from: IdentifiedObject
aliasName	String	inherited from: IdentifiedObject
description	String	inherited from: IdentifiedObject

Association ends

Mult from	[Mult] name (type)	note
0..1	[0..*] ConnectivityNode (ConnectivityNode)	The list of nodes which have the same bus name in the normal topology. Note that this list of ConnectivityNodes should be connected by objects derived from Switch that are normally closed.
0..*	[0..1] ControlArea (ControlArea)	The control area into which the BusNameMarker is included.
0..*	[0..1] ReportingGroup (ReportingGroup)	The reporting group to which this BusNameMarker belongs.
1..*	[0..1] ModelingAuthoritySet (ModelingAuthoritySet)	inherited from: IdentifiedObject

6.5.3 ConnectivityNode

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

Attributes

name	type	note
mRID	String	inherited from: IdentifiedObject
name	String	inherited from: IdentifiedObject
localName	String	inherited from: IdentifiedObject
pathName	String	inherited from: IdentifiedObject
aliasName	String	inherited from: IdentifiedObject
description	String	inherited from: IdentifiedObject

Association ends

Mult from	[Mult] name (type)	note
0..*	[0..1] BusNameMarker (BusNameMarker)	The associated name of the bus (TopologicalNode) containing the ConnectivityNode is derived by an algorithm that uses the bus name marker.
0..*	[1] MemberOf_EquipmentContainer (ConnectivityNodeContainer)	Container of this connectivity node.
0..1	[0..*] Terminals (Terminal)	Terminals interconnect with zero impedance at a node. Measurements on a node apply to all of its terminals.
0..*	[0..1] TopologicalNode (TopologicalNode)	Several ConnectivityNode(s) may combine together to form a single TopologicalNode, depending on the current state of the network.

Mult from	[Mult] name (type)	note
1..*	[0..1] ModelingAuthoritySet (ModelingAuthoritySet)	inherited from: IdentifiedObject

6.5.4 TopologicalIsland

An electrically connected subset of the network. Topological islands can change as the current network state changes (i.e., disconnect switches, breakers, etc. change state).

Attributes

name	type	note
mRID	String	inherited from: IdentifiedObject
name	String	inherited from: IdentifiedObject
localName	String	inherited from: IdentifiedObject
pathName	String	inherited from: IdentifiedObject
aliasName	String	inherited from: IdentifiedObject
description	String	inherited from: IdentifiedObject

Association ends

Mult from	[Mult] name (type)	note
0..1	[0..1] AngleRef_TopologicalNode (TopologicalNode)	The angle reference for the island. Normally there is one TopologicalNode that is selected as the angle reference for each island. Other reference schemes exist, so the association is optional.
1	[1..*] TopologicalNodes (TopologicalNode)	A topological node belongs to a topological island
1..*	[0..1] ModelingAuthoritySet (ModelingAuthoritySet)	inherited from: IdentifiedObject

6.5.5 TopologicalNode

A set of connectivity nodes that, in the current network state, are connected together through any type of closed switches, including jumpers. Topological nodes can change as the current network state changes (i.e., switches, breakers, etc. change state).

Attributes

name	type	note
energized	Boolean	True if node energized
loadCarrying	Boolean	True if node is load carrying
netInjectionP	ActivePower	Net injection active power
netInjectionQ	ReactivePower	Net injection reactive power
observabilityFlag	Boolean	The observability status of the node
phaseAngle	AngleRadians	Phase angle of node
voltage	Voltage	Voltage of node
mRID	String	inherited from: IdentifiedObject
name	String	inherited from: IdentifiedObject
localName	String	inherited from: IdentifiedObject
pathName	String	inherited from: IdentifiedObject
aliasName	String	inherited from: IdentifiedObject

name	type	note
description	String	inherited from: IdentifiedObject

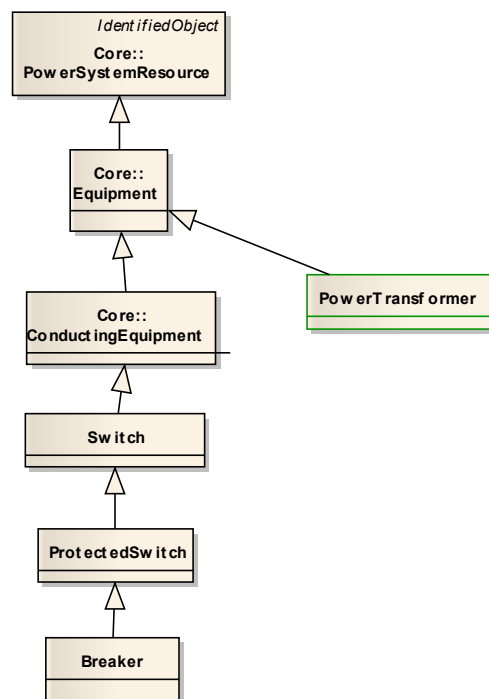
Association ends

Mult from	[Mult] name (type)	note
0..1	[0..*] ConnectivityNodes (ConnectivityNode)	Several ConnectivityNode(s) may combine together to form a single TopologicalNode, depending on the current state of the network.
0..*	[0..1] ConnectivityNodeContainer (ConnectivityNodeContainer)	The connectivity node container to which the topological node belongs.
0..*	[0..1] ControlArea (ControlArea)	The control area into which the node is included.
0..*	[0..1] ReportingGroup (ReportingGroup)	The reporting group to which the topological node belongs.
0..1	[0..*] Terminal (Terminal)	The terminals associated with the topological node. This can be used as an alternative to the connectivity node path to terminal, thus making it unnecessary to model connectivity nodes in some cases. Note that the if connectivity nodes are in the model, this association would probably not be used.
0..1	[0..1] AngleRef_TopologicalIsland (TopologicalIsland)	The island for which the node is an angle reference. Normally there is one angle reference node for each island.
1..*	[1] TopologicalIsland (TopologicalIsland)	A topological node belongs to a topological island.
1..*	[0..1] ModelingAuthoritySet (ModelingAuthoritySet)	inherited from: IdentifiedObject

6.6 Wires

6.6.1 Wires package summary

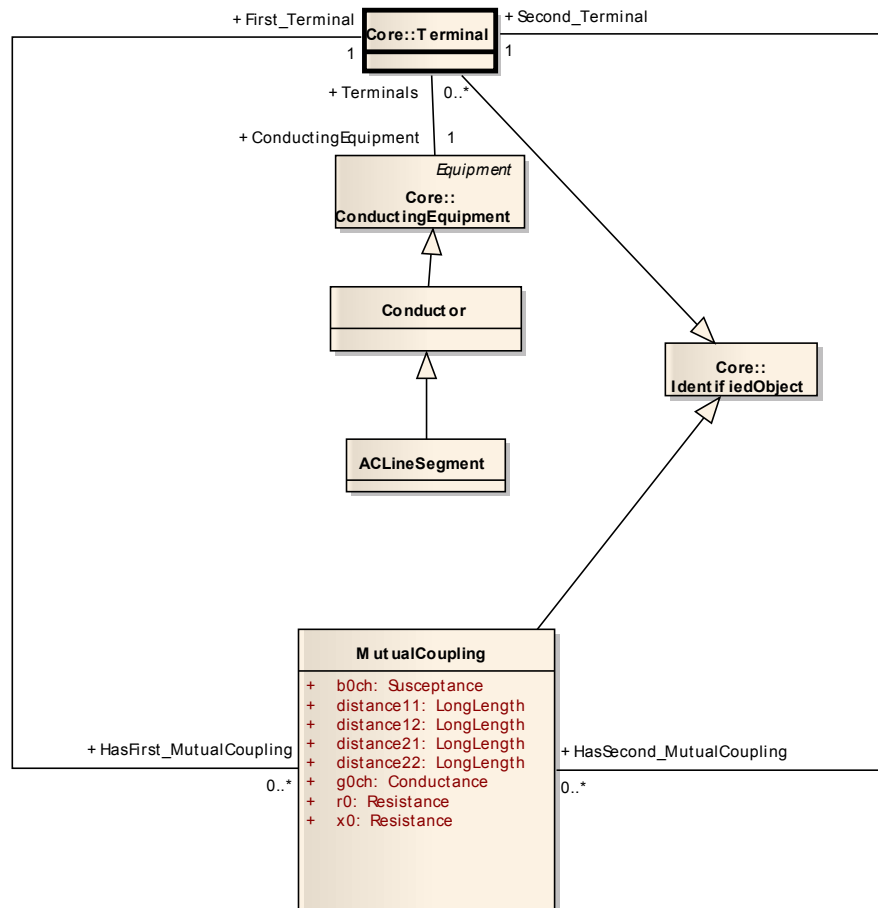
An extension to the Core and Topology package that models information on the electrical characteristics of transmission and distribution networks. This package is used by network applications such as State Estimation, Load Flow and Optimal Power Flow.



IEC 2024/11

Figure 36 – DocumentationExampleInheritance

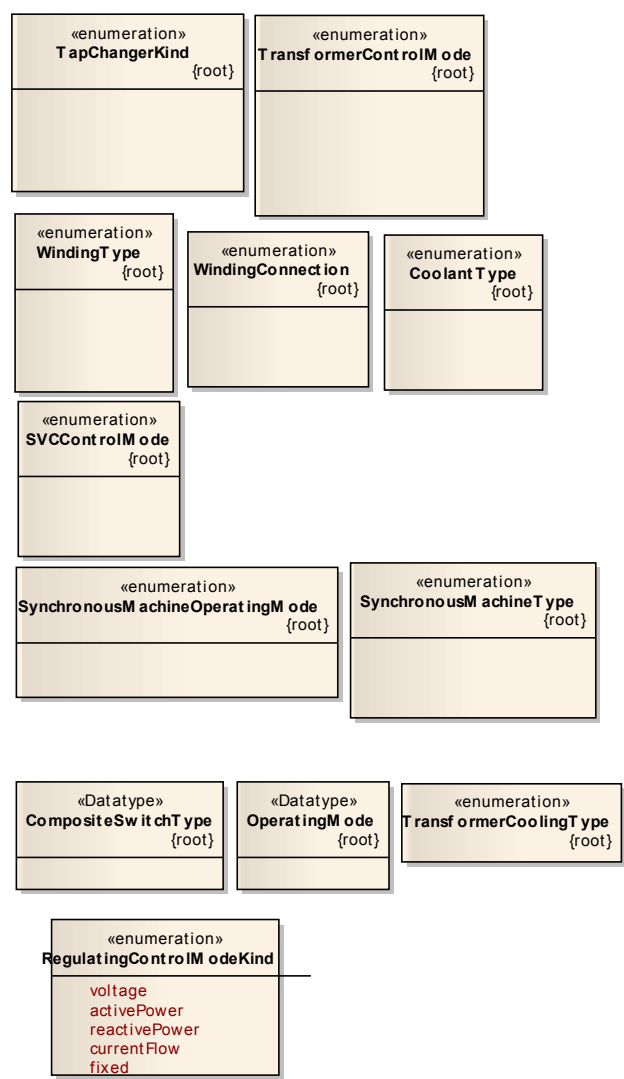
Figure 36 is documented as follows. This shows an example of inheritance in UML. This diagram is only to support figures in the documentation.



IEC 2025/11

Figure 37 – MutualCoupling

Figure 37 is not documented.



IEC 2026/11

Figure 38 – Datatypes

Figure 38 is documented as follows. This diagram shows the data types specific to the Wires package.

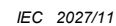
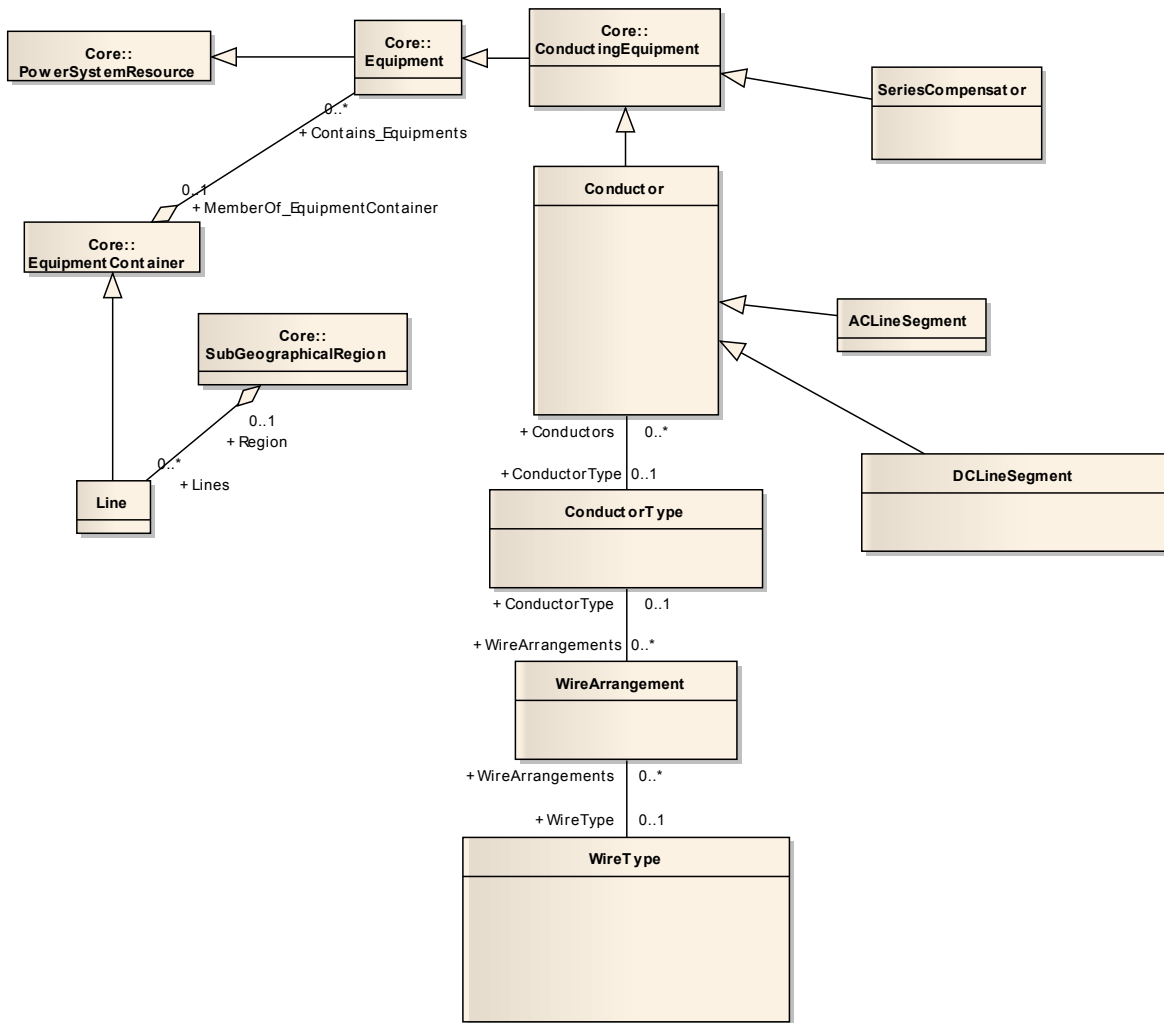


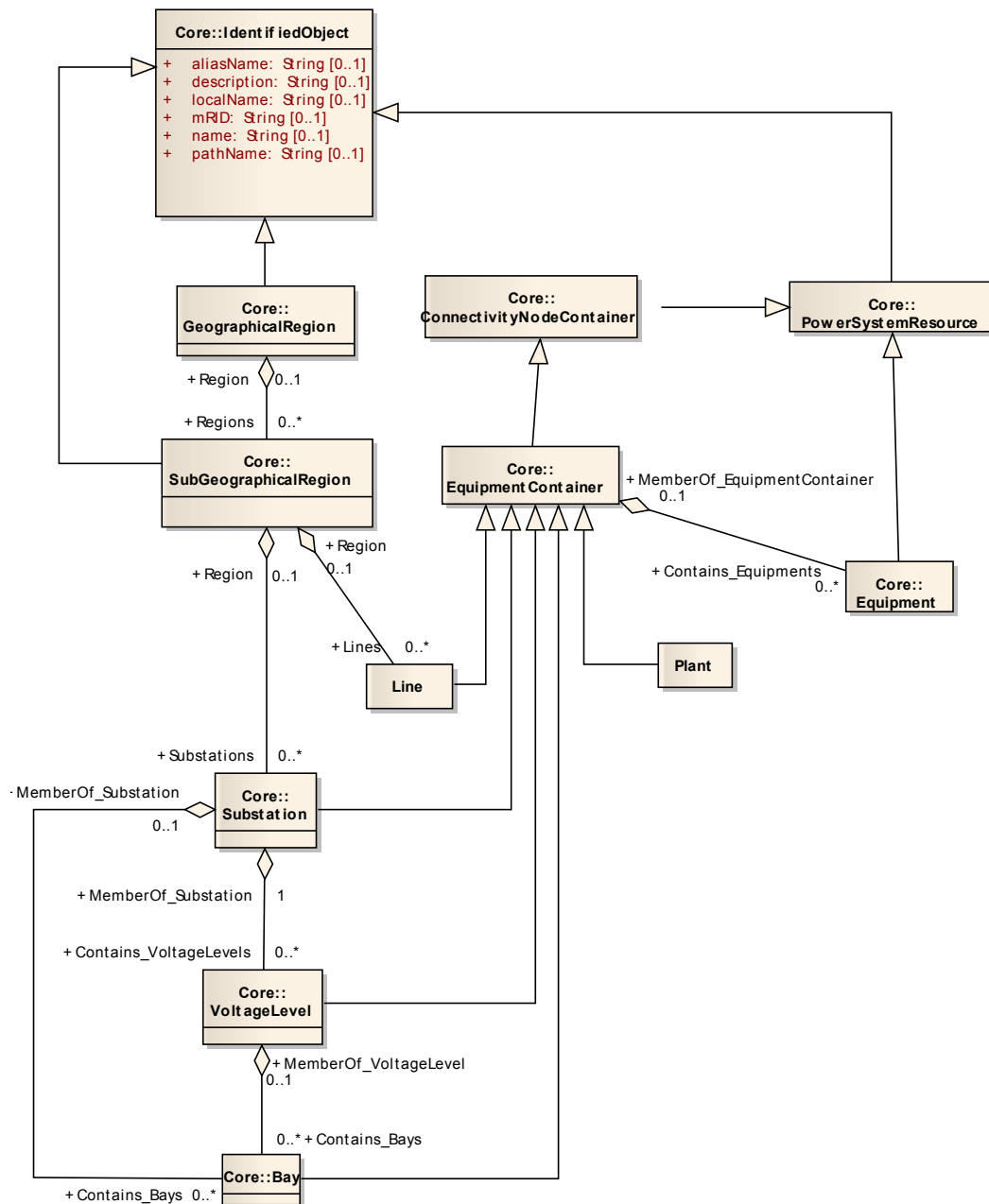
Figure 39 is documented as follows. This diagram describes inheritance between classes in and related to the Wires package.



IEC 2028/11

Figure 40 – LineModel

Figure 40 is documented as follows. This diagram shows all classes related to the transmission line model.



IEC 2029/11

Figure 41 – NamingHierarchyPart1

Figure 41 is documented as follows. The diagram shows the upper part of the naming hierarchy. The hierarchy is a way to organize and name equipment. Hence it is tightly related to the IdentifiedObject and its attributes. The Equipment class is further specialized into many subtypes that are all contained by subclasses of the EquipmentContainer.

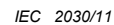
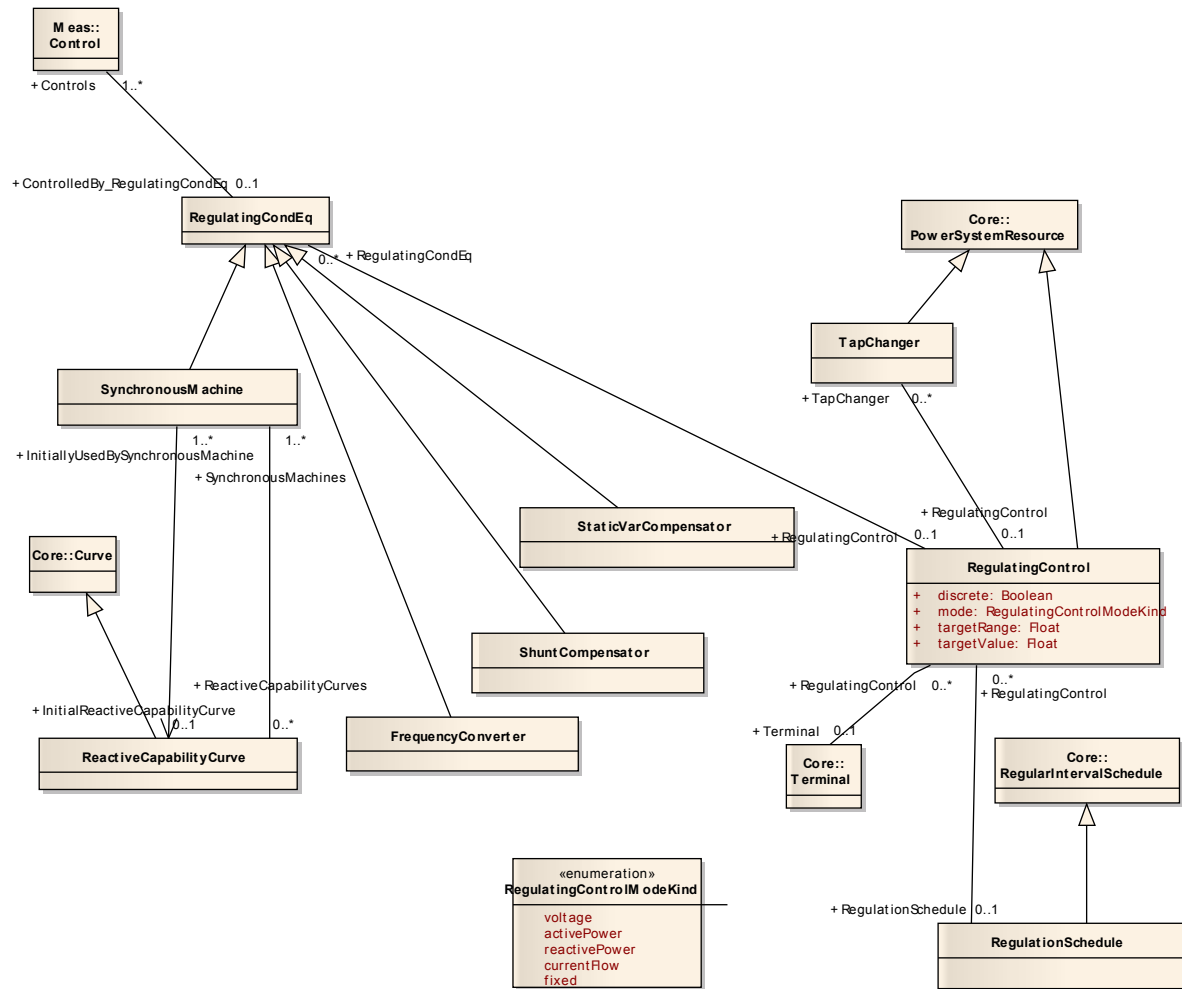


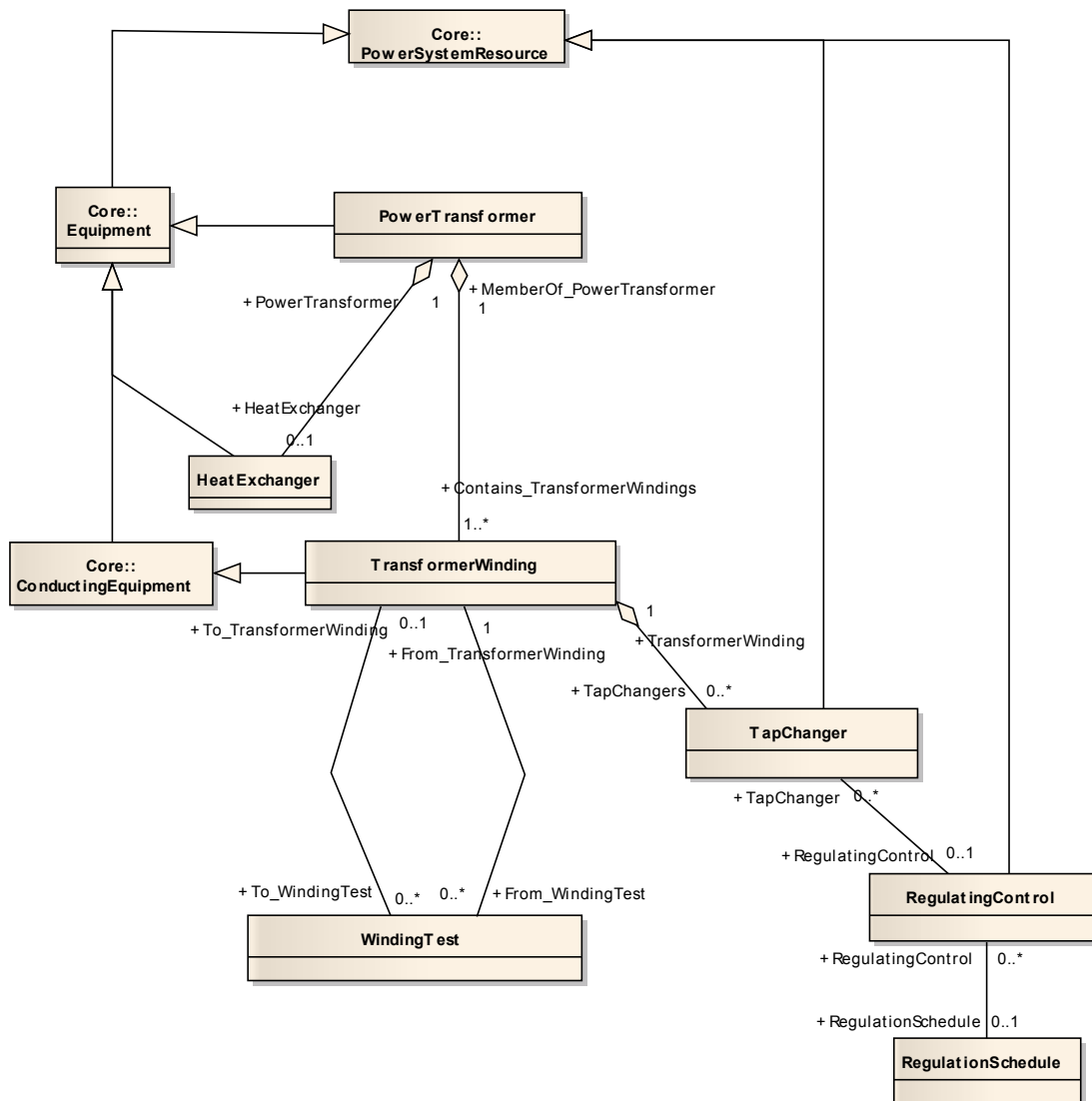
Figure 42 is documented as follows. The diagram shows the lower part of the naming hierarchy. It shows how the Equipment class is further specialized into many subtypes that are all contained by subclasses of the EquipmentContainer. For the subclasses of equipment container refer to part 1 of the diagram.



IEC 2031/11

Figure 43 – RegulatingEquipment

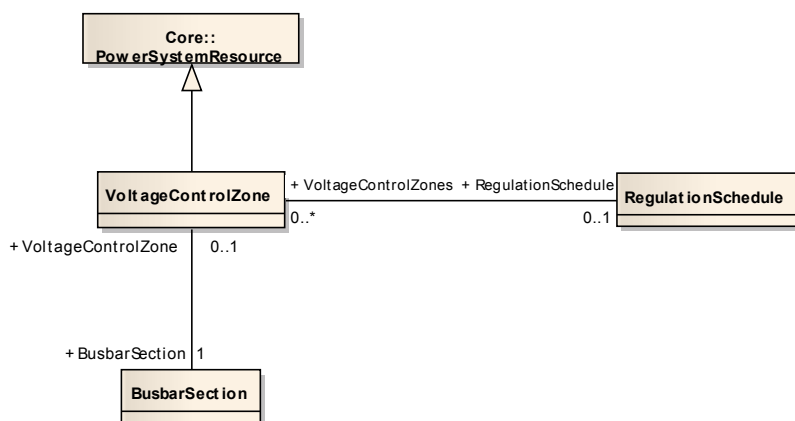
Figure 43 is documented as follows. The diagram shows all classes related to equipment regulation and reactive power compensation.



IEC 2032/11

Figure 44 – TransformerModel

Figure 44 is documented as follows. This diagram shows all classes related to the transformer model.



IEC 2033/11

Figure 45 – VoltageControl

Figure 45 is documented as follows. This diagram shows all classes related to area voltage control.

6.6.2 ACLineSegment

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

Attributes

name	type	note
b0ch	Susceptance	inherited from: Conductor
bch	Susceptance	inherited from: Conductor
g0ch	Conductance	inherited from: Conductor
gch	Conductance	inherited from: Conductor
length	LongLength	inherited from: Conductor
r	Resistance	inherited from: Conductor
r0	Resistance	inherited from: Conductor
x	Reactance	inherited from: Conductor
x0	Reactance	inherited from: Conductor
phases	PhaseCode	inherited from: ConductingEquipment
normallyInService	Boolean	inherited from: Equipment
mRID	String	inherited from: IdentifiedObject
name	String	inherited from: IdentifiedObject
localName	String	inherited from: IdentifiedObject
pathName	String	inherited from: IdentifiedObject
aliasName	String	inherited from: IdentifiedObject
description	String	inherited from: IdentifiedObject

Association ends

Mult from	[Mult] name (type)	note
0..*	[0..1] ConductorType (ConductorType)	inherited from: Conductor
0..*	[0..1] BaseVoltage (BaseVoltage)	inherited from: ConductingEquipment
1	[0..*] ClearanceTags (ClearanceTag)	inherited from: ConductingEquipment
0..*	[0..*] ProtectionEquipments (ProtectionEquipment)	inherited from: ConductingEquipment
1	[0..*] Terminals (Terminal)	inherited from: ConductingEquipment
1	[0..*] ContingencyEquipment (ContingencyEquipment)	inherited from: Equipment
0..*	[0..1] MemberOf_EquipmentContainer (EquipmentContainer)	inherited from: Equipment
1	[0..*] OperationalLimitSet (OperationalLimitSet)	inherited from: Equipment
0..*	[0..*] OperatedBy_Companies (Company)	inherited from: PowerSystemResource
1	[0..*] Contains_Measurements (Measurement)	inherited from: PowerSystemResource
1	[0..*] OperatingShare (OperatingShare)	inherited from: PowerSystemResource
1	[0..1] OutageSchedule (OutageSchedule)	inherited from: PowerSystemResource
0..*	[0..*] PsrLists (PsrList)	inherited from: PowerSystemResource
0..*	[0..1] PSRType (PSRType)	inherited from: PowerSystemResource
0..*	[0..*] ReportingGroup (ReportingGroup)	inherited from: PowerSystemResource
1..*	[0..1] ModelingAuthoritySet (ModelingAuthoritySet)	inherited from: IdentifiedObject

6.6.3 Breaker

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

Attributes

name	type	note
ratedCurrent	CurrentFlow	Fault interrupting current rating.
inTransitTime	Seconds	The transition time from open to close.
normalOpen	Boolean	inherited from: Switch
switchOnCount	Integer	inherited from: Switch
switchOnDate	AbsoluteDateTime	inherited from: Switch
retained	Boolean	inherited from: Switch
phases	PhaseCode	inherited from: ConductingEquipment
normallyInService	Boolean	inherited from: Equipment
mRID	String	inherited from: IdentifiedObject
name	String	inherited from: IdentifiedObject
localName	String	inherited from: IdentifiedObject
pathName	String	inherited from: IdentifiedObject
aliasName	String	inherited from: IdentifiedObject
description	String	inherited from: IdentifiedObject

Association ends

Mult from	[Mult] name (type)	note
0..*	[0..*] OperatedBy_ProtectionEquipments (ProtectionEquipment)	inherited from: ProtectedSwitch
1	[0..*] RecloseSequences (RecloseSequence)	inherited from: ProtectedSwitch
0..*	[0..1] CompositeSwitch (CompositeSwitch)	inherited from: Switch
0..*	[0..*] SwitchingOperations (SwitchingOperation)	inherited from: Switch
0..*	[0..1] BaseVoltage (BaseVoltage)	inherited from: ConductingEquipment
1	[0..*] ClearanceTags (ClearanceTag)	inherited from: ConductingEquipment
0..*	[0..*] ProtectionEquipments (ProtectionEquipment)	inherited from: ConductingEquipment
1	[0..*] Terminals (Terminal)	inherited from: ConductingEquipment
1	[0..*] ContingencyEquipment (ContingencyEquipment)	inherited from: Equipment
0..*	[0..1] MemberOf_EquipmentContainer (EquipmentContainer)	inherited from: Equipment
1	[0..*] OperationalLimitSet (OperationalLimitSet)	inherited from: Equipment
0..*	[0..*] OperatedBy_Companies (Company)	inherited from: PowerSystemResource
1	[0..*] Contains_Measurements (Measurement)	inherited from: PowerSystemResource
1	[0..*] OperatingShare (OperatingShare)	inherited from: PowerSystemResource
1	[0..1] OutageSchedule (OutageSchedule)	inherited from: PowerSystemResource
0..*	[0..*] PsrLists (PsrList)	inherited from: PowerSystemResource
0..*	[0..1] PSRTtype (PSRTtype)	inherited from: PowerSystemResource
0..*	[0..*] ReportingGroup (ReportingGroup)	inherited from: PowerSystemResource
1..*	[0..1] ModelingAuthoritySet (ModelingAuthoritySet)	inherited from: IdentifiedObject

6.6.4 BusbarSection

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

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

Attributes

name	type	note
phases	PhaseCode	inherited from: ConductingEquipment
normallyInService	Boolean	inherited from: Equipment
mRID	String	inherited from: IdentifiedObject
name	String	inherited from: IdentifiedObject
localName	String	inherited from: IdentifiedObject
pathName	String	inherited from: IdentifiedObject
aliasName	String	inherited from: IdentifiedObject
description	String	inherited from: IdentifiedObject

Association ends

Mult from	[Mult] name (type)	note
1	[0..1] VoltageControlZone (VoltageControlZone)	A VoltageControlZone is controlled by a designated BusbarSection.
0..*	[0..1] BaseVoltage (BaseVoltage)	inherited from: ConductingEquipment
1	[0..*] ClearanceTags (ClearanceTag)	inherited from: ConductingEquipment
0..*	[0..*] ProtectionEquipments (ProtectionEquipment)	inherited from: ConductingEquipment
1	[0..*] Terminals (Terminal)	inherited from: ConductingEquipment
1	[0..*] ContingencyEquipment (ContingencyEquipment)	inherited from: Equipment
0..*	[0..1] MemberOf_EquipmentContainer (EquipmentContainer)	inherited from: Equipment
1	[0..*] OperationalLimitSet (OperationalLimitSet)	inherited from: Equipment
0..*	[0..*] OperatedBy_Companies (Company)	inherited from: PowerSystemResource
1	[0..*] Contains_Measurements (Measurement)	inherited from: PowerSystemResource
1	[0..*] OperatingShare (OperatingShare)	inherited from: PowerSystemResource
1	[0..1] OutageSchedule (OutageSchedule)	inherited from: PowerSystemResource
0..*	[0..*] PsrLists (PsrList)	inherited from: PowerSystemResource
0..*	[0..1] PSRType (PSRType)	inherited from: PowerSystemResource
0..*	[0..*] ReportingGroup (ReportingGroup)	inherited from: PowerSystemResource
1..*	[0..1] ModelingAuthoritySet (ModelingAuthoritySet)	inherited from: IdentifiedObject

6.6.5 CompositeSwitch

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

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

Attributes

name	type	note
compositeSwitchType	CompositeSwitchType	An alphanumeric code that can be used as a reference to extra information such as the description of the interlocking scheme if any.
normallyInService	Boolean	inherited from: Equipment
mRID	String	inherited from: IdentifiedObject
name	String	inherited from: IdentifiedObject
localName	String	inherited from: IdentifiedObject
pathName	String	inherited from: IdentifiedObject
aliasName	String	inherited from: IdentifiedObject
description	String	inherited from: IdentifiedObject

Association ends

Mult from	[Mult] name (type)	note
0..1	[0..*] Switches (Switch)	Switches contained in this Composite switch
1	[0..*] ContingencyEquipment (ContingencyEquipment)	inherited from: Equipment
0..*	[0..1] MemberOf_EquipmentContainer (EquipmentContainer)	inherited from: Equipment
1	[0..*] OperationalLimitSet (OperationalLimitSet)	inherited from: Equipment
0..*	[0..*] OperatedBy_Companies (Company)	inherited from: PowerSystemResource
1	[0..*] Contains_Measurements (Measurement)	inherited from: PowerSystemResource
1	[0..*] OperatingShare (OperatingShare)	inherited from: PowerSystemResource
1	[0..1] OutageSchedule (OutageSchedule)	inherited from: PowerSystemResource
0..*	[0..*] PsrLists (PsrList)	inherited from: PowerSystemResource
0..*	[0..1] PSRTtype (PSRTtype)	inherited from: PowerSystemResource
0..*	[0..*] ReportingGroup (ReportingGroup)	inherited from: PowerSystemResource
1..*	[0..1] ModelingAuthoritySet (ModelingAuthoritySet)	inherited from: IdentifiedObject

6.6.6 CompositeSwitchType Datatype

An alphanumeric code that can be used as a reference to extra information such as the description of the interlocking scheme if any.

Attributes

name	type	note
value	String	

6.6.7 Conductor

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

Attributes

name	type	note
b0ch	Susceptance	Zero sequence shunt (charging) susceptance, uniformly distributed, of the entire line section.
bch	Susceptance	Positive sequence shunt (charging) susceptance, uniformly distributed, of the entire line section.
g0ch	Conductance	Zero sequence shunt (charging) conductance, uniformly distributed, of the entire line section.
gch	Conductance	Positive sequence shunt (charging) conductance, uniformly distributed, of the entire line section.
length	LongLength	Segment length for calculating line section capabilities
r	Resistance	Positive sequence series resistance of the entire line section.
r0	Resistance	Zero sequence series resistance of the entire line section.
x	Reactance	Positive sequence series reactance of the entire line section.
x0	Reactance	Zero sequence series reactance of the entire line section

name	type	note
phases	PhaseCode	inherited from: ConductingEquipment
normallyInService	Boolean	inherited from: Equipment
mRID	String	inherited from: IdentifiedObject
name	String	inherited from: IdentifiedObject
localName	String	inherited from: IdentifiedObject
pathName	String	inherited from: IdentifiedObject
aliasName	String	inherited from: IdentifiedObject
description	String	inherited from: IdentifiedObject

Association ends

Mult from	[Mult] name (type)	note
0..*	[0..1] ConductorType (ConductorType)	Sections of conductor are physically described by a conductor type
0..*	[0..1] BaseVoltage (BaseVoltage)	inherited from: ConductingEquipment
1	[0..*] ClearanceTags (ClearanceTag)	inherited from: ConductingEquipment
0..*	[0..*] ProtectionEquipments (ProtectionEquipment)	inherited from: ConductingEquipment
1	[0..*] Terminals (Terminal)	inherited from: ConductingEquipment
1	[0..*] ContingencyEquipment (ContingencyEquipment)	inherited from: Equipment
0..*	[0..1] MemberOf_EquipmentContainer (EquipmentContainer)	inherited from: Equipment
1	[0..*] OperationalLimitSet (OperationalLimitSet)	inherited from: Equipment
0..*	[0..*] OperatedBy_Companies (Company)	inherited from: PowerSystemResource
1	[0..*] Contains_Measurements (Measurement)	inherited from: PowerSystemResource
1	[0..*] OperatingShare (OperatingShare)	inherited from: PowerSystemResource
1	[0..1] OutageSchedule (OutageSchedule)	inherited from: PowerSystemResource
0..*	[0..*] PsrLists (PsrList)	inherited from: PowerSystemResource
0..*	[0..1] PSRTtype (PSRTtype)	inherited from: PowerSystemResource
0..*	[0..*] ReportingGroup (ReportingGroup)	inherited from: PowerSystemResource
1..*	[0..1] ModelingAuthoritySet (ModelingAuthoritySet)	inherited from: IdentifiedObject

6.6.8 ConductorType

Wire or cable conductor (per IEEE specs). A specific type of wire or combination of wires not insulated from one another, suitable for carrying electric current. It may be bare or insulated.

Attributes

name	type	note
sheathResistance	Resistance	Resistance of the sheath for cable conductors
sheathReactance	Reactance	Reactance of the sheath for cable conductors
mRID	String	inherited from: IdentifiedObject
name	String	inherited from: IdentifiedObject
localName	String	inherited from: IdentifiedObject
pathName	String	inherited from: IdentifiedObject
aliasName	String	inherited from: IdentifiedObject
description	String	inherited from: IdentifiedObject

Association ends

Mult from	[Mult] name (type)	note
0..1	[0..*] Conductors (Conductor)	Sections of conductor are physically described by a conductor type.
0..1	[0..*] WireArrangements (WireArrangement)	A ConductorType is made up of wires that can be configured in several ways.
1..*	[0..1] ModelingAuthoritySet (ModelingAuthoritySet)	inherited from: IdentifiedObject

6.6.9 Connector

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

Attributes

name	type	note
phases	PhaseCode	inherited from: ConductingEquipment
normallyInService	Boolean	inherited from: Equipment
mRID	String	inherited from: IdentifiedObject
name	String	inherited from: IdentifiedObject
localName	String	inherited from: IdentifiedObject
pathName	String	inherited from: IdentifiedObject
aliasName	String	inherited from: IdentifiedObject
description	String	inherited from: IdentifiedObject

Association ends

Mult from	[Mult] name (type)	note
0..*	[0..1] BaseVoltage (BaseVoltage)	inherited from: ConductingEquipment
1	[0..*] ClearanceTags (ClearanceTag)	inherited from: ConductingEquipment
0..*	[0..*] ProtectionEquipments (ProtectionEquipment)	inherited from: ConductingEquipment
1	[0..*] Terminals (Terminal)	inherited from: ConductingEquipment
1	[0..*] ContingencyEquipment (ContingencyEquipment)	inherited from: Equipment
0..*	[0..1] MemberOf_EquipmentContainer (EquipmentContainer)	inherited from: Equipment
1	[0..*] OperationalLimitSet (OperationalLimitSet)	inherited from: Equipment
0..*	[0..*] OperatedBy_Companies (Company)	inherited from: PowerSystemResource
1	[0..*] Contains_Measurements (Measurement)	inherited from: PowerSystemResource
1	[0..*] OperatingShare (OperatingShare)	inherited from: PowerSystemResource
1	[0..1] OutageSchedule (OutageSchedule)	inherited from: PowerSystemResource
0..*	[0..*] PsrLists (PsrList)	inherited from: PowerSystemResource
0..*	[0..1] PSRType (PSRType)	inherited from: PowerSystemResource
0..*	[0..*] ReportingGroup (ReportingGroup)	inherited from: PowerSystemResource
1..*	[0..1] ModelingAuthoritySet (ModelingAuthoritySet)	inherited from: IdentifiedObject

6.6.10 CoolantType enumeration

Method of cooling a machine.

Enums

name	note
air	
hydrogenGas	
water	

6.6.11 DCLineSegment

A wire or combination of wires not insulated from one another, with consistent electrical characteristics, used to carry direct current between points in the DC region of the power system.

Attributes

name	type	note
dcSegmentInductance	Inductance	Inductance of the DC line segment
dcSegmentResistance	Resistance	Resistance of the DC line segment
b0ch	Susceptance	inherited from: Conductor
bch	Susceptance	inherited from: Conductor
g0ch	Conductance	inherited from: Conductor
gch	Conductance	inherited from: Conductor
length	LongLength	inherited from: Conductor
r	Resistance	inherited from: Conductor
r0	Resistance	inherited from: Conductor
x	Reactance	inherited from: Conductor
x0	Reactance	inherited from: Conductor
phases	PhaseCode	inherited from: ConductingEquipment
normallyInService	Boolean	inherited from: Equipment
mRID	String	inherited from: IdentifiedObject
name	String	inherited from: IdentifiedObject
localName	String	inherited from: IdentifiedObject
pathName	String	inherited from: IdentifiedObject
aliasName	String	inherited from: IdentifiedObject
description	String	inherited from: IdentifiedObject

Association ends

Mult from	[Mult] name (type)	note
0..*	[0..1] ConductorType (ConductorType)	inherited from: Conductor
0..*	[0..1] BaseVoltage (BaseVoltage)	inherited from: ConductingEquipment
1	[0..*] ClearanceTags (ClearanceTag)	inherited from: ConductingEquipment
0..*	[0..*] ProtectionEquipments (ProtectionEquipment)	inherited from: ConductingEquipment
1	[0..*] Terminals (Terminal)	inherited from: ConductingEquipment
1	[0..*] ContingencyEquipment (ContingencyEquipment)	inherited from: Equipment
0..*	[0..1] MemberOf_EquipmentContainer (EquipmentContainer)	inherited from: Equipment
1	[0..*] OperationalLimitSet (OperationalLimitSet)	inherited from: Equipment
0..*	[0..*] OperatedBy_Companies (Company)	inherited from: PowerSystemResource
1	[0..*] Contains_Measurements (Measurement)	inherited from: PowerSystemResource

Mult from	[Mult] name (type)	note
1	[0..*] OperatingShare (OperatingShare)	inherited from: PowerSystemResource
1	[0..1] OutageSchedule (OutageSchedule)	inherited from: PowerSystemResource
0..*	[0..*] PsrLists (PsrList)	inherited from: PowerSystemResource
0..*	[0..1] PSRTYPE (PSRTYPE)	inherited from: PowerSystemResource
0..*	[0..*] ReportingGroup (ReportingGroup)	inherited from: PowerSystemResource
1..*	[0..1] ModelingAuthoritySet (ModelingAuthoritySet)	inherited from: IdentifiedObject

6.6.12 Disconnecter

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.

Attributes

name	type	note
normalOpen	Boolean	inherited from: Switch
switchOnCount	Integer	inherited from: Switch
switchOnDate	AbsoluteDateTime	inherited from: Switch
retained	Boolean	inherited from: Switch
phases	PhaseCode	inherited from: ConductingEquipment
normallyInService	Boolean	inherited from: Equipment
mRID	String	inherited from: IdentifiedObject
name	String	inherited from: IdentifiedObject
localName	String	inherited from: IdentifiedObject
pathName	String	inherited from: IdentifiedObject
aliasName	String	inherited from: IdentifiedObject
description	String	inherited from: IdentifiedObject

Association ends

Mult from	[Mult] name (type)	note
0..*	[0..1] CompositeSwitch (CompositeSwitch)	inherited from: Switch
0..*	[0..*] SwitchingOperations (SwitchingOperation)	inherited from: Switch
0..*	[0..1] BaseVoltage (BaseVoltage)	inherited from: ConductingEquipment
1	[0..*] ClearanceTags (ClearanceTag)	inherited from: ConductingEquipment
0..*	[0..*] ProtectionEquipments (ProtectionEquipment)	inherited from: ConductingEquipment
1	[0..*] Terminals (Terminal)	inherited from: ConductingEquipment
1	[0..*] ContingencyEquipment (ContingencyEquipment)	inherited from: Equipment
0..*	[0..1] MemberOf_EquipmentContainer (EquipmentContainer)	inherited from: Equipment
1	[0..*] OperationalLimitSet (OperationalLimitSet)	inherited from: Equipment
0..*	[0..*] OperatedBy_Companies (Company)	inherited from: PowerSystemResource
1	[0..*] Contains_Measurements (Measurement)	inherited from: PowerSystemResource
1	[0..*] OperatingShare (OperatingShare)	inherited from: PowerSystemResource
1	[0..1] OutageSchedule (OutageSchedule)	inherited from: PowerSystemResource
0..*	[0..*] PsrLists (PsrList)	inherited from: PowerSystemResource

Mult from	[Mult] name (type)	note
0..*	[0..1] PSRTtype (PSRTtype)	inherited from: PowerSystemResource
0..*	[0..*] ReportingGroup (ReportingGroup)	inherited from: PowerSystemResource
1..*	[0..1] ModelingAuthoritySet (ModelingAuthoritySet)	inherited from: IdentifiedObject

6.6.13 EnergyConsumer

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

Attributes

name	type	note
customerCount	Integer	Number of individual customers represented by this Demand.
pfixed	ActivePower	Active power of the load that is a fixed quantity.
pfixedPct	PerCent	Fixed active power as per cent of load group fixed active power.
qfixed	ReactivePower	Reactive power of the load that is a fixed quantity.
qfixedPct	PerCent	Fixed reactive power as per cent of load group fixed reactive power.
phases	PhaseCode	inherited from: ConductingEquipment
normallyInService	Boolean	inherited from: Equipment
mRID	String	inherited from: IdentifiedObject
name	String	inherited from: IdentifiedObject
localName	String	inherited from: IdentifiedObject
pathName	String	inherited from: IdentifiedObject
aliasName	String	inherited from: IdentifiedObject
description	String	inherited from: IdentifiedObject

Association ends

Mult from	[Mult] name (type)	note
0..*	[0..1] LoadResponse (LoadResponseCharacteristic)	The load response characteristic of this load.
1..*	[0..1] PowerCutZone (PowerCutZone)	An energy consumer is assigned to a power cut zone.
0..*	[0..1] BaseVoltage (BaseVoltage)	inherited from: ConductingEquipment
1	[0..*] ClearanceTags (ClearanceTag)	inherited from: ConductingEquipment
0..*	[0..*] ProtectionEquipments (ProtectionEquipment)	inherited from: ConductingEquipment
1	[0..*] Terminals (Terminal)	inherited from: ConductingEquipment
1	[0..*] ContingencyEquipment (ContingencyEquipment)	inherited from: Equipment
0..*	[0..1] MemberOf_EquipmentContainer (EquipmentContainer)	inherited from: Equipment
1	[0..*] OperationalLimitSet (OperationalLimitSet)	inherited from: Equipment
0..*	[0..*] OperatedBy_Companies (Company)	inherited from: PowerSystemResource
1	[0..*] Contains_Measurements (Measurement)	inherited from: PowerSystemResource
1	[0..*] OperatingShare (OperatingShare)	inherited from: PowerSystemResource
1	[0..1] OutageSchedule (OutageSchedule)	inherited from: PowerSystemResource
0..*	[0..*] PsrLists (PsrList)	inherited from: PowerSystemResource
0..*	[0..1] PSRTtype (PSRTtype)	inherited from: PowerSystemResource

Mult from	[Mult] name (type)	note
0..*	[0..*] ReportingGroup (ReportingGroup)	inherited from: PowerSystemResource
1..*	[0..1] ModelingAuthoritySet (ModelingAuthoritySet)	inherited from: IdentifiedObject

6.6.14 EnergySource

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

Attributes

name	type	note
xn	Reactance	Negative sequence Thevenin reactance
rn	Resistance	Negative sequence Thevenin resistance
nominalVoltage	Voltage	Phase-to-phase nominal voltage
x	Reactance	Positive sequence Thevenin reactance
r	Resistance	Positive sequence Thevenin resistance
voltageAngle	AngleRadians	Phase angle of a-phase open circuit
voltageMagnitude	Voltage	Phase-to-phase open circuit voltage magnitude
x0	Reactance	Zero sequence Thevenin reactance
r0	Resistance	Zero sequence Thevenin resistance
activePower	ActivePower	High voltage source load
phases	PhaseCode	inherited from: ConductingEquipment
normallyInService	Boolean	inherited from: Equipment
mRID	String	inherited from: IdentifiedObject
name	String	inherited from: IdentifiedObject
localName	String	inherited from: IdentifiedObject
pathName	String	inherited from: IdentifiedObject
aliasName	String	inherited from: IdentifiedObject
description	String	inherited from: IdentifiedObject

Association ends

Mult from	[Mult] name (type)	note
0..*	[0..1] BaseVoltage (BaseVoltage)	inherited from: ConductingEquipment
1	[0..*] ClearanceTags (ClearanceTag)	inherited from: ConductingEquipment
0..*	[0..*] ProtectionEquipments (ProtectionEquipment)	inherited from: ConductingEquipment
1	[0..*] Terminals (Terminal)	inherited from: ConductingEquipment
1	[0..*] ContingencyEquipment (ContingencyEquipment)	inherited from: Equipment
0..*	[0..1] MemberOf_EquipmentContainer (EquipmentContainer)	inherited from: Equipment
1	[0..*] OperationalLimitSet (OperationalLimitSet)	inherited from: Equipment
0..*	[0..*] OperatedBy_Companies (Company)	inherited from: PowerSystemResource
1	[0..*] Contains_Measurements (Measurement)	inherited from: PowerSystemResource
1	[0..*] OperatingShare (OperatingShare)	inherited from: PowerSystemResource
1	[0..1] OutageSchedule (OutageSchedule)	inherited from: PowerSystemResource
0..*	[0..*] PsrLists (PsrList)	inherited from: PowerSystemResource
0..*	[0..1] PSRType (PSRType)	inherited from: PowerSystemResource

Mult from	[Mult] name (type)	note
0..*	[0..*] ReportingGroup (ReportingGroup)	inherited from: PowerSystemResource
1..*	[0..1] ModelingAuthoritySet (ModelingAuthoritySet)	inherited from: IdentifiedObject

6.6.15 FrequencyConverter

A device to convert from one frequency to another (e.g., frequency F1 to F2) comprises a pair of FrequencyConverter instances. One converts from F1 to DC, the other converts the DC to F2.

Attributes

name	type	note
frequency	Frequency	Frequency on the AC side.
maxP	ActivePower	The maximum active power on the DC side at which the frequency converter should operate.
maxU	Voltage	The maximum voltage on the DC side at which the frequency converter should operate.
minP	ActivePower	The minimum active power on the DC side at which the frequency converter should operate.
minU	Voltage	The minimum voltage on the DC side at which the frequency converter should operate.
operatingMode	OperatingMode	Operating mode for the frequency converter
phases	PhaseCode	inherited from: ConductingEquipment
normallyInService	Boolean	inherited from: Equipment
mRID	String	inherited from: IdentifiedObject
name	String	inherited from: IdentifiedObject
localName	String	inherited from: IdentifiedObject
pathName	String	inherited from: IdentifiedObject
aliasName	String	inherited from: IdentifiedObject
description	String	inherited from: IdentifiedObject

Association ends

Mult from	[Mult] name (type)	note
0..1	[1..*] Controls (Control)	inherited from: RegulatingCondEq
0..*	[0..1] RegulatingControl (RegulatingControl)	inherited from: RegulatingCondEq
0..*	[0..1] BaseVoltage (BaseVoltage)	inherited from: ConductingEquipment
1	[0..*] ClearanceTags (ClearanceTag)	inherited from: ConductingEquipment
0..*	[0..*] ProtectionEquipments (ProtectionEquipment)	inherited from: ConductingEquipment
1	[0..*] Terminals (Terminal)	inherited from: ConductingEquipment
1	[0..*] ContingencyEquipment (ContingencyEquipment)	inherited from: Equipment
0..*	[0..1] MemberOf_EquipmentContainer (EquipmentContainer)	inherited from: Equipment
1	[0..*] OperationalLimitSet (OperationalLimitSet)	inherited from: Equipment
0..*	[0..*] OperatedBy_Companies (Company)	inherited from: PowerSystemResource
1	[0..*] Contains_Measurements (Measurement)	inherited from: PowerSystemResource
1	[0..*] OperatingShare (OperatingShare)	inherited from: PowerSystemResource
1	[0..1] OutageSchedule (OutageSchedule)	inherited from: PowerSystemResource
0..*	[0..*] PsrLists (PsrList)	inherited from: PowerSystemResource

Mult from	[Mult] name (type)	note
0..*	[0..1] PSRTType (PSRTType)	inherited from: PowerSystemResource
0..*	[0..*] ReportingGroup (ReportingGroup)	inherited from: PowerSystemResource
1..*	[0..1] ModelingAuthoritySet (ModelingAuthoritySet)	inherited from: IdentifiedObject

6.6.16 Fuse

An overcurrent protective device with a circuit opening fusible part that is heated and severed by the passage of overcurrent through it. A fuse is considered a switching device because it breaks current.

Attributes

name	type	note
ampRating	CurrentFlow	Fault interrupting current rating
normalOpen	Boolean	inherited from: Switch
switchOnCount	Integer	inherited from: Switch
switchOnDate	AbsoluteDateTime	inherited from: Switch
retained	Boolean	inherited from: Switch
phases	PhaseCode	inherited from: ConductingEquipment
normallyInService	Boolean	inherited from: Equipment
mRID	String	inherited from: IdentifiedObject
name	String	inherited from: IdentifiedObject
localName	String	inherited from: IdentifiedObject
pathName	String	inherited from: IdentifiedObject
aliasName	String	inherited from: IdentifiedObject
description	String	inherited from: IdentifiedObject

Association ends

Mult from	[Mult] name (type)	note
0..*	[0..1] CompositeSwitch (CompositeSwitch)	inherited from: Switch
0..*	[0..*] SwitchingOperations (SwitchingOperation)	inherited from: Switch
0..*	[0..1] BaseVoltage (BaseVoltage)	inherited from: ConductingEquipment
1	[0..*] ClearanceTags (ClearanceTag)	inherited from: ConductingEquipment
0..*	[0..*] ProtectionEquipments (ProtectionEquipment)	inherited from: ConductingEquipment
1	[0..*] Terminals (Terminal)	inherited from: ConductingEquipment
1	[0..*] ContingencyEquipment (ContingencyEquipment)	inherited from: Equipment
0..*	[0..1] MemberOf_EquipmentContainer (EquipmentContainer)	inherited from: Equipment
1	[0..*] OperationalLimitSet (OperationalLimitSet)	inherited from: Equipment
0..*	[0..*] OperatedBy_Companies (Company)	inherited from: PowerSystemResource
1	[0..*] Contains_Measurements (Measurement)	inherited from: PowerSystemResource
1	[0..*] OperatingShare (OperatingShare)	inherited from: PowerSystemResource
1	[0..1] OutageSchedule (OutageSchedule)	inherited from: PowerSystemResource
0..*	[0..*] PsrLists (PsrList)	inherited from: PowerSystemResource
0..*	[0..1] PSRTType (PSRTType)	inherited from: PowerSystemResource
0..*	[0..*] ReportingGroup (ReportingGroup)	inherited from: PowerSystemResource

Mult from	[Mult] name (type)	note
1..*	[0..1] ModelingAuthoritySet (ModelingAuthoritySet)	inherited from: IdentifiedObject

6.6.17 Ground

A common point for connecting grounded conducting equipment such as shunt capacitors. The power system model can have more than one ground.

Attributes

name	type	note
phases	PhaseCode	inherited from: ConductingEquipment
normallyInService	Boolean	inherited from: Equipment
mRID	String	inherited from: IdentifiedObject
name	String	inherited from: IdentifiedObject
localName	String	inherited from: IdentifiedObject
pathName	String	inherited from: IdentifiedObject
aliasName	String	inherited from: IdentifiedObject
description	String	inherited from: IdentifiedObject

Association ends

Mult from	[Mult] name (type)	note
0..*	[0..1] BaseVoltage (BaseVoltage)	inherited from: ConductingEquipment
1	[0..*] ClearanceTags (ClearanceTag)	inherited from: ConductingEquipment
0..*	[0..*] ProtectionEquipments (ProtectionEquipment)	inherited from: ConductingEquipment
1	[0..*] Terminals (Terminal)	inherited from: ConductingEquipment
1	[0..*] ContingencyEquipment (ContingencyEquipment)	inherited from: Equipment
0..*	[0..1] MemberOf_EquipmentContainer (EquipmentContainer)	inherited from: Equipment
1	[0..*] OperationalLimitSet (OperationalLimitSet)	inherited from: Equipment
0..*	[0..*] OperatedBy_Companies (Company)	inherited from: PowerSystemResource
1	[0..*] Contains_Measurements (Measurement)	inherited from: PowerSystemResource
1	[0..*] OperatingShare (OperatingShare)	inherited from: PowerSystemResource
1	[0..1] OutageSchedule (OutageSchedule)	inherited from: PowerSystemResource
0..*	[0..*] PsrLists (PsrList)	inherited from: PowerSystemResource
0..*	[0..1] PSRTYPE (PSRTYPE)	inherited from: PowerSystemResource
0..*	[0..*] ReportingGroup (ReportingGroup)	inherited from: PowerSystemResource
1..*	[0..1] ModelingAuthoritySet (ModelingAuthoritySet)	inherited from: IdentifiedObject

6.6.18 GroundDisconnector

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

Attributes

name	type	note
normalOpen	Boolean	inherited from: Switch
switchOnCount	Integer	inherited from: Switch

switchOnDate	AbsoluteDateTime	inherited from: Switch
retained	Boolean	inherited from: Switch
phases	PhaseCode	inherited from: ConductingEquipment
normallyInService	Boolean	inherited from: Equipment
mRID	String	inherited from: IdentifiedObject
name	String	inherited from: IdentifiedObject
localName	String	inherited from: IdentifiedObject
pathName	String	inherited from: IdentifiedObject
aliasName	String	inherited from: IdentifiedObject
description	String	inherited from: IdentifiedObject

Association ends

Mult from	[Mult] name (type)	note
0..*	[0..1] CompositeSwitch (CompositeSwitch)	inherited from: Switch
0..*	[0..*] SwitchingOperations (SwitchingOperation)	inherited from: Switch
0..*	[0..1] BaseVoltage (BaseVoltage)	inherited from: ConductingEquipment
1	[0..*] ClearanceTags (ClearanceTag)	inherited from: ConductingEquipment
0..*	[0..*] ProtectionEquipments (ProtectionEquipment)	inherited from: ConductingEquipment
1	[0..*] Terminals (Terminal)	inherited from: ConductingEquipment
1	[0..*] ContingencyEquipment (ContingencyEquipment)	inherited from: Equipment
0..*	[0..1] MemberOf_EquipmentContainer (EquipmentContainer)	inherited from: Equipment
1	[0..*] OperationalLimitSet (OperationalLimitSet)	inherited from: Equipment
0..*	[0..*] OperatedBy_Companies (Company)	inherited from: PowerSystemResource
1	[0..*] Contains_Measurements (Measurement)	inherited from: PowerSystemResource
1	[0..*] OperatingShare (OperatingShare)	inherited from: PowerSystemResource
1	[0..1] OutageSchedule (OutageSchedule)	inherited from: PowerSystemResource
0..*	[0..*] PsrLists (PsrList)	inherited from: PowerSystemResource
0..*	[0..1] PSRTYPE (PSRTYPE)	inherited from: PowerSystemResource
0..*	[0..*] ReportingGroup (ReportingGroup)	inherited from: PowerSystemResource
1..*	[0..1] ModelingAuthoritySet (ModelingAuthoritySet)	inherited from: IdentifiedObject

6.6.19 HeatExchanger

Equipment for the cooling of electrical equipment and the extraction of heat.

Attributes

name	type	note
normallyInService	Boolean	inherited from: Equipment
mRID	String	inherited from: IdentifiedObject
name	String	inherited from: IdentifiedObject
localName	String	inherited from: IdentifiedObject
pathName	String	inherited from: IdentifiedObject
aliasName	String	inherited from: IdentifiedObject
description	String	inherited from: IdentifiedObject

Association ends

Mult from	[Mult] name (type)	note
0..1	[1] PowerTransformer (PowerTransformer)	A transformer may have a heat exchanger.
1	[0..*] ContingencyEquipment (ContingencyEquipment)	inherited from: Equipment
0..*	[0..1] MemberOf_EquipmentContainer (EquipmentContainer)	inherited from: Equipment
1	[0..*] OperationalLimitSet (OperationalLimitSet)	inherited from: Equipment
0..*	[0..*] OperatedBy_Companies (Company)	inherited from: PowerSystemResource
1	[0..*] Contains_Measurements (Measurement)	inherited from: PowerSystemResource
1	[0..*] OperatingShare (OperatingShare)	inherited from: PowerSystemResource
1	[0..1] OutageSchedule (OutageSchedule)	inherited from: PowerSystemResource
0..*	[0..*] PsrLists (PsrList)	inherited from: PowerSystemResource
0..*	[0..1] PSRType (PSRType)	inherited from: PowerSystemResource
0..*	[0..*] ReportingGroup (ReportingGroup)	inherited from: PowerSystemResource
1..*	[0..1] ModelingAuthoritySet (ModelingAuthoritySet)	inherited from: IdentifiedObject

6.6.20 Jumper

A short section of conductor with negligible impedance which can be manually removed and replaced if the circuit is de-energized. Note that zero-impedance branches can be modeled by an ACLineSegment with a zero impedance ConductorType.

Attributes

name	type	note
normalOpen	Boolean	inherited from: Switch
switchOnCount	Integer	inherited from: Switch
switchOnDate	AbsoluteDateTime	inherited from: Switch
retained	Boolean	inherited from: Switch
phases	PhaseCode	inherited from: ConductingEquipment
normallyInService	Boolean	inherited from: Equipment
mRID	String	inherited from: IdentifiedObject
name	String	inherited from: IdentifiedObject
localName	String	inherited from: IdentifiedObject
pathName	String	inherited from: IdentifiedObject
aliasName	String	inherited from: IdentifiedObject
description	String	inherited from: IdentifiedObject

Association ends

Mult from	[Mult] name (type)	note
0..*	[0..1] CompositeSwitch (CompositeSwitch)	inherited from: Switch
0..*	[0..*] SwitchingOperations (SwitchingOperation)	inherited from: Switch
0..*	[0..1] BaseVoltage (BaseVoltage)	inherited from: ConductingEquipment
1	[0..*] ClearanceTags (ClearanceTag)	inherited from: ConductingEquipment
0..*	[0..*] ProtectionEquipments (ProtectionEquipment)	inherited from: ConductingEquipment
1	[0..*] Terminals (Terminal)	inherited from: ConductingEquipment

1	[0..*] ContingencyEquipment (ContingencyEquipment)	inherited from: Equipment
0..*	[0..1] MemberOf_EquipmentContainer (EquipmentContainer)	inherited from: Equipment
1	[0..*] OperationalLimitSet (OperationalLimitSet)	inherited from: Equipment
0..*	[0..*] OperatedBy_Companies (Company)	inherited from: PowerSystemResource
1	[0..*] Contains_Measurements (Measurement)	inherited from: PowerSystemResource
1	[0..*] OperatingShare (OperatingShare)	inherited from: PowerSystemResource
1	[0..1] OutageSchedule (OutageSchedule)	inherited from: PowerSystemResource
0..*	[0..*] PsrLists (PsrList)	inherited from: PowerSystemResource
0..*	[0..1] PSRTType (PSRTType)	inherited from: PowerSystemResource
0..*	[0..*] ReportingGroup (ReportingGroup)	inherited from: PowerSystemResource
1..*	[0..1] ModelingAuthoritySet (ModelingAuthoritySet)	inherited from: IdentifiedObject

6.6.21 Junction

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

Attributes

name	type	note
phases	PhaseCode	inherited from: ConductingEquipment
normallyInService	Boolean	inherited from: Equipment
mRID	String	inherited from: IdentifiedObject
name	String	inherited from: IdentifiedObject
localName	String	inherited from: IdentifiedObject
pathName	String	inherited from: IdentifiedObject
aliasName	String	inherited from: IdentifiedObject
description	String	inherited from: IdentifiedObject

Association ends

Mult from	[Mult] name (type)	note
0..*	[0..1] BaseVoltage (BaseVoltage)	inherited from: ConductingEquipment
1	[0..*] ClearanceTags (ClearanceTag)	inherited from: ConductingEquipment
0..*	[0..*] ProtectionEquipments (ProtectionEquipment)	inherited from: ConductingEquipment
1	[0..*] Terminals (Terminal)	inherited from: ConductingEquipment
1	[0..*] ContingencyEquipment (ContingencyEquipment)	inherited from: Equipment
0..*	[0..1] MemberOf_EquipmentContainer (EquipmentContainer)	inherited from: Equipment
1	[0..*] OperationalLimitSet (OperationalLimitSet)	inherited from: Equipment
0..*	[0..*] OperatedBy_Companies (Company)	inherited from: PowerSystemResource
1	[0..*] Contains_Measurements (Measurement)	inherited from: PowerSystemResource
1	[0..*] OperatingShare (OperatingShare)	inherited from: PowerSystemResource
1	[0..1] OutageSchedule (OutageSchedule)	inherited from: PowerSystemResource
0..*	[0..*] PsrLists (PsrList)	inherited from: PowerSystemResource
0..*	[0..1] PSRTType (PSRTType)	inherited from: PowerSystemResource
0..*	[0..*] ReportingGroup (ReportingGroup)	inherited from: PowerSystemResource
1..*	[0..1] ModelingAuthoritySet (ModelingAuthoritySet)	inherited from: IdentifiedObject

6.6.22 Line

A component part of a system extending between adjacent substations or from a substation to an adjacent interconnection point.

Attributes

name	type	note
mRID	String	inherited from: IdentifiedObject
name	String	inherited from: IdentifiedObject
localName	String	inherited from: IdentifiedObject
pathName	String	inherited from: IdentifiedObject
aliasName	String	inherited from: IdentifiedObject
description	String	inherited from: IdentifiedObject

Association ends

Mult from	[Mult] name (type)	note
0..*	[0..1] Region (SubGeographicalRegion)	A Line can be contained by a SubGeographical Region.
0..1	[0..*] Contains_Equipments (Equipment)	inherited from: EquipmentContainer
1	[0..*] ConnectivityNodes (ConnectivityNode)	inherited from: ConnectivityNodeContainer
0..1	[0..*] TopologicalNode (TopologicalNode)	inherited from: ConnectivityNodeContainer
0..*	[0..*] OperatedBy_Companies (Company)	inherited from: PowerSystemResource
1	[0..*] Contains_Measurements (Measurement)	inherited from: PowerSystemResource
1	[0..*] OperatingShare (OperatingShare)	inherited from: PowerSystemResource
1	[0..1] OutageSchedule (OutageSchedule)	inherited from: PowerSystemResource
0..*	[0..*] PsrLists (PsrList)	inherited from: PowerSystemResource
0..*	[0..1] PSRType (PSRType)	inherited from: PowerSystemResource
0..*	[0..*] ReportingGroup (ReportingGroup)	inherited from: PowerSystemResource
1..*	[0..1] ModelingAuthoritySet (ModelingAuthoritySet)	inherited from: IdentifiedObject

6.6.23 LoadBreakSwitch

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

Attributes

name	type	note
ratedCurrent	CurrentFlow	Current carrying capacity of a wire or cable under stated thermal conditions
normalOpen	Boolean	inherited from: Switch
switchOnCount	Integer	inherited from: Switch
switchOnDate	AbsoluteDateTime	inherited from: Switch
retained	Boolean	inherited from: Switch
phases	PhaseCode	inherited from: ConductingEquipment
normallyInService	Boolean	inherited from: Equipment
mRID	String	inherited from: IdentifiedObject
name	String	inherited from: IdentifiedObject

localName	String	inherited from: IdentifiedObject
pathName	String	inherited from: IdentifiedObject
aliasName	String	inherited from: IdentifiedObject
description	String	inherited from: IdentifiedObject

Association ends

Mult from	[Mult] name (type)	note
0..*	[0..*] OperatedBy_ProtectionEquipments (ProtectionEquipment)	inherited from: ProtectedSwitch
1	[0..*] RecloseSequences (RecloseSequence)	inherited from: ProtectedSwitch
0..*	[0..1] CompositeSwitch (CompositeSwitch)	inherited from: Switch
0..*	[0..*] SwitchingOperations (SwitchingOperation)	inherited from: Switch
0..*	[0..1] BaseVoltage (BaseVoltage)	inherited from: ConductingEquipment
1	[0..*] ClearanceTags (ClearanceTag)	inherited from: ConductingEquipment
0..*	[0..*] ProtectionEquipments (ProtectionEquipment)	inherited from: ConductingEquipment
1	[0..*] Terminals (Terminal)	inherited from: ConductingEquipment
1	[0..*] ContingencyEquipment (ContingencyEquipment)	inherited from: Equipment
0..*	[0..1] MemberOf_EquipmentContainer (EquipmentContainer)	inherited from: Equipment
1	[0..*] OperationalLimitSet (OperationalLimitSet)	inherited from: Equipment
0..*	[0..*] OperatedBy_Companies (Company)	inherited from: PowerSystemResource
1	[0..*] Contains_Measurements (Measurement)	inherited from: PowerSystemResource
1	[0..*] OperatingShare (OperatingShare)	inherited from: PowerSystemResource
1	[0..1] OutageSchedule (OutageSchedule)	inherited from: PowerSystemResource
0..*	[0..*] PsrLists (PsrList)	inherited from: PowerSystemResource
0..*	[0..1] PSRType (PSRType)	inherited from: PowerSystemResource
0..*	[0..*] ReportingGroup (ReportingGroup)	inherited from: PowerSystemResource
1..*	[0..1] ModelingAuthoritySet (ModelingAuthoritySet)	inherited from: IdentifiedObject

6.6.24 MutualCoupling

This class represents the zero sequence line mutual coupling.

Attributes

name	type	note
b0ch	Susceptance	Zero sequence mutual coupling shunt (charging) susceptance, uniformly distributed, of the entire line section
distance11	LongLength	Distance from the first line's specified terminal to start of coupled region
distance12	LongLength	Distance from the first line's from specified terminal to end of coupled region
distance21	LongLength	Distance from the second line's specified terminal to start of coupled region
distance22	LongLength	Distance from the second line's specified terminal to end of coupled region
g0ch	Conductance	Zero sequence mutual coupling shunt (charging) conductance, uniformly distributed, of the entire line section
r0	Resistance	Zero sequence branch-to-branch mutual impedance coupling, resistance

x0	Resistance	Zero sequence branch-to-branch mutual impedance coupling, reactance
mRID	String	inherited from: IdentifiedObject
name	String	inherited from: IdentifiedObject
localName	String	inherited from: IdentifiedObject
pathName	String	inherited from: IdentifiedObject
aliasName	String	inherited from: IdentifiedObject
description	String	inherited from: IdentifiedObject

Association ends

Mult from	[Mult] name (type)	note
0..*	[1] First_Terminal (Terminal)	The starting terminal for the calculation of distances along the first branch of the mutual coupling. Normally MutualCoupling would only be used for terminals of AC line segments. The first and second terminals of a mutual coupling should point to different AC line segments.
0..*	[1] Second_Terminal (Terminal)	The starting terminal for the calculation of distances along the second branch of the mutual coupling.
1..*	[0..1] ModelingAuthoritySet (ModelingAuthoritySet)	inherited from: IdentifiedObject

6.6.25 OperatingMode Datatype

Textual name for an operating mode.

Attributes

name	type	note
value	String	

6.6.26 Plant

A Plant is a collection of equipment for purposes of generation.

Attributes

name	type	note
mRID	String	inherited from: IdentifiedObject
name	String	inherited from: IdentifiedObject
localName	String	inherited from: IdentifiedObject
pathName	String	inherited from: IdentifiedObject
aliasName	String	inherited from: IdentifiedObject
description	String	inherited from: IdentifiedObject

Association ends

Mult from	[Mult] name (type)	note
0..1	[0..*] Contains_Equipments (Equipment)	inherited from: EquipmentContainer
1	[0..*] ConnectivityNodes (ConnectivityNode)	inherited from: ConnectivityNodeContainer
0..1	[0..*] TopologicalNode (TopologicalNode)	inherited from: ConnectivityNodeContainer

0..*	[0..*] OperatedBy_Companies (Company)	inherited from: PowerSystemResource
1	[0..*] Contains_Measurements (Measurement)	inherited from: PowerSystemResource
1	[0..*] OperatingShare (OperatingShare)	inherited from: PowerSystemResource
1	[0..1] OutageSchedule (OutageSchedule)	inherited from: PowerSystemResource
0..*	[0..*] PsrLists (PsrList)	inherited from: PowerSystemResource
0..*	[0..1] PSRTYPE (PSRTYPE)	inherited from: PowerSystemResource
0..*	[0..*] ReportingGroup (ReportingGroup)	inherited from: PowerSystemResource
1..*	[0..1] ModelingAuthoritySet (ModelingAuthoritySet)	inherited from: IdentifiedObject

6.6.27 PowerTransformer

An electrical device consisting of two or more coupled windings, with or without a magnetic core, for introducing mutual coupling between electric circuits. Transformers can be used to control voltage and phase shift (active power flow).

Attributes

name	type	note
bmagSat	PerCent	Core shunt magnetizing susceptance in the saturation region
magBaseU	Voltage	The reference voltage at which the magnetizing saturation measurements were made
magSatFlux	PerCent	Core magnetizing saturation curve knee flux level
phases	PhaseCode	Describes the phases carried by a power transformer
transfCoolingType	TransformerCoolingType	Type of transformer cooling
normallyInService	Boolean	inherited from: Equipment
mRID	String	inherited from: IdentifiedObject
name	String	inherited from: IdentifiedObject
localName	String	inherited from: IdentifiedObject
pathName	String	inherited from: IdentifiedObject
aliasName	String	inherited from: IdentifiedObject
description	String	inherited from: IdentifiedObject

Association ends

Mult from	[Mult] name (type)	note
1	[0..1] HeatExchanger (HeatExchanger)	A transformer may have a heat exchanger.
1	[1..*] Contains_TransformerWindings (TransformerWinding)	A transformer has windings.
1	[0..*] ContingencyEquipment (ContingencyEquipment)	inherited from: Equipment
0..*	[0..1] MemberOf_EquipmentContainer (EquipmentContainer)	inherited from: Equipment
1	[0..*] OperationalLimitSet (OperationalLimitSet)	inherited from: Equipment
0..*	[0..*] OperatedBy_Companies (Company)	inherited from: PowerSystemResource
1	[0..*] Contains_Measurements (Measurement)	inherited from: PowerSystemResource
1	[0..*] OperatingShare (OperatingShare)	inherited from: PowerSystemResource
1	[0..1] OutageSchedule (OutageSchedule)	inherited from: PowerSystemResource
0..*	[0..*] PsrLists (PsrList)	inherited from: PowerSystemResource
0..*	[0..1] PSRTYPE (PSRTYPE)	inherited from: PowerSystemResource
0..*	[0..*] ReportingGroup (ReportingGroup)	inherited from: PowerSystemResource

1..*	[0..1] ModelingAuthoritySet (ModelingAuthoritySet)	inherited from: IdentifiedObject
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6.6.28 ProtectedSwitch

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

Attributes

name	type	note
normalOpen	Boolean	inherited from: Switch
switchOnCount	Integer	inherited from: Switch
switchOnDate	AbsoluteDateTime	inherited from: Switch
retained	Boolean	inherited from: Switch
phases	PhaseCode	inherited from: ConductingEquipment
normalllyInService	Boolean	inherited from: Equipment
mRID	String	inherited from: IdentifiedObject
name	String	inherited from: IdentifiedObject
localName	String	inherited from: IdentifiedObject
pathName	String	inherited from: IdentifiedObject
aliasName	String	inherited from: IdentifiedObject
description	String	inherited from: IdentifiedObject

Association ends

Mult from	[Mult] name (type)	note
0..*	[0..*] OperatedBy_ProtectionEquipments (ProtectionEquipment)	Protection equipments that operate this ProtectedSwitch.
1	[0..*] RecloseSequences (RecloseSequence)	A breaker may have zero or more automatic reclosures after a trip occurs.
0..*	[0..1] CompositeSwitch (CompositeSwitch)	inherited from: Switch
0..*	[0..*] SwitchingOperations (SwitchingOperation)	inherited from: Switch
0..*	[0..1] BaseVoltage (BaseVoltage)	inherited from: ConductingEquipment
1	[0..*] ClearanceTags (ClearanceTag)	inherited from: ConductingEquipment
0..*	[0..*] ProtectionEquipments (ProtectionEquipment)	inherited from: ConductingEquipment
1	[0..*] Terminals (Terminal)	inherited from: ConductingEquipment
1	[0..*] ContingencyEquipment (ContingencyEquipment)	inherited from: Equipment
0..*	[0..1] MemberOf_EquipmentContainer (EquipmentContainer)	inherited from: Equipment
1	[0..*] OperationalLimitSet (OperationalLimitSet)	inherited from: Equipment
0..*	[0..*] OperatedBy_Companies (Company)	inherited from: PowerSystemResource
1	[0..*] Contains_Measurements (Measurement)	inherited from: PowerSystemResource
1	[0..*] OperatingShare (OperatingShare)	inherited from: PowerSystemResource
1	[0..1] OutageSchedule (OutageSchedule)	inherited from: PowerSystemResource
0..*	[0..*] PsrLists (PsrList)	inherited from: PowerSystemResource
0..*	[0..1] PSRType (PSRType)	inherited from: PowerSystemResource
0..*	[0..*] ReportingGroup (ReportingGroup)	inherited from: PowerSystemResource
1..*	[0..1] ModelingAuthoritySet (ModelingAuthoritySet)	inherited from: IdentifiedObject

6.6.29 ReactiveCapabilityCurve

Reactive power rating envelope versus the synchronous machine's active power, in both the generating and motoring modes. For each active power value there is a corresponding high and low reactive power limit value. Typically there will be a separate curve for each coolant condition, such as hydrogen pressure. The Y1 axis values represent reactive minimum and the Y2 axis values represent reactive maximum.

Attributes

name	type	note
coolantTemperature	Temperature	The machine's coolant temperature (e.g., ambient air or stator circulating water)
hydrogenPressure	Pressure	The hydrogen coolant pressure
curveStyle	CurveStyle	inherited from: Curve
xUnit	UnitSymbol	inherited from: Curve
xMultiplier	UnitMultiplier	inherited from: Curve
y1Unit	UnitSymbol	inherited from: Curve
y1Multiplier	UnitMultiplier	inherited from: Curve
y2Unit	UnitSymbol	inherited from: Curve
y2Multiplier	UnitMultiplier	inherited from: Curve
mRID	String	inherited from: IdentifiedObject
name	String	inherited from: IdentifiedObject
localName	String	inherited from: IdentifiedObject
pathName	String	inherited from: IdentifiedObject
aliasName	String	inherited from: IdentifiedObject
description	String	inherited from: IdentifiedObject

Association ends

Mult from	[Mult] name (type)	note
0..1	[1..*] InitiallyUsedBySynchronousMachine (SynchronousMachine)	Synchronous machines using this curve as default.
0..*	[1..*] SynchronousMachines (SynchronousMachine)	Synchronous machines using this curve.
1	[0..*] CurveScheduleDatas (CurveData)	inherited from: Curve
1..*	[0..1] ModelingAuthoritySet (ModelingAuthoritySet)	inherited from: IdentifiedObject

6.6.30 RectifierInverter

Bi-directional AC-DC conversion equipment that can be used to control DC current, DC voltage, DC power flow, or firing angle.

Attributes

name	type	note
ratedU	Voltage	Rectifier/inverter primary base voltage.
bridges	Integer	Number of bridges.
commutatingReactance	Reactance	Commutating reactance at AC bus frequency.
commutatingResistance	Resistance	Commutating resistance.
compoundResistance	Resistance	Compounding resistance.
minCompoundVoltage	Voltage	Minimum compounded DC voltage.

frequency	Frequency	Frequency on the AC side.
maxP	ActivePower	The maximum active power on the DC side at which the converter should operate.
minP	ActivePower	The minimum active power on the DC side at which the converter should operate.
maxU	Voltage	The maximum voltage on the DC side at which the converter should operate.
minU	Voltage	The minimum voltage on the DC side at which the converter should operate.
operatingMode	OperatingMode	Operating mode for the converter.
phases	PhaseCode	inherited from: ConductingEquipment
normallyInService	Boolean	inherited from: Equipment
mRID	String	inherited from: IdentifiedObject
name	String	inherited from: IdentifiedObject
localName	String	inherited from: IdentifiedObject
pathName	String	inherited from: IdentifiedObject
aliasName	String	inherited from: IdentifiedObject
description	String	inherited from: IdentifiedObject

Association ends

Mult from	[Mult] name (type)	note
0..*	[0..1] BaseVoltage (BaseVoltage)	inherited from: ConductingEquipment
1	[0..*] ClearanceTags (ClearanceTag)	inherited from: ConductingEquipment
0..*	[0..*] ProtectionEquipments (ProtectionEquipment)	inherited from: ConductingEquipment
1	[0..*] Terminals (Terminal)	inherited from: ConductingEquipment
1	[0..*] ContingencyEquipment (ContingencyEquipment)	inherited from: Equipment
0..*	[0..1] MemberOf_EquipmentContainer (EquipmentContainer)	inherited from: Equipment
1	[0..*] OperationalLimitSet (OperationalLimitSet)	inherited from: Equipment
0..*	[0..*] OperatedBy_Companies (Company)	inherited from: PowerSystemResource
1	[0..*] Contains_Measurements (Measurement)	inherited from: PowerSystemResource
1	[0..*] OperatingShare (OperatingShare)	inherited from: PowerSystemResource
1	[0..1] OutageSchedule (OutageSchedule)	inherited from: PowerSystemResource
0..*	[0..*] PsrLists (PsrList)	inherited from: PowerSystemResource
0..*	[0..1] PSRTtype (PSRTtype)	inherited from: PowerSystemResource
0..*	[0..*] ReportingGroup (ReportingGroup)	inherited from: PowerSystemResource
1..*	[0..1] ModelingAuthoritySet (ModelingAuthoritySet)	inherited from: IdentifiedObject

6.6.31 RegulatingCondEq

RegulatingCondEq is a type of ConductingEquipment that can regulate Measurements and have a RegulationSchedule.

Attributes

name	type	note
phases	PhaseCode	inherited from: ConductingEquipment
normallyInService	Boolean	inherited from: Equipment
mRID	String	inherited from: IdentifiedObject

name	String	inherited from: IdentifiedObject
localName	String	inherited from: IdentifiedObject
pathName	String	inherited from: IdentifiedObject
aliasName	String	inherited from: IdentifiedObject
description	String	inherited from: IdentifiedObject

Association ends

Mult from	[Mult] name (type)	note
0..1	[1..*] Controls (Control)	The controller outputs used to actually govern a regulating device, e.g. the magnetization of a synchronous machine or capacitor bank breaker actuator.
0..*	[0..1] RegulatingControl (RegulatingControl)	copy from ...
0..*	[0..1] BaseVoltage (BaseVoltage)	inherited from: ConductingEquipment
1	[0..*] ClearanceTags (ClearanceTag)	inherited from: ConductingEquipment
0..*	[0..*] ProtectionEquipments (ProtectionEquipment)	inherited from: ConductingEquipment
1	[0..*] Terminals (Terminal)	inherited from: ConductingEquipment
1	[0..*] ContingencyEquipment (ContingencyEquipment)	inherited from: Equipment
0..*	[0..1] MemberOf_EquipmentContainer (EquipmentContainer)	inherited from: Equipment
1	[0..*] OperationalLimitSet (OperationalLimitSet)	inherited from: Equipment
0..*	[0..*] OperatedBy_Companies (Company)	inherited from: PowerSystemResource
1	[0..*] Contains_Measurements (Measurement)	inherited from: PowerSystemResource
1	[0..*] OperatingShare (OperatingShare)	inherited from: PowerSystemResource
1	[0..1] OutageSchedule (OutageSchedule)	inherited from: PowerSystemResource
0..*	[0..*] PsrLists (PsrList)	inherited from: PowerSystemResource
0..*	[0..1] PSRType (PSRType)	inherited from: PowerSystemResource
0..*	[0..*] ReportingGroup (ReportingGroup)	inherited from: PowerSystemResource
1..*	[0..1] ModelingAuthoritySet (ModelingAuthoritySet)	inherited from: IdentifiedObject

6.6.32 RegulatingControl

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

Attributes

name	type	note
mode	RegulatingControlModeKind	The regulating control mode presently available. This specification allows for determining the kind of regulation without need for obtaining the units from a schedule.
targetRange	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 value has the units appropriate to the mode attribute.
targetValue	Float	The target value specified for case input. This value can be used for the target value without the use of schedules. The value has the units appropriate to the mode attribute.
discrete	Boolean	The regulation is performed in a discrete mode.
mRID	String	inherited from: IdentifiedObject

name	String	inherited from: IdentifiedObject
localName	String	inherited from: IdentifiedObject
pathName	String	inherited from: IdentifiedObject
aliasName	String	inherited from: IdentifiedObject
description	String	inherited from: IdentifiedObject

Association ends

Mult from	[Mult] name (type)	note
0..1	[0..*] RegulatingCondEq (RegulatingCondEq)	The equipment participating in regulating control.
0..*	[0..1] RegulationSchedule (RegulationSchedule)	Schedule for this regulating regulating control.
0..1	[0..*] TapChanger (TapChanger)	The tap changers participating in regulation.
0..*	[0..1] Terminal (Terminal)	The terminal associated with this regulating control.
0..*	[0..*] OperatedBy_Companies (Company)	inherited from: PowerSystemResource
1	[0..*] Contains_Measurements (Measurement)	inherited from: PowerSystemResource
1	[0..*] OperatingShare (OperatingShare)	inherited from: PowerSystemResource
1	[0..1] OutageSchedule (OutageSchedule)	inherited from: PowerSystemResource
0..*	[0..*] PsrLists (PsrList)	inherited from: PowerSystemResource
0..*	[0..1] PSRTYPE (PSRTYPE)	inherited from: PowerSystemResource
0..*	[0..*] ReportingGroup (ReportingGroup)	inherited from: PowerSystemResource
1..*	[0..1] ModelingAuthoritySet (ModelingAuthoritySet)	inherited from: IdentifiedObject

6.6.33 RegulatingControlModeKind enumeration

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

Enums

name	note
voltage	Voltage is specified.
activePower	Active power is specified.
reactivePower	Reactive power is specified.
currentFlow	Current flow is specified.
fixed	The regulation mode is fixed, and thus not regulating.

6.6.34 RegulationSchedule

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

Attributes

name	type	note
lineDropCompensation	Boolean	Flag to indicate that line drop compensation is to be applied
lineDropR	Resistance	Line drop resistance
lineDropX	Reactance	Line drop reactance
timeStep	Seconds	inherited from: RegularIntervalSchedule
endTime	AbsoluteDateTime	inherited from: RegularIntervalSchedule

name	type	note
startTime	AbsoluteDateTime	inherited from: BasicIntervalSchedule
value1Unit	UnitSymbol	inherited from: BasicIntervalSchedule
value1Multiplier	UnitMultiplier	inherited from: BasicIntervalSchedule
value2Unit	UnitSymbol	inherited from: BasicIntervalSchedule
value2Multiplier	UnitMultiplier	inherited from: BasicIntervalSchedule
mRID	String	inherited from: IdentifiedObject
name	String	inherited from: IdentifiedObject
localName	String	inherited from: IdentifiedObject
pathName	String	inherited from: IdentifiedObject
aliasName	String	inherited from: IdentifiedObject
description	String	inherited from: IdentifiedObject

Association ends

Mult from	[Mult] name (type)	note
0..1	[0..*] RegulatingControl (RegulatingControl)	Regulating controls that have this Schedule.
0..1	[0..*] VoltageControlZones (VoltageControlZone)	A VoltageControlZone may have a voltage regulation schedule.
1	[1..*] TimePoints (RegularTimePoint)	inherited from: RegularIntervalSchedule
1..*	[0..1] ModelingAuthoritySet (ModelingAuthoritySet)	inherited from: IdentifiedObject

6.6.35 SeriesCompensator

A series compensator is a series capacitor or reactor or an AC transmission line without charging susceptance.

Attributes

name	type	note
r	Resistance	Positive sequence resistance
x	Reactance	Positive sequence reactance
phases	PhaseCode	inherited from: ConductingEquipment
normallyInService	Boolean	inherited from: Equipment
mRID	String	inherited from: IdentifiedObject
name	String	inherited from: IdentifiedObject
localName	String	inherited from: IdentifiedObject
pathName	String	inherited from: IdentifiedObject
aliasName	String	inherited from: IdentifiedObject
description	String	inherited from: IdentifiedObject

Association ends

Mult from	[Mult] name (type)	note
0..*	[0..1] BaseVoltage (BaseVoltage)	inherited from: ConductingEquipment
1	[0..*] ClearanceTags (ClearanceTag)	inherited from: ConductingEquipment
0..*	[0..*] ProtectionEquipments (ProtectionEquipment)	inherited from: ConductingEquipment
1	[0..*] Terminals (Terminal)	inherited from: ConductingEquipment

Mult from	[Mult] name (type)	note
1	[0..*] ContingencyEquipment (ContingencyEquipment)	inherited from: Equipment
0..*	[0..1] MemberOf_EquipmentContainer (EquipmentContainer)	inherited from: Equipment
1	[0..*] OperationalLimitSet (OperationalLimitSet)	inherited from: Equipment
0..*	[0..*] OperatedBy_Companies (Company)	inherited from: PowerSystemResource
1	[0..*] Contains_Measurements (Measurement)	inherited from: PowerSystemResource
1	[0..*] OperatingShare (OperatingShare)	inherited from: PowerSystemResource
1	[0..1] OutageSchedule (OutageSchedule)	inherited from: PowerSystemResource
0..*	[0..*] PsrLists (PsrList)	inherited from: PowerSystemResource
0..*	[0..1] PSRTYPE (PSRTYPE)	inherited from: PowerSystemResource
0..*	[0..*] ReportingGroup (ReportingGroup)	inherited from: PowerSystemResource
1..*	[0..1] ModelingAuthoritySet (ModelingAuthoritySet)	inherited from: IdentifiedObject

6.6.36 ShuntCompensator

A shunt capacitor or reactor or switchable bank of shunt capacitors or reactors. A section of a shunt compensator is an individual capacitor or reactor. Negative values for mVArPerSection and nominalMVAR indicate that the compensator is a reactor.

Attributes

name	type	note
aVRDelay	Seconds	Time delay required for the device to be connected or disconnected by automatic voltage regulation (AVR).
b0PerSection	Susceptance	Zero sequence shunt (charging) susceptance per section.
g0PerSection	Conductance	Zero sequence shunt (charging) conductance per section.
maximumSections	Integer	For a capacitor bank, the maximum number of sections that may be switched in.
maxU	Voltage	The maximum voltage at which the capacitor bank should operate.
minU	Voltage	The minimum voltage at which the capacitor bank should operate.
nomQ	ReactivePower	Nominal reactive power output of the capacitor bank at the nominal voltage. This number should be positive.
nomU	Voltage	The nominal voltage at which the nominal reactive power was measured. This should normally be within 10 % of the voltage at which the capacitor is connected to the network.
normalSections	Integer	For a capacitor bank, the normal number of sections switched in. This number should correspond to the nominal reactive power (nomQ).
reactivePerSection	ReactivePower	For a capacitor bank, the size in reactive power of each switchable section at the nominal voltage.
switchOnCount	Integer	The switch on count since the capacitor count was last reset or initialized.
switchOnDate	AbsoluteDateTime	The date and time when the capacitor bank was last switched on.
voltageSensitivity	VoltagePerReactivePower	Voltage sensitivity required for the device to regulate the bus voltage, in voltage/reactive power.
yPerSection	Admittance	For a capacitor bank, the admittance of each switchable section. Calculated using the reactive

name	type	note
		power per section and corrected for network voltage.
phases	PhaseCode	inherited from: ConductingEquipment
normallyInService	Boolean	inherited from: Equipment
mRID	String	inherited from: IdentifiedObject
name	String	inherited from: IdentifiedObject
localName	String	inherited from: IdentifiedObject
pathName	String	inherited from: IdentifiedObject
aliasName	String	inherited from: IdentifiedObject
description	String	inherited from: IdentifiedObject

Association ends

Mult from	[Mult] name (type)	note
0..1	[1..*] Controls (Control)	inherited from: RegulatingCondEq
0..*	[0..1] RegulatingControl (RegulatingControl)	inherited from: RegulatingCondEq
0..*	[0..1] BaseVoltage (BaseVoltage)	inherited from: ConductingEquipment
1	[0..*] ClearanceTags (ClearanceTag)	inherited from: ConductingEquipment
0..*	[0..*] ProtectionEquipments (ProtectionEquipment)	inherited from: ConductingEquipment
1	[0..*] Terminals (Terminal)	inherited from: ConductingEquipment
1	[0..*] ContingencyEquipment (ContingencyEquipment)	inherited from: Equipment
0..*	[0..1] MemberOf_EquipmentContainer (EquipmentContainer)	inherited from: Equipment
1	[0..*] OperationalLimitSet (OperationalLimitSet)	inherited from: Equipment
0..*	[0..*] OperatedBy_Companies (Company)	inherited from: PowerSystemResource
1	[0..*] Contains_Measurements (Measurement)	inherited from: PowerSystemResource
1	[0..*] OperatingShare (OperatingShare)	inherited from: PowerSystemResource
1	[0..1] OutageSchedule (OutageSchedule)	inherited from: PowerSystemResource
0..*	[0..*] PsrLists (PsrList)	inherited from: PowerSystemResource
0..*	[0..1] PSRTType (PSRTType)	inherited from: PowerSystemResource
0..*	[0..*] ReportingGroup (ReportingGroup)	inherited from: PowerSystemResource
1..*	[0..1] ModelingAuthoritySet (ModelingAuthoritySet)	inherited from: IdentifiedObject

6.6.37 StaticVarCompensator

A facility for providing variable and controllable shunt reactive power. The SVC typically consists of a stepdown transformer, filter, thyristor-controlled reactor, and thyristor-switched capacitor arms.

The SVC may operate in fixed MVar output mode or in voltage control mode. When in voltage control mode, the output of the SVC will be proportional to the deviation of voltage at the controlled bus from the voltage setpoint. The SVC characteristic slope defines the proportion. If the voltage at the controlled bus is equal to the voltage setpoint, the SVC MVar output is zero.

Attributes

name	type	note
capacitiveRating	Reactance	Maximum available capacitive reactive power.
inductiveRating	Reactance	Maximum available inductive reactive power.
sVCControlMode	SVCCControlMode	SVC control mode.
slope	VoltagePerReactivePower	The characteristics slope of an SVC defines how the

name	type	note
		reactive power output changes in proportion to the difference between the regulated bus voltage and the voltage setpoint.
voltageSetPoint	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.
phases	PhaseCode	inherited from: ConductingEquipment
normallyInService	Boolean	inherited from: Equipment
mRID	String	inherited from: IdentifiedObject
name	String	inherited from: IdentifiedObject
localName	String	inherited from: IdentifiedObject
pathName	String	inherited from: IdentifiedObject
aliasName	String	inherited from: IdentifiedObject
description	String	inherited from: IdentifiedObject

Association ends

Mult from	[Mult] name (type)	note
0..1	[1..*] Controls (Control)	inherited from: RegulatingCondEq
0..*	[0..1] RegulatingControl (RegulatingControl)	inherited from: RegulatingCondEq
0..*	[0..1] BaseVoltage (BaseVoltage)	inherited from: ConductingEquipment
1	[0..*] ClearanceTags (ClearanceTag)	inherited from: ConductingEquipment
0..*	[0..*] ProtectionEquipments (ProtectionEquipment)	inherited from: ConductingEquipment
1	[0..*] Terminals (Terminal)	inherited from: ConductingEquipment
1	[0..*] ContingencyEquipment (ContingencyEquipment)	inherited from: Equipment
0..*	[0..1] MemberOf_EquipmentContainer (EquipmentContainer)	inherited from: Equipment
1	[0..*] OperationalLimitSet (OperationalLimitSet)	inherited from: Equipment
0..*	[0..*] OperatedBy_Companies (Company)	inherited from: PowerSystemResource
1	[0..*] Contains_Measurements (Measurement)	inherited from: PowerSystemResource
1	[0..*] OperatingShare (OperatingShare)	inherited from: PowerSystemResource
1	[0..1] OutageSchedule (OutageSchedule)	inherited from: PowerSystemResource
0..*	[0..*] PsrLists (PsrList)	inherited from: PowerSystemResource
0..*	[0..1] PSRTYPE (PSRTYPE)	inherited from: PowerSystemResource
0..*	[0..*] ReportingGroup (ReportingGroup)	inherited from: PowerSystemResource
1..*	[0..1] ModelingAuthoritySet (ModelingAuthoritySet)	inherited from: IdentifiedObject

6.6.38 SVCControlMode enumeration

Static VAr compensator control mode.

Enums

name	note
reactivePower	
voltage	
off	

6.6.39 Switch

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

Attributes

name	type	note
normalOpen	Boolean	The attribute is used in cases when no Measurement for the status value is present. If the switch has a status measurement, the Discrete.normalValue is expected to match with the Switch.normalOpen.
switchOnCount	Integer	The switch on count since the switch was last reset or initialized.
switchOnDate	AbsoluteDateTime	The date and time when the switch was last switched on.
retained	Boolean	Branch is retained in a bus branch model.
phases	PhaseCode	inherited from: ConductingEquipment
normallyInService	Boolean	inherited from: Equipment
mRID	String	inherited from: IdentifiedObject
name	String	inherited from: IdentifiedObject
localName	String	inherited from: IdentifiedObject
pathName	String	inherited from: IdentifiedObject
aliasName	String	inherited from: IdentifiedObject
description	String	inherited from: IdentifiedObject

Association ends

Mult from	[Mult] name (type)	note
0..*	[0..1] CompositeSwitch (CompositeSwitch)	Composite switch this switch belongs to.
0..*	[0..*] SwitchingOperations (SwitchingOperation)	A switch may be operated by many schedules.
0..*	[0..1] BaseVoltage (BaseVoltage)	inherited from: ConductingEquipment
1	[0..*] ClearanceTags (ClearanceTag)	inherited from: ConductingEquipment
0..*	[0..*] ProtectionEquipments (ProtectionEquipment)	inherited from: ConductingEquipment
1	[0..*] Terminals (Terminal)	inherited from: ConductingEquipment
1	[0..*] ContingencyEquipment (ContingencyEquipment)	inherited from: Equipment
0..*	[0..1] MemberOf_EquipmentContainer (EquipmentContainer)	inherited from: Equipment
1	[0..*] OperationalLimitSet (OperationalLimitSet)	inherited from: Equipment
0..*	[0..*] OperatedBy_Companies (Company)	inherited from: PowerSystemResource
1	[0..*] Contains_Measurements (Measurement)	inherited from: PowerSystemResource
1	[0..*] OperatingShare (OperatingShare)	inherited from: PowerSystemResource
1	[0..1] OutageSchedule (OutageSchedule)	inherited from: PowerSystemResource
0..*	[0..*] PsrLists (PsrList)	inherited from: PowerSystemResource
0..*	[0..1] PSRType (PSRType)	inherited from: PowerSystemResource
0..*	[0..*] ReportingGroup (ReportingGroup)	inherited from: PowerSystemResource
1..*	[0..1] ModelingAuthoritySet (ModelingAuthoritySet)	inherited from: IdentifiedObject

6.6.40 SynchronousMachine

An electromechanical device that operates synchronously with the network. It is a single machine operating either as a generator or synchronous condenser or pump.

Attributes

name	type	note
aVRToManualLag	Seconds	Time delay required when switching from automatic voltage regulation (AVR) to Manual for a lagging MVar violation.
aVRToManualLead	Seconds	Time delay required when switching from automatic voltage regulation (AVR) to Manual for a leading MVar violation.
baseQ	ReactivePower	Default base reactive power value. This value represents the initial reactive power that can be used by any application function.
condenserP	ActivePower	Active power consumed when in condenser mode operation.
coolantCondition	Float	Temperature or pressure of coolant medium.
coolantType	CoolantType	Method of cooling the machine.
damping	Damping	Damping torque coefficient, a proportionality constant that, when multiplied by the angular velocity of the rotor poles with respect to the magnetic field (frequency), results in the damping torque.
inertia	PU	The energy stored in the rotor when operating at rated speed. This value is used in the accelerating power reference frame for operator training simulator solutions.
manualToAVR	Seconds	Time delay required when switching from Manual to automatic voltage regulation (AVR). This value is used in the accelerating power reference frame for powerflow solutions.
maxQ	ReactivePower	Maximum reactive power limit. This is the maximum (nameplate) limit for the unit.
maxU	Voltage	Maximum voltage limit for the unit.
minQ	ReactivePower	Minimum reactive power limit for the unit.
minU	Voltage	Minimum voltage limit for the unit.
operatingMode	SynchronousMachineOperatingMode	Current mode of operation.
qPercent	PerCent	Percent of the coordinated reactive control that comes from this machine.
r	Resistance	Positive sequence resistance of the synchronous machine.
r0	Resistance	Zero sequence resistance of the synchronous machine.
r2	Resistance	Negative sequence resistance.
ratedS	ApparentPower	Nameplate apparent power rating for the unit.
referencePriority	Integer	Priority of unit for reference bus selection. 0 = don't care (default) 1 = highest priority. 2 is less than 1 and so on.
type	SynchronousMachineType	Modes that this synchronous machine can operate in.
x	Reactance	Positive sequence reactance of the synchronous machine.
x0	Reactance	Zero sequence reactance of the synchronous machine.
x2	Reactance	Negative sequence reactance.
xDirectSubtrans	Reactance	Direct-axis subtransient reactance, also known as X"d.
xDirectSync	Reactance	Direct-axis synchronous reactance: the quotient of a sustained value of that AC component of armature voltage that is produced by the total direct-axis flux

name	type	note
		due to direct-axis armature current and the value of the AC component of this current, the machine running at rated speed. (Xd)
xDirectTrans	Reactance	Direct-axis transient reactance, also known as X'd.
xQuadSubtrans	Reactance	Quadrature-axis subtransient reactance, also known as X"q.
xQuadSync	Reactance	Quadrature-axis synchronous reactance (Xq): the ratio of the component of reactive armature voltage, due to the quadrature-axis component of armature current, to this component of current, under steady state conditions and at rated frequency.
xQuadTrans	Reactance	Quadrature-axis transient reactance, also known as X'q.
phases	PhaseCode	inherited from: ConductingEquipment
normallyInService	Boolean	inherited from: Equipment
mRID	String	inherited from: IdentifiedObject
name	String	inherited from: IdentifiedObject
localName	String	inherited from: IdentifiedObject
pathName	String	inherited from: IdentifiedObject
aliasName	String	inherited from: IdentifiedObject
description	String	inherited from: IdentifiedObject

Association ends

Mult from	[Mult] name (type)	note
1..*	[0..1] MemberOf_GeneratingUnit (GeneratingUnit)	A synchronous machine may operate as a generator and as such becomes a member of a generating unit.
1	[0..1] Drives_HydroPump (HydroPump)	The synchronous machine drives the turbine which moves the water from a low elevation to a higher elevation. The direction of machine rotation for pumping may or may not be the same as for generating.
0..*	[0..*] DrivenBy_PrimeMover (PrimeMover)	Prime movers that drive this SynchronousMachine.
1..*	[0..1] InitialReactiveCapabilityCurve (ReactiveCapabilityCurve)	The default ReactiveCapabilityCurve for use by a SynchronousMachine.
1..*	[0..*] ReactiveCapabilityCurves (ReactiveCapabilityCurve)	All available reactive capability curves for this SynchronousMachine.
0..1	[1..*] Controls (Control)	inherited from: RegulatingCondEq
0..*	[0..1] RegulatingControl (RegulatingControl)	inherited from: RegulatingCondEq
0..*	[0..1] BaseVoltage (BaseVoltage)	inherited from: ConductingEquipment
1	[0..*] ClearanceTags (ClearanceTag)	inherited from: ConductingEquipment
0..*	[0..*] ProtectionEquipments (ProtectionEquipment)	inherited from: ConductingEquipment
1	[0..*] Terminals (Terminal)	inherited from: ConductingEquipment
1	[0..*] ContingencyEquipment (ContingencyEquipment)	inherited from: Equipment
0..*	[0..1] MemberOf_EquipmentContainer (EquipmentContainer)	inherited from: Equipment
1	[0..*] OperationalLimitSet (OperationalLimitSet)	inherited from: Equipment
0..*	[0..*] OperatedBy_Companies (Company)	inherited from: PowerSystemResource
1	[0..*] Contains_Measurements (Measurement)	inherited from: PowerSystemResource
1	[0..*] OperatingShare (OperatingShare)	inherited from: PowerSystemResource

Mult from	[Mult] name (type)	note
1	[0..1] OutageSchedule (OutageSchedule)	inherited from: PowerSystemResource
0..*	[0..*] PsrLists (PsrList)	inherited from: PowerSystemResource
0..*	[0..1] PSRType (PSRType)	inherited from: PowerSystemResource
0..*	[0..*] ReportingGroup (ReportingGroup)	inherited from: PowerSystemResource
1..*	[0..1] ModelingAuthoritySet (ModelingAuthoritySet)	inherited from: IdentifiedObject

6.6.41 SynchronousMachineOperatingMode enumeration

Synchronous machine operating mode.

Enums

name	note
generator	
condenser	

6.6.42 SynchronousMachineType enumeration

Synchronous machine type.

Enums

name	note
generator	
condenser	
generator_or_condenser	

6.6.43 TapChanger

Mechanism for changing transformer winding tap positions.

Attributes

name	type	note
highStep	Integer	Highest possible tap step position, advance from neutral.
initialDelay	Seconds	For an LTC, the delay for initial tap changer operation (first step change).
lowStep	Integer	Lowest possible tap step position, retard from neutral.
neutralStep	Integer	The neutral tap step position for this winding.
neutralU	Voltage	Voltage at which the winding operates at the neutral tap setting.
normalStep	Integer	The tap step position used in "normal" network operation for this winding. For a "Fixed" tap changer indicates the current physical tap setting.
stepPhaseShiftIncrement	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).
stepVoltageIncrement	PerCent	Tap step increment, in per cent of nominal voltage, per step position.
subsequentDelay	Seconds	For an LTC, the delay for subsequent tap changer operation (second and later step changes).

name	type	note
tcuControlMode	TransformerControlMode	For an LTC, the tap changer control mode.
type	TapChangerKind	The type of tap changer. Indicates the ability of the transformer to perform various regulation tasks. The tap changer must be also be associated with a RegulationControl object before any regulation is possible.
mRID	String	inherited from: IdentifiedObject
name	String	inherited from: IdentifiedObject
localName	String	inherited from: IdentifiedObject
pathName	String	inherited from: IdentifiedObject
aliasName	String	inherited from: IdentifiedObject
description	String	inherited from: IdentifiedObject

Association ends

Mult from	[Mult] name (type)	note
0..*	[0..1] RegulatingControl (RegulatingControl)	
0..*	[1] TransformerWinding (TransformerWinding)	A transformer winding may have tap changers, separately for voltage and phase angle.
0..*	[0..*] OperatedBy_Companies (Company)	inherited from: PowerSystemResource
1	[0..*] Contains_Measurements (Measurement)	inherited from: PowerSystemResource
1	[0..*] OperatingShare (OperatingShare)	inherited from: PowerSystemResource
1	[0..1] OutageSchedule (OutageSchedule)	inherited from: PowerSystemResource
0..*	[0..*] PsrLists (PsrList)	inherited from: PowerSystemResource
0..*	[0..1] PSRTType (PSRTType)	inherited from: PowerSystemResource
0..*	[0..*] ReportingGroup (ReportingGroup)	inherited from: PowerSystemResource
1..*	[0..1] ModelingAuthoritySet (ModelingAuthoritySet)	inherited from: IdentifiedObject

6.6.44 TapChangerKind enumeration

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

Enums

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

6.6.45 TransformerControlMode enumeration

Control modes for a transformer.

Enums

name	note
off	Off control
local	Local control
volt	Voltage control
active	Active power flow control
reactive	Reactive power flow control

6.6.46 TransformerCoolingType enumeration

Type of transformer cooling.

6.6.47 TransformerWinding

A winding is associated with each defined terminal of a transformer (or phase shifter).

Attributes

name	type	note
b	Susceptance	Magnetizing branch susceptance (B mag).
b0	Susceptance	Zero sequence magnetizing branch susceptance.
connectionType	WindingConnection	The type of connection of the winding.
emergencyS	ApparentPower	The apparent power that the winding can carry under emergency conditions.
g	Conductance	Magnetizing branch conductance (G mag).
g0	Conductance	Zero sequence magnetizing branch conductance.
grounded	Boolean	Set if the winding is grounded.
insulationU	Voltage	Basic insulation level voltage rating.
r	Resistance	Positive sequence series resistance of the winding.
r0	Resistance	Zero sequence series resistance of the winding.
ratedS	ApparentPower	The normal apparent power rating for the winding.
ratedU	Voltage	The rated voltage (phase-to-phase) of the winding, usually the same as the neutral voltage.
rground	Resistance	Ground resistance path through connected grounding transformer.
shortTermS	ApparentPower	Apparent power that the winding can carry for a short period of time.
windingType	WindingType	The type of winding.
x	Reactance	Positive sequence series reactance of the winding.
x0	Reactance	Zero sequence series reactance of the winding.
xground	Reactance	Ground reactance path through connected grounding transformer.
phases	PhaseCode	inherited from: ConductingEquipment
normallyInService	Boolean	inherited from: Equipment
mRID	String	inherited from: IdentifiedObject
name	String	inherited from: IdentifiedObject
localName	String	inherited from: IdentifiedObject
pathName	String	inherited from: IdentifiedObject
aliasName	String	inherited from: IdentifiedObject

name	type	note
description	String	inherited from: IdentifiedObject

Association ends

Mult from	[Mult] name (type)	note
1..*	[1] MemberOf_PowerTransformer (PowerTransformer)	A transformer has windings.
1	[0..*] TapChangers (TapChanger)	A transformer winding may have tap changers, separately for voltage and phase angle. If a TransformerWinding does not have an associated TapChanger, the winding is assumed to be fixed tap.
1	[0..*] From_WindingTest (WindingTest)	The transformer winding tests for which the transformer winding (terminal) participates as the "from" part of the test.
0..1	[0..*] To_WindingTest (WindingTest)	The winding tests for which the transformer winding (terminal) participates as the "to" end of the test.
0..*	[0..1] BaseVoltage (BaseVoltage)	inherited from: ConductingEquipment
1	[0..*] ClearanceTags (ClearanceTag)	inherited from: ConductingEquipment
0..*	[0..*] ProtectionEquipments (ProtectionEquipment)	inherited from: ConductingEquipment
1	[0..*] Terminals (Terminal)	inherited from: ConductingEquipment
1	[0..*] ContingencyEquipment (ContingencyEquipment)	inherited from: Equipment
0..*	[0..1] MemberOf_EquipmentContainer (EquipmentContainer)	inherited from: Equipment
1	[0..*] OperationalLimitSet (OperationalLimitSet)	inherited from: Equipment
0..*	[0..*] OperatedBy_Companies (Company)	inherited from: PowerSystemResource
1	[0..*] Contains_Measurements (Measurement)	inherited from: PowerSystemResource
1	[0..*] OperatingShare (OperatingShare)	inherited from: PowerSystemResource
1	[0..1] OutageSchedule (OutageSchedule)	inherited from: PowerSystemResource
0..*	[0..*] PsrLists (PsrList)	inherited from: PowerSystemResource
0..*	[0..1] PSRTType (PSRTType)	inherited from: PowerSystemResource
0..*	[0..*] ReportingGroup (ReportingGroup)	inherited from: PowerSystemResource
1..*	[0..1] ModelingAuthoritySet (ModelingAuthoritySet)	inherited from: IdentifiedObject

6.6.48 VoltageControlZone

An area of the power system network which is defined for secondary voltage control purposes. A voltage control zone consists of a collection of substations with a designated bus bar section whose voltage will be controlled.

Attributes

name	type	note
mRID	String	inherited from: IdentifiedObject
name	String	inherited from: IdentifiedObject
localName	String	inherited from: IdentifiedObject
pathName	String	inherited from: IdentifiedObject
aliasName	String	inherited from: IdentifiedObject
description	String	inherited from: IdentifiedObject

Association ends

Mult from	[Mult] name (type)	note
0..1	[1] BusbarSection (BusbarSection)	A VoltageControlZone is controlled by a designated BusbarSection.
0..*	[0..1] RegulationSchedule (RegulationSchedule)	A VoltageControlZone may have a voltage regulation schedule.
0..*	[0..*] OperatedBy_Companies (Company)	inherited from: PowerSystemResource
1	[0..*] Contains_Measurements (Measurement)	inherited from: PowerSystemResource
1	[0..*] OperatingShare (OperatingShare)	inherited from: PowerSystemResource
1	[0..1] OutageSchedule (OutageSchedule)	inherited from: PowerSystemResource
0..*	[0..*] PsrLists (PsrList)	inherited from: PowerSystemResource
0..*	[0..1] PSRTYPE (PSRTYPE)	inherited from: PowerSystemResource
0..*	[0..*] ReportingGroup (ReportingGroup)	inherited from: PowerSystemResource
1..*	[0..1] ModelingAuthoritySet (ModelingAuthoritySet)	inherited from: IdentifiedObject

6.6.49 WindingConnection enumeration

Winding connection type.

Enums

name	note
D	Delta
Y	Wye
Z	ZigZag

6.6.50 WindingTest

Physical winding test data for the winding/tap pairs of a transformer (or phase shifter). This test data can be used to derive other attributes of specific transformer or phase shifter models.

Attributes

name	type	note
excitingCurrent	PerCent	The exciting current on open-circuit test, expressed as a percentage of rated current, at nominal voltage.
fromTapStep	Integer	The tap step number for the "from" winding of the test pair.
leakageImpedance	Impedance	The leakage impedance measured at the "from" winding with the "to" winding short-circuited and all other windings open-circuited. Leakage impedance is expressed in units based on the apparent power and voltage ratings of the "from" winding.
loadLoss	KWActivePower	The load loss kW ("to" winding short-circuited) from the test report.
noLoadLoss	KWActivePower	The no load loss kW ("to" winding open-circuited) from the test report.
phaseShift	AngleDegrees	The phase shift measured at the open-circuited "to" winding, with the "from" winding set to the "from" winding's rated voltage and all other windings open-circuited.
toTapStep	Integer	The tap step number for the "to" winding of the test pair.
voltage	Voltage	The voltage measured at the open-circuited "to" winding, with the "from" winding set to the "from"

name	type	note
		winding's rated voltage and all other windings open-circuited.
mRID	String	inherited from: IdentifiedObject
name	String	inherited from: IdentifiedObject
localName	String	inherited from: IdentifiedObject
pathName	String	inherited from: IdentifiedObject
aliasName	String	inherited from: IdentifiedObject
description	String	inherited from: IdentifiedObject

Association ends

Mult from	[Mult] name (type)	note
0..*	[1] From_TransformerWinding (TransformerWinding)	The winding from which the test was conducted.
0..*	[0..1] To_TransformerWinding (TransformerWinding)	The winding to which the test was conducted. Note that although the "from" side of the test is required, the "to" side of a test is not always required.
1..*	[0..1] ModelingAuthoritySet (ModelingAuthoritySet)	inherited from: IdentifiedObject

6.6.51 WindingType enumeration

Winding type.

Enums

name	note
primary	
secondary	
tertiary	
quaternary	

6.6.52 WireArrangement

Identification, spacing and configuration of the wires of a ConductorType, with reference to their type.

Attributes

name	type	note
mountingPointX	Integer	Mounting point where wire One is mounted
mountingPointY	Integer	Mounting point where wire One is mounted
mRID	String	inherited from: IdentifiedObject
name	String	inherited from: IdentifiedObject
localName	String	inherited from: IdentifiedObject
pathName	String	inherited from: IdentifiedObject
aliasName	String	inherited from: IdentifiedObject
description	String	inherited from: IdentifiedObject

Association ends

Mult from	[Mult] name (type)	note
0..*	[0..1] ConductorType (ConductorType)	A ConductorType is made up of wires that can be configured in several ways.
0..*	[0..1] WireType (WireType)	A WireType is mounted at a specified place in a WireArrangement.
1..*	[0..1] ModelingAuthoritySet (ModelingAuthoritySet)	inherited from: IdentifiedObject

6.6.53 WireType

Wire conductor (per IEEE specs). A specific type of wire or combination of wires, not insulated from each other, suitable for carrying electrical current.

Attributes

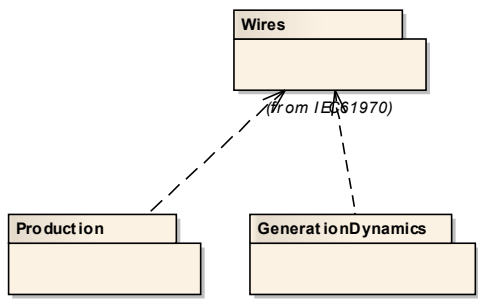
name	type	note
phaseConductorCount	Integer	Number of conductor strands in the (symmetrical) bundle (1 to 12).
phaseConductorSpacing	ShortLength	Distance between conductor strands in a (symmetrical) bundle.
ratedCurrent	CurrentFlow	Current carrying capacity of a wire or cable under stated thermal conditions.
gMR	ShortLength	Geometric mean radius. If we replace the conductor by a thin walled tube of radius GMR, then its reactance is identical to the reactance of the actual conductor.
radius	ShortLength	The radius of the conductor.
resistance	Resistance	The resistance per unit length of the conductor.
mRID	String	inherited from: IdentifiedObject
name	String	inherited from: IdentifiedObject
localName	String	inherited from: IdentifiedObject
pathName	String	inherited from: IdentifiedObject
aliasName	String	inherited from: IdentifiedObject
description	String	inherited from: IdentifiedObject

Association ends

Mult from	[Mult] name (type)	note
0..1	[0..*] WireArrangements (WireArrangement)	A WireType is mounted at a specified place in a WireArrangement.
1..*	[0..1] ModelingAuthoritySet (ModelingAuthoritySet)	inherited from: IdentifiedObject

6.7 Generation □ Generation package summary

This package contains packages that have information for Unit Commitment and Economic Dispatch of Hydro and Thermal Generating Units, Load Forecasting, Automatic Generation Control, and Unit Modeling for Dynamic Training Simulator.



IEC 2034/11

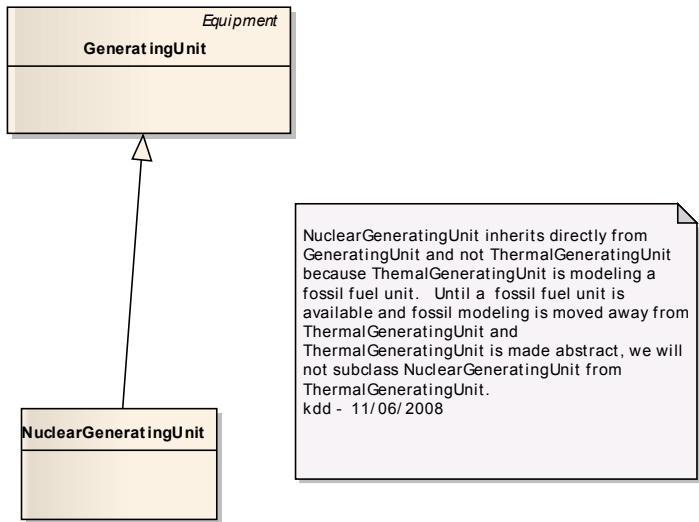
Figure 46 – Main

Figure 46 is documented as follows. This diagram shows the two main packages comprising Generation and their dependency relationship with the Wires package.

6.8 Production

6.8.1 Production package summary

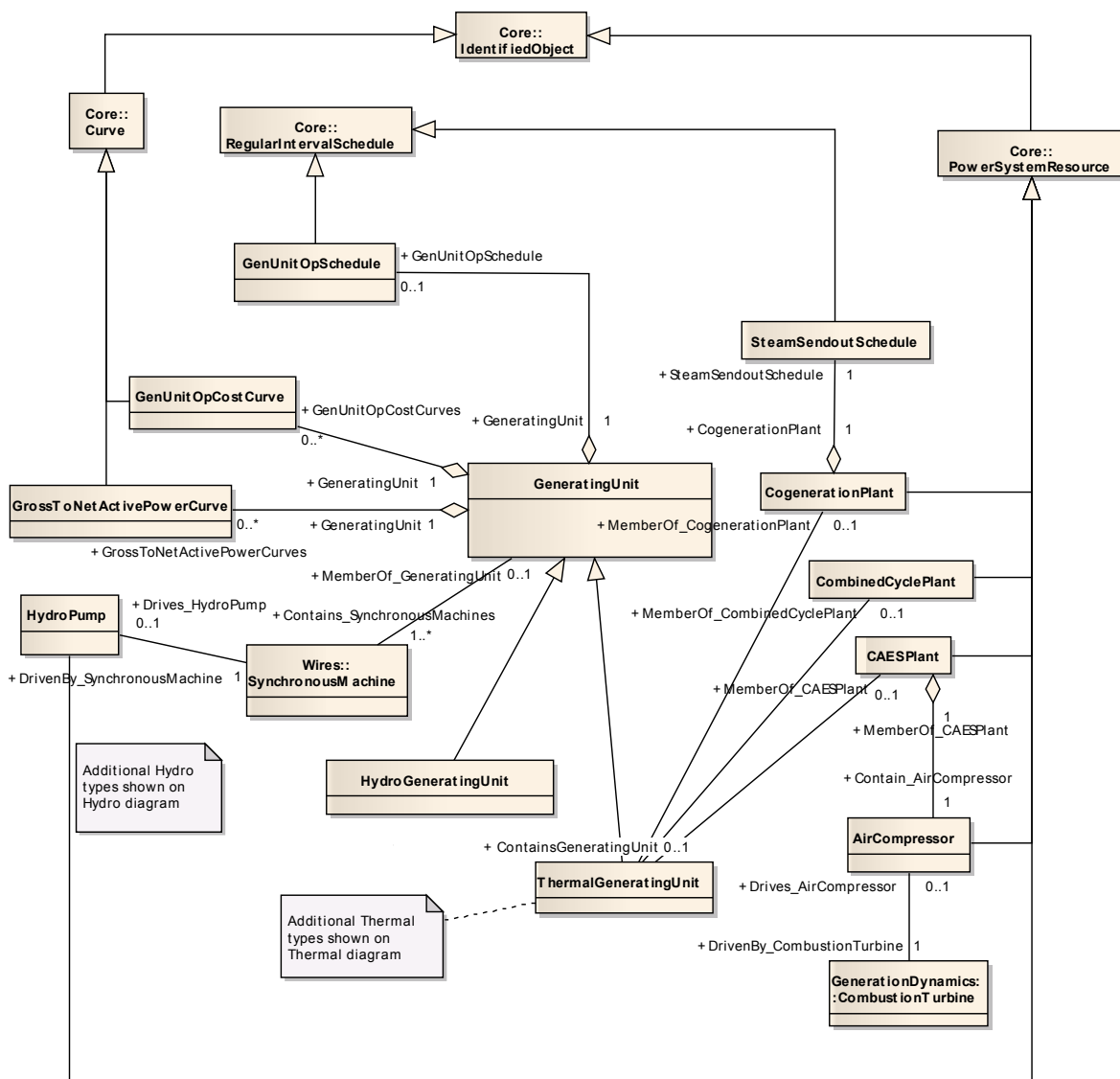
The production package is responsible for classes which describe various kinds of generators. These classes also provide production costing information which is used to economically allocate demand among committed units and calculate reserve quantities.



IEC 2035/11

Figure 47 – Nuclear

Figure 47 is not documented.



IEC 2036/11

Figure 48 – Main

Figure 48 is documented as follows. This diagram shows all classes included in the Production package that are needed by both Hydro and Thermal generation. It also shows key external classes that have associations with Production classes.



IEC 2037/11

Figure 49 – Datatypes

Figure 49 is documented as follows. This diagram shows the data types specific to the Production package.

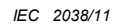


Figure 50 – Hydro

Figure 50 is documented as follows. This diagram shows all classes included in the Hydro package as well as the key external classes that have associations with Hydro classes.

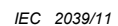


Figure 51 is documented as follows. This diagram shows all classes included in the Thermal package as well as the key external classes that have associations with Thermal classes.

Combustion turbine air compressor which is an integral part of a compressed air energy storage (CAES) plant.

name	type	note
airCompressorRating	Float	Rating of the CAES air compressor
mRID	String	inherited from: IdentifiedObject
name	String	inherited from: IdentifiedObject
localName	String	inherited from: IdentifiedObject
pathName	String	inherited from: IdentifiedObject
aliasName	String	inherited from: IdentifiedObject
description	String	inherited from: IdentifiedObject

Association ends

Mult from	[Mult] name (type)	note
1	[1] MemberOf_CAESPlant (CAESPlant)	An air compressor may be a member of a compressed air energy storage plant.
0..1	[1] DrivenBy_CombustionTurbine (CombustionTurbine)	A CAES air compressor is driven by combustion turbine.
0..*	[0..*] OperatedBy_Companies (Company)	inherited from: PowerSystemResource
1	[0..*] Contains_Measurements (Measurement)	inherited from: PowerSystemResource
1	[0..*] OperatingShare (OperatingShare)	inherited from: PowerSystemResource
1	[0..1] OutageSchedule (OutageSchedule)	inherited from: PowerSystemResource
0..*	[0..*] PsrLists (PsrList)	inherited from: PowerSystemResource
0..*	[0..1] PSRType (PSRType)	inherited from: PowerSystemResource
0..*	[0..*] ReportingGroup (ReportingGroup)	inherited from: PowerSystemResource
1..*	[0..1] ModelingAuthoritySet (ModelingAuthoritySet)	inherited from: IdentifiedObject

6.8.3 CAESPlant

Compressed air energy storage plant.

Attributes

name	type	note
energyStorageCapacity	RealEnergy	The rated energy storage capacity
ratedCapacityP	ActivePower	The CAES plant's gross rated generating capacity
mRID	String	inherited from: IdentifiedObject
name	String	inherited from: IdentifiedObject
localName	String	inherited from: IdentifiedObject
pathName	String	inherited from: IdentifiedObject
aliasName	String	inherited from: IdentifiedObject
description	String	inherited from: IdentifiedObject

Association ends

Mult from	[Mult] name (type)	note
1	[1] Contain_AirCompressor (AirCompressor)	An air compressor may be a member of a compressed air energy storage plant.
0..1	[0..1] Contain_ThermalGeneratingUnit (ThermalGeneratingUnit)	A thermal generating unit may be a member of a compressed air energy storage plant.
0..*	[0..*] OperatedBy_Companies (Company)	inherited from: PowerSystemResource
1	[0..*] Contains_Measurements (Measurement)	inherited from: PowerSystemResource
1	[0..*] OperatingShare (OperatingShare)	inherited from: PowerSystemResource
1	[0..1] OutageSchedule (OutageSchedule)	inherited from: PowerSystemResource
0..*	[0..*] PsrLists (PsrList)	inherited from: PowerSystemResource
0..*	[0..1] PSRType (PSRType)	inherited from: PowerSystemResource
0..*	[0..*] ReportingGroup (ReportingGroup)	inherited from: PowerSystemResource
1..*	[0..1] ModelingAuthoritySet (ModelingAuthoritySet)	inherited from: IdentifiedObject

6.8.4 Classification Datatype

1..n, with 1 the most detailed, highest priority, etc.

Attributes

name	type	note
value	Integer	
unit=none (const)	UnitSymbol	
multiplier=none (const)	UnitMultiplier	

6.8.5 CogenerationPlant

A set of thermal generating units for the production of electrical energy and process steam (usually from the output of the steam turbines). The steam sendout is typically used for industrial purposes or for municipal heating and cooling.

Attributes

name	type	note
cogenHPSendoutRating	Float	The high pressure steam sendout
cogenHPSteamRating	Float	The high pressure steam rating
cogenLPSendoutRating	Float	The low pressure steam sendout
cogenLPSteamRating	Float	The low pressure steam rating
ratedP	ActivePower	The rated output active power of the cogeneration plant
mRID	String	inherited from: IdentifiedObject
name	String	inherited from: IdentifiedObject
localName	String	inherited from: IdentifiedObject
pathName	String	inherited from: IdentifiedObject
aliasName	String	inherited from: IdentifiedObject
description	String	inherited from: IdentifiedObject

Association ends

Mult from	[Mult] name (type)	note
1	[1] SteamSendoutSchedule (SteamSendoutSchedule)	A cogeneration plant has a steam sendout schedule.
0..1	[0..*] Contain_ThermalGeneratingUnits (ThermalGeneratingUnit)	A thermal generating unit may be a member of a cogeneration plant.
0..*	[0..*] OperatedBy_Companies (Company)	inherited from: PowerSystemResource
1	[0..*] Contains_Measurements (Measurement)	inherited from: PowerSystemResource
1	[0..*] OperatingShare (OperatingShare)	inherited from: PowerSystemResource
1	[0..1] OutageSchedule (OutageSchedule)	inherited from: PowerSystemResource
0..*	[0..*] PsrLists (PsrList)	inherited from: PowerSystemResource
0..*	[0..1] PSRTtype (PSRTtype)	inherited from: PowerSystemResource
0..*	[0..*] ReportingGroup (ReportingGroup)	inherited from: PowerSystemResource
1..*	[0..1] ModelingAuthoritySet (ModelingAuthoritySet)	inherited from: IdentifiedObject

6.8.6 CombinedCyclePlant

A set of combustion turbines and steam turbines where the exhaust heat from the combustion turbines is recovered to make steam for the steam turbines, resulting in greater overall plant efficiency.

Attributes

name	type	note
combCyclePlantRating	ActivePower	The combined cycle plant's active power output rating
mRID	String	inherited from: IdentifiedObject
name	String	inherited from: IdentifiedObject
localName	String	inherited from: IdentifiedObject
pathName	String	inherited from: IdentifiedObject
aliasName	String	inherited from: IdentifiedObject
description	String	inherited from: IdentifiedObject

Association ends

Mult from	[Mult] name (type)	note
0..1	[0..*] Contain_ThermalGeneratingUnits (ThermalGeneratingUnit)	A thermal generating unit may be a member of a combined cycle plant.
0..*	[0..*] OperatedBy_Companies (Company)	inherited from: PowerSystemResource
1	[0..*] Contains_Measurements (Measurement)	inherited from: PowerSystemResource
1	[0..*] OperatingShare (OperatingShare)	inherited from: PowerSystemResource
1	[0..1] OutageSchedule (OutageSchedule)	inherited from: PowerSystemResource
0..*	[0..*] PsrLists (PsrList)	inherited from: PowerSystemResource
0..*	[0..1] PSRTYPE (PSRTYPE)	inherited from: PowerSystemResource
0..*	[0..*] ReportingGroup (ReportingGroup)	inherited from: PowerSystemResource
1..*	[0..1] ModelingAuthoritySet (ModelingAuthoritySet)	inherited from: IdentifiedObject

6.8.7 CostPerHeatUnit Datatype

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

Attributes

name	type	note
value	Float	
unit	MonetaryAmountPerHeatUnit	
multiplier	UnitMultiplier	

6.8.8 Emission Datatype

Quantity of emission per fuel heat content.

Attributes

name	type	note
value	Float	
unit=kg/J (const)	UnitSymbol	
multiplier	UnitMultiplier	

6.8.9 EmissionAccount

Accounts for tracking emissions usage and credits for thermal generating units. A unit may have zero or more emission accounts, and will typically have one for tracking usage and one for tracking credits.

Attributes

name	type	note
emissionType	EmissionType	The type of emission, for example sulfur dioxide (SO ₂). The y1AxisUnits of the curve contains the unit of measure (e.g. kg) and the emissionType is the type of emission (e.g. sulfur dioxide).
emissionValueSource	EmissionValueSource	The source of the emission value.
curveStyle	CurveStyle	inherited from: Curve
xUnit	UnitSymbol	inherited from: Curve
xMultiplier	UnitMultiplier	inherited from: Curve
y1Unit	UnitSymbol	inherited from: Curve
y1Multiplier	UnitMultiplier	inherited from: Curve
y2Unit	UnitSymbol	inherited from: Curve
y2Multiplier	UnitMultiplier	inherited from: Curve
mRID	String	inherited from: IdentifiedObject
name	String	inherited from: IdentifiedObject
localName	String	inherited from: IdentifiedObject
pathName	String	inherited from: IdentifiedObject
aliasName	String	inherited from: IdentifiedObject
description	String	inherited from: IdentifiedObject

Association ends

Mult from	[Mult] name (type)	note
0..*	[1] ThermalGeneratingUnit (ThermalGeneratingUnit)	A thermal generating unit may have one or more emission allowance accounts.
1	[0..*] CurveScheduleDatas (CurveData)	inherited from: Curve
1..*	[0..1] ModelingAuthoritySet (ModelingAuthoritySet)	inherited from: IdentifiedObject

6.8.10 EmissionCurve

Relationship between the unit's emission rate in units of mass per hour (Y-axis) and output active power (X-axis) for a given type of emission. This curve applies when only one type of fuel is being burned.

Attributes

name	type	note
emissionContent	Emission	The emission content per quantity of fuel burned.
emissionType	EmissionType	The type of emission, which also gives the production rate measurement unit. The y1AxisUnits of the curve contains the unit of measure (e.g. kg) and the emissionType is the type of emission (e.g. sulfur dioxide).
isNetGrossP	Boolean	Flag is set to true when output is expressed in net active power
curveStyle	CurveStyle	inherited from: Curve
xUnit	UnitSymbol	inherited from: Curve

name	type	note
xMultiplier	UnitMultiplier	inherited from: Curve
y1Unit	UnitSymbol	inherited from: Curve
y1Multiplier	UnitMultiplier	inherited from: Curve
y2Unit	UnitSymbol	inherited from: Curve
y2Multiplier	UnitMultiplier	inherited from: Curve
mRID	String	inherited from: IdentifiedObject
name	String	inherited from: IdentifiedObject
localName	String	inherited from: IdentifiedObject
pathName	String	inherited from: IdentifiedObject
aliasName	String	inherited from: IdentifiedObject
description	String	inherited from: IdentifiedObject

Association ends

Mult from	[Mult] name (type)	note
0..*	[1] ThermalGeneratingUnit (ThermalGeneratingUnit)	A thermal generating unit may have one or more emission curves.
1	[0..*] CurveScheduleDatas (CurveData)	inherited from: Curve
1..*	[0..1] ModelingAuthoritySet (ModelingAuthoritySet)	inherited from: IdentifiedObject

6.8.11 EmissionType enumeration

The type of emission.

Enums

name	note
sulfurDioxide	
carbonDioxide	
nitrogenOxide	
hydrogenSulfide	
chlorine	
carbonDisulfide	

6.8.12 EmissionValueSource enumeration

The source of the emission value.

Enums

name	note
measured	
calculated	

6.8.13 FossilFuel

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

Attributes

name	type	note
fossilFuelType	FuelType	The type of fossil fuel, such as coal, oil, or gas.
fuelCost	CostPerHeatUnit	The cost in terms of heat value for the given type of fuel.
fuelDispatchCost	CostPerHeatUnit	The cost of fuel used for economic dispatching which includes: fuel cost, transportation cost, and incremental maintenance cost.
fuelEffFactor	PU	The efficiency factor for the fuel (per unit) in terms of the effective energy absorbed.
fuelHandlingCost	CostPerHeatUnit	Handling and processing cost associated with this fuel.
fuelHeatContent	Float	The amount of heat per weight (or volume) of the given type of fuel.
fuelMixture	PerCent	Relative amount of the given type of fuel, when multiple fuels are being consumed.
fuelSulfur	PU	The fuel's fraction of pollution credit per unit of heat content.
highBreakpointP	ActivePower	The active power output level of the unit at which the given type of fuel is switched on. This fuel (e.g., oil) is sometimes used to supplement the base fuel (e.g., coal) at high active power output levels.
lowBreakpointP	ActivePower	The active power output level of the unit at which the given type of fuel is switched off. This fuel (e.g., oil) is sometimes used to stabilize the base fuel (e.g., coal) at low active power output levels.
mRID	String	inherited from: IdentifiedObject
name	String	inherited from: IdentifiedObject
localName	String	inherited from: IdentifiedObject
pathName	String	inherited from: IdentifiedObject
aliasName	String	inherited from: IdentifiedObject
description	String	inherited from: IdentifiedObject

Association ends

Mult from	[Mult] name (type)	note
1	[0..*] FuelAllocationSchedule (FuelAllocationSchedule)	A fuel allocation schedule must have a fossil fuel.
0..*	[1] ThermalGeneratingUnit (ThermalGeneratingUnit)	A thermal generating unit may have one or more fossil fuels.
1..*	[0..1] ModelingAuthoritySet (ModelingAuthoritySet)	inherited from: IdentifiedObject

6.8.14 FuelAllocationSchedule

The amount of fuel of a given type which is allocated for consumption over a specified period of time.

Attributes

name	type	note
fuelAllocationEndDate	AbsoluteDateTime	The end time and date of the fuel allocation schedule.
fuelAllocationStartDate	AbsoluteDateTime	The start time and date of the fuel allocation schedule.
fuelType	FuelType	The type of fuel, which also indicates the corresponding measurement unit.

maxFuelAllocation	Float	The maximum amount fuel that is allocated for consumption for the scheduled time period.
minFuelAllocation	Float	The minimum amount fuel that is allocated for consumption for the scheduled time period, e.g., based on a "take-or-pay" contract.
curveStyle	CurveStyle	inherited from: Curve
xUnit	UnitSymbol	inherited from: Curve
xMultiplier	UnitMultiplier	inherited from: Curve
y1Unit	UnitSymbol	inherited from: Curve
y1Multiplier	UnitMultiplier	inherited from: Curve
y2Unit	UnitSymbol	inherited from: Curve
y2Multiplier	UnitMultiplier	inherited from: Curve
mRID	String	inherited from: IdentifiedObject
name	String	inherited from: IdentifiedObject
localName	String	inherited from: IdentifiedObject
pathName	String	inherited from: IdentifiedObject
aliasName	String	inherited from: IdentifiedObject
description	String	inherited from: IdentifiedObject

Association ends

Mult from	[Mult] name (type)	note
0..*	[1] FossilFuel (FossilFuel)	A fuel allocation schedule must have a fossil fuel.
0..*	[1] ThermalGeneratingUnit (ThermalGeneratingUnit)	A thermal generating unit may have one or more fuel allocation schedules.
1	[0..*] CurveScheduleDatas (CurveData)	inherited from: Curve
1..*	[0..1] ModelingAuthoritySet (ModelingAuthoritySet)	inherited from: IdentifiedObject

6.8.15 FuelType enumeration

Type of fuel.

Enums

name	note
coal	
oil	
gas	

6.8.16 GeneratingUnit

A single or set of synchronous machines for converting mechanical power into alternating-current power. For example, individual machines within a set may be defined for scheduling purposes while a single control signal is derived for the set. In this case, there would be a GeneratingUnit for each member of the set and an additional GeneratingUnit corresponding to the set.

Attributes

name	type	note
allocSpinResP	ActivePower	The planned unused capacity (spinning reserve) which can be used to support emergency load.

name	type	note
autoCntrlMarginP	ActivePower	The planned unused capacity which can be used to support automatic control overruns.
baseP	ActivePower	For dispatchable units, this value represents the economic active power basepoint. For units that are not dispatchable, this value represents the fixed generation value. The value must be between the operating low and high limits.
controlDeadband	ActivePower	Unit control error deadband. When a unit's desired active power change is less than this deadband, then no control pulses will be sent to the unit.
controlPulseHigh	Seconds	Pulse high limit which is the largest control pulse that the unit can respond to.
controlPulseLow	Seconds	Pulse low limit which is the smallest control pulse that the unit can respond to.
controlResponseRate	ActivePowerChangeRate	Unit response rate which specifies the active power change for a control pulse of one second in the most responsive loading level of the unit.
dispReserveFlag	Boolean	
efficiency	PU	The efficiency of the unit in converting mechanical energy, from the prime mover, into electrical energy.
energyMinP	HeatRate	
fastStartFlag	Boolean	
fuelPriority	Integer	
genControlMode	GeneratorControlMode	The unit control mode.
genControlSource	GeneratorControlSource	The source of controls for a generating unit.
genOperatingMode	GeneratorOperatingMode	Operating mode for secondary control.
governorMPL	PU	Governor motor position limit.
governorSCD	PerCent	Governor speed changer droop.
highControlLimit	ActivePower	High limit for secondary (AGC) control.
initialP	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	Float	Generating unit economic participation factor.
lowControlLimit	ActivePower	Low limit for secondary (AGC) control.
lowerRampRate	ActivePowerChangeRate	
maxEconomicP	ActivePower	Maximum high economic active power limit, that should not exceed the maximum operating active power limit.
maximumAllowableSpinningReserve	ActivePower	Maximum allowable spinning reserve. Spinning reserve will never be considered greater than this value regardless of the current operating point.
maxOperatingP	ActivePower	This is the maximum operating active power limit the dispatcher can enter for this unit.
minEconomicP	ActivePower	Low economic active power limit that must be greater than or equal to the minimum operating active power limit.
minimumOffTime	Seconds	Minimum time interval between unit shutdown and startup.
minOperatingP	ActivePower	This is the minimum operating active power limit the dispatcher can enter for this unit.
modelDetail	Classification	Detail level of the generator model data.
normalPF	Float	Generating unit economic participation factor.
penaltyFactor	Float	Defined as: $1 / (1 - \text{Incremental transmission loss})$; with the incremental transmission loss expressed as

name	type	note
		a plus or minus value. The typical range of penalty factors is (0,9 to 1,1).
raiseRampRate	ActivePowerChangeRate	
ratedGrossMaxP	ActivePower	The unit's gross rated maximum capacity (Book Value).
ratedGrossMinP	ActivePower	The gross rated minimum generation level which the unit can safely operate at while delivering power to the transmission grid.
ratedNetMaxP	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	Float	Generating unit economic participation factor.
spinReserveRamp	ActivePowerChangeRate	
startupCost	Money	The initial startup cost incurred for each start of the GeneratingUnit.
startupTime	Seconds	Time it takes to get the unit on-line, from the time that the prime mover mechanical power is applied.
stepChange	ActivePower	
tieLinePF	Float	Generating unit economic participation factor.
variableCost	Money	The variable cost component of production per unit of ActivePower.
normalllyInService	Boolean	inherited from: Equipment
mRID	String	inherited from: IdentifiedObject
name	String	inherited from: IdentifiedObject
localName	String	inherited from: IdentifiedObject
pathName	String	inherited from: IdentifiedObject
aliasName	String	inherited from: IdentifiedObject
description	String	inherited from: IdentifiedObject

Association ends

Mult from	[Mult] name (type)	note
1	[0..*] ControlAreaGeneratingUnit (ControlAreaGeneratingUnit)	ControlArea specifications for this generating unit.
1	[0..*] GenUnitOpCostCurves (GenUnitOpCostCurve)	A generating unit may have one or more cost curves, depending upon fuel mixture and fuel cost.
1	[0..1] GenUnitOpSchedule (GenUnitOpSchedule)	A generating unit may have an operating schedule, indicating the planned operation of the unit.
1	[0..*] GrossToNetActivePowerCurves (GrossToNetActivePowerCurve)	A generating unit may have a gross active power to net active power curve, describing the losses and auxiliary power requirements of the unit.
0..1	[1..*] Contains_SynchronousMachines (SynchronousMachine)	A synchronous machine may operate as a generator and as such becomes a member of a generating unit.
1	[0..*] ContingencyEquipment (ContingencyEquipment)	inherited from: Equipment
0..*	[0..1] MemberOf_EquipmentContainer (EquipmentContainer)	inherited from: Equipment
1	[0..*] OperationalLimitSet (OperationalLimitSet)	inherited from: Equipment
0..*	[0..*] OperatedBy_Companies (Company)	inherited from: PowerSystemResource

Mult from	[Mult] name (type)	note
1	[0..*] Contains_Measurements (Measurement)	inherited from: PowerSystemResource
1	[0..*] OperatingShare (OperatingShare)	inherited from: PowerSystemResource
1	[0..1] OutageSchedule (OutageSchedule)	inherited from: PowerSystemResource
0..*	[0..*] PsrLists (PsrList)	inherited from: PowerSystemResource
0..*	[0..1] PSRTYPE (PSRTYPE)	inherited from: PowerSystemResource
0..*	[0..*] ReportingGroup (ReportingGroup)	inherited from: PowerSystemResource
1..*	[0..1] ModelingAuthoritySet (ModelingAuthoritySet)	inherited from: IdentifiedObject

6.8.17 GeneratorControlMode enumeration

Unit control modes.

Enums

name	note
setpoint	
pulse	

6.8.18 GeneratorControlSource enumeration

The source of controls for a generating unit.

Enums

name	note
Unavailable	
offAGC	
onAGC	
PlantControl	

6.8.19 GeneratorOperatingMode enumeration

Operating mode for secondary generator control.

Enums

name	note
Off	
Manual	
Fixed	
LFC	
AGC	
EDC	
MRN	
REG	

6.8.20 GenUnitOpCostCurve

Relationship between unit operating cost (Y-axis) and unit output active power (X-axis). The operating cost curve for thermal units is derived from heat input and fuel costs. The operating cost curve for hydro units is derived from water flow rates and equivalent water costs.

Attributes

name	type	note
isNetGrossP	Boolean	Flag is set to true when output is expressed in net active power
curveStyle	CurveStyle	inherited from: Curve
xUnit	UnitSymbol	inherited from: Curve
xMultiplier	UnitMultiplier	inherited from: Curve
y1Unit	UnitSymbol	inherited from: Curve
y1Multiplier	UnitMultiplier	inherited from: Curve
y2Unit	UnitSymbol	inherited from: Curve
y2Multiplier	UnitMultiplier	inherited from: Curve
mRID	String	inherited from: IdentifiedObject
name	String	inherited from: IdentifiedObject
localName	String	inherited from: IdentifiedObject
pathName	String	inherited from: IdentifiedObject
aliasName	String	inherited from: IdentifiedObject
description	String	inherited from: IdentifiedObject

Association ends

Mult from	[Mult] name (type)	note
0..*	[1] GeneratingUnit (GeneratingUnit)	A generating unit may have one or more cost curves, depending upon fuel mixture and fuel cost.
1	[0..*] CurveScheduleDatas (CurveData)	inherited from: Curve
1..*	[0..1] ModelingAuthoritySet (ModelingAuthoritySet)	inherited from: IdentifiedObject

6.8.21 GenUnitOpSchedule

The generating unit's Operator-approved current operating schedule (or plan), typically produced with the aid of unit commitment type analyses. The X-axis represents absolute time. The Y1-axis represents the status (0=off-line and unavailable: 1=available: 2=must run: 3=must run at fixed power value: etc.). The Y2-axis represents the must run fixed power value where required.

Attributes

name	type	note
timeStep	Seconds	inherited from: RegularIntervalSchedule
endTime	AbsoluteDateTime	inherited from: RegularIntervalSchedule
startTime	AbsoluteDateTime	inherited from: BasicIntervalSchedule
value1Unit	UnitSymbol	inherited from: BasicIntervalSchedule
value1Multiplier	UnitMultiplier	inherited from: BasicIntervalSchedule
value2Unit	UnitSymbol	inherited from: BasicIntervalSchedule
value2Multiplier	UnitMultiplier	inherited from: BasicIntervalSchedule
mRID	String	inherited from: IdentifiedObject
name	String	inherited from: IdentifiedObject
localName	String	inherited from: IdentifiedObject
pathName	String	inherited from: IdentifiedObject
aliasName	String	inherited from: IdentifiedObject

description	String	inherited from: IdentifiedObject
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Association ends

Mult from	[Mult] name (type)	note
0..1	[1] GeneratingUnit (GeneratingUnit)	A generating unit may have an operating schedule, indicating the planned operation of the unit.
1	[1..*] TimePoints (RegularTimePoint)	inherited from: RegularIntervalSchedule
1..*	[0..1] ModelingAuthoritySet (ModelingAuthoritySet)	inherited from: IdentifiedObject

6.8.22 GrossToNetActivePowerCurve

Relationship between the generating unit's gross active power output on the X-axis (measured at the terminals of the machine(s)) and the generating unit's net active power output on the Y-axis (based on utility-defined measurements at the power station). Station service loads, when 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.

Attributes

name	type	note
curveStyle	CurveStyle	inherited from: Curve
xUnit	UnitSymbol	inherited from: Curve
xMultiplier	UnitMultiplier	inherited from: Curve
y1Unit	UnitSymbol	inherited from: Curve
y1Multiplier	UnitMultiplier	inherited from: Curve
y2Unit	UnitSymbol	inherited from: Curve
y2Multiplier	UnitMultiplier	inherited from: Curve
mRID	String	inherited from: IdentifiedObject
name	String	inherited from: IdentifiedObject
localName	String	inherited from: IdentifiedObject
pathName	String	inherited from: IdentifiedObject
aliasName	String	inherited from: IdentifiedObject
description	String	inherited from: IdentifiedObject

Association ends

Mult from	[Mult] name (type)	note
0..*	[1] GeneratingUnit (GeneratingUnit)	A generating unit may have a gross active power to net active power curve, describing the losses and auxiliary power requirements of the unit-
1	[0..*] CurveScheduleDatas (CurveData)	inherited from: Curve
1..*	[0..1] ModelingAuthoritySet (ModelingAuthoritySet)	inherited from: IdentifiedObject

6.8.23 HeatInputCurve

Relationship between unit heat input in energy per time for main fuel (Y1-axis) and supplemental fuel (Y2-axis) versus unit output in active power (X-axis). The quantity of main fuel used to sustain generation at this output level is prorated for throttling between definition points. The quantity of supplemental fuel used at this output level is fixed and not prorated.

Attributes

name	type	note
auxPowerOffset	ActivePower	Power output - auxiliary power offset adjustment factor.
auxPowerMult	PU	Power output - auxiliary power multiplier adjustment factor.
heatInputEff	PU	Heat input - efficiency multiplier adjustment factor.
heatInputOffset	HeatRate	Heat input - offset adjustment factor.
isNetGrossP	Boolean	Flag is set to true when output is expressed in net active power.
curveStyle	CurveStyle	inherited from: Curve
xUnit	UnitSymbol	inherited from: Curve
xMultiplier	UnitMultiplier	inherited from: Curve
y1Unit	UnitSymbol	inherited from: Curve
y1Multiplier	UnitMultiplier	inherited from: Curve
y2Unit	UnitSymbol	inherited from: Curve
y2Multiplier	UnitMultiplier	inherited from: Curve
mRID	String	inherited from: IdentifiedObject
name	String	inherited from: IdentifiedObject
localName	String	inherited from: IdentifiedObject
pathName	String	inherited from: IdentifiedObject
aliasName	String	inherited from: IdentifiedObject
description	String	inherited from: IdentifiedObject

Association ends

Mult from	[Mult] name (type)	note
0..1	[1] ThermalGeneratingUnit (ThermalGeneratingUnit)	A thermal generating unit may have a heat input curve.
1	[0..*] CurveScheduleDatas (CurveData)	inherited from: Curve
1..*	[0..1] ModelingAuthoritySet (ModelingAuthoritySet)	inherited from: IdentifiedObject

6.8.24 HeatRate Datatype

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

Attributes

name	type	note
value	Float	
unit=J/s (const)	UnitSymbol	
multiplier	UnitMultiplier	

6.8.25 HeatRateCurve

Relationship between unit heat rate per active power (Y-axis) and unit output (X-axis). The heat input is from all fuels.

Attributes

name	type	note
isNetGrossP	Boolean	Flag is set to true when output is expressed in net active power.
curveStyle	CurveStyle	inherited from: Curve
xUnit	UnitSymbol	inherited from: Curve
xMultiplier	UnitMultiplier	inherited from: Curve
y1Unit	UnitSymbol	inherited from: Curve
y1Multiplier	UnitMultiplier	inherited from: Curve
y2Unit	UnitSymbol	inherited from: Curve
y2Multiplier	UnitMultiplier	inherited from: Curve
mRID	String	inherited from: IdentifiedObject
name	String	inherited from: IdentifiedObject
localName	String	inherited from: IdentifiedObject
pathName	String	inherited from: IdentifiedObject
aliasName	String	inherited from: IdentifiedObject
description	String	inherited from: IdentifiedObject

Association ends

Mult from	[Mult] name (type)	note
0..1	[1] ThermalGeneratingUnit (ThermalGeneratingUnit)	A thermal generating unit may have a heat rate curve.
1	[0..*] CurveScheduleDatas (CurveData)	inherited from: Curve
1..*	[0..1] ModelingAuthoritySet (ModelingAuthoritySet)	inherited from: IdentifiedObject

6.8.26 HydroEnergyConversionKind enumeration

Specifies the capability of the hydro generating unit to convert energy as a generator or pump.

Enums

name	note
generator	Able to generate power, but not able to pump water for energy storage.
pumpAndGenerator	Able to both generate power and pump water for energy storage.

6.8.27 HydroGeneratingEfficiencyCurve

Relationship between unit efficiency in percent and unit output active power for a given net head in meters. The relationship between efficiency, discharge, head, and power output is expressed as follows: $E = KP / HQ$.

where

E is the percentage;

P is the active power;

H is the height;

Q is the volume/time unit;

K is the constant.

For example, a curve instance for a given net head could relate efficiency (Y-axis) versus active power output (X-axis) or versus discharge on the X-axis.

Attributes

name	type	note
curveStyle	CurveStyle	inherited from: Curve
xUnit	UnitSymbol	inherited from: Curve
xMultiplier	UnitMultiplier	inherited from: Curve
y1Unit	UnitSymbol	inherited from: Curve
y1Multiplier	UnitMultiplier	inherited from: Curve
y2Unit	UnitSymbol	inherited from: Curve
y2Multiplier	UnitMultiplier	inherited from: Curve
mRID	String	inherited from: IdentifiedObject
name	String	inherited from: IdentifiedObject
localName	String	inherited from: IdentifiedObject
pathName	String	inherited from: IdentifiedObject
aliasName	String	inherited from: IdentifiedObject
description	String	inherited from: IdentifiedObject

Association ends

Mult from	[Mult] name (type)	note
0..*	[1] HydroGeneratingUnit (HydroGeneratingUnit)	A hydro generating unit has an efficiency curve.
1	[0..*] CurveScheduleDatas (CurveData)	inherited from: Curve
1..*	[0..1] ModelingAuthoritySet (ModelingAuthoritySet)	inherited from: IdentifiedObject

6.8.28 HydroGeneratingUnit

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

Attributes

name	type	note
energyConversionCapability	HydroEnergyConversionKind	Energy conversion capability for generating
hydroUnitWaterCost	Float	The equivalent cost of water that drives the hydro turbine, expressed as cost per volume
allocSpinResP	ActivePower	inherited from: GeneratingUnit
autoCntrlMarginP	ActivePower	inherited from: GeneratingUnit
baseP	ActivePower	inherited from: GeneratingUnit
controlDeadband	ActivePower	inherited from: GeneratingUnit
controlPulseHigh	Seconds	inherited from: GeneratingUnit
controlPulseLow	Seconds	inherited from: GeneratingUnit
controlResponseRate	ActivePowerChangeRate	inherited from: GeneratingUnit
dispReserveFlag	Boolean	inherited from: GeneratingUnit
efficiency	PU	inherited from: GeneratingUnit

name	type	note
energyMinP	HeatRate	inherited from: GeneratingUnit
fastStartFlag	Boolean	inherited from: GeneratingUnit
fuelPriority	Integer	inherited from: GeneratingUnit
genControlMode	GeneratorControlMode	inherited from: GeneratingUnit
genControlSource	GeneratorControlSource	inherited from: GeneratingUnit
genOperatingMode	GeneratorOperatingMode	inherited from: GeneratingUnit
governorMPL	PU	inherited from: GeneratingUnit
governorSCD	PerCent	inherited from: GeneratingUnit
highControlLimit	ActivePower	inherited from: GeneratingUnit
initialP	ActivePower	inherited from: GeneratingUnit
longPF	Float	inherited from: GeneratingUnit
lowControlLimit	ActivePower	inherited from: GeneratingUnit
lowerRampRate	ActivePowerChangeRate	inherited from: GeneratingUnit
maxEconomicP	ActivePower	inherited from: GeneratingUnit
maximumAllowableSpinningReserve	ActivePower	inherited from: GeneratingUnit
maxOperatingP	ActivePower	inherited from: GeneratingUnit
minEconomicP	ActivePower	inherited from: GeneratingUnit
minimumOffTime	Seconds	inherited from: GeneratingUnit
minOperatingP	ActivePower	inherited from: GeneratingUnit
modelDetail	Classification	inherited from: GeneratingUnit
normalPF	Float	inherited from: GeneratingUnit
penaltyFactor	Float	inherited from: GeneratingUnit
raiseRampRate	ActivePowerChangeRate	inherited from: GeneratingUnit
ratedGrossMaxP	ActivePower	inherited from: GeneratingUnit
ratedGrossMinP	ActivePower	inherited from: GeneratingUnit
ratedNetMaxP	ActivePower	inherited from: GeneratingUnit
shortPF	Float	inherited from: GeneratingUnit
spinReserveRamp	ActivePowerChangeRate	inherited from: GeneratingUnit
startupCost	Money	inherited from: GeneratingUnit
startupTime	Seconds	inherited from: GeneratingUnit
stepChange	ActivePower	inherited from: GeneratingUnit
tieLinePF	Float	inherited from: GeneratingUnit
variableCost	Money	inherited from: GeneratingUnit
normallyInService	Boolean	inherited from: Equipment
mRID	String	inherited from: IdentifiedObject
name	String	inherited from: IdentifiedObject
localName	String	inherited from: IdentifiedObject
pathName	String	inherited from: IdentifiedObject
aliasName	String	inherited from: IdentifiedObject
description	String	inherited from: IdentifiedObject

Association ends

Mult from	[Mult] name (type)	note
1	[0..*] HydroGeneratingEfficiencyCurves (HydroGeneratingEfficiencyCurve)	A hydro generating unit has an efficiency curve.
1..*	[1] MemberOf_HydroPowerPlant (HydroPowerPlant)	The hydro generating unit belongs to a hydro power plant.
1	[0..1] PenstockLossCurve (PenstockLossCurve)	A hydro generating unit has a penstock loss curve.
1	[0..*] TailbayLossCurve (TailbayLossCurve)	A hydro generating unit has a tailbay loss curve.
1	[0..*] ControlAreaGeneratingUnit (ControlAreaGeneratingUnit)	inherited from: GeneratingUnit
1	[0..*] GenUnitOpCostCurves (GenUnitOpCostCurve)	inherited from: GeneratingUnit
1	[0..1] GenUnitOpSchedule (GenUnitOpSchedule)	inherited from: GeneratingUnit
1	[0..*] GrossToNetActivePowerCurves (GrossToNetActivePowerCurve)	inherited from: GeneratingUnit
0..1	[1..*] Contains_SynchronousMachines (SynchronousMachine)	inherited from: GeneratingUnit
1	[0..*] ContingencyEquipment (ContingencyEquipment)	inherited from: Equipment
0..*	[0..1] MemberOf_EquipmentContainer (EquipmentContainer)	inherited from: Equipment
1	[0..*] OperationalLimitSet (OperationalLimitSet)	inherited from: Equipment
0..*	[0..*] OperatedBy_Companies (Company)	inherited from: PowerSystemResource
1	[0..*] Contains_Measurements (Measurement)	inherited from: PowerSystemResource
Mult from	[Mult] name (type)	note
1	[0..*] OperatingShare (OperatingShare)	inherited from: PowerSystemResource
1	[0..1] OutageSchedule (OutageSchedule)	inherited from: PowerSystemResource
0..*	[0..*] PsrLists (PsrList)	inherited from: PowerSystemResource
0..*	[0..1] PSRTtype (PSRTtype)	inherited from: PowerSystemResource
0..*	[0..*] ReportingGroup (ReportingGroup)	inherited from: PowerSystemResource
1..*	[0..1] ModelingAuthoritySet (ModelingAuthoritySet)	inherited from: IdentifiedObject

6.8.29 HydroPlantType enumeration

The type of hydro power plant.

Enums

name	note
runOfRiver	
pumpedStorage	
majorStorage	
minorStorage	

6.8.30 HydroPowerPlant

A hydro power station which can generate or pump. When generating, the generator turbines receive their water from an upper reservoir. When pumping, the pumps receive their water from a lower reservoir.

Attributes

name	type	note
dischargeTravelDelay	Seconds	Water travel delay from tailbay to next downstream hydro power station
hydroPlantType	HydroPlantType	The type of hydro power plant
penstockType	PenstockType	Type and configuration of hydro plant penstock(s)
plantDischargeCapacity	Float	Total plant discharge capacity in cubic meters per second
genRatedP	ActivePower	The hydro plant's generating rating active power for rated head conditions
pumpRatedP	ActivePower	The hydro plant's pumping rating active power for rated head conditions
plantRatedHead	Float	The plant's rated gross head in meters
surgeTankCode	SurgeTankCode	A code describing the type (or absence) of surge tank that is associated with the hydro power plant
surgeTankCrestLevel	WaterLevel	The level at which the surge tank spills
mRID	String	inherited from: IdentifiedObject
name	String	inherited from: IdentifiedObject
localName	String	inherited from: IdentifiedObject
pathName	String	inherited from: IdentifiedObject
aliasName	String	inherited from: IdentifiedObject
description	String	inherited from: IdentifiedObject

Association ends

Mult from	[Mult] name (type)	note
1	[1..*] Contain_HydroGeneratingUnits (HydroGeneratingUnit)	The hydro generating unit belongs to a hydro power plant.
0..1	[1..*] Contain_HydroPumps (HydroPump)	The hydro pump may be a member of a pumped storage plant or a pump for distributing water.
0..*	[1] GenSourcePumpDischarge (Reservoir)	Generators are supplied water from or pumps discharge water to an upstream reservoir.
0..*	[0..1] Reservoir (Reservoir)	Generators discharge water to or pumps are supplied water from a downstream reservoir.
0..*	[0..*] OperatedBy_Companies (Company)	inherited from: PowerSystemResource
1	[0..*] Contains_Measurements (Measurement)	inherited from: PowerSystemResource
1	[0..*] OperatingShare (OperatingShare)	inherited from: PowerSystemResource
1	[0..1] OutageSchedule (OutageSchedule)	inherited from: PowerSystemResource
0..*	[0..*] PsrLists (PsrList)	inherited from: PowerSystemResource
0..*	[0..1] PSRTType (PSRTType)	inherited from: PowerSystemResource
0..*	[0..*] ReportingGroup (ReportingGroup)	inherited from: PowerSystemResource
1..*	[0..1] ModelingAuthoritySet (ModelingAuthoritySet)	inherited from: IdentifiedObject

6.8.31 HydroPump

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

Attributes

name	type	note
pumpDischAtMaxHead	Float	The pumping discharge (m ³ /s) under maximum head conditions, usually at full gate
pumpDischAtMinHead	Float	The pumping discharge (m ³ /s) under minimum head conditions, usually at full gate
pumpPowerAtMaxHead	ActivePower	The pumping power under maximum head conditions, usually at full gate
pumpPowerAtMinHead	ActivePower	The pumping power under minimum head conditions, usually at full gate.
mRID	String	inherited from: IdentifiedObject
name	String	inherited from: IdentifiedObject
localName	String	inherited from: IdentifiedObject
pathName	String	inherited from: IdentifiedObject
aliasName	String	inherited from: IdentifiedObject
description	String	inherited from: IdentifiedObject

Association ends

Mult from	[Mult] name (type)	note
1..*	[0..1] MemberOf_HydroPowerPlant (HydroPowerPlant)	The hydro pump may be a member of a pumped storage plant or a pump for distributing water.
1	[0..1] HydroPumpOpSchedule (HydroPumpOpSchedule)	The hydro pump has a pumping schedule over time, indicating when pumping is to occur.
0..1	[1] DrivenBy_SynchronousMachine (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.
0..*	[0..*] OperatedBy_Companies (Company)	inherited from: PowerSystemResource
1	[0..*] Contains_Measurements (Measurement)	inherited from: PowerSystemResource
1	[0..*] OperatingShare (OperatingShare)	inherited from: PowerSystemResource
1	[0..1] OutageSchedule (OutageSchedule)	inherited from: PowerSystemResource
0..*	[0..*] PsrLists (PsrList)	inherited from: PowerSystemResource
0..*	[0..1] PSRType (PSRType)	inherited from: PowerSystemResource
0..*	[0..*] ReportingGroup (ReportingGroup)	inherited from: PowerSystemResource
1..*	[0..1] ModelingAuthoritySet (ModelingAuthoritySet)	inherited from: IdentifiedObject

6.8.32 HydroPumpOpSchedule

The hydro pump's operator-approved current operating schedule (or plan), typically produced with the aid of unit commitment type analyses. The unit's operating schedule status is typically given as: (0=unavailable) (1=available to startup or shutdown) (2=must pump).

Attributes

name	type	note
timeStep	Seconds	inherited from: RegularIntervalSchedule
endTime	AbsoluteDateTime	inherited from: RegularIntervalSchedule
startTime	AbsoluteDateTime	inherited from: BasicIntervalSchedule

value1Unit	UnitSymbol	inherited from: BasicIntervalSchedule
value1Multiplier	UnitMultiplier	inherited from: BasicIntervalSchedule
value2Unit	UnitSymbol	inherited from: BasicIntervalSchedule
value2Multiplier	UnitMultiplier	inherited from: BasicIntervalSchedule
mRID	String	inherited from: IdentifiedObject
name	String	inherited from: IdentifiedObject
localName	String	inherited from: IdentifiedObject
pathName	String	inherited from: IdentifiedObject
aliasName	String	inherited from: IdentifiedObject
description	String	inherited from: IdentifiedObject

Association ends

Mult from	[Mult] name (type)	note
0..1	[1] HydroPump (HydroPump)	The hydro pump has a pumping schedule over time, indicating when pumping is to occur.
1	[1..*] TimePoints (RegularTimePoint)	inherited from: RegularIntervalSchedule
1..*	[0..1] ModelingAuthoritySet (ModelingAuthoritySet)	inherited from: IdentifiedObject

6.8.33 IncrementalHeatRateCurve

Relationship between unit incremental heat rate in (delta energy/time) per (delta active power) and unit output in active power. The IHR curve represents the slope of the HeatInputCurve. Note that the "incremental heat rate" and the "heat rate" have the same engineering units.

Attributes

name	type	note
isNetGrossP	Boolean	Flag is set to true when output is expressed in net active power.
curveStyle	CurveStyle	inherited from: Curve
xUnit	UnitSymbol	inherited from: Curve
xMultiplier	UnitMultiplier	inherited from: Curve
y1Unit	UnitSymbol	inherited from: Curve
y1Multiplier	UnitMultiplier	inherited from: Curve
y2Unit	UnitSymbol	inherited from: Curve
y2Multiplier	UnitMultiplier	inherited from: Curve
mRID	String	inherited from: IdentifiedObject
name	String	inherited from: IdentifiedObject
localName	String	inherited from: IdentifiedObject
pathName	String	inherited from: IdentifiedObject
aliasName	String	inherited from: IdentifiedObject
description	String	inherited from: IdentifiedObject

Association ends

Mult from	[Mult] name (type)	note
0..1	[1] ThermalGeneratingUnit (ThermalGeneratingUnit)	A thermal generating unit may have an incremental heat rate curve.
1	[0..*] CurveScheduleDatas (CurveData)	inherited from: Curve
1..*	[0..1] ModelingAuthoritySet (ModelingAuthoritySet)	inherited from: IdentifiedObject

6.8.34 InflowForecast

Natural water inflow to a reservoir, usually forecasted from predicted rain and snowmelt. Typically in one hour increments for up to 10 days. The forecast is given in average cubic meters per second over the time increment.

Attributes

name	type	note
timeStep	Seconds	inherited from: RegularIntervalSchedule
endTime	AbsoluteDateTime	inherited from: RegularIntervalSchedule
startTime	AbsoluteDateTime	inherited from: BasicIntervalSchedule
value1Unit	UnitSymbol	inherited from: BasicIntervalSchedule
value1Multiplier	UnitMultiplier	inherited from: BasicIntervalSchedule
value2Unit	UnitSymbol	inherited from: BasicIntervalSchedule
value2Multiplier	UnitMultiplier	inherited from: BasicIntervalSchedule
mRID	String	inherited from: IdentifiedObject
name	String	inherited from: IdentifiedObject
localName	String	inherited from: IdentifiedObject
pathName	String	inherited from: IdentifiedObject
aliasName	String	inherited from: IdentifiedObject
description	String	inherited from: IdentifiedObject

Association ends

Mult from	[Mult] name (type)	note
0..*	[1] Reservoir (Reservoir)	A reservoir may have a "natural" inflow forecast.
1	[1..*] TimePoints (RegularTimePoint)	inherited from: RegularIntervalSchedule
1..*	[0..1] ModelingAuthoritySet (ModelingAuthoritySet)	inherited from: IdentifiedObject

6.8.35 LevelVsVolumeCurve

Relationship between reservoir volume and reservoir level. The volume is at the y-axis and the reservoir level at the x-axis.

Attributes

name	type	note
curveStyle	CurveStyle	inherited from: Curve
xUnit	UnitSymbol	inherited from: Curve
xMultiplier	UnitMultiplier	inherited from: Curve

y1Unit	UnitSymbol	inherited from: Curve
y1Multiplier	UnitMultiplier	inherited from: Curve
y2Unit	UnitSymbol	inherited from: Curve
y2Multiplier	UnitMultiplier	inherited from: Curve
mRID	String	inherited from: IdentifiedObject
name	String	inherited from: IdentifiedObject
localName	String	inherited from: IdentifiedObject
pathName	String	inherited from: IdentifiedObject
aliasName	String	inherited from: IdentifiedObject
description	String	inherited from: IdentifiedObject

Association ends

Mult from	[Mult] name (type)	note
0..*	[1] Reservoir (Reservoir)	A reservoir may have a level versus volume relationship.
1	[0..*] CurveScheduleDatas (CurveData)	inherited from: Curve
1..*	[0..1] ModelingAuthoritySet (ModelingAuthoritySet)	inherited from: IdentifiedObject

6.8.36 NuclearGeneratingUnit

A nuclear generating unit.

Attributes

name	type	note
allocSpinResP	ActivePower	inherited from: GeneratingUnit
autoCtrlMarginP	ActivePower	inherited from: GeneratingUnit
baseP	ActivePower	inherited from: GeneratingUnit
controlDeadband	ActivePower	inherited from: GeneratingUnit
controlPulseHigh	Seconds	inherited from: GeneratingUnit
controlPulseLow	Seconds	inherited from: GeneratingUnit
controlResponseRate	ActivePowerChangeRate	inherited from: GeneratingUnit
dispReserveFlag	Boolean	inherited from: GeneratingUnit
efficiency	PU	inherited from: GeneratingUnit
energyMinP	HeatRate	inherited from: GeneratingUnit
fastStartFlag	Boolean	inherited from: GeneratingUnit
fuelPriority	Integer	inherited from: GeneratingUnit
genControlMode	GeneratorControlMode	inherited from: GeneratingUnit
genControlSource	GeneratorControlSource	inherited from: GeneratingUnit
genOperatingMode	GeneratorOperatingMode	inherited from: GeneratingUnit
governorMPL	PU	inherited from: GeneratingUnit
governorSCD	PerCent	inherited from: GeneratingUnit
highControlLimit	ActivePower	inherited from: GeneratingUnit
initialP	ActivePower	inherited from: GeneratingUnit
longPF	Float	inherited from: GeneratingUnit
lowControlLimit	ActivePower	inherited from: GeneratingUnit

name	type	note
lowerRampRate	ActivePowerChangeRate	inherited from: GeneratingUnit
maxEconomicP	ActivePower	inherited from: GeneratingUnit
maximumAllowableSpinningReserve	ActivePower	inherited from: GeneratingUnit
maxOperatingP	ActivePower	inherited from: GeneratingUnit
minEconomicP	ActivePower	inherited from: GeneratingUnit
minimumOffTime	Seconds	inherited from: GeneratingUnit
minOperatingP	ActivePower	inherited from: GeneratingUnit
modelDetail	Classification	inherited from: GeneratingUnit
normalPF	Float	inherited from: GeneratingUnit
penaltyFactor	Float	inherited from: GeneratingUnit
raiseRampRate	ActivePowerChangeRate	inherited from: GeneratingUnit
ratedGrossMaxP	ActivePower	inherited from: GeneratingUnit
ratedGrossMinP	ActivePower	inherited from: GeneratingUnit
ratedNetMaxP	ActivePower	inherited from: GeneratingUnit
shortPF	Float	inherited from: GeneratingUnit
spinReserveRamp	ActivePowerChangeRate	inherited from: GeneratingUnit
startupCost	Money	inherited from: GeneratingUnit
startupTime	Seconds	inherited from: GeneratingUnit
stepChange	ActivePower	inherited from: GeneratingUnit
tieLinePF	Float	inherited from: GeneratingUnit
variableCost	Money	inherited from: GeneratingUnit
normallyInService	Boolean	inherited from: Equipment
mRID	String	inherited from: IdentifiedObject
name	String	inherited from: IdentifiedObject
localName	String	inherited from: IdentifiedObject
pathName	String	inherited from: IdentifiedObject
aliasName	String	inherited from: IdentifiedObject
description	String	inherited from: IdentifiedObject

Association ends

Mult from	[Mult] name (type)	note
1	[0..*] ControlAreaGeneratingUnit (ControlAreaGeneratingUnit)	inherited from: GeneratingUnit
1	[0..*] GenUnitOpCostCurves (GenUnitOpCostCurve)	inherited from: GeneratingUnit
1	[0..1] GenUnitOpSchedule (GenUnitOpSchedule)	inherited from: GeneratingUnit
1	[0..*] GrossToNetActivePowerCurves (GrossToNetActivePowerCurve)	inherited from: GeneratingUnit
0..1	[1..*] Contains_SynchronousMachines (SynchronousMachine)	inherited from: GeneratingUnit
1	[0..*] ContingencyEquipment (ContingencyEquipment)	inherited from: Equipment
0..*	[0..1] MemberOf_EquipmentContainer (EquipmentContainer)	inherited from: Equipment
1	[0..*] OperationalLimitSet (OperationalLimitSet)	inherited from: Equipment
0..*	[0..*] OperatedBy_Companies (Company)	inherited from: PowerSystemResource
1	[0..*] Contains_Measurements (Measurement)	inherited from: PowerSystemResource
1	[0..*] OperatingShare (OperatingShare)	inherited from: PowerSystemResource

Mult from	[Mult] name (type)	note
1	[0..1] OutageSchedule (OutageSchedule)	inherited from: PowerSystemResource
0..*	[0..*] PsrLists (PsrList)	inherited from: PowerSystemResource
0..*	[0..1] PSRType (PSRType)	inherited from: PowerSystemResource
0..*	[0..*] ReportingGroup (ReportingGroup)	inherited from: PowerSystemResource
1..*	[0..1] ModelingAuthoritySet (ModelingAuthoritySet)	inherited from: IdentifiedObject

6.8.37 PenstockLossCurve

Relationship between penstock head loss (in meters) and total discharge through the penstock (in cubic meters per second). One or more turbines may be connected to the same penstock.

Attributes

name	type	note
curveStyle	CurveStyle	inherited from: Curve
xUnit	UnitSymbol	inherited from: Curve
xMultiplier	UnitMultiplier	inherited from: Curve
y1Unit	UnitSymbol	inherited from: Curve
y1Multiplier	UnitMultiplier	inherited from: Curve
y2Unit	UnitSymbol	inherited from: Curve
y2Multiplier	UnitMultiplier	inherited from: Curve
mRID	String	inherited from: IdentifiedObject
name	String	inherited from: IdentifiedObject
localName	String	inherited from: IdentifiedObject
pathName	String	inherited from: IdentifiedObject
aliasName	String	inherited from: IdentifiedObject
description	String	inherited from: IdentifiedObject

Association ends

Mult from	[Mult] name (type)	note
0..1	[1] HydroGeneratingUnit (HydroGeneratingUnit)	A hydro generating unit has a penstock loss curve.
1	[0..*] CurveScheduleDatas (CurveData)	inherited from: Curve
1..*	[0..1] ModelingAuthoritySet (ModelingAuthoritySet)	inherited from: IdentifiedObject

6.8.38 PenstockType enumeration

Type of hydro plant penstock.

6.8.39 Reservoir

A water storage facility within a hydro system, including: ponds, lakes, lagoons, and rivers. The storage is usually behind some type of dam.

Attributes

name	type	note
activeStorageCapacity	Volume	Storage volume between the full supply level and the normal minimum operating level.
energyStorageRating	Float	The reservoir's energy storage rating in energy for given head conditions.
fullSupplyLevel	WaterLevel	Full supply level, above which water will spill. This can be the spillway crest level or the top of closed gates.
grossCapacity	Volume	Total capacity of reservoir.
normalMinOperateLevel	WaterLevel	Normal minimum operating level below which the penstocks will draw air.
riverOutletWorks	String	River outlet works for riparian right releases or other purposes.
spillTravelDelay	Seconds	The spillway water travel delay to the next downstream reservoir.

name	type	note
spillwayCapacity	Float	The flow capacity of the spillway in cubic meters per second.
spillwayCrestLength	Float	The length of the spillway crest in meters.
spillwayCrestLevel	WaterLevel	Spillway crest level above which water will spill.
spillWayGateType	SpillwayGateType	Type of spillway gate, including parameters.
mRID	String	inherited from: IdentifiedObject
name	String	inherited from: IdentifiedObject
localName	String	inherited from: IdentifiedObject
pathName	String	inherited from: IdentifiedObject
aliasName	String	inherited from: IdentifiedObject
description	String	inherited from: IdentifiedObject

Association ends

Mult from	[Mult] name (type)	note
0..1	[0..*] HydroPowerPlants (HydroPowerPlant)	Generators discharge water to or pumps are supplied water from a downstream reservoir.
1	[0..*] UpstreamFrom (HydroPowerPlant)	Generators are supplied water from or pumps discharge water to an upstream reservoir.
1	[0..*] InflowForecast (InflowForecast)	A reservoir may have a "natural" inflow forecast.
1	[0..*] LevelVsVolumeCurve (LevelVsVolumeCurve)	A reservoir may have a level versus volume relationship.
0..1	[0..*] SpillsInto (Reservoir)	A reservoir may spill into a downstream reservoir
1	[0..1] TargetLevelSchedule (TargetLevelSchedule)	A reservoir may have a water level target schedule.
0..*	[0..*] OperatedBy_Companies (Company)	inherited from: PowerSystemResource
1	[0..*] Contains_Measurements (Measurement)	inherited from: PowerSystemResource
1	[0..*] OperatingShare (OperatingShare)	inherited from: PowerSystemResource
1	[0..1] OutageSchedule (OutageSchedule)	inherited from: PowerSystemResource

Mult from	[Mult] name (type)	note
0..*	[0..*] PsrLists (PsrList)	inherited from: PowerSystemResource
0..*	[0..1] PSRTtype (PSRTtype)	inherited from: PowerSystemResource
0..*	[0..*] ReportingGroup (ReportingGroup)	inherited from: PowerSystemResource
1..*	[0..1] ModelingAuthoritySet (ModelingAuthoritySet)	inherited from: IdentifiedObject

6.8.40 ShutdownCurve

Relationship between the rate in gross active power/minute (Y-axis) at which a unit should be shutdown and its present gross MW output (X-axis).

Attributes

name	type	note
shutdownCost	Money	Fixed shutdown cost
shutdownDate	AbsoluteDateTime	The date and time of the most recent generating unit shutdown
curveStyle	CurveStyle	inherited from: Curve

name	type	note
xUnit	UnitSymbol	inherited from: Curve
xMultiplier	UnitMultiplier	inherited from: Curve
y1Unit	UnitSymbol	inherited from: Curve
y1Multiplier	UnitMultiplier	inherited from: Curve
y2Unit	UnitSymbol	inherited from: Curve
y2Multiplier	UnitMultiplier	inherited from: Curve
mRID	String	inherited from: IdentifiedObject
name	String	inherited from: IdentifiedObject
localName	String	inherited from: IdentifiedObject
pathName	String	inherited from: IdentifiedObject
aliasName	String	inherited from: IdentifiedObject
description	String	inherited from: IdentifiedObject

Association ends

Mult from	[Mult] name (type)	note
0..1	[1] ThermalGeneratingUnit (ThermalGeneratingUnit)	A thermal generating unit may have a shutdown curve.
1	[0..*] CurveScheduleDatas (CurveData)	inherited from: Curve
1..*	[0..1] ModelingAuthoritySet (ModelingAuthoritySet)	inherited from: IdentifiedObject

6.8.41 SpillwayGateType Enumeration

Type of spillway gate.

6.8.42 StartIgnFuelCurve

The quantity of ignition fuel (Y-axis) used to restart and repay the auxiliary power consumed versus the number of hours (X-axis) the unit was off line.

Attributes

name	type	note
ignitionFuelType	FuelType	Type of ignition fuel
curveStyle	CurveStyle	inherited from: Curve
xUnit	UnitSymbol	inherited from: Curve
xMultiplier	UnitMultiplier	inherited from: Curve
y1Unit	UnitSymbol	inherited from: Curve
y1Multiplier	UnitMultiplier	inherited from: Curve
y2Unit	UnitSymbol	inherited from: Curve
y2Multiplier	UnitMultiplier	inherited from: Curve
mRID	String	inherited from: IdentifiedObject
name	String	inherited from: IdentifiedObject
localName	String	inherited from: IdentifiedObject
pathName	String	inherited from: IdentifiedObject
aliasName	String	inherited from: IdentifiedObject
description	String	inherited from: IdentifiedObject

Association ends

Mult from	[Mult] name (type)	note
0..1	[1] StartupModel (StartupModel)	The unit's startup model may have a startup ignition fuel curve.
1	[0..*] CurveScheduleDatas (CurveData)	inherited from: Curve
1..*	[0..1] ModelingAuthoritySet (ModelingAuthoritySet)	inherited from: IdentifiedObject

6.8.43 StartMainFuelCurve

The quantity of main fuel (Y-axis) used to restart and repay the auxiliary power consumed versus the number of hours (X-axis) the unit was off line.

Attributes

name	type	note
mainFuelType	FuelType	Type of main fuel
curveStyle	CurveStyle	inherited from: Curve
xUnit	UnitSymbol	inherited from: Curve
xMultiplier	UnitMultiplier	inherited from: Curve
y1Unit	UnitSymbol	inherited from: Curve
y1Multiplier	UnitMultiplier	inherited from: Curve
y2Unit	UnitSymbol	inherited from: Curve
y2Multiplier	UnitMultiplier	inherited from: Curve
mRID	String	inherited from: IdentifiedObject
name	String	inherited from: IdentifiedObject
localName	String	inherited from: IdentifiedObject
pathName	String	inherited from: IdentifiedObject
aliasName	String	inherited from: IdentifiedObject
description	String	inherited from: IdentifiedObject

Association ends

Mult from	[Mult] name (type)	note
0..1	[1] StartupModel (StartupModel)	The unit's startup model may have a startup main fuel curve.
1	[0..*] CurveScheduleDatas (CurveData)	inherited from: Curve
1..*	[0..1] ModelingAuthoritySet (ModelingAuthoritySet)	inherited from: IdentifiedObject

6.8.44 StartRampCurve

Rate in gross active power/minute (Y-axis) at which a unit can be loaded versus the number of hours (X-axis) the unit was off line.

Attributes

name	type	note
hotStandbyRamp	ActivePowerChangeRate	The startup ramp rate in gross for a unit that is on hot standby
curveStyle	CurveStyle	inherited from: Curve
xUnit	UnitSymbol	inherited from: Curve
xMultiplier	UnitMultiplier	inherited from: Curve
y1Unit	UnitSymbol	inherited from: Curve
y1Multiplier	UnitMultiplier	inherited from: Curve
y2Unit	UnitSymbol	inherited from: Curve
y2Multiplier	UnitMultiplier	inherited from: Curve
mRID	String	inherited from: IdentifiedObject
name	String	inherited from: IdentifiedObject
localName	String	inherited from: IdentifiedObject
pathName	String	inherited from: IdentifiedObject
aliasName	String	inherited from: IdentifiedObject
description	String	inherited from: IdentifiedObject

Association ends

Mult from	[Mult] name (type)	note
0..1	[1] StartupModel (StartupModel)	The unit's startup model may have a startup ramp curve
1	[0..*] CurveScheduleDatas (CurveData)	inherited from: Curve
1..*	[0..1] ModelingAuthoritySet (ModelingAuthoritySet)	inherited from: IdentifiedObject

6.8.45 StartupModel

Unit start up characteristics depending on how long the unit has been off line.

Attributes

name	type	note
fixedMaintCost	CostRate	Fixed maintenance cost
hotStandbyHeat	HeatRate	The amount of heat input per time unit required for hot standby operation.
incrementalMaintCost	CostPerEnergyUnit	Incremental maintenance cost.

minimumDowntime	Hours	The minimum number of hours the unit must be down before restart.
minimumRunTime	Hours	The minimum number of hours the unit must be operating before being allowed to shut down.
riskFactorCost	Money	The opportunity cost associated with the return in monetary unit. This represents the restart's "share" of the unit depreciation and risk of an event which would damage the unit.
startupCost	Money	Total miscellaneous start up costs.
startupDate	AbsoluteDateTime	The date and time of the most recent generating unit startup.
startupPriority	Integer	Startup priority within control area where lower numbers indicate higher priorities. More than one unit in an area may be assigned the same priority.
stbyAuxP	ActivePower	The unit's auxiliary active power consumption to maintain standby mode.
mRID	String	inherited from: IdentifiedObject
name	String	inherited from: IdentifiedObject
localName	String	inherited from: IdentifiedObject
pathName	String	inherited from: IdentifiedObject
aliasName	String	inherited from: IdentifiedObject
description	String	inherited from: IdentifiedObject

Association ends

Mult from	[Mult] name (type)	note
1	[0..1] StartIgnFuelCurve (StartIgnFuelCurve)	The unit's startup model may have a startup ignition fuel curve.
1	[0..1] StartMainFuelCurve (StartMainFuelCurve)	The unit's startup model may have a startup main fuel curve.
1	[0..1] StartRampCurve (StartRampCurve)	The unit's startup model may have a startup ramp curve.
0..1	[1] ThermalGeneratingUnit (ThermalGeneratingUnit)	A thermal generating unit may have a startup model.
1..*	[0..1] ModelingAuthoritySet (ModelingAuthoritySet)	inherited from: IdentifiedObject

6.8.46 SteamSendoutSchedule

The cogeneration plant's steam sendout schedule in volume per time unit.

Attributes

name	type	note
timeStep	Seconds	inherited from: RegularIntervalSchedule
endTime	AbsoluteDateTime	inherited from: RegularIntervalSchedule
startTime	AbsoluteDateTime	inherited from: BasicIntervalSchedule
value1Unit	UnitSymbol	inherited from: BasicIntervalSchedule
value1Multiplier	UnitMultiplier	inherited from: BasicIntervalSchedule
value2Unit	UnitSymbol	inherited from: BasicIntervalSchedule
value2Multiplier	UnitMultiplier	inherited from: BasicIntervalSchedule
mRID	String	inherited from: IdentifiedObject
name	String	inherited from: IdentifiedObject

name	type	note
localName	String	inherited from: IdentifiedObject
pathName	String	inherited from: IdentifiedObject
aliasName	String	inherited from: IdentifiedObject
description	String	inherited from: IdentifiedObject

Association ends

Mult from	[Mult] name (type)	note
1	[1] CogenerationPlant (CogenerationPlant)	A cogeneration plant has a steam sendout schedule
1	[1..*] TimePoints (RegularTimePoint)	inherited from: RegularIntervalSchedule
1..*	[0..1] ModelingAuthoritySet (ModelingAuthoritySet)	inherited from: IdentifiedObject

6.8.47 SurgeTankCode enumeration

Type (or absence) of surge tank that is associated with the hydro power plant.

6.8.48 TailbayLossCurve

Relationship between tailbay head loss height (y-axis) and the total discharge into the power station's tailbay volume per time unit (x-axis) . There could be more than one curve depending on the level of the tailbay reservoir or river level.

Attributes

name	type	note
curveStyle	CurveStyle	inherited from: Curve
xUnit	UnitSymbol	inherited from: Curve
xMultiplier	UnitMultiplier	inherited from: Curve
y1Unit	UnitSymbol	inherited from: Curve
y1Multiplier	UnitMultiplier	inherited from: Curve
y2Unit	UnitSymbol	inherited from: Curve
y2Multiplier	UnitMultiplier	inherited from: Curve
mRID	String	inherited from: IdentifiedObject
name	String	inherited from: IdentifiedObject
localName	String	inherited from: IdentifiedObject
pathName	String	inherited from: IdentifiedObject
aliasName	String	inherited from: IdentifiedObject
description	String	inherited from: IdentifiedObject

Association ends

Mult from	[Mult] name (type)	note
0..*	[1] HydroGeneratingUnit (HydroGeneratingUnit)	A hydro generating unit has a tailbay loss curve.
1	[0..*] CurveScheduleDatas (CurveData)	inherited from: Curve
1..*	[0..1] ModelingAuthoritySet (ModelingAuthoritySet)	inherited from: IdentifiedObject

6.8.49 TargetLevelSchedule

Reservoir water level targets from advanced studies or "rule curves". Typically in 1 h increments for up to 10 days.

Attributes

name	type	note
highLevelLimit	WaterLevel	High target level limit, above which the reservoir operation will be penalized
lowLevelLimit	WaterLevel	Low target level limit, below which the reservoir operation will be penalized
curveStyle	CurveStyle	inherited from: Curve
xUnit	UnitSymbol	inherited from: Curve
xMultiplier	UnitMultiplier	inherited from: Curve
y1Unit	UnitSymbol	inherited from: Curve
y1Multiplier	UnitMultiplier	inherited from: Curve
y2Unit	UnitSymbol	inherited from: Curve
y2Multiplier	UnitMultiplier	inherited from: Curve
mRID	String	inherited from: IdentifiedObject
name	String	inherited from: IdentifiedObject
localName	String	inherited from: IdentifiedObject
pathName	String	inherited from: IdentifiedObject
aliasName	String	inherited from: IdentifiedObject
description	String	inherited from: IdentifiedObject

Association ends

Mult from	[Mult] name (type)	note
0..1	[1] Reservoir (Reservoir)	A reservoir may have a water level target schedule.
1	[0..*] CurveScheduleDatas (CurveData)	inherited from: Curve
1..*	[0..1] ModelingAuthoritySet (ModelingAuthoritySet)	inherited from: IdentifiedObject

6.8.50 ThermalGeneratingUnit

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

Attributes

name	type	note
oMCost	CostPerHeatUnit	Operating and maintenance cost for the thermal unit
allocSpinResP	ActivePower	inherited from: GeneratingUnit
autoCntrlMarginP	ActivePower	inherited from: GeneratingUnit
baseP	ActivePower	inherited from: GeneratingUnit
controlDeadband	ActivePower	inherited from: GeneratingUnit
controlPulseHigh	Seconds	inherited from: GeneratingUnit
controlPulseLow	Seconds	inherited from: GeneratingUnit
controlResponseRate	ActivePowerChangeRate	inherited from: GeneratingUnit

name	type	note
dispReserveFlag	Boolean	inherited from: GeneratingUnit
efficiency	PU	inherited from: GeneratingUnit
energyMinP	HeatRate	inherited from: GeneratingUnit
fastStartFlag	Boolean	inherited from: GeneratingUnit
fuelPriority	Integer	inherited from: GeneratingUnit
genControlMode	GeneratorControlMode	inherited from: GeneratingUnit
genControlSource	GeneratorControlSource	inherited from: GeneratingUnit
genOperatingMode	GeneratorOperatingMode	inherited from: GeneratingUnit
governorMPL	PU	inherited from: GeneratingUnit
governorSCD	PerCent	inherited from: GeneratingUnit
highControlLimit	ActivePower	inherited from: GeneratingUnit
initialP	ActivePower	inherited from: GeneratingUnit
longPF	Float	inherited from: GeneratingUnit
lowControlLimit	ActivePower	inherited from: GeneratingUnit
lowerRampRate	ActivePowerChangeRate	inherited from: GeneratingUnit
maxEconomicP	ActivePower	inherited from: GeneratingUnit
maximumAllowableSpinningReserve	ActivePower	inherited from: GeneratingUnit
maxOperatingP	ActivePower	inherited from: GeneratingUnit
minEconomicP	ActivePower	inherited from: GeneratingUnit
minimumOffTime	Seconds	inherited from: GeneratingUnit
minOperatingP	ActivePower	inherited from: GeneratingUnit
modelDetail	Classification	inherited from: GeneratingUnit
normalPF	Float	inherited from: GeneratingUnit
penaltyFactor	Float	inherited from: GeneratingUnit
raiseRampRate	ActivePowerChangeRate	inherited from: GeneratingUnit
ratedGrossMaxP	ActivePower	inherited from: GeneratingUnit
ratedGrossMinP	ActivePower	inherited from: GeneratingUnit
ratedNetMaxP	ActivePower	inherited from: GeneratingUnit
shortPF	Float	inherited from: GeneratingUnit
spinReserveRamp	ActivePowerChangeRate	inherited from: GeneratingUnit
startupCost	Money	inherited from: GeneratingUnit
startupTime	Seconds	inherited from: GeneratingUnit
stepChange	ActivePower	inherited from: GeneratingUnit
tieLinePF	Float	inherited from: GeneratingUnit
variableCost	Money	inherited from: GeneratingUnit
normallyInService	Boolean	inherited from: Equipment
mRID	String	inherited from: IdentifiedObject
name	String	inherited from: IdentifiedObject
localName	String	inherited from: IdentifiedObject
pathName	String	inherited from: IdentifiedObject
aliasName	String	inherited from: IdentifiedObject
description	String	inherited from: IdentifiedObject

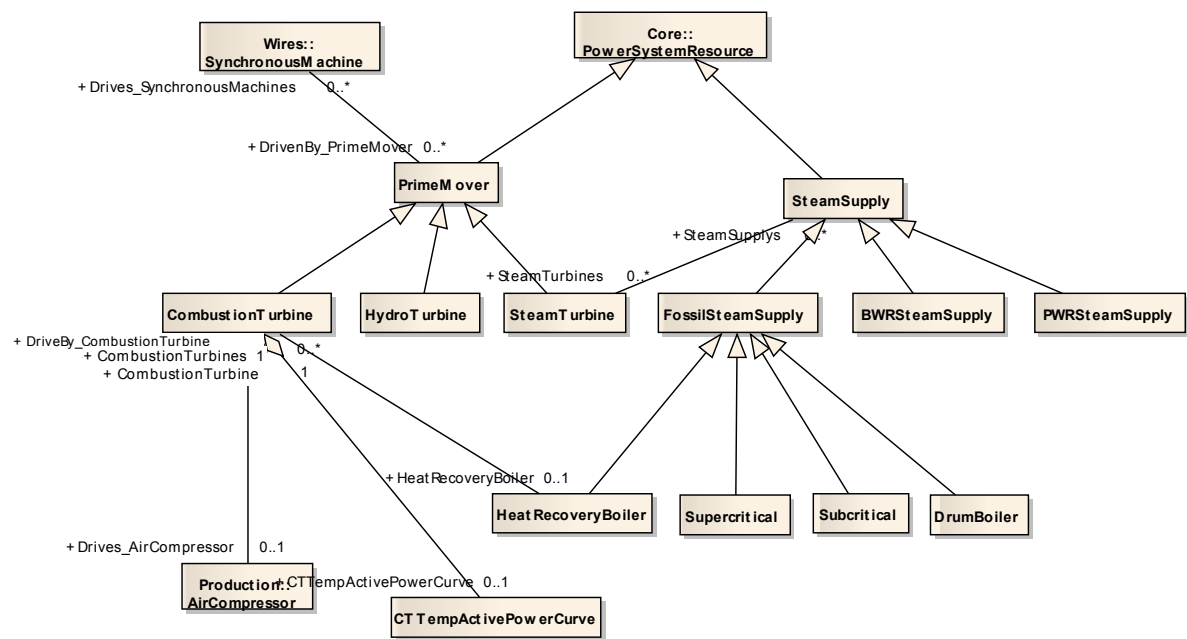
Association ends

Mult from	[Mult] name (type)	note
0..1	[0..1] MemberOf_CAESPlant (CAESPlant)	A thermal generating unit may be a member of a compressed air energy storage plant.
0..*	[0..1] MemberOf_CogenerationPlant (CogenerationPlant)	A thermal generating unit may be a member of a cogeneration plant.
0..*	[0..1] MemberOf_CombinedCyclePlant (CombinedCyclePlant)	A thermal generating unit may be a member of a combined cycle plant.
1	[0..*] EmissionAccounts (EmissionAccount)	A thermal generating unit may have one or more emission allowance accounts.
1	[0..*] EmissionCurves (EmissionCurve)	A thermal generating unit may have one or more emission curves.
1	[0..*] FossilFuels (FossilFuel)	A thermal generating unit may have one or more fossil fuels.
1	[0..*] FuelAllocationSchedules (FuelAllocationSchedule)	A thermal generating unit may have one or more fuel allocation schedules.
1	[0..1] HeatInputCurve (HeatInputCurve)	A thermal generating unit may have a heat input curve.
1	[0..1] HeatRateCurve (HeatRateCurve)	A thermal generating unit may have a heat rate curve.
1	[0..1] IncrementalHeatRateCurve (IncrementalHeatRateCurve)	A thermal generating unit may have an incremental heat rate curve.
1	[0..1] ShutdownCurve (ShutdownCurve)	A thermal generating unit may have a shutdown curve.
1	[0..1] StartupModel (StartupModel)	A thermal generating unit may have a startup model.
1	[0..*] ControlAreaGeneratingUnit (ControlAreaGeneratingUnit)	inherited from: GeneratingUnit
1	[0..*] GenUnitOpCostCurves (GenUnitOpCostCurve)	inherited from: GeneratingUnit
1	[0..1] GenUnitOpSchedule (GenUnitOpSchedule)	inherited from: GeneratingUnit
1	[0..*] GrossToNetActivePowerCurves (GrossToNetActivePowerCurve)	inherited from: GeneratingUnit
0..1	[1..*] Contains_SynchronousMachines (SynchronousMachine)	inherited from: GeneratingUnit
1	[0..*] ContingencyEquipment (ContingencyEquipment)	inherited from: Equipment
0..*	[0..1] MemberOf_EquipmentContainer (EquipmentContainer)	inherited from: Equipment
1	[0..*] OperationalLimitSet (OperationalLimitSet)	inherited from: Equipment
0..*	[0..*] OperatedBy_Companies (Company)	inherited from: PowerSystemResource
1	[0..*] Contains_Measurements (Measurement)	inherited from: PowerSystemResource
1	[0..*] OperatingShare (OperatingShare)	inherited from: PowerSystemResource
1	[0..1] OutageSchedule (OutageSchedule)	inherited from: PowerSystemResource
0..*	[0..*] PsrLists (PsrList)	inherited from: PowerSystemResource
0..*	[0..1] PSRTType (PSRTType)	inherited from: PowerSystemResource
0..*	[0..*] ReportingGroup (ReportingGroup)	inherited from: PowerSystemResource
1..*	[0..1] ModelingAuthoritySet (ModelingAuthoritySet)	inherited from: IdentifiedObject

6.9 GenerationDynamics

6.9.1 GenerationDynamics package summary

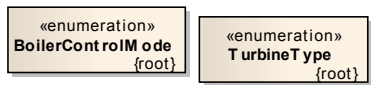
The Generation Dynamics package contains prime movers, such as turbines and boilers, which are needed for simulation and educational purposes.



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Figure 52 – Main

Figure 52 is documented as follows. This diagram shows all classes included in the GenerationDynamics package as well as the key external classes that have associations with GenerationDynamics classes.



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Figure 53 – Datatypes

Figure 53 is documented as follows. This diagram shows the data types specific to the GenerationDynamics package.

6.9.2 BoilerControlMode enumeration

Boiler control mode.

Enums

name	note
following	
coordinated	

6.9.3 BWRSteamSupply

Boiling water reactor used as a steam supply to a steam turbine.

Attributes

name	type	note
highPowerLimit	PU	High power limit
inCoreThermalTC	Seconds	In-core thermal time constant

name	type	note
integralGain	Float	Integral gain
lowerLimit	PU	Initial lower limit
lowPowerLimit	PU	Low power limit
pressureLimit	PU	Pressure limit
pressureSetpointGA	Float	Pressure setpoint gain adjuster
pressureSetpointTC1	Seconds	Pressure setpoint time constant
pressureSetpointTC2	Seconds	Pressure setpoint time constant
proportionalGain	Float	Proportional gain
rfAux1	PU	Coefficient for modeling the effect of off-nominal frequency and voltage on recirculation and core flow, which affects the BWR power output
rfAux2	PU	Coefficient for modeling the effect of off-nominal frequency and voltage on recirculation and core flow, which affects the BWR power output
rfAux3	PU	Coefficient for modeling the effect of off-nominal frequency and voltage on recirculation and core flow, which affects the BWR power output
rfAux4	PU	Coefficient for modeling the effect of off-nominal frequency and voltage on recirculation and core flow, which affects the BWR power output
rfAux5	PU	Coefficient for modeling the effect of off-nominal frequency and voltage on recirculation and core flow, which affects the BWR power output
rfAux6	PU	Coefficient for modeling the effect of off-nominal frequency and voltage on recirculation and core flow, which affects the BWR power output
rfAux7	PU	Coefficient for modeling the effect of off-nominal frequency and voltage on recirculation and core flow, which affects the BWR power output
rfAux8	PU	Coefficient for modeling the effect of off-nominal frequency and voltage on recirculation and core flow, which affects the BWR power output
rodPattern	PU	Rod pattern
rodPatternConstant	Float	Constant associated with rod pattern
upperLimit	PU	Initial upper limit
steamSupplyRating	Float	inherited from: SteamSupply
mRID	String	inherited from: IdentifiedObject
name	String	inherited from: IdentifiedObject
localName	String	inherited from: IdentifiedObject
pathName	String	inherited from: IdentifiedObject
aliasName	String	inherited from: IdentifiedObject
description	String	inherited from: IdentifiedObject

Association ends

Mult from	[Mult] name (type)	note
0..*	[0..*] SteamTurbines (SteamTurbine)	inherited from: SteamSupply
0..*	[0..*] OperatedBy_Companies (Company)	inherited from: PowerSystemResource
1	[0..*] Contains_Measurements (Measurement)	inherited from: PowerSystemResource
1	[0..*] OperatingShare (OperatingShare)	inherited from: PowerSystemResource

1	[0..1] OutageSchedule (OutageSchedule)	inherited from: PowerSystemResource
0..*	[0..*] PsrLists (PsrList)	inherited from: PowerSystemResource
0..*	[0..1] PSRType (PSRType)	inherited from: PowerSystemResource
0..*	[0..*] ReportingGroup (ReportingGroup)	inherited from: PowerSystemResource
1..*	[0..1] ModelingAuthoritySet (ModelingAuthoritySet)	inherited from: IdentifiedObject

6.9.4 CombustionTurbine

A prime mover that is typically fueled by gas or light oil.

Attributes

name	type	note
ambientTemp	Temperature	Default ambient temperature to be used in modeling applications
auxPowerVersusFrequency	PU	Off-nominal frequency effect on turbine auxiliaries. Per unit reduction in auxiliary active power consumption versus per unit reduction in frequency (from rated frequency)
auxPowerVersusVoltage	PU	Off-nominal voltage effect on turbine auxiliaries. Per unit reduction in auxiliary active power consumption versus per unit reduction in auxiliary bus voltage (from a specified voltage level)
capabilityVersusFrequency	PU	Off-nominal frequency effect on turbine capability. Per unit reduction in unit active power capability versus per unit reduction in frequency (from rated frequency)
heatRecoveryFlag	Boolean	Flag that is set to true if the combustion turbine is associated with a heat recovery boiler
powerVariationByTemp	PU	Per unit change in power per (versus) unit change in ambient temperature
referenceTemp	Temperature	Reference temperature at which the output of the turbine was defined
timeConstant	Seconds	The time constant for the turbine
primeMoverRating	Float	inherited from: PrimeMover
mRID	String	inherited from: IdentifiedObject
name	String	inherited from: IdentifiedObject
localName	String	inherited from: IdentifiedObject
pathName	String	inherited from: IdentifiedObject
aliasName	String	inherited from: IdentifiedObject
description	String	inherited from: IdentifiedObject

Association ends

Mult from	[Mult] name (type)	note
1	[0..1] Drives_AirCompressor (AirCompressor)	A CAES air compressor is driven by combustion turbine.
1	[0..1] CTTempActivePowerCurve (CTTempActivePowerCurve)	A combustion turbine may have an active power versus ambient temperature relationship.
0..*	[0..1] HeatRecoveryBoiler (HeatRecoveryBoiler)	A combustion turbine may have a heat recovery boiler for making steam.
0..*	[0..*] Drives_SynchronousMachines (SynchronousMachine)	inherited from: PrimeMover
0..*	[0..*] OperatedBy_Companies (Company)	inherited from: PowerSystemResource

1	[0..*] Contains_Measurements (Measurement)	inherited from: PowerSystemResource
1	[0..*] OperatingShare (OperatingShare)	inherited from: PowerSystemResource
1	[0..1] OutageSchedule (OutageSchedule)	inherited from: PowerSystemResource
0..*	[0..*] PsrLists (PsrList)	inherited from: PowerSystemResource
0..*	[0..1] PSRTYPE (PSRTYPE)	inherited from: PowerSystemResource
0..*	[0..*] ReportingGroup (ReportingGroup)	inherited from: PowerSystemResource
1..*	[0..1] ModelingAuthoritySet (ModelingAuthoritySet)	inherited from: IdentifiedObject

6.9.5 CTTempActivePowerCurve

Relationship between the combustion turbine's power output rating in gross active power (X-axis) and the ambient air temperature (Y-axis).

Attributes

name	type	note
curveStyle	CurveStyle	inherited from: Curve
xUnit	UnitSymbol	inherited from: Curve
xMultiplier	UnitMultiplier	inherited from: Curve
y1Unit	UnitSymbol	inherited from: Curve
y1Multiplier	UnitMultiplier	inherited from: Curve
y2Unit	UnitSymbol	inherited from: Curve
y2Multiplier	UnitMultiplier	inherited from: Curve
mRID	String	inherited from: IdentifiedObject
name	String	inherited from: IdentifiedObject
localName	String	inherited from: IdentifiedObject
pathName	String	inherited from: IdentifiedObject
aliasName	String	inherited from: IdentifiedObject
description	String	inherited from: IdentifiedObject

Association ends

Mult from	[Mult] name (type)	note
0..1	[1] CombustionTurbine (CombustionTurbine)	A combustion turbine may have an active power versus ambient temperature relationship.
1	[0..*] CurveScheduleDatas (CurveData)	inherited from: Curve
1..*	[0..1] ModelingAuthoritySet (ModelingAuthoritySet)	inherited from: IdentifiedObject

6.9.6 DrumBoiler

Drum boiler.

Attributes

name	type	note
drumBoilerRating	Float	Rating of drum boiler in steam units
auxPowerVersusFrequency	PU	inherited from: FossilSteamSupply
auxPowerversusVoltage	PU	inherited from: FossilSteamSupply
controlC	Float	inherited from: FossilSteamSupply

name	type	note
boilerControlMode	BoilerControlMode	inherited from: FossilSteamSupply
controlErrorBiasP	Float	inherited from: FossilSteamSupply
controlPC	Float	inherited from: FossilSteamSupply
controlPEB	Float	inherited from: FossilSteamSupply
controlPED	PU	inherited from: FossilSteamSupply
controlTC	Float	inherited from: FossilSteamSupply
feedWaterIG	Float	inherited from: FossilSteamSupply
feedWaterPG	Float	inherited from: FossilSteamSupply
feedWaterTC	Seconds	inherited from: FossilSteamSupply
fuelDemandLimit	PU	inherited from: FossilSteamSupply
fuelSupplyDelay	Seconds	inherited from: FossilSteamSupply
mechPowerSensorLag	Seconds	inherited from: FossilSteamSupply
fuelSupplyTC	Seconds	inherited from: FossilSteamSupply
maxErrorRateP	Float	inherited from: FossilSteamSupply
minErrorRateP	Float	inherited from: FossilSteamSupply
pressureCtrlIDG	Float	inherited from: FossilSteamSupply
pressureCtrlIG	Float	inherited from: FossilSteamSupply
pressureCtrlPG	Float	inherited from: FossilSteamSupply
pressureFeedback	Integer	inherited from: FossilSteamSupply
superHeater1Capacity	Float	inherited from: FossilSteamSupply
superHeater2Capacity	Float	inherited from: FossilSteamSupply
superHeaterPipePD	Float	inherited from: FossilSteamSupply
throttlePressureSP	PU	inherited from: FossilSteamSupply
steamSupplyRating	Float	inherited from: SteamSupply
mRID	String	inherited from: IdentifiedObject
name	String	inherited from: IdentifiedObject
localName	String	inherited from: IdentifiedObject
pathName	String	inherited from: IdentifiedObject
aliasName	String	inherited from: IdentifiedObject
description	String	inherited from: IdentifiedObject

Association ends

Mult from	[Mult] name (type)	note
0..*	[0..*] SteamTurbines (SteamTurbine)	inherited from: SteamSupply
0..*	[0..*] OperatedBy_Companies (Company)	inherited from: PowerSystemResource
1	[0..*] Contains_Measurements (Measurement)	inherited from: PowerSystemResource
1	[0..*] OperatingShare (OperatingShare)	inherited from: PowerSystemResource
1	[0..1] OutageSchedule (OutageSchedule)	inherited from: PowerSystemResource
0..*	[0..*] PsrLists (PsrList)	inherited from: PowerSystemResource
0..*	[0..1] PSRTtype (PSRTtype)	inherited from: PowerSystemResource
0..*	[0..*] ReportingGroup (ReportingGroup)	inherited from: PowerSystemResource
1..*	[0..1] ModelingAuthoritySet (ModelingAuthoritySet)	inherited from: IdentifiedObject

6.9.7 FossilSteamSupply

Fossil fueled boiler (e.g., coal, oil, gas).

Attributes

name	type	note
auxPowerVersusFrequency	PU	Off-nominal frequency effect on auxiliary real power. Per unit active power variation versus per unit frequency variation.
auxPowerversusVoltage	PU	Off-nominal voltage effect on auxiliary real power. Per unit active power variation versus per unit voltage variation.
controlIC	Float	Integral constant
boilerControlMode	BoilerControlMode	The control mode of the boiler
controlErrorBiasP	Float	Active power error bias ratio
controlPC	Float	Proportional constant
controlPEB	Float	Pressure error bias ratio
controlPED	PU	Pressure error deadband
controlTC	Float	Time constant
feedWaterIG	Float	Feedwater integral gain ratio
feedWaterPG	Float	Feedwater proportional gain ratio
feedWaterTC	Seconds	Feedwater time constant ratio
fuelDemandLimit	PU	Fuel demand limit
fuelSupplyDelay	Seconds	Fuel delay
mechPowerSensorLag	Seconds	Mechanical power sensor lag
fuelSupplyTC	Seconds	Fuel supply time constant
maxErrorRateP	Float	Active power maximum error rate limit
minErrorRateP	Float	Active power minimum error rate limit
pressureCtrlDG	Float	Pressure control derivative gain ratio
pressureCtrlIG	Float	Pressure control integral gain ratio
pressureCtrlPG	Float	Pressure control proportional gain ratio
pressureFeedback	Integer	Pressure feedback indicator
superHeater1Capacity	Float	Drum/primary superheater capacity
superHeater2Capacity	Float	Secondary superheater capacity
superHeaterPipePD	Float	Superheater pipe pressure drop constant
throttlePressureSP	PU	Throttle pressure setpoint
steamSupplyRating	Float	inherited from: SteamSupply
mRID	String	inherited from: IdentifiedObject
name	String	inherited from: IdentifiedObject
localName	String	inherited from: IdentifiedObject
pathName	String	inherited from: IdentifiedObject
aliasName	String	inherited from: IdentifiedObject
description	String	inherited from: IdentifiedObject

Association ends

Mult from	[Mult] name (type)	note
0..*	[0..*] SteamTurbines (SteamTurbine)	inherited from: SteamSupply
0..*	[0..*] OperatedBy_Companies (Company)	inherited from: PowerSystemResource
1	[0..*] Contains_Measurements (Measurement)	inherited from: PowerSystemResource
1	[0..*] OperatingShare (OperatingShare)	inherited from: PowerSystemResource
1	[0..1] OutageSchedule (OutageSchedule)	inherited from: PowerSystemResource
0..*	[0..*] PsrLists (PsrList)	inherited from: PowerSystemResource
0..*	[0..1] PSRTtype (PSRTtype)	inherited from: PowerSystemResource
0..*	[0..*] ReportingGroup (ReportingGroup)	inherited from: PowerSystemResource
1..*	[0..1] ModelingAuthoritySet (ModelingAuthoritySet)	inherited from: IdentifiedObject

6.9.8 HeatRecoveryBoiler

The heat recovery system associated with combustion turbines in order to produce steam for combined cycle plants.

Attributes

name	type	note
steamSupplyRating2	Float	The steam supply rating in kilopounds per hour, if dual pressure boiler
auxPowerVersusFrequency	PU	inherited from: FossilSteamSupply
auxPowerversusVoltage	PU	inherited from: FossilSteamSupply
controlIC	Float	inherited from: FossilSteamSupply
boilerControlMode	BoilerControlMode	inherited from: FossilSteamSupply
controlErrorBiasP	Float	inherited from: FossilSteamSupply
controlPC	Float	inherited from: FossilSteamSupply
controlPEB	Float	inherited from: FossilSteamSupply
controlPED	PU	inherited from: FossilSteamSupply
controlTC	Float	inherited from: FossilSteamSupply
feedWaterIG	Float	inherited from: FossilSteamSupply
feedWaterPG	Float	inherited from: FossilSteamSupply
feedWaterTC	Seconds	inherited from: FossilSteamSupply
fuelDemandLimit	PU	inherited from: FossilSteamSupply
fuelSupplyDelay	Seconds	inherited from: FossilSteamSupply
mechPowerSensorLag	Seconds	inherited from: FossilSteamSupply
fuelSupplyTC	Seconds	inherited from: FossilSteamSupply
maxErrorRateP	Float	inherited from: FossilSteamSupply
minErrorRateP	Float	inherited from: FossilSteamSupply
pressureCtrlDG	Float	inherited from: FossilSteamSupply
pressureCtrlIG	Float	inherited from: FossilSteamSupply
pressureCtrlPG	Float	inherited from: FossilSteamSupply
pressureFeedback	Integer	inherited from: FossilSteamSupply
superHeater1Capacity	Float	inherited from: FossilSteamSupply
superHeater2Capacity	Float	inherited from: FossilSteamSupply

name	type	note
superHeaterPipePD	Float	inherited from: FossilSteamSupply
throttlePressureSP	PU	inherited from: FossilSteamSupply
steamSupplyRating	Float	inherited from: SteamSupply
mRID	String	inherited from: IdentifiedObject
name	String	inherited from: IdentifiedObject
localName	String	inherited from: IdentifiedObject
pathName	String	inherited from: IdentifiedObject
aliasName	String	inherited from: IdentifiedObject
description	String	inherited from: IdentifiedObject

Association ends

Mult from	[Mult] name (type)	note
0..1	[0..*] CombustionTurbines (CombustionTurbine)	A combustion turbine may have a heat recovery boiler for making steam.
0..*	[0..*] SteamTurbines (SteamTurbine)	inherited from: SteamSupply
0..*	[0..*] OperatedBy_Companies (Company)	inherited from: PowerSystemResource
1	[0..*] Contains_Measurements (Measurement)	inherited from: PowerSystemResource
1	[0..*] OperatingShare (OperatingShare)	inherited from: PowerSystemResource
1	[0..1] OutageSchedule (OutageSchedule)	inherited from: PowerSystemResource
0..*	[0..*] PsrLists (PsrList)	inherited from: PowerSystemResource
0..*	[0..1] PSRTYPE (PSRTYPE)	inherited from: PowerSystemResource
0..*	[0..*] ReportingGroup (ReportingGroup)	inherited from: PowerSystemResource
1..*	[0..1] ModelingAuthoritySet (ModelingAuthoritySet)	inherited from: IdentifiedObject

6.9.9 HydroTurbine

A water driven prime mover. Typical turbine types are: Francis, Kaplan, and Pelton.

Attributes

name	type	note
gateRateLimit	Float	Gate rate limit
gateUpperLimit	PU	Gate upper limit
minHeadMaxP	ActivePower	Maximum efficiency active power at minimum head conditions
maxHeadMaxP	ActivePower	Maximum efficiency active power at maximum head conditions
speedRating	RotationSpeed	Rated speed in number of revolutions
speedRegulation	PU	Speed regulation
transientDroopTime	Seconds	Transient droop time constant
transientRegulation	PU	Transient regulation
turbineRating	ActivePower	Rated turbine active power
turbineType	TurbineType	Type of turbine
waterStartingTime	Seconds	Water starting time
primeMoverRating	Float	inherited from: PrimeMover
mRID	String	inherited from: IdentifiedObject

name	type	note
name	String	inherited from: IdentifiedObject
localName	String	inherited from: IdentifiedObject
pathName	String	inherited from: IdentifiedObject
aliasName	String	inherited from: IdentifiedObject
description	String	inherited from: IdentifiedObject

Association ends

Mult from	[Mult] name (type)	note
0..*	[0..*] Drives_SynchronousMachines (SynchronousMachine)	inherited from: PrimeMover
0..*	[0..*] OperatedBy_Companies (Company)	inherited from: PowerSystemResource
1	[0..*] Contains_Measurements (Measurement)	inherited from: PowerSystemResource
1	[0..*] OperatingShare (OperatingShare)	inherited from: PowerSystemResource
1	[0..1] OutageSchedule (OutageSchedule)	inherited from: PowerSystemResource
0..*	[0..*] PsrLists (PsrList)	inherited from: PowerSystemResource
0..*	[0..1] PSRType (PSRType)	inherited from: PowerSystemResource
0..*	[0..*] ReportingGroup (ReportingGroup)	inherited from: PowerSystemResource
1..*	[0..1] ModelingAuthoritySet (ModelingAuthoritySet)	inherited from: IdentifiedObject

6.9.10 PrimeMover

The machine used to develop mechanical energy used to drive a generator.

Attributes

name	type	note
primeMoverRating	Float	Rating of prime mover
mRID	String	inherited from: IdentifiedObject
name	String	inherited from: IdentifiedObject
localName	String	inherited from: IdentifiedObject
pathName	String	inherited from: IdentifiedObject
aliasName	String	inherited from: IdentifiedObject
description	String	inherited from: IdentifiedObject

Association ends

Mult from	[Mult] name (type)	note
0..*	[0..*] Drives_SynchronousMachines (SynchronousMachine)	Synchronous machines this prime mover drives
0..*	[0..*] OperatedBy_Companies (Company)	inherited from: PowerSystemResource
1	[0..*] Contains_Measurements (Measurement)	inherited from: PowerSystemResource
1	[0..*] OperatingShare (OperatingShare)	inherited from: PowerSystemResource
1	[0..1] OutageSchedule (OutageSchedule)	inherited from: PowerSystemResource
0..*	[0..*] PsrLists (PsrList)	inherited from: PowerSystemResource
0..*	[0..1] PSRType (PSRType)	inherited from: PowerSystemResource
0..*	[0..*] ReportingGroup (ReportingGroup)	inherited from: PowerSystemResource

1..*	[0..1] ModelingAuthoritySet (ModelingAuthoritySet)	inherited from: IdentifiedObject
------	--	----------------------------------

6.9.11 PWRSteamSupply

Pressurized water reactor used as a steam supply to a steam turbine.

Attributes

name	type	note
coldLegFBLagTC	PU	Cold leg feedback lag time constant
coldLegFBLeadTC1	PU	Cold leg feedback lead time constant
coldLegFBLeadTC2	PU	Cold leg feedback lead time constant
coldLegFG1	PU	Cold leg feedback Gain 1
coldLegFG2	PU	Cold leg feedback Gain 2
coldLegLagTC	PU	Cold leg lag time constant
coreHTLagTC1	PU	Core heat transfer lag time constant
coreHTLagTC2	PU	Core heat transfer lag time constant
coreNeutronicsEffTC	PU	Core neutronics effective time constant
coreNeutronicsHT	PU	Core neutronics and heat transfer
feedbackFactor	PU	Feedback factor
hotLegLagTC	PU	Hot leg lag time constant
hotLegSteamGain	PU	Hot leg steam gain
hotLegToColdLegGain	PU	Hot leg to cold leg gain
pressureCG	PU	Pressure control gain

name	type	note
steamFlowFG	PU	Steam flow feedback gain
steamPressureDropLagTC	PU	Steam pressure drop lag time constant
steamPressureFG	PU	Steam pressure feedback gain
throttlePressureFactor	PU	Throttle pressure factor
throttlePressureSP	PU	Throttle pressure setpoint
steamSupplyRating	Float	inherited from: SteamSupply
mRID	String	inherited from: IdentifiedObject
name	String	inherited from: IdentifiedObject
localName	String	inherited from: IdentifiedObject
pathName	String	inherited from: IdentifiedObject
aliasName	String	inherited from: IdentifiedObject
description	String	inherited from: IdentifiedObject

Association ends

Mult from	[Mult] name (type)	note
0..*	[0..*] SteamTurbines (SteamTurbine)	inherited from: SteamSupply
0..*	[0..*] OperatedBy_Companies (Company)	inherited from: PowerSystemResource
1	[0..*] Contains_Measurements (Measurement)	inherited from: PowerSystemResource
1	[0..*] OperatingShare (OperatingShare)	inherited from: PowerSystemResource

1	[0..1] OutageSchedule (OutageSchedule)	inherited from: PowerSystemResource
0..*	[0..*] PsrLists (PsrList)	inherited from: PowerSystemResource
0..*	[0..1] PSRTYPE (PSRTYPE)	inherited from: PowerSystemResource
0..*	[0..*] ReportingGroup (ReportingGroup)	inherited from: PowerSystemResource
1..*	[0..1] ModelingAuthoritySet (ModelingAuthoritySet)	inherited from: IdentifiedObject

6.9.12 SteamSupply

Steam supply for steam turbine.

Attributes

name	type	note
steamSupplyRating	Float	Rating of steam supply
mRID	String	inherited from: IdentifiedObject
name	String	inherited from: IdentifiedObject
localName	String	inherited from: IdentifiedObject
pathName	String	inherited from: IdentifiedObject
aliasName	String	inherited from: IdentifiedObject
description	String	inherited from: IdentifiedObject

Association ends

Mult from	[Mult] name (type)	note
0..*	[0..*] SteamTurbines (SteamTurbine)	Steam turbines may have steam supplied by a steam supply.
0..*	[0..*] OperatedBy_Companies (Company)	inherited from: PowerSystemResource
1	[0..*] Contains_Measurements (Measurement)	inherited from: PowerSystemResource
1	[0..*] OperatingShare (OperatingShare)	inherited from: PowerSystemResource
1	[0..1] OutageSchedule (OutageSchedule)	inherited from: PowerSystemResource
0..*	[0..*] PsrLists (PsrList)	inherited from: PowerSystemResource
0..*	[0..1] PSRTYPE (PSRTYPE)	inherited from: PowerSystemResource
0..*	[0..*] ReportingGroup (ReportingGroup)	inherited from: PowerSystemResource
1..*	[0..1] ModelingAuthoritySet (ModelingAuthoritySet)	inherited from: IdentifiedObject

6.9.13 SteamTurbine

Steam turbine.

Attributes

name	type	note
crossoverTC	Seconds	Crossover time constant
reheater1TC	Seconds	First reheater time constant
reheater2TC	Seconds	Second reheater time constant
shaft1PowerHP	Float	Fraction of power from shaft 1 high pressure turbine output
shaft1PowerIP	Float	Fraction of power from shaft 1 intermediate pressure turbine output
shaft1PowerLP1	Float	Fraction of power from shaft 1 first low pressure turbine output

shaft1PowerLP2	Float	Fraction of power from shaft 1 second low pressure turbine output
shaft2PowerHP	Float	Fraction of power from shaft 2 high pressure turbine output
shaft2PowerIP	Float	Fraction of power from shaft 2 intermediate pressure turbine output
shaft2PowerLP1	Float	Fraction of power from shaft 2 first low pressure turbine output
shaft2PowerLP2	Float	Fraction of power from shaft 2 second low pressure turbine output
steamChestTC	Seconds	Steam chest time constant
primeMoverRating	Float	inherited from: PrimeMover
mRID	String	inherited from: IdentifiedObject
name	String	inherited from: IdentifiedObject
localName	String	inherited from: IdentifiedObject
pathName	String	inherited from: IdentifiedObject
aliasName	String	inherited from: IdentifiedObject
description	String	inherited from: IdentifiedObject

Association ends

Mult from	[Mult] name (type)	note
0..*	[0..*] SteamSupplies (SteamSupply)	Steam turbines may have steam supplied by a steam supply.
0..*	[0..*] Drives_SynchronousMachines (SynchronousMachine)	inherited from: PrimeMover
0..*	[0..*] OperatedBy_Companies (Company)	inherited from: PowerSystemResource
1	[0..*] Contains_Measurements (Measurement)	inherited from: PowerSystemResource
1	[0..*] OperatingShare (OperatingShare)	inherited from: PowerSystemResource
1	[0..1] OutageSchedule (OutageSchedule)	inherited from: PowerSystemResource
0..*	[0..*] PsrLists (PsrList)	inherited from: PowerSystemResource
0..*	[0..1] PSRType (PSRType)	inherited from: PowerSystemResource
0..*	[0..*] ReportingGroup (ReportingGroup)	inherited from: PowerSystemResource
1..*	[0..1] ModelingAuthoritySet (ModelingAuthoritySet)	inherited from: IdentifiedObject

6.9.14 Subcritical

Once-through subcritical boiler.

Attributes

name	type	note
auxPowerVersusFrequency	PU	inherited from: FossilSteamSupply
auxPowerVersusVoltage	PU	inherited from: FossilSteamSupply
controlIC	Float	inherited from: FossilSteamSupply
boilerControlMode	BoilerControlMode	inherited from: FossilSteamSupply
controlErrorBiasP	Float	inherited from: FossilSteamSupply
controlPC	Float	inherited from: FossilSteamSupply
controlPEB	Float	inherited from: FossilSteamSupply
controlPED	PU	inherited from: FossilSteamSupply

controlTC	Float	inherited from: FossilSteamSupply
feedWaterIG	Float	inherited from: FossilSteamSupply
feedWaterPG	Float	inherited from: FossilSteamSupply
feedWaterTC	Seconds	inherited from: FossilSteamSupply
fuelDemandLimit	PU	inherited from: FossilSteamSupply
fuelSupplyDelay	Seconds	inherited from: FossilSteamSupply
mechPowerSensorLag	Seconds	inherited from: FossilSteamSupply
fuelSupplyTC	Seconds	inherited from: FossilSteamSupply
maxErrorRateP	Float	inherited from: FossilSteamSupply
minErrorRateP	Float	inherited from: FossilSteamSupply
pressureCtrlIDG	Float	inherited from: FossilSteamSupply
pressureCtrlIG	Float	inherited from: FossilSteamSupply
pressureCtrlPG	Float	inherited from: FossilSteamSupply
pressureFeedback	Integer	inherited from: FossilSteamSupply
superHeater1Capacity	Float	inherited from: FossilSteamSupply
superHeater2Capacity	Float	inherited from: FossilSteamSupply
superHeaterPipePD	Float	inherited from: FossilSteamSupply
throttlePressureSP	PU	inherited from: FossilSteamSupply
steamSupplyRating	Float	inherited from: SteamSupply
mRID	String	inherited from: IdentifiedObject
name	String	inherited from: IdentifiedObject
localName	String	inherited from: IdentifiedObject
pathName	String	inherited from: IdentifiedObject
aliasName	String	inherited from: IdentifiedObject
description	String	inherited from: IdentifiedObject

Association ends

Mult from	[Mult] name (type)	note
0..*	[0..*] SteamTurbines (SteamTurbine)	inherited from: SteamSupply
0..*	[0..*] OperatedBy_Companies (Company)	inherited from: PowerSystemResource
1	[0..*] Contains_Measurements (Measurement)	inherited from: PowerSystemResource
1	[0..*] OperatingShare (OperatingShare)	inherited from: PowerSystemResource
1	[0..1] OutageSchedule (OutageSchedule)	inherited from: PowerSystemResource
0..*	[0..*] PsrLists (PsrList)	inherited from: PowerSystemResource
0..*	[0..1] PSRTYPE (PSRTYPE)	inherited from: PowerSystemResource
0..*	[0..*] ReportingGroup (ReportingGroup)	inherited from: PowerSystemResource
1..*	[0..1] ModelingAuthoritySet (ModelingAuthoritySet)	inherited from: IdentifiedObject

6.9.15 Supercritical

Once-through supercritical boiler.

Attributes

name	type	note
auxPowerVersusFrequency	PU	inherited from: FossilSteamSupply
auxPowerversusVoltage	PU	inherited from: FossilSteamSupply
controlIC	Float	inherited from: FossilSteamSupply
boilerControlMode	BoilerControlMode	inherited from: FossilSteamSupply
controlErrorBiasP	Float	inherited from: FossilSteamSupply
controlPC	Float	inherited from: FossilSteamSupply
controlPEB	Float	inherited from: FossilSteamSupply
controlPED	PU	inherited from: FossilSteamSupply
controlTC	Float	inherited from: FossilSteamSupply
feedWaterIG	Float	inherited from: FossilSteamSupply
feedWaterPG	Float	inherited from: FossilSteamSupply
feedWaterTC	Seconds	inherited from: FossilSteamSupply
fuelDemandLimit	PU	inherited from: FossilSteamSupply
fuelSupplyDelay	Seconds	inherited from: FossilSteamSupply
mechPowerSensorLag	Seconds	inherited from: FossilSteamSupply
fuelSupplyTC	Seconds	inherited from: FossilSteamSupply
maxErrorRateP	Float	inherited from: FossilSteamSupply
minErrorRateP	Float	inherited from: FossilSteamSupply
pressureCtrlDG	Float	inherited from: FossilSteamSupply
pressureCtrlIG	Float	inherited from: FossilSteamSupply
pressureCtrlPG	Float	inherited from: FossilSteamSupply
pressureFeedback	Integer	inherited from: FossilSteamSupply
superHeater1Capacity	Float	inherited from: FossilSteamSupply
superHeater2Capacity	Float	inherited from: FossilSteamSupply
superHeaterPipePD	Float	inherited from: FossilSteamSupply
throttlePressureSP	PU	inherited from: FossilSteamSupply
steamSupplyRating	Float	inherited from: SteamSupply
mRID	String	inherited from: IdentifiedObject
name	String	inherited from: IdentifiedObject
localName	String	inherited from: IdentifiedObject
pathName	String	inherited from: IdentifiedObject
aliasName	String	inherited from: IdentifiedObject
description	String	inherited from: IdentifiedObject

Association ends

Mult from	[Mult] name (type)	note
0..*	[0..*] SteamTurbines (SteamTurbine)	inherited from: SteamSupply
0..*	[0..*] OperatedBy_Companies (Company)	inherited from: PowerSystemResource
1	[0..*] Contains_Measurements (Measurement)	inherited from: PowerSystemResource
1	[0..*] OperatingShare (OperatingShare)	inherited from: PowerSystemResource
1	[0..1] OutageSchedule (OutageSchedule)	inherited from: PowerSystemResource
0..*	[0..*] PsrLists (PsrList)	inherited from: PowerSystemResource
0..*	[0..1] PSRTtype (PSRTtype)	inherited from: PowerSystemResource
0..*	[0..*] ReportingGroup (ReportingGroup)	inherited from: PowerSystemResource
1..*	[0..1] ModelingAuthoritySet (ModelingAuthoritySet)	inherited from: IdentifiedObject

6.9.16 TurbineType enumeration

Type of turbine.

Enums

name	note
francis	
pelton	
kaplan	

6.10 LoadModel

6.10.1 LoadModel package summary

This package is responsible for modeling the energy consumers and the system load as curves and associated curve data. Special circumstances that may affect the load, such as seasons and daytypes, are also included here.

This information is used by Load Forecasting and Load Management.

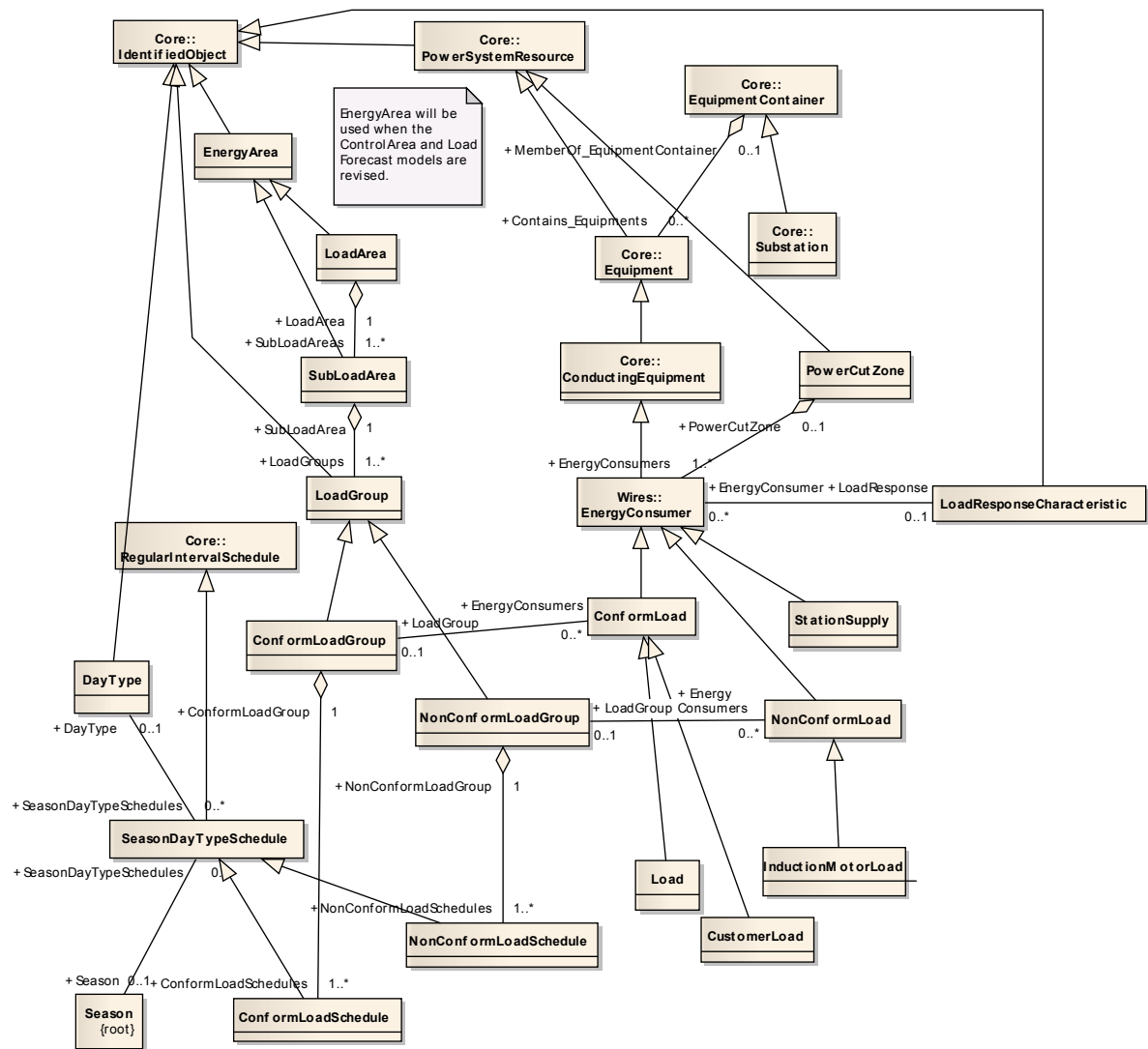


Figure 54 – Main

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Figure 54 is documented as follows. This diagram shows all classes included in the LoadModel package as well as the key external classes that have associations with LoadModel classes.

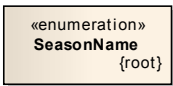


Figure 55 – Datatypes

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Figure 55 is not documented.

6.10.2 ConformLoad

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

Attributes

name	type	note
customerCount	Integer	inherited from: EnergyConsumer
pfixed	ActivePower	inherited from: EnergyConsumer
pfixedPct	PerCent	inherited from: EnergyConsumer
qfixed	ReactivePower	inherited from: EnergyConsumer
qfixedPct	PerCent	inherited from: EnergyConsumer
phases	PhaseCode	inherited from: ConductingEquipment
normallyInService	Boolean	inherited from: Equipment
mRID	String	inherited from: IdentifiedObject
name	String	inherited from: IdentifiedObject
localName	String	inherited from: IdentifiedObject
pathName	String	inherited from: IdentifiedObject
aliasName	String	inherited from: IdentifiedObject
description	String	inherited from: IdentifiedObject

Association ends

Mult from	[Mult] name (type)	note
0..*	[0..1] LoadGroup (ConformLoadGroup)	Group of this ConformLoad
0..*	[0..1] LoadResponse (LoadResponseCharacteristic)	inherited from: EnergyConsumer
1..*	[0..1] PowerCutZone (PowerCutZone)	inherited from: EnergyConsumer
0..*	[0..1] BaseVoltage (BaseVoltage)	inherited from: ConductingEquipment
1	[0..*] ClearanceTags (ClearanceTag)	inherited from: ConductingEquipment
0..*	[0..*] ProtectionEquipments (ProtectionEquipment)	inherited from: ConductingEquipment
1	[0..*] Terminals (Terminal)	inherited from: ConductingEquipment
1	[0..*] ContingencyEquipment (ContingencyEquipment)	inherited from: Equipment
0..*	[0..1] MemberOf_EquipmentContainer (EquipmentContainer)	inherited from: Equipment
1	[0..*] OperationalLimitSet (OperationalLimitSet)	inherited from: Equipment
0..*	[0..*] OperatedBy_Companies (Company)	inherited from: PowerSystemResource
1	[0..*] Contains_Measurements (Measurement)	inherited from: PowerSystemResource
1	[0..*] OperatingShare (OperatingShare)	inherited from: PowerSystemResource
1	[0..1] OutageSchedule (OutageSchedule)	inherited from: PowerSystemResource
0..*	[0..*] PsrLists (PsrList)	inherited from: PowerSystemResource
0..*	[0..1] PSRTtype (PSRTtype)	inherited from: PowerSystemResource
0..*	[0..*] ReportingGroup (ReportingGroup)	inherited from: PowerSystemResource
1..*	[0..1] ModelingAuthoritySet (ModelingAuthoritySet)	inherited from: IdentifiedObject

6.10.3 ConformLoadGroup

Load that follows a daily and seasonal load variation pattern.

Attributes

name	type	note
mRID	String	inherited from: IdentifiedObject
name	String	inherited from: IdentifiedObject

localName	String	inherited from: IdentifiedObject
pathName	String	inherited from: IdentifiedObject
aliasName	String	inherited from: IdentifiedObject
description	String	inherited from: IdentifiedObject

Association ends

Mult from	[Mult] name (type)	note
0..1	[0..*] EnergyConsumers (ConformLoad)	Conform loads assigned to this ConformLoadGroup
1	[1..*] ConformLoadSchedules (ConformLoadSchedule)	The ConformLoadSchedules in the ConformLoadGroup
1..*	[1] SubLoadArea (SubLoadArea)	inherited from: LoadGroup
1..*	[0..1] ModelingAuthoritySet (ModelingAuthoritySet)	inherited from: IdentifiedObject

6.10.4 ConformLoadSchedule

A curve of load versus time (X-axis) showing the active power values (Y1-axis) and reactive power (Y2-axis) for each unit of the period covered. This curve represents a typical pattern of load over the time period for a given day type and season.

Attributes

name	type	note
timeStep	Seconds	inherited from: RegularIntervalSchedule
endTime	AbsoluteDateTime	inherited from: RegularIntervalSchedule
startTime	AbsoluteDateTime	inherited from: BasicIntervalSchedule
value1Unit	UnitSymbol	inherited from: BasicIntervalSchedule
value1Multiplier	UnitMultiplier	inherited from: BasicIntervalSchedule
value2Unit	UnitSymbol	inherited from: BasicIntervalSchedule
value2Multiplier	UnitMultiplier	inherited from: BasicIntervalSchedule
mRID	String	inherited from: IdentifiedObject
name	String	inherited from: IdentifiedObject
localName	String	inherited from: IdentifiedObject
pathName	String	inherited from: IdentifiedObject
aliasName	String	inherited from: IdentifiedObject
description	String	inherited from: IdentifiedObject

Association ends

Mult from	[Mult] name (type)	note
1..*	[1] ConformLoadGroup (ConformLoadGroup)	The ConformLoadGroup where the ConformLoadSchedule belongs
0..*	[0..1] DayType (DayType)	inherited from: SeasonDayTypeSchedule
0..*	[0..1] Season (Season)	inherited from: SeasonDayTypeSchedule
1	[1..*] TimePoints (RegularTimePoint)	inherited from: RegularIntervalSchedule
1..*	[0..1] ModelingAuthoritySet (ModelingAuthoritySet)	inherited from: IdentifiedObject

6.10.5 CustomerLoad

A meter for measuring customer energy consumption.

Attributes

name	Type	Note
customerCount	Integer	inherited from: EnergyConsumer
pfixed	ActivePower	inherited from: EnergyConsumer
pfixedPct	PerCent	inherited from: EnergyConsumer
qfixed	ReactivePower	inherited from: EnergyConsumer
qfixedPct	PerCent	inherited from: EnergyConsumer
phases	PhaseCode	inherited from: ConductingEquipment
normallyInService	Boolean	inherited from: Equipment
mRID	String	inherited from: IdentifiedObject
name	String	inherited from: IdentifiedObject
localName	String	inherited from: IdentifiedObject
pathName	String	inherited from: IdentifiedObject
aliasName	String	inherited from: IdentifiedObject
description	String	inherited from: IdentifiedObject

Association ends

Mult from	[Mult] name (type)	note
0..*	[0..1] LoadGroup (ConformLoadGroup)	inherited from: ConformLoad
0..*	[0..1] LoadResponse (LoadResponseCharacteristic)	inherited from: EnergyConsumer
1..*	[0..1] PowerCutZone (PowerCutZone)	inherited from: EnergyConsumer
0..*	[0..1] BaseVoltage (BaseVoltage)	inherited from: ConductingEquipment
1	[0..*] ClearanceTags (ClearanceTag)	inherited from: ConductingEquipment
0..*	[0..*] ProtectionEquipments (ProtectionEquipment)	inherited from: ConductingEquipment
1	[0..*] Terminals (Terminal)	inherited from: ConductingEquipment
1	[0..*] ContingencyEquipment (ContingencyEquipment)	inherited from: Equipment
0..*	[0..1] MemberOf_EquipmentContainer (EquipmentContainer)	inherited from: Equipment
1	[0..*] OperationalLimitSet (OperationalLimitSet)	inherited from: Equipment
0..*	[0..*] OperatedBy_Companies (Company)	inherited from: PowerSystemResource
1	[0..*] Contains_Measurements (Measurement)	inherited from: PowerSystemResource
1	[0..*] OperatingShare (OperatingShare)	inherited from: PowerSystemResource
1	[0..1] OutageSchedule (OutageSchedule)	inherited from: PowerSystemResource
0..*	[0..*] PsrLists (PsrList)	inherited from: PowerSystemResource
0..*	[0..1] PSRTType (PSRTType)	inherited from: PowerSystemResource
0..*	[0..*] ReportingGroup (ReportingGroup)	inherited from: PowerSystemResource
1..*	[0..1] ModelingAuthoritySet (ModelingAuthoritySet)	inherited from: IdentifiedObject

6.10.6 DayType

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

Attributes

name	type	note
mRID	String	inherited from: IdentifiedObject
name	String	inherited from: IdentifiedObject
localName	String	inherited from: IdentifiedObject
pathName	String	inherited from: IdentifiedObject
aliasName	String	inherited from: IdentifiedObject
description	String	inherited from: IdentifiedObject

Association ends

Mult from	[Mult] name (type)	note
0..1	[0..*] SeasonDayTypeSchedules (SeasonDayTypeSchedule)	Schedules that use this DayType
1..*	[0..1] ModelingAuthoritySet (ModelingAuthoritySet)	inherited from: IdentifiedObject

6.10.7 EnergyArea

The class describes an area having energy production or consumption. The class is the basis for further specialization.

Attributes

name	type	note
mRID	String	inherited from: IdentifiedObject
name	String	inherited from: IdentifiedObject
localName	String	inherited from: IdentifiedObject
pathName	String	inherited from: IdentifiedObject
aliasName	String	inherited from: IdentifiedObject
description	String	inherited from: IdentifiedObject

Association ends

Mult from	[Mult] name (type)	note
0..1	[0..1] ControlArea (ControlArea)	The control area specification that is used for the load forecast
1..*	[0..1] ModelingAuthoritySet (ModelingAuthoritySet)	inherited from: IdentifiedObject

6.10.8 InductionMotorLoad

Large three phase induction motor load.

Attributes

name	type	note
customerCount	Integer	inherited from: EnergyConsumer
pfixed	ActivePower	inherited from: EnergyConsumer
pfixedPct	PerCent	inherited from: EnergyConsumer
qfixed	ReactivePower	inherited from: EnergyConsumer
qfixedPct	PerCent	inherited from: EnergyConsumer
phases	PhaseCode	inherited from: ConductingEquipment

name	type	note
normallyInService	Boolean	inherited from: Equipment
mRID	String	inherited from: IdentifiedObject
name	String	inherited from: IdentifiedObject
localName	String	inherited from: IdentifiedObject
pathName	String	inherited from: IdentifiedObject
aliasName	String	inherited from: IdentifiedObject
description	String	inherited from: IdentifiedObject

Association ends

Mult from	[Mult] name (type)	note
0..*	[0..1] LoadGroup (NonConformLoadGroup)	inherited from: NonConformLoad
0..*	[0..1] LoadResponse (LoadResponseCharacteristic)	inherited from: EnergyConsumer
1..*	[0..1] PowerCutZone (PowerCutZone)	inherited from: EnergyConsumer
0..*	[0..1] BaseVoltage (BaseVoltage)	inherited from: ConductingEquipment
1	[0..*] ClearanceTags (ClearanceTag)	inherited from: ConductingEquipment
0..*	[0..*] ProtectionEquipments (ProtectionEquipment)	inherited from: ConductingEquipment
1	[0..*] Terminals (Terminal)	inherited from: ConductingEquipment
1	[0..*] ContingencyEquipment (ContingencyEquipment)	inherited from: Equipment
0..*	[0..1] MemberOf_EquipmentContainer (EquipmentContainer)	inherited from: Equipment
1	[0..*] OperationalLimitSet (OperationalLimitSet)	inherited from: Equipment
0..*	[0..*] OperatedBy_Companies (Company)	inherited from: PowerSystemResource
1	[0..*] Contains_Measurements (Measurement)	inherited from: PowerSystemResource
1	[0..*] OperatingShare (OperatingShare)	inherited from: PowerSystemResource
1	[0..1] OutageSchedule (OutageSchedule)	inherited from: PowerSystemResource
0..*	[0..*] PsrLists (PsrList)	inherited from: PowerSystemResource
0..*	[0..1] PSRTType (PSRTType)	inherited from: PowerSystemResource
0..*	[0..*] ReportingGroup (ReportingGroup)	inherited from: PowerSystemResource
1..*	[0..1] ModelingAuthoritySet (ModelingAuthoritySet)	inherited from: IdentifiedObject

6.10.9 Load

A generic equivalent for an energy consumer on a transmission or distribution voltage level. It may be under load management and also has cold load pick up characteristics.

Attributes

name	type	note
feederLoadMgtFactor	PerCent	The feeder's contribution to load management
coldPickUpFactorQ	PerCent	The amount of nominal feeder reactive power that is picked up cold
coldPickUpFactorP	PerCent	The amount of nominal feeder active power that is picked up cold
phaseRatedCurrent	CurrentFlow	The rated individual phase current
loadAllocationFactor	Float	Permit assignment of loads on a participation factor basis. Given three equivalent loads with factors of 10, 25 and 15, a feeder load of 100 A could be allocated on the feeder as 20 A, 50 A and 30 A.

name	type	note
customerCount	Integer	inherited from: EnergyConsumer
pfixed	ActivePower	inherited from: EnergyConsumer
pfixedPct	PerCent	inherited from: EnergyConsumer
qfixed	ReactivePower	inherited from: EnergyConsumer
qfixedPct	PerCent	inherited from: EnergyConsumer
phases	PhaseCode	inherited from: ConductingEquipment
normallyInService	Boolean	inherited from: Equipment
mRID	String	inherited from: IdentifiedObject
name	String	inherited from: IdentifiedObject
localName	String	inherited from: IdentifiedObject
pathName	String	inherited from: IdentifiedObject
aliasName	String	inherited from: IdentifiedObject
description	String	inherited from: IdentifiedObject

Association ends

Mult from	[Mult] name (type)	note
0..*	[0..1] LoadGroup (ConformLoadGroup)	inherited from: ConformLoad
0..*	[0..1] LoadResponse (LoadResponseCharacteristic)	inherited from: EnergyConsumer
1..*	[0..1] PowerCutZone (PowerCutZone)	inherited from: EnergyConsumer
0..*	[0..1] BaseVoltage (BaseVoltage)	inherited from: ConductingEquipment
1	[0..*] ClearanceTags (ClearanceTag)	inherited from: ConductingEquipment
0..*	[0..*] ProtectionEquipments (ProtectionEquipment)	inherited from: ConductingEquipment
1	[0..*] Terminals (Terminal)	inherited from: ConductingEquipment
1	[0..*] ContingencyEquipment (ContingencyEquipment)	inherited from: Equipment
0..*	[0..1] MemberOf_EquipmentContainer (EquipmentContainer)	inherited from: Equipment
1	[0..*] OperationalLimitSet (OperationalLimitSet)	inherited from: Equipment
0..*	[0..*] OperatedBy_Companies (Company)	inherited from: PowerSystemResource
1	[0..*] Contains_Measurements (Measurement)	inherited from: PowerSystemResource
1	[0..*] OperatingShare (OperatingShare)	inherited from: PowerSystemResource
1	[0..1] OutageSchedule (OutageSchedule)	inherited from: PowerSystemResource

Mult from	[Mult] name (type)	note
0..*	[0..*] PsrLists (PsrList)	inherited from: PowerSystemResource
0..*	[0..1] PSRType (PSRType)	inherited from: PowerSystemResource
0..*	[0..*] ReportingGroup (ReportingGroup)	inherited from: PowerSystemResource
1..*	[0..1] ModelingAuthoritySet (ModelingAuthoritySet)	inherited from: IdentifiedObject

6.10.10 LoadArea

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

Attributes

name	type	note
mRID	String	inherited from: IdentifiedObject
name	String	inherited from: IdentifiedObject
localName	String	inherited from: IdentifiedObject
pathName	String	inherited from: IdentifiedObject
aliasName	String	inherited from: IdentifiedObject
description	String	inherited from: IdentifiedObject

Association ends

Mult from	[Mult] name (type)	note
1	[1..*] SubLoadAreas (SubLoadArea)	The SubLoadAreas in the LoadArea
0..1	[0..1] ControlArea (ControlArea)	inherited from: EnergyArea
1..*	[0..1] ModelingAuthoritySet (ModelingAuthoritySet)	inherited from: IdentifiedObject

6.10.11 LoadGroup

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

Attributes

name	type	note
mRID	String	inherited from: IdentifiedObject
name	String	inherited from: IdentifiedObject
localName	String	inherited from: IdentifiedObject
pathName	String	inherited from: IdentifiedObject
aliasName	String	inherited from: IdentifiedObject
description	String	inherited from: IdentifiedObject

Association ends

Mult from	[Mult] name (type)	note
1..*	[1] SubLoadArea (SubLoadArea)	The SubLoadArea where the Loadgroup belongs
1..*	[0..1] ModelingAuthoritySet (ModelingAuthoritySet)	inherited from: IdentifiedObject

6.10.12 LoadResponseCharacteristic

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

Attributes

name	type	note
exponentModel	Boolean	Indicates the exponential voltage dependency model (pVoltageExponent and qVoltageExponent) to be used. If false, the coefficient model (consisting of pConstantImpedance, pConstantCurrent, pConstantPower, qConstantImpedance, qConstantCurrent, and qConstantPower) is to be used.
pConstantCurrent	Float	Portion of active power load modeled as constant current. Used only if the useExponentModel is false. This value is normalized against the sum of pZ, pI, and pP.
pConstantImpedance	Float	Portion of active power load modeled as constant impedance. Used only if the useExponentModel is false. This value is normalized against the sum of pZ, pI, and pP.
pConstantPower	Float	Portion of active power load modeled as constant power. Used only if the useExponentModel is false. This value is normalized against the sum of pZ, pI, and pP.
pFrequencyExponent	Float	Exponent of per unit frequency effecting active power.
pVoltageExponent	Float	Exponent of per unit voltage effecting real power. This model used only when "useExponentModel" is true.
qConstantCurrent	Float	Portion of reactive power load modeled as constant current. Used only if the useExponentModel is false. This value is normalized against the sum of qZ, qI, and qP.
qConstantImpedance	Float	Portion of reactive power load modeled as constant impedance. Used only if the useExponentModel is false. This value is normalized against the sum of qZ, qI, and qP.
qConstantPower	Float	Portion of reactive power load modeled as constant power. Used only if the useExponentModel is false. This value is normalized against the sum of qZ, qI, and qP.
qFrequencyExponent	Float	Exponent of per unit frequency effecting reactive power.
qVoltageExponent	Float	Exponent of per unit voltage effecting reactive power. This model used only when "useExponentModel" is true.
mRID	String	inherited from: IdentifiedObject
name	String	inherited from: IdentifiedObject
localName	String	inherited from: IdentifiedObject
pathName	String	inherited from: IdentifiedObject
aliasName	String	inherited from: IdentifiedObject
description	String	inherited from: IdentifiedObject

Association ends

Mult from	[Mult] name (type)	note
0..1	[0..*] EnergyConsumer (EnergyConsumer)	The set of loads that have the response characteristics
1..*	[0..1] ModelingAuthoritySet (ModelingAuthoritySet)	inherited from: IdentifiedObject

6.10.13 NonConformLoad

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

Attributes

name	type	note
customerCount	Integer	inherited from: EnergyConsumer
pfixed	ActivePower	inherited from: EnergyConsumer
pfixedPct	PerCent	inherited from: EnergyConsumer
qfixed	ReactivePower	inherited from: EnergyConsumer
qfixedPct	PerCent	inherited from: EnergyConsumer
phases	PhaseCode	inherited from: ConductingEquipment
normallyInService	Boolean	inherited from: Equipment
mRID	String	inherited from: IdentifiedObject
name	String	inherited from: IdentifiedObject
localName	String	inherited from: IdentifiedObject
pathName	String	inherited from: IdentifiedObject
aliasName	String	inherited from: IdentifiedObject
description	String	inherited from: IdentifiedObject

Association ends

Mult from	[Mult] name (type)	note
0..*	[0..1] LoadGroup (NonConformLoadGroup)	Group of this ConformLoad
0..*	[0..1] LoadResponse (LoadResponseCharacteristic)	inherited from: EnergyConsumer
1..*	[0..1] PowerCutZone (PowerCutZone)	inherited from: EnergyConsumer
0..*	[0..1] BaseVoltage (BaseVoltage)	inherited from: ConductingEquipment
1	[0..*] ClearanceTags (ClearanceTag)	inherited from: ConductingEquipment
0..*	[0..*] ProtectionEquipments (ProtectionEquipment)	inherited from: ConductingEquipment
1	[0..*] Terminals (Terminal)	inherited from: ConductingEquipment
1	[0..*] ContingencyEquipment (ContingencyEquipment)	inherited from: Equipment
0..*	[0..1] MemberOf_EquipmentContainer (EquipmentContainer)	inherited from: Equipment
1	[0..*] OperationalLimitSet (OperationalLimitSet)	inherited from: Equipment
0..*	[0..*] OperatedBy_Companies (Company)	inherited from: PowerSystemResource
1	[0..*] Contains_Measurements (Measurement)	inherited from: PowerSystemResource
1	[0..*] OperatingShare (OperatingShare)	inherited from: PowerSystemResource
1	[0..1] OutageSchedule (OutageSchedule)	inherited from: PowerSystemResource
0..*	[0..*] PsrLists (PsrList)	inherited from: PowerSystemResource
0..*	[0..1] PSRType (PSRType)	inherited from: PowerSystemResource
0..*	[0..*] ReportingGroup (ReportingGroup)	inherited from: PowerSystemResource
1..*	[0..1] ModelingAuthoritySet (ModelingAuthoritySet)	inherited from: IdentifiedObject

6.10.14 NonConformLoadGroup

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

Attributes

name	type	note
mRID	String	inherited from: IdentifiedObject
name	String	inherited from: IdentifiedObject
localName	String	inherited from: IdentifiedObject
pathName	String	inherited from: IdentifiedObject
aliasName	String	inherited from: IdentifiedObject
description	String	inherited from: IdentifiedObject

Association ends

Mult from	[Mult] name (type)	note
0..1	[0..*] EnergyConsumers (NonConformLoad)	Conform loads assigned to this ConformLoadGroup
1	[1..*] NonConformLoadSchedules (NonConformLoadSchedule)	The NonConformLoadSchedules in the NonConformLoadGroup
1..*	[1] SubLoadArea (SubLoadArea)	inherited from: LoadGroup
1..*	[0..1] ModelingAuthoritySet (ModelingAuthoritySet)	inherited from: IdentifiedObject

6.10.15 NonConformLoadSchedule

An active power (Y1-axis) and reactive power (Y2-axis) schedule (curves) versus time (X-axis) for non-conforming loads, e.g., large industrial load or power station service (where modeled).

Attributes

name	type	note
timeStep	Seconds	inherited from: RegularIntervalSchedule
endTime	AbsoluteDateTime	inherited from: RegularIntervalSchedule
startTime	AbsoluteDateTime	inherited from: BasicIntervalSchedule
value1Unit	UnitSymbol	inherited from: BasicIntervalSchedule
value1Multiplier	UnitMultiplier	inherited from: BasicIntervalSchedule
value2Unit	UnitSymbol	inherited from: BasicIntervalSchedule
value2Multiplier	UnitMultiplier	inherited from: BasicIntervalSchedule
mRID	String	inherited from: IdentifiedObject
name	String	inherited from: IdentifiedObject
localName	String	inherited from: IdentifiedObject
pathName	String	inherited from: IdentifiedObject
aliasName	String	inherited from: IdentifiedObject
description	String	inherited from: IdentifiedObject

Association ends

Mult from	[Mult] name (type)	note
1..*	[1] NonConformLoadGroup (NonConformLoadGroup)	The NonConformLoadGroup where the NonConformLoadSchedule belongs
0..*	[0..1] DayType (DayType)	inherited from: SeasonDayTypeSchedule
0..*	[0..1] Season (Season)	inherited from: SeasonDayTypeSchedule

Mult from	[Mult] name (type)	note
1	[1..*] TimePoints (RegularTimePoint)	inherited from: RegularIntervalSchedule
1..*	[0..1] ModelingAuthoritySet (ModelingAuthoritySet)	inherited from: IdentifiedObject

6.10.16 PowerCutZone

An area or zone of the power system which is used for load shedding purposes.

Attributes

name	type	note
cutLevel1	PerCent	First level (amount) of load to cut as a percentage of total zone load
cutLevel2	PerCent	Second level (amount) of load to cut as a percentage of total zone load
mRID	String	inherited from: IdentifiedObject
name	String	inherited from: IdentifiedObject
localName	String	inherited from: IdentifiedObject
pathName	String	inherited from: IdentifiedObject
aliasName	String	inherited from: IdentifiedObject
description	String	inherited from: IdentifiedObject

Association ends

Mult from	[Mult] name (type)	note
0..1	[1..*] EnergyConsumers (EnergyConsumer)	An energy consumer is assigned to a power cut zone.
0..*	[0..*] OperatedBy_Companies (Company)	inherited from: PowerSystemResource
1	[0..*] Contains_Measurements (Measurement)	inherited from: PowerSystemResource
1	[0..*] OperatingShare (OperatingShare)	inherited from: PowerSystemResource
1	[0..1] OutageSchedule (OutageSchedule)	inherited from: PowerSystemResource
0..*	[0..*] PsrLists (PsrList)	inherited from: PowerSystemResource
0..*	[0..1] PSRTtype (PSRTtype)	inherited from: PowerSystemResource
0..*	[0..*] ReportingGroup (ReportingGroup)	inherited from: PowerSystemResource
1..*	[0..1] ModelingAuthoritySet (ModelingAuthoritySet)	inherited from: IdentifiedObject

6.10.17 Season

A specified time period of the year, e.g., Spring, Summer, Fall, Winter.

Attributes

name	type	note
name	SeasonName	Name of the season
endDate	AbsoluteDateTime	Date season ends
startDate	AbsoluteDateTime	Date season starts

Association ends

Mult from	[Mult] name (type)	note
0..1	[0..*] SeasonDayTypeSchedules (SeasonDayTypeSchedule)	Schedules that use this season

6.10.18 SeasonDayTypeSchedule

The schedule specialize RegularIntervalSchedule with type curve data for a specific type of day and season. This means that curves of this type cover a 24 h period.

Attributes

name	type	note
timeStep	Seconds	inherited from: RegularIntervalSchedule
endTime	AbsoluteDateTime	inherited from: RegularIntervalSchedule
startTime	AbsoluteDateTime	inherited from: BasicIntervalSchedule
value1Unit	UnitSymbol	inherited from: BasicIntervalSchedule
value1Multiplier	UnitMultiplier	inherited from: BasicIntervalSchedule
value2Unit	UnitSymbol	inherited from: BasicIntervalSchedule
value2Multiplier	UnitMultiplier	inherited from: BasicIntervalSchedule
mRID	String	inherited from: IdentifiedObject
name	String	inherited from: IdentifiedObject
localName	String	inherited from: IdentifiedObject
pathName	String	inherited from: IdentifiedObject
aliasName	String	inherited from: IdentifiedObject
description	String	inherited from: IdentifiedObject

Association ends

Mult from	[Mult] name (type)	note
0..*	[0..1] DayType (DayType)	DayType for the Schedule
0..*	[0..1] Season (Season)	Season for the Schedule
1	[1..*] TimePoints (RegularTimePoint)	inherited from: RegularIntervalSchedule
1..*	[0..1] ModelingAuthoritySet (ModelingAuthoritySet)	inherited from: IdentifiedObject

6.10.19 SeasonName enumeration

Name of season.

Enums

name	note
winter	
spring	
summer	
fall	

6.10.20 StationSupply

Station supply with load derived from the station output.

Attributes

name	type	note
customerCount	Integer	inherited from: EnergyConsumer
pfixed	ActivePower	inherited from: EnergyConsumer
pfixedPct	PerCent	inherited from: EnergyConsumer
qfixed	ReactivePower	inherited from: EnergyConsumer
qfixedPct	PerCent	inherited from: EnergyConsumer
phases	PhaseCode	inherited from: ConductingEquipment
normallyInService	Boolean	inherited from: Equipment
mRID	String	inherited from: IdentifiedObject
name	String	inherited from: IdentifiedObject
localName	String	inherited from: IdentifiedObject
pathName	String	inherited from: IdentifiedObject
aliasName	String	inherited from: IdentifiedObject
description	String	inherited from: IdentifiedObject

Association ends

Mult from	[Mult] name (type)	note
0..*	[0..1] LoadResponse (LoadResponseCharacteristic)	inherited from: EnergyConsumer
1..*	[0..1] PowerCutZone (PowerCutZone)	inherited from: EnergyConsumer
0..*	[0..1] BaseVoltage (BaseVoltage)	inherited from: ConductingEquipment
1	[0..*] ClearanceTags (ClearanceTag)	inherited from: ConductingEquipment
0..*	[0..*] ProtectionEquipments (ProtectionEquipment)	inherited from: ConductingEquipment
1	[0..*] Terminals (Terminal)	inherited from: ConductingEquipment
1	[0..*] ContingencyEquipment (ContingencyEquipment)	inherited from: Equipment
0..*	[0..1] MemberOf_EquipmentContainer (EquipmentContainer)	inherited from: Equipment
1	[0..*] OperationalLimitSet (OperationalLimitSet)	inherited from: Equipment
0..*	[0..*] OperatedBy_Companies (Company)	inherited from: PowerSystemResource
1	[0..*] Contains_Measurements (Measurement)	inherited from: PowerSystemResource
1	[0..*] OperatingShare (OperatingShare)	inherited from: PowerSystemResource
1	[0..1] OutageSchedule (OutageSchedule)	inherited from: PowerSystemResource
0..*	[0..*] PsrLists (PsrList)	inherited from: PowerSystemResource
0..*	[0..1] PSRTYPE (PSRTYPE)	inherited from: PowerSystemResource
0..*	[0..*] ReportingGroup (ReportingGroup)	inherited from: PowerSystemResource
1..*	[0..1] ModelingAuthoritySet (ModelingAuthoritySet)	inherited from: IdentifiedObject

6.10.21 SubLoadArea

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

Attributes

name	type	note
mRID	String	inherited from: IdentifiedObject
name	String	inherited from: IdentifiedObject

name	type	note
localName	String	inherited from: IdentifiedObject
pathName	String	inherited from: IdentifiedObject
aliasName	String	inherited from: IdentifiedObject
description	String	inherited from: IdentifiedObject

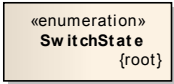
Association ends

Mult from	[Mult] name (type)	note
1..*	[1] LoadArea (LoadArea)	The LoadArea where the SubLoadArea belongs
1	[1..*] LoadGroups (LoadGroup)	The Loadgroups in the SubLoadArea
0..1	[0..1] ControlArea (ControlArea)	inherited from: EnergyArea
1..*	[0..1] ModelingAuthoritySet (ModelingAuthoritySet)	inherited from: IdentifiedObject

6.11 Outage

6.11.1 Outage package summary

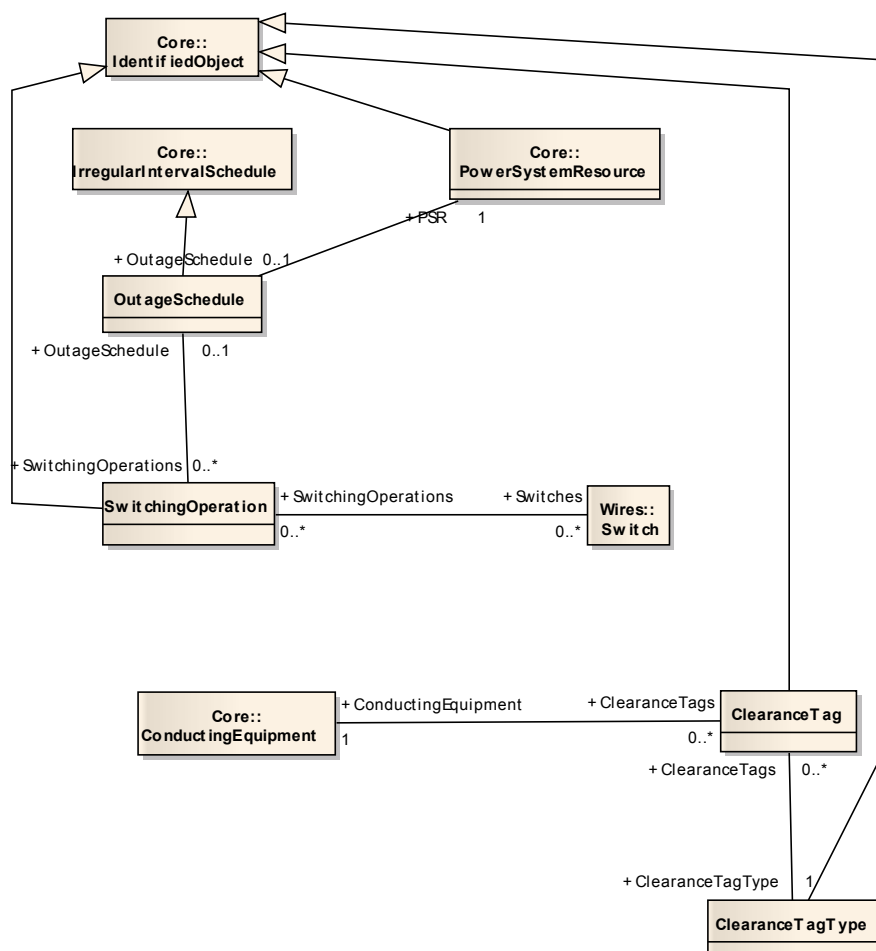
An extension to the Core and Wires packages that models information on the current and planned network configuration. These entities are optional within typical network applications.



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Figure 56 – Datatypes

Figure 56 is documented as follows. This diagram shows the data types specific to the Outage package.



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Figure 57 – Main

Figure 57 is documented as follows. This diagram shows all classes included in the Outage package as well as the key external classes that have associations with Outage classes.

6.11.2 ClearanceTag

A clearance tag that is used to authorize and schedule work on conducting equipment in the field. Tagged equipment is not available for commercial service.

Attributes

name	type	note
authorityName	String	The name of the person who is authorized to issue the tag
deenergizeReqFlag	Boolean	Set true if equipment must be deenergized
groundReqFlag	Boolean	Set true if equipment must be grounded
phaseCheckReqFlag	Boolean	Set true if equipment phasing must be checked
tagIssueTime	AbsoluteDateTime	The time at which the clearance tag was issued
workDescription	String	Description of the work to be performed
workEndTime	AbsoluteDateTime	The time at which the clearance tag is scheduled to be removed
workStartTime	AbsoluteDateTime	The time at which the clearance tag is scheduled to be set

name	type	note
mRID	String	inherited from: IdentifiedObject
name	String	inherited from: IdentifiedObject
localName	String	inherited from: IdentifiedObject
pathName	String	inherited from: IdentifiedObject
aliasName	String	inherited from: IdentifiedObject
description	String	inherited from: IdentifiedObject

Association ends

Mult from	[Mult] name (type)	note
0..*	[1] ClearanceTagType (ClearanceTagType)	The type of tag, depending on the purpose of the work to be performed and/or the type of supervisory control allowed.
0..*	[1] ConductingEquipment (ConductingEquipment)	Conducting equipment may have multiple clearance tags for authorized field work.
1..*	[0..1] ModelingAuthoritySet (ModelingAuthoritySet)	inherited from: IdentifiedObject

6.11.3 ClearanceTagType

Type of ClearanceTag. Could indicate the type of work to be performed and/or the type of supervisory control.

Attributes

name	type	note
mRID	String	inherited from: IdentifiedObject
name	String	inherited from: IdentifiedObject
localName	String	inherited from: IdentifiedObject
pathName	String	inherited from: IdentifiedObject
aliasName	String	inherited from: IdentifiedObject
description	String	inherited from: IdentifiedObject

Association ends

Mult from	[Mult] name (type)	note
1	[0..*] ClearanceTags (ClearanceTag)	The ClearanceTags currently being defined for this type
1..*	[0..1] ModelingAuthoritySet (ModelingAuthoritySet)	inherited from: IdentifiedObject

6.11.4 OutageSchedule

The period of time that a piece of equipment is out of service, for example for maintenance or testing, including the equipment's active power rating while under maintenance. The X-axis represents absolute time and the Y-axis represents the equipment's available rating while out of service.

Attributes

name	type	note
startTime	AbsoluteDateTime	inherited from: BasicIntervalSchedule
value1Unit	UnitSymbol	inherited from: BasicIntervalSchedule
value1Multiplier	UnitMultiplier	inherited from: BasicIntervalSchedule
value2Unit	UnitSymbol	inherited from: BasicIntervalSchedule
value2Multiplier	UnitMultiplier	inherited from: BasicIntervalSchedule
mRID	String	inherited from: IdentifiedObject
name	String	inherited from: IdentifiedObject
localName	String	inherited from: IdentifiedObject
pathName	String	inherited from: IdentifiedObject
aliasName	String	inherited from: IdentifiedObject
description	String	inherited from: IdentifiedObject

Association ends

Mult from	[Mult] name (type)	note
0..1	[1] PSR (PowerSystemResource)	A power system resource may have an outage schedule.
0..1	[0..*] SwitchingOperations (SwitchingOperation)	An OutageSchedule may operate many switches.
1	[1..*] TimePoints (IrregularTimePoint)	inherited from: IrregularIntervalSchedule
1..*	[0..1] ModelingAuthoritySet (ModelingAuthoritySet)	inherited from: IdentifiedObject

6.11.5 SwitchingOperation

A SwitchingOperation is used to define individual switch operations for an OutageSchedule. This OutageSchedule may be associated with another item of Substation such as a Transformer, Line, or Generator; or with the Switch itself as a PowerSystemResource. A Switch may be referenced by many OutageSchedules.

Attributes

name	type	note
operationTime	AbsoluteDateTime	Time of operation in same units as OutageSchedule.xAxisUnits
newState	SwitchState	The switch position that shall result from this SwitchingOperation
mRID	String	inherited from: IdentifiedObject
name	String	inherited from: IdentifiedObject
localName	String	inherited from: IdentifiedObject
pathName	String	inherited from: IdentifiedObject
aliasName	String	inherited from: IdentifiedObject
description	String	inherited from: IdentifiedObject

Association ends

Mult from	[Mult] name (type)	note
0..*	[0..1] OutageSchedule (OutageSchedule)	An OutageSchedule may operate many switches.
0..*	[0..*] Switches (Switch)	A switch may be operated by many schedules.
1..*	[0..1] ModelingAuthoritySet (ModelingAuthoritySet)	inherited from: IdentifiedObject

6.11.6 SwitchState enumeration

Possible states for a switch.

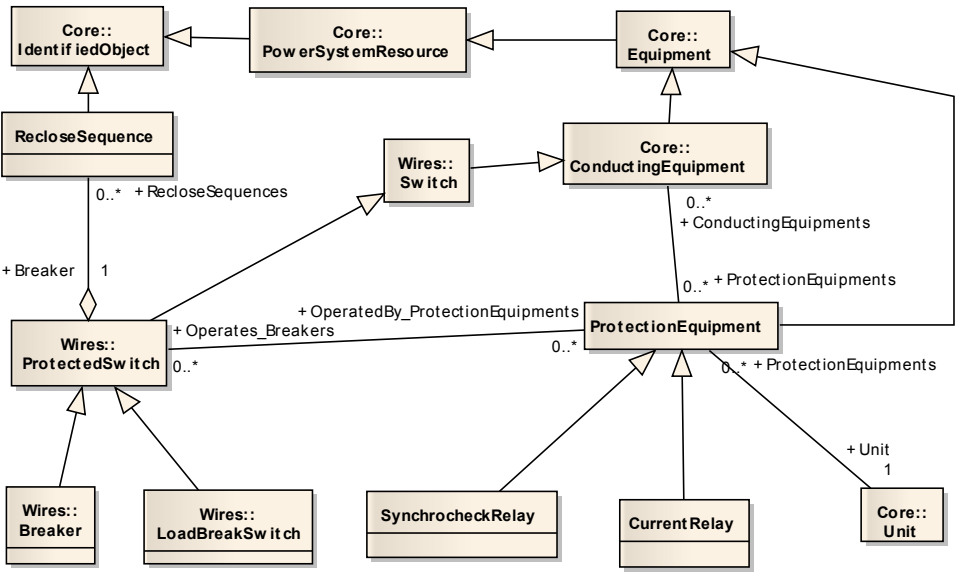
Enums

name	note
open	
close	

6.12 Protection

6.12.1 Protection package summary

An extension to the Core and Wires packages that models information for protection equipment such as relays. These entities are used within training simulators and distribution network fault location applications.



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Figure 58 – Main

Figure 58 is documented as follows. This diagram shows all classes included in the Protection package as well as the key external classes that have associations with Protection classes.

6.12.2 CurrentRelay

A device that checks current flow values in any direction or designated direction.

Attributes

name	type	note
currentLimit1	CurrentFlow	Current limit #1 for inverse time pickup
currentLimit2	CurrentFlow	Current limit #2 for inverse time pickup
currentLimit3	CurrentFlow	Current limit #3 for inverse time pickup
inverseTimeFlag	Boolean	Set true if the current relay has inverse time characteristic
timeDelay1	Seconds	Inverse time delay #1 for current limit #1
timeDelay2	Seconds	Inverse time delay #2 for current limit #2
timeDelay3	Seconds	Inverse time delay #3 for current limit #3
relayDelayTime	Seconds	inherited from: ProtectionEquipment
highLimit	Float	inherited from: ProtectionEquipment
lowLimit	Float	inherited from: ProtectionEquipment
powerDirectionFlag	Boolean	inherited from: ProtectionEquipment
normallyInService	Boolean	inherited from: Equipment
mRID	String	inherited from: IdentifiedObject
name	String	inherited from: IdentifiedObject
localName	String	inherited from: IdentifiedObject
pathName	String	inherited from: IdentifiedObject
aliasName	String	inherited from: IdentifiedObject
description	String	inherited from: IdentifiedObject

Association ends

Mult from	[Mult] name (type)	note
0..*	[0..*] ConductingEquipments (ConductingEquipment)	inherited from: ProtectionEquipment
0..*	[0..*] Operates_Breakers (ProtectedSwitch)	inherited from: ProtectionEquipment
0..*	[1] Unit (Unit)	inherited from: ProtectionEquipment
1	[0..*] ContingencyEquipment (ContingencyEquipment)	inherited from: Equipment
0..*	[0..1] MemberOf_EquipmentContainer (EquipmentContainer)	inherited from: Equipment
1	[0..*] OperationalLimitSet (OperationalLimitSet)	inherited from: Equipment
0..*	[0..*] OperatedBy_Companies (Company)	inherited from: PowerSystemResource
1	[0..*] Contains_Measurements (Measurement)	inherited from: PowerSystemResource
1	[0..*] OperatingShare (OperatingShare)	inherited from: PowerSystemResource
1	[0..1] OutageSchedule (OutageSchedule)	inherited from: PowerSystemResource
0..*	[0..*] PsrLists (PsrList)	inherited from: PowerSystemResource
0..*	[0..1] PSRTYPE (PSRTYPE)	inherited from: PowerSystemResource
0..*	[0..*] ReportingGroup (ReportingGroup)	inherited from: PowerSystemResource
1..*	[0..1] ModelingAuthoritySet (ModelingAuthoritySet)	inherited from: IdentifiedObject

6.12.3 ProtectionEquipment

An electrical device designed to respond to input conditions in a prescribed manner and after specified conditions are met to cause contact operation or similar abrupt change in associated electric control circuits, or simply to display the detected condition. Protection equipment are associated with conducting equipment and usually operate circuit breakers.

Attributes

name	type	note
relayDelayTime	Seconds	The time delay from detection of abnormal conditions to relay operation
highLimit	Float	The maximum allowable value
lowLimit	Float	The minimum allowable value
powerDirectionFlag	Boolean	Direction same as positive active power flow value
normallyInService	Boolean	inherited from: Equipment
mRID	String	inherited from: IdentifiedObject
name	String	inherited from: IdentifiedObject
localName	String	inherited from: IdentifiedObject
pathName	String	inherited from: IdentifiedObject
aliasName	String	inherited from: IdentifiedObject
description	String	inherited from: IdentifiedObject

Association ends

Mult from	[Mult] name (type)	note
0..*	[0..*] ConductingEquipments (ConductingEquipment)	Protection equipment may be used to protect specific conducting equipment. Multiple equipment may be protected or monitored by multiple protection equipment.
0..*	[0..*] Operates_Breakers (ProtectedSwitch)	Protected switches operated by this ProtectionEquipment.
0..*	[1] Unit (Unit)	The unit for the protection equipment.
1	[0..*] ContingencyEquipment (ContingencyEquipment)	inherited from: Equipment
0..*	[0..1] MemberOf_EquipmentContainer (EquipmentContainer)	inherited from: Equipment
1	[0..*] OperationalLimitSet (OperationalLimitSet)	inherited from: Equipment
0..*	[0..*] OperatedBy_Companies (Company)	inherited from: PowerSystemResource
1	[0..*] Contains_Measurements (Measurement)	inherited from: PowerSystemResource
1	[0..*] OperatingShare (OperatingShare)	inherited from: PowerSystemResource
1	[0..1] OutageSchedule (OutageSchedule)	inherited from: PowerSystemResource
0..*	[0..*] PsrLists (PsrList)	inherited from: PowerSystemResource
0..*	[0..1] PSRType (PSRType)	inherited from: PowerSystemResource
0..*	[0..*] ReportingGroup (ReportingGroup)	inherited from: PowerSystemResource
1..*	[0..1] ModelingAuthoritySet (ModelingAuthoritySet)	inherited from: IdentifiedObject

6.12.4 RecloseSequence

A reclose sequence (open and close) is defined for each possible reclosure of a breaker.

Attributes

name	type	note
recloseDelay	Seconds	Indicates the time lapse before the reclose step will execute a reclose.
recloseStep	Integer	Indicates the ordinal position of the reclose step relative to other steps in the sequence.
mRID	String	inherited from: IdentifiedObject
name	String	inherited from: IdentifiedObject
localName	String	inherited from: IdentifiedObject
pathName	String	inherited from: IdentifiedObject
aliasName	String	inherited from: IdentifiedObject
description	String	inherited from: IdentifiedObject

Association ends

Mult from	[Mult] name (type)	note
0..*	[1] Breaker (ProtectedSwitch)	A breaker may have zero or more automatic reclosures after a trip occurs.
1..*	[0..1] ModelingAuthoritySet (ModelingAuthoritySet)	inherited from: IdentifiedObject

6.12.5 SynchrocheckRelay

A device that operates when two AC circuits are within the desired limits of frequency, phase angle, and voltage, to permit or to cause the paralleling of these two circuits. Used to prevent the paralleling of non-synchronous topological islands.

Attributes

name	type	note
maxAngleDiff	AngleRadians	The maximum allowable voltage vector phase angle difference across the open device
maxFreqDiff	Frequency	The maximum allowable frequency difference across the open device
maxVoltDiff	Voltage	The maximum allowable difference voltage across the open device
relayDelayTime	Seconds	inherited from: ProtectionEquipment
highLimit	Float	inherited from: ProtectionEquipment
lowLimit	Float	inherited from: ProtectionEquipment
powerDirectionFlag	Boolean	inherited from: ProtectionEquipment
normallyInService	Boolean	inherited from: Equipment
mRID	String	inherited from: IdentifiedObject
name	String	inherited from: IdentifiedObject
localName	String	inherited from: IdentifiedObject
pathName	String	inherited from: IdentifiedObject
aliasName	String	inherited from: IdentifiedObject
description	String	inherited from: IdentifiedObject

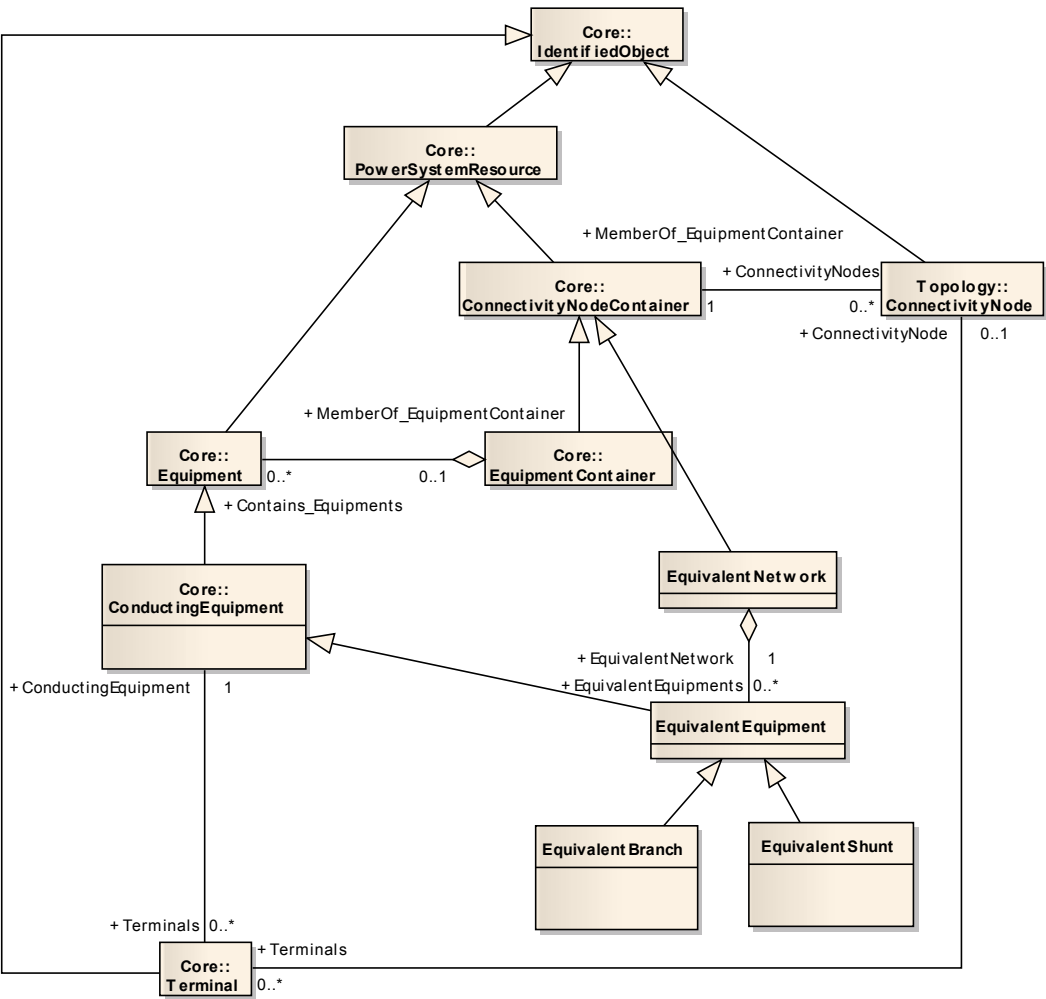
Association ends

Mult from	[Mult] name (type)	note
0..*	[0..*] ConductingEquipments (ConductingEquipment)	inherited from: ProtectionEquipment
0..*	[0..*] Operates_Breakers (ProtectedSwitch)	inherited from: ProtectionEquipment
0..*	[1] Unit (Unit)	inherited from: ProtectionEquipment
1	[0..*] ContingencyEquipment (ContingencyEquipment)	inherited from: Equipment
0..*	[0..1] MemberOf_EquipmentContainer (EquipmentContainer)	inherited from: Equipment
1	[0..*] OperationalLimitSet (OperationalLimitSet)	inherited from: Equipment
0..*	[0..*] OperatedBy_Companies (Company)	inherited from: PowerSystemResource
1	[0..*] Contains_Measurements (Measurement)	inherited from: PowerSystemResource
1	[0..*] OperatingShare (OperatingShare)	inherited from: PowerSystemResource
1	[0..1] OutageSchedule (OutageSchedule)	inherited from: PowerSystemResource
0..*	[0..*] PsrLists (PsrList)	inherited from: PowerSystemResource
0..*	[0..1] PSRType (PSRType)	inherited from: PowerSystemResource
0..*	[0..*] ReportingGroup (ReportingGroup)	inherited from: PowerSystemResource
1..*	[0..1] ModelingAuthoritySet (ModelingAuthoritySet)	inherited from: IdentifiedObject

6.13 Equivalentents

6.13.1 Equivalentents package summary

The equivalentents package models equivalent networks.



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Figure 59 – Main

Figure 59 is not documented.

6.13.2 EquivalentBranch

The class represents equivalent branches.

Attributes

name	type	note
r	Resistance	Positive sequence series resistance of the reduced branch
x	Reactance	Positive sequence series reactance of the reduced branch
phases	PhaseCode	inherited from: ConductingEquipment
normallyInService	Boolean	inherited from: Equipment
mRID	String	inherited from: IdentifiedObject
name	String	inherited from: IdentifiedObject
localName	String	inherited from: IdentifiedObject
pathName	String	inherited from: IdentifiedObject

aliasName	String	inherited from: IdentifiedObject
description	String	inherited from: IdentifiedObject

Association ends

Mult from	[Mult] name (type)	note
0..*	[1] EquivalentNetwork (EquivalentNetwork)	inherited from: EquivalentEquipment
0..*	[0..1] BaseVoltage (BaseVoltage)	inherited from: ConductingEquipment
1	[0..*] ClearanceTags (ClearanceTag)	inherited from: ConductingEquipment
0..*	[0..*] ProtectionEquipments (ProtectionEquipment)	inherited from: ConductingEquipment
1	[0..*] Terminals (Terminal)	inherited from: ConductingEquipment
1	[0..*] ContingencyEquipment (ContingencyEquipment)	inherited from: Equipment
0..*	[0..1] MemberOf_EquipmentContainer (EquipmentContainer)	inherited from: Equipment
1	[0..*] OperationalLimitSet (OperationalLimitSet)	inherited from: Equipment
0..*	[0..*] OperatedBy_Companies (Company)	inherited from: PowerSystemResource
1	[0..*] Contains_Measurements (Measurement)	inherited from: PowerSystemResource
1	[0..*] OperatingShare (OperatingShare)	inherited from: PowerSystemResource
1	[0..1] OutageSchedule (OutageSchedule)	inherited from: PowerSystemResource
0..*	[0..*] PsrLists (PsrList)	inherited from: PowerSystemResource
0..*	[0..1] PSRTYPE (PSRTYPE)	inherited from: PowerSystemResource
0..*	[0..*] ReportingGroup (ReportingGroup)	inherited from: PowerSystemResource
1..*	[0..1] ModelingAuthoritySet (ModelingAuthoritySet)	inherited from: IdentifiedObject

6.13.3 EquivalentEquipment

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

Attributes

name	type	note
phases	PhaseCode	inherited from: ConductingEquipment
normallyInService	Boolean	inherited from: Equipment
mRID	String	inherited from: IdentifiedObject
name	String	inherited from: IdentifiedObject
localName	String	inherited from: IdentifiedObject
pathName	String	inherited from: IdentifiedObject
aliasName	String	inherited from: IdentifiedObject
description	String	inherited from: IdentifiedObject

Association ends

Mult from	[Mult] name (type)	note
0..*	[1] EquivalentNetwork (EquivalentNetwork)	The equivalent where the reduced model belongs
0..*	[0..1] BaseVoltage (BaseVoltage)	inherited from: ConductingEquipment
1	[0..*] ClearanceTags (ClearanceTag)	inherited from: ConductingEquipment
0..*	[0..*] ProtectionEquipments (ProtectionEquipment)	inherited from: ConductingEquipment

1	[0..*] Terminals (Terminal)	inherited from: ConductingEquipment
1	[0..*] ContingencyEquipment (ContingencyEquipment)	inherited from: Equipment
0..*	[0..1] MemberOf_EquipmentContainer (EquipmentContainer)	inherited from: Equipment
1	[0..*] OperationalLimitSet (OperationalLimitSet)	inherited from: Equipment
0..*	[0..*] OperatedBy_Companies (Company)	inherited from: PowerSystemResource
1	[0..*] Contains_Measurements (Measurement)	inherited from: PowerSystemResource
1	[0..*] OperatingShare (OperatingShare)	inherited from: PowerSystemResource
1	[0..1] OutageSchedule (OutageSchedule)	inherited from: PowerSystemResource
0..*	[0..*] PsrLists (PsrList)	inherited from: PowerSystemResource
0..*	[0..1] PSRTYPE (PSRTYPE)	inherited from: PowerSystemResource
0..*	[0..*] ReportingGroup (ReportingGroup)	inherited from: PowerSystemResource
1..*	[0..1] ModelingAuthoritySet (ModelingAuthoritySet)	inherited from: IdentifiedObject

6.13.4 EquivalentNetwork

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.

Attributes

name	type	note
mRID	String	inherited from: IdentifiedObject
name	String	inherited from: IdentifiedObject
localName	String	inherited from: IdentifiedObject
pathName	String	inherited from: IdentifiedObject
aliasName	String	inherited from: IdentifiedObject
description	String	inherited from: IdentifiedObject

Association ends

Mult from	[Mult] name (type)	note
1	[0..*] EquivalentEquipments (EquivalentEquipment)	The associated reduced equivalents
1	[0..*] ConnectivityNodes (ConnectivityNode)	inherited from: ConnectivityNodeContainer
0..1	[0..*] TopologicalNode (TopologicalNode)	inherited from: ConnectivityNodeContainer
0..*	[0..*] OperatedBy_Companies (Company)	inherited from: PowerSystemResource
1	[0..*] Contains_Measurements (Measurement)	inherited from: PowerSystemResource
1	[0..*] OperatingShare (OperatingShare)	inherited from: PowerSystemResource
1	[0..1] OutageSchedule (OutageSchedule)	inherited from: PowerSystemResource
0..*	[0..*] PsrLists (PsrList)	inherited from: PowerSystemResource
0..*	[0..1] PSRTYPE (PSRTYPE)	inherited from: PowerSystemResource
0..*	[0..*] ReportingGroup (ReportingGroup)	inherited from: PowerSystemResource
1..*	[0..1] ModelingAuthoritySet (ModelingAuthoritySet)	inherited from: IdentifiedObject

6.13.5 EquivalentShunt

The class represents equivalent shunts.

Attributes

name	type	note
b	Susceptance	Positive sequence shunt susceptance
g	Conductance	Positive sequence shunt conductance
phases	PhaseCode	inherited from: ConductingEquipment
normallyInService	Boolean	inherited from: Equipment
mRID	String	inherited from: IdentifiedObject
name	String	inherited from: IdentifiedObject
localName	String	inherited from: IdentifiedObject
pathName	String	inherited from: IdentifiedObject
aliasName	String	inherited from: IdentifiedObject
description	String	inherited from: IdentifiedObject

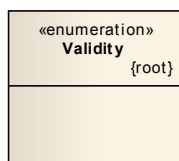
Association ends

Mult from	[Mult] name (type)	note
0..*	[1] EquivalentNetwork (EquivalentNetwork)	inherited from: EquivalentEquipment
0..*	[0..1] BaseVoltage (BaseVoltage)	inherited from: ConductingEquipment
1	[0..*] ClearanceTags (ClearanceTag)	inherited from: ConductingEquipment
0..*	[0..*] ProtectionEquipments (ProtectionEquipment)	inherited from: ConductingEquipment
1	[0..*] Terminals (Terminal)	inherited from: ConductingEquipment
1	[0..*] ContingencyEquipment (ContingencyEquipment)	inherited from: Equipment
0..*	[0..1] MemberOf_EquipmentContainer (EquipmentContainer)	inherited from: Equipment
1	[0..*] OperationalLimitSet (OperationalLimitSet)	inherited from: Equipment
0..*	[0..*] OperatedBy_Companies (Company)	inherited from: PowerSystemResource
1	[0..*] Contains_Measurements (Measurement)	inherited from: PowerSystemResource
1	[0..*] OperatingShare (OperatingShare)	inherited from: PowerSystemResource
1	[0..1] OutageSchedule (OutageSchedule)	inherited from: PowerSystemResource
0..*	[0..*] PsrLists (PsrList)	inherited from: PowerSystemResource
0..*	[0..1] PSRType (PSRType)	inherited from: PowerSystemResource
0..*	[0..*] ReportingGroup (ReportingGroup)	inherited from: PowerSystemResource
1..*	[0..1] ModelingAuthoritySet (ModelingAuthoritySet)	inherited from: IdentifiedObject

6.14 Meas

6.14.1 Meas package summary

Contains entities that describe dynamic measurement data exchanged between applications.



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Figure 60 – Datatypes

Figure 60 is not documented.

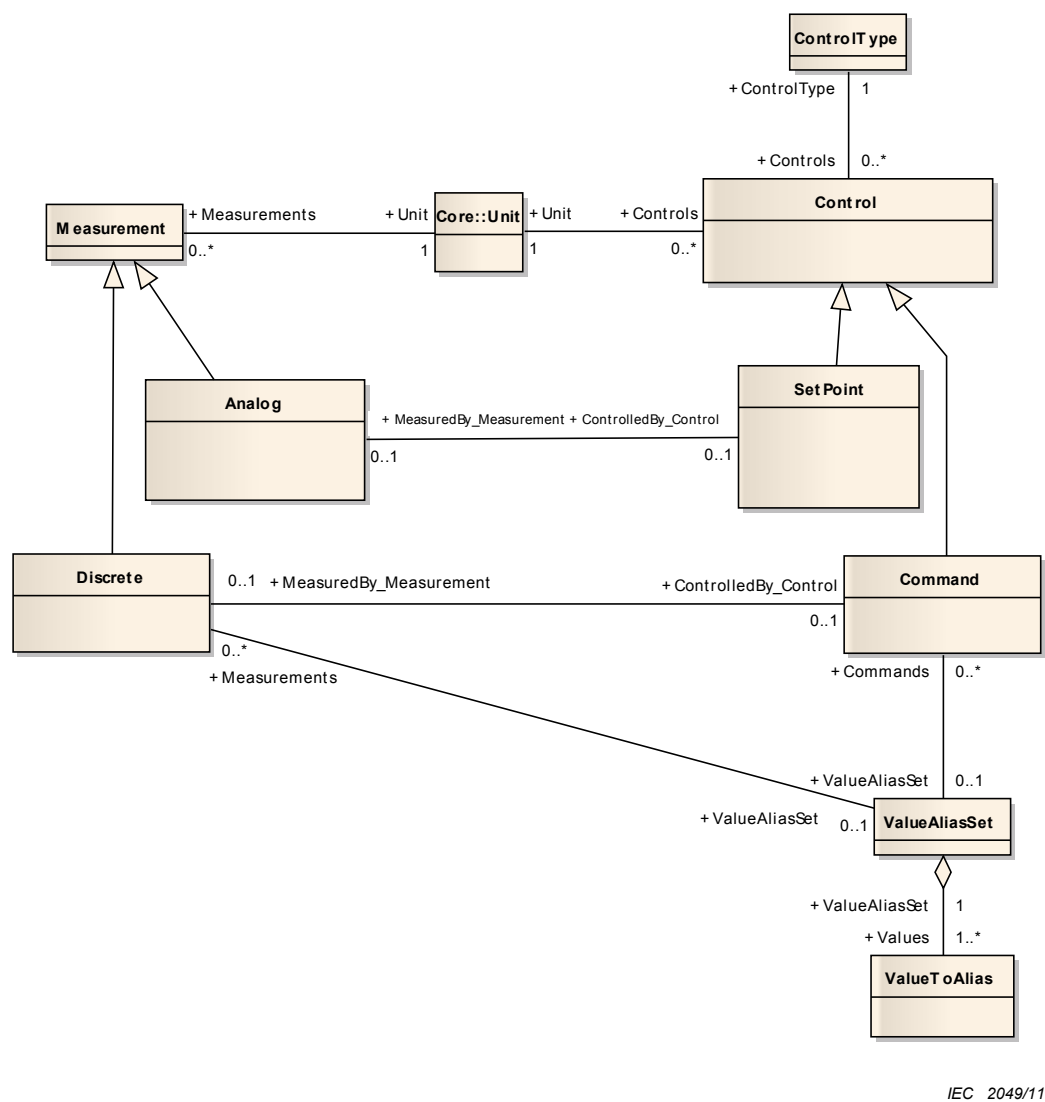
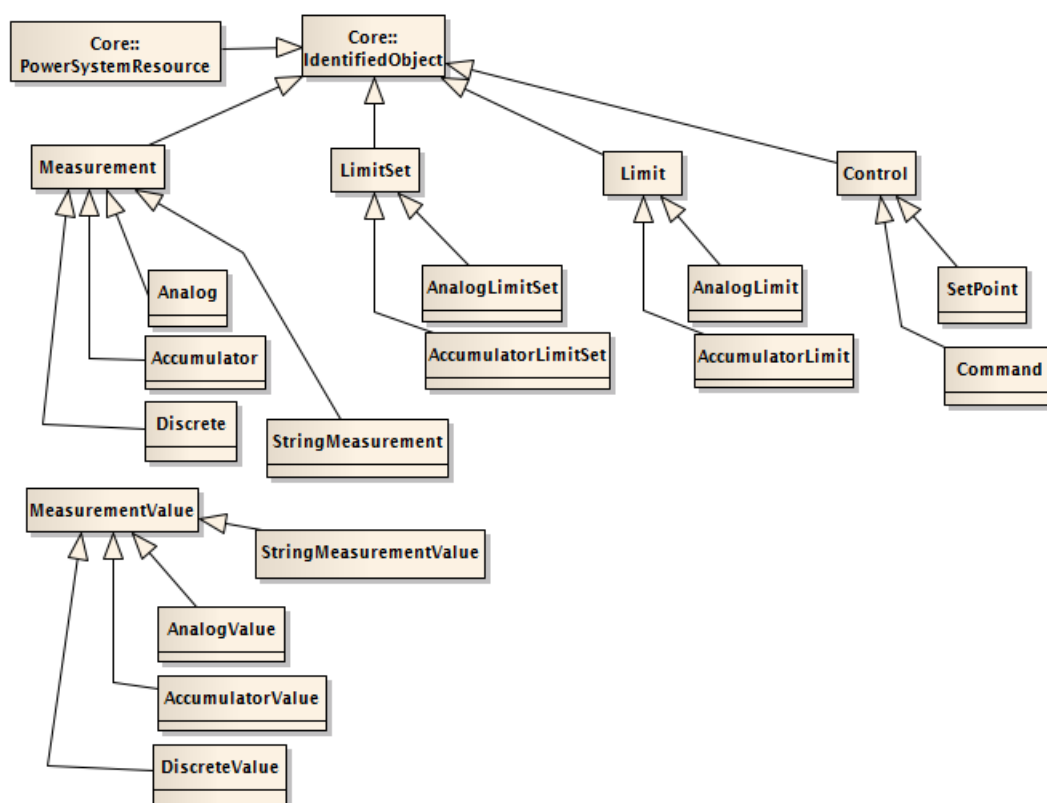


Figure 61 – Control

Figure 61 is documented as follows. This diagram shows all classes included in the Meas package.



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Figure 62 – InheritanceStructure

Figure 62 is documented as follows. This diagram shows the measurement classes inherit basic classes.

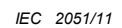
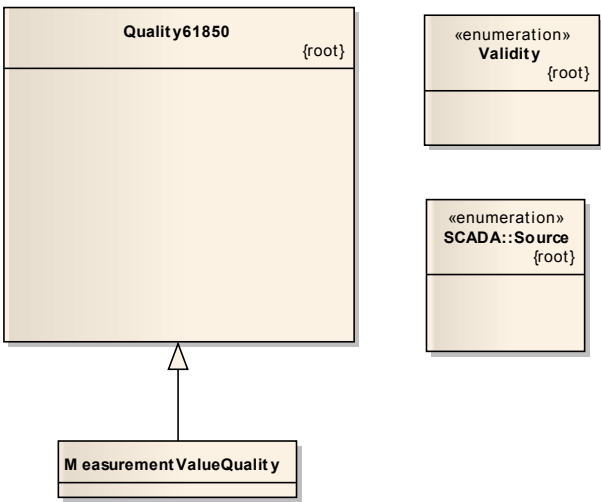


Figure 63 is documented as follows. This diagram shows classes central to the Measurement package and connections to some external classes.



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Figure 64 – Quality

Figure 64 is documented as follows. This diagram shows the details of the quality codes. The quality flags can be used also in other packages not only specific to MeasurementValues. A generalized Quality class is added and inherited into MeasurementValueQuality.

6.14.2 Accumulator

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

Attributes

name	type	note
maxValue	Integer	Normal value range maximum for any of the MeasurementValue.values. Used for scaling, e.g. in bar graphs or of telemetered raw values.
mRID	String	inherited from: IdentifiedObject
name	String	inherited from: IdentifiedObject
localName	String	inherited from: IdentifiedObject
pathName	String	inherited from: IdentifiedObject
aliasName	String	inherited from: IdentifiedObject
description	String	inherited from: IdentifiedObject

Association ends

Mult from	[Mult] name (type)	note
0..*	[0..*] LimitSets (AccumulatorLimitSet)	A measurement may have zero or more limit ranges defined for it.
1	[1..*] Contain_MeasurementValues (AccumulatorValue)	The values connected to this measurement.
0..*	[1] MeasurementType (MeasurementType)	inherited from: Measurement
0..*	[1] MemberOf_PSR (PowerSystemResource)	inherited from: Measurement
0..*	[0..1] Terminal (Terminal)	inherited from: Measurement
0..*	[1] Unit (Unit)	inherited from: Measurement
1..*	[0..1] ModelingAuthoritySet (ModelingAuthoritySet)	inherited from: IdentifiedObject

6.14.3 AccumulatorLimit

Limit values for Accumulator measurements.

Attributes

name	type	note
value	Integer	The value to supervise against. The value is positive.
mRID	String	inherited from: IdentifiedObject
name	String	inherited from: IdentifiedObject
localName	String	inherited from: IdentifiedObject
pathName	String	inherited from: IdentifiedObject
aliasName	String	inherited from: IdentifiedObject
description	String	inherited from: IdentifiedObject

Association ends

Mult from	[Mult] name (type)	note
1..*	[1] LimitSet (AccumulatorLimitSet)	The set of limits
1..*	[0..1] ModelingAuthoritySet (ModelingAuthoritySet)	inherited from: IdentifiedObject

6.14.4 AccumulatorLimitSet

An AccumulatorLimitSet specifies a set of Limits that are associated with an Accumulator measurement.

Attributes

name	type	note
isPercentageLimits	Boolean	inherited from: LimitSet
mRID	String	inherited from: IdentifiedObject
name	String	inherited from: IdentifiedObject
localName	String	inherited from: IdentifiedObject
pathName	String	inherited from: IdentifiedObject
aliasName	String	inherited from: IdentifiedObject
description	String	inherited from: IdentifiedObject

Association ends

Mult from	[Mult] name (type)	note
0..*	[0..*] Measurements (Accumulator)	The Measurements using the LimitSet
1	[1..*] Limits (AccumulatorLimit)	The limit values used for supervision of Measurements
1..*	[0..1] ModelingAuthoritySet (ModelingAuthoritySet)	inherited from: IdentifiedObject

6.14.5 AccumulatorValue

AccumulatorValue represents an accumulated (counted) MeasurementValue.

Attributes

name	type	note
value	Integer	The value to supervise. The value is positive.
timeStamp	AbsoluteDateTime	inherited from: MeasurementValue
sensorAccuracy	PerCent	inherited from: MeasurementValue
mRID	String	inherited from: IdentifiedObject
name	String	inherited from: IdentifiedObject
localName	String	inherited from: IdentifiedObject
pathName	String	inherited from: IdentifiedObject
aliasName	String	inherited from: IdentifiedObject
description	String	inherited from: IdentifiedObject

Association ends

Mult from	[Mult] name (type)	note
1..*	[1] MemberOf_Measurement (Accumulator)	Measurement to which this value is connected
1	[1] MeasurementValueQuality (MeasurementValueQuality)	inherited from: MeasurementValue
0..*	[1] MeasurementValueSource (MeasurementValueSource)	inherited from: MeasurementValue
1	[0..1] RemoteSource (RemoteSource)	inherited from: MeasurementValue
1..*	[0..1] ModelingAuthoritySet (ModelingAuthoritySet)	inherited from: IdentifiedObject

6.14.6 Analog

Analog represents an analog Measurement.

Attributes

name	type	note
maxValue	Float	Normal value range maximum for any of the MeasurementValue.values. Used for scaling, e.g. in bar graphs or of telemetered raw values.
minValue	Float	Normal value range minimum for any of the MeasurementValue.values. Used for scaling, e.g. in bar graphs or of telemetered raw values
normalValue	Float	Normal measurement value, e.g., used for percentage calculations.
positiveFlowIn	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.
mRID	String	inherited from: IdentifiedObject
name	String	inherited from: IdentifiedObject
localName	String	inherited from: IdentifiedObject
pathName	String	inherited from: IdentifiedObject
aliasName	String	inherited from: IdentifiedObject
description	String	inherited from: IdentifiedObject

Association ends

Mult from	[Mult] name (type)	note
0..*	[0..*] LimitSets (AnalogLimitSet)	A measurement may have zero or more limit ranges defined for it.
1	[1..*] Contain_MeasurementValues (AnalogValue)	The values connected to this measurement.
0..1	[0..1] ControlledBy_Control (SetPoint)	The control variable associated with the measurement.
0..*	[1] MeasurementType (MeasurementType)	inherited from: Measurement
0..*	[1] MemberOf_PSR (PowerSystemResource)	inherited from: Measurement
0..*	[0..1] Terminal (Terminal)	inherited from: Measurement
0..*	[1] Unit (Unit)	inherited from: Measurement
1..*	[0..1] ModelingAuthoritySet (ModelingAuthoritySet)	inherited from: IdentifiedObject

6.14.7 AnalogLimit

Limit values for Analog measurements.

Attributes

name	type	note
value	Float	The value to supervise against
mRID	String	inherited from: IdentifiedObject
name	String	inherited from: IdentifiedObject
localName	String	inherited from: IdentifiedObject
pathName	String	inherited from: IdentifiedObject
aliasName	String	inherited from: IdentifiedObject
description	String	inherited from: IdentifiedObject

Association ends

Mult from	[Mult] name (type)	note
0..*	[1] LimitSet (AnalogLimitSet)	The set of limits
1..*	[0..1] ModelingAuthoritySet (ModelingAuthoritySet)	inherited from: IdentifiedObject

6.14.8 AnalogLimitSet

An AnalogLimitSet specifies a set of Limits that are associated with an Analog measurement.

Attributes

name	type	note
isPercentageLimits	Boolean	inherited from: LimitSet
mRID	String	inherited from: IdentifiedObject
name	String	inherited from: IdentifiedObject
localName	String	inherited from: IdentifiedObject
pathName	String	inherited from: IdentifiedObject
aliasName	String	inherited from: IdentifiedObject
description	String	inherited from: IdentifiedObject

Association ends

Mult from	[Mult] name (type)	note
0..*	[0..*] Measurements (Analog)	The Measurements using the LimitSet
1	[0..*] Limits (AnalogLimit)	The limit values used for supervision of Measurements
1..*	[0..1] ModelingAuthoritySet (ModelingAuthoritySet)	inherited from: IdentifiedObject

6.14.9 AnalogValue

AnalogValue represents an analog MeasurementValue.

Attributes

name	type	note
value	Float	The value to supervise.
timeStamp	AbsoluteDateTime	inherited from: MeasurementValue
sensorAccuracy	PerCent	inherited from: MeasurementValue
mRID	String	inherited from: IdentifiedObject
name	String	inherited from: IdentifiedObject
localName	String	inherited from: IdentifiedObject
pathName	String	inherited from: IdentifiedObject
aliasName	String	inherited from: IdentifiedObject
description	String	inherited from: IdentifiedObject

Association ends

Mult from	[Mult] name (type)	note
1	[0..*] AltGeneratingUnit (AltGeneratingUnitMeas)	The alternate generating unit for which this measurement value applies.
1	[0..*] AltTieMeas (AltTieMeas)	The usage of the measurement within the control area specification.
1..*	[1] MemberOf_Measurement (Analog)	Measurement to which this value is connected.
1	[1] MeasurementValueQuality (MeasurementValueQuality)	inherited from: MeasurementValue
0..*	[1] MeasurementValueSource (MeasurementValueSource)	inherited from: MeasurementValue
1	[0..1] RemoteSource (RemoteSource)	inherited from: MeasurementValue
1..*	[0..1] ModelingAuthoritySet (ModelingAuthoritySet)	inherited from: IdentifiedObject

6.14.10 Command

A Command is a discrete control used for supervisory control.

Attributes

name	type	note
value	Integer	The value representing the actuator output
normalValue	Integer	Normal value for Control.value e.g. used for percentage scaling
timeStamp	AbsoluteDateTime	inherited from: Control
operationInProgress	Boolean	inherited from: Control

name	type	note
mRID	String	inherited from: IdentifiedObject
name	String	inherited from: IdentifiedObject
localName	String	inherited from: IdentifiedObject
pathName	String	inherited from: IdentifiedObject
aliasName	String	inherited from: IdentifiedObject
description	String	inherited from: IdentifiedObject

Association ends

Mult from	[Mult] name (type)	note
0..1	[0..1] MeasuredBy_Measurement (Discrete)	The Measurement variable used for control.
0..*	[0..1] ValueAliasSet (ValueAliasSet)	The Commands using the set for translation.
0..*	[1] ControlType (ControlType)	inherited from: Control
1..*	[0..1] ControlledBy_RegulatingCondEq (RegulatingCondEq)	inherited from: Control
1	[0..1] RemoteControl (RemoteControl)	inherited from: Control
0..*	[1] Unit (Unit)	inherited from: Control
1..*	[0..1] ModelingAuthoritySet (ModelingAuthoritySet)	inherited from: IdentifiedObject

6.14.11 Control

Control is used for supervisory/device control. It represents control outputs that are used to change the state in a process, e.g. close or open breaker, a set point value or a raise lower command.

Attributes

name	type	note
timeStamp	AbsoluteDateTime	The last time a control output was sent
operationInProgress	Boolean	Indicates that a client is currently sending control commands that has not completed
mRID	String	inherited from: IdentifiedObject
name	String	inherited from: IdentifiedObject
localName	String	inherited from: IdentifiedObject
pathName	String	inherited from: IdentifiedObject
aliasName	String	inherited from: IdentifiedObject
description	String	inherited from: IdentifiedObject

Association ends

Mult from	[Mult] name (type)	note
0..*	[1] ControlType (ControlType)	The type of Control
1..*	[0..1] ControlledBy_RegulatingCondEq (RegulatingCondEq)	Regulating device governed by this control output.
1	[0..1] RemoteControl (RemoteControl)	The remote point controlling the physical actuator.
0..*	[1] Unit (Unit)	The Unit for the Control.
1..*	[0..1] ModelingAuthoritySet (ModelingAuthoritySet)	inherited from: IdentifiedObject

6.14.12 ControlType

Specifies the type of Control, e.g. BreakerOn/Off, GeneratorVoltageSetPoint, TieLineFlow etc. The ControlType.name shall be unique among all specified types and describe the type. The ControlType.aliasName is meant to be used for localization.

Attributes

name	type	note
mRID	String	inherited from: IdentifiedObject
name	String	inherited from: IdentifiedObject
localName	String	inherited from: IdentifiedObject
pathName	String	inherited from: IdentifiedObject
aliasName	String	inherited from: IdentifiedObject
description	String	inherited from: IdentifiedObject

Association ends

Mult from	[Mult] name (type)	note
1	[0..*] Controls (Control)	The Controls having the ControlType
1..*	[0..1] ModelingAuthoritySet (ModelingAuthoritySet)	inherited from: IdentifiedObject

6.14.13 Discrete

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

Attributes

name	type	note
maxValue	Integer	Normal value range maximum for any of the MeasurementValue.values. Used for scaling, e.g. in bar graphs or of telemetered raw values.
minValue	Integer	Normal value range minimum for any of the MeasurementValue.values. Used for scaling, e.g. in bar graphs or of telemetered raw values
normalValue	Integer	Normal measurement value, e.g., used for percentage calculations.
mRID	String	inherited from: IdentifiedObject
name	String	inherited from: IdentifiedObject
localName	String	inherited from: IdentifiedObject
pathName	String	inherited from: IdentifiedObject
aliasName	String	inherited from: IdentifiedObject
description	String	inherited from: IdentifiedObject

Association ends

Mult from	[Mult] name (type)	note
0..1	[0..1] ControlledBy_Control (Command)	The Control variable associated with the Measurement.
1	[1..*] Contain_MeasurementValues (DiscreteValue)	The values connected to this measurement.
0..*	[0..1] ValueAliasSet (ValueAliasSet)	The ValueAliasSet used for translation of a

Mult from	[Mult] name (type)	note
		MeasurementValue.value to a name
0..*	[1] MeasurementType (MeasurementType)	inherited from: Measurement
0..*	[1] MemberOf_PSR (PowerSystemResource)	inherited from: Measurement
0..*	[0..1] Terminal (Terminal)	inherited from: Measurement
0..*	[1] Unit (Unit)	inherited from: Measurement
1..*	[0..1] ModelingAuthoritySet (ModelingAuthoritySet)	inherited from: IdentifiedObject

6.14.14 DiscreteValue

DiscreteValue represents a discrete MeasurementValue.

Attributes

name	type	note
value	Integer	The value to supervise.
timeStamp	AbsoluteDateTime	inherited from: MeasurementValue
sensorAccuracy	PerCent	inherited from: MeasurementValue
mRID	String	inherited from: IdentifiedObject
name	String	inherited from: IdentifiedObject
localName	String	inherited from: IdentifiedObject
pathName	String	inherited from: IdentifiedObject
aliasName	String	inherited from: IdentifiedObject
description	String	inherited from: IdentifiedObject

Association ends

Mult from	[Mult] name (type)	note
1..*	[1] MemberOf_Measurement (Discrete)	Measurement to which this value is connected.
1	[1] MeasurementValueQuality (MeasurementValueQuality)	inherited from: MeasurementValue
0..*	[1] MeasurementValueSource (MeasurementValueSource)	inherited from: MeasurementValue
1	[0..1] RemoteSource (RemoteSource)	inherited from: MeasurementValue
1..*	[0..1] ModelingAuthoritySet (ModelingAuthoritySet)	inherited from: IdentifiedObject

6.14.15 Limit

Specifies one limit value for a Measurement. A Measurement typically has several limits that are kept together by the LimitSet class. The actual meaning and use of a Limit instance (i.e., if it is an alarm or warning limit or if it is a high or low limit) is not captured in the Limit class. However the name of a Limit instance may indicate both meaning and use.

Attributes

name	type	note
mRID	String	inherited from: IdentifiedObject
name	String	inherited from: IdentifiedObject
localName	String	inherited from: IdentifiedObject
pathName	String	inherited from: IdentifiedObject
aliasName	String	inherited from: IdentifiedObject

name	type	note
description	String	inherited from: IdentifiedObject

Association ends

Mult from	[Mult] name (type)	note
1..*	[0..1] ModelingAuthoritySet (ModelingAuthoritySet)	inherited from: IdentifiedObject

6.14.16 LimitSet

Specifies a set of Limits that are associated with a Measurement. A Measurement may have several LimitSets corresponding to seasonal or other changing conditions. The condition is captured in the name and description attributes. The same LimitSet may be used for several Measurements. In particular percentage limits are used this way.

Attributes

name	type	note
isPercentageLimits	Boolean	Tells if the limit values are in percentage of normalValue or the specified Unit for Measurements and Controls.
mRID	String	inherited from: IdentifiedObject
name	String	inherited from: IdentifiedObject
localName	String	inherited from: IdentifiedObject
pathName	String	inherited from: IdentifiedObject
aliasName	String	inherited from: IdentifiedObject
description	String	inherited from: IdentifiedObject

Association ends

Mult from	[Mult] name (type)	note
1..*	[0..1] ModelingAuthoritySet (ModelingAuthoritySet)	inherited from: IdentifiedObject

6.14.17 Measurement

A Measurement represents any measured, calculated or non-measured non-calculated quantity. Any piece of equipment may contain Measurements, e.g. a substation may have temperature measurements and door open indications, a transformer may have oil temperature and tank pressure measurements, a bay may contain a number of power flow measurements and a Breaker may contain a switch status measurement.

The PSR - Measurement association is intended to capture this use of Measurement and is included in the naming hierarchy based on EquipmentContainer. The naming hierarchy typically has Measurements as 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.

Two possible paths exist:

- 1) Measurement-Terminal- ConnectivityNode-Terminal-ConductingEquipment
- 2) Measurement-Terminal-ConductingEquipment

Alternative 2) is the only allowed use.

When the sensor location is needed both Measurement-PSR and Measurement-Terminal are used. The Measurement-Terminal association is never used alone.

Attributes

name	type	note
mRID	String	inherited from: IdentifiedObject
name	String	inherited from: IdentifiedObject
localName	String	inherited from: IdentifiedObject
pathName	String	inherited from: IdentifiedObject
aliasName	String	inherited from: IdentifiedObject
description	String	inherited from: IdentifiedObject

Association ends

Mult from	[Mult] name (type)	note
0..*	[1] MeasurementType (MeasurementType)	The type for the Measurement.
0..*	[1] MemberOf_PSR (PowerSystemResource)	The PowerSystemResource that contains the Measurement in the naming hierarchy.
0..*	[0..1] Terminal (Terminal)	One or more measurements may be associated with a terminal in the network.
0..*	[1] Unit (Unit)	The Unit for the Measurement.
1..*	[0..1] ModelingAuthoritySet (ModelingAuthoritySet)	inherited from: IdentifiedObject

6.14.18 MeasurementType

Specifies the type of Measurement, e.g. IndoorTemperature, OutDoorTemperature, BusVoltage, GeneratorVoltage, LineFlow etc. The MeasurementType.name shall be unique among all specified types and describe the type. The MeasurementType.aliasName is meant to be used for localization.

Attributes

name	type	note
mRID	String	inherited from: IdentifiedObject
name	String	inherited from: IdentifiedObject
localName	String	inherited from: IdentifiedObject
pathName	String	inherited from: IdentifiedObject
aliasName	String	inherited from: IdentifiedObject
description	String	inherited from: IdentifiedObject

Association ends

Mult from	[Mult] name (type)	note
1	[0..*] Measurements (Measurement)	The measurements associated with the Type
1..*	[0..1] ModelingAuthoritySet (ModelingAuthoritySet)	inherited from: IdentifiedObject

6.14.19 MeasurementValue

The current state for a measurement. A state value is an instance of a measurement from a specific source. Measurements can be associated with many state values, each representing a different source for the measurement.

Attributes

name	type	note
timeStamp	AbsoluteDateTime	The time when the value was last updated
sensorAccuracy	PerCent	The limit, expressed as a percentage of the sensor maximum, that errors will not exceed when the sensor is used under reference conditions
mRID	String	inherited from: IdentifiedObject
name	String	inherited from: IdentifiedObject
localName	String	inherited from: IdentifiedObject
pathName	String	inherited from: IdentifiedObject
aliasName	String	inherited from: IdentifiedObject
description	String	inherited from: IdentifiedObject

Association ends

Mult from	[Mult] name (type)	note
1	[1] MeasurementValueQuality (MeasurementValueQuality)	A MeasurementValue has a MeasurementValueQuality associated with it.
0..*	[1] MeasurementValueSource (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 this document.
1	[0..1] RemoteSource (RemoteSource)	Link to the physical telemetered point associated with this measurement.
1..*	[0..1] ModelingAuthoritySet (ModelingAuthoritySet)	inherited from: IdentifiedObject

6.14.20 MeasurementValueQuality

Measurement quality flags. Bits 0 to 10 are defined for substation automation in IEC 61850-7-3. Bits 11 to 15 are reserved for future expansion by that document. Bits 16 to 31 are reserved for EMS applications.

Attributes

name	type	note
badReference	Boolean	inherited from: Quality61850
estimatorReplaced=false	Boolean	inherited from: Quality61850
failure	Boolean	inherited from: Quality61850
oldData	Boolean	inherited from: Quality61850
operatorBlocked=false	Boolean	inherited from: Quality61850
oscillatory	Boolean	inherited from: Quality61850
outOfRange	Boolean	inherited from: Quality61850
overFlow	Boolean	inherited from: Quality61850
source=PROCESS	Source	inherited from: Quality61850
suspect	Boolean	inherited from: Quality61850
test=false	Boolean	inherited from: Quality61850
validity=GOOD	Validity	inherited from: Quality61850

Association ends

Mult from	[Mult] name (type)	note
1	[1] MeasurementValue (MeasurementValue)	A MeasurementValue has a MeasurementValueQuality associated with it.

6.14.21 MeasurementValueSource

MeasurementValueSource describes the alternative sources updating a MeasurementValue. User conventions for how to use the MeasurementValueSource attributes are described in the introduction to this document.

Attributes

name	type	note
mRID	String	inherited from: IdentifiedObject
name	String	inherited from: IdentifiedObject
localName	String	inherited from: IdentifiedObject
pathName	String	inherited from: IdentifiedObject
aliasName	String	inherited from: IdentifiedObject
description	String	inherited from: IdentifiedObject

Association ends

Mult from	[Mult] name (type)	note
1	[0..*] MeasurementValues (MeasurementValue)	The MeasurementValues updated by the source
1..*	[0..1] ModelingAuthoritySet (ModelingAuthoritySet)	inherited from: IdentifiedObject

6.14.22 Quality61850

Quality flags in this class are as defined in IEC 61850, except for estimatorReplaced, which has been included in this class for convenience.

Attributes

name	type	note
badReference	Boolean	Measurement value may be incorrect due to a reference being out of calibration.
estimatorReplaced=false	Boolean	Value has been replaced by State Estimator. estimatorReplaced is not an IEC 61850 quality bit but has been put in this class for convenience.
failure	Boolean	This identifier indicates that a supervision function has detected an internal or external failure, e.g. communication failure.
oldData	Boolean	Measurement value is old and possibly invalid, as it has not been successfully updated during a specified time interval.
operatorBlocked=false	Boolean	Measurement value is blocked and hence unavailable for transmission.
oscillatory	Boolean	To prevent some overload of the communication, it is sensible to detect and suppress oscillating (fast changing) binary inputs. If a signal changes in a defined time (tosc) twice in the same direction (from 0 to 1 or from 1 to 0) then oscillation is detected and the detail quality identifier "oscillatory" is set. If it is detected, a configured numbers of transient changes could be passed by. In this time the validity status "questionable" is set. If after this defined numbers of changes the signal is still in the oscillating state, the value shall be set either to the opposite state of the previous stable value or to a defined default value. In this case, the validity status "questionable" is reset and "invalid" is set as long as the signal is oscillating. If it is configured such that no transient changes should be passed by, then the validity status "invalid" is set immediately in addition to the detail quality identifier "oscillatory" (used for status information only).
outOfRange	Boolean	Measurement value is beyond a predefined range of value.
overFlow	Boolean	Measurement value is beyond the capability of being represented properly. For example, a counter value overflows from maximum count back to a value of zero.
source=PROCESS	Source	Source gives information related to the origin of a value. The value may be acquired from the process, defaulted or substituted.
suspect	Boolean	A correlation function has detected that the value is not consistent with other values. Typically set by a network State Estimator.
test=false	Boolean	Measurement value is transmitted for test purposes.
validity=GOOD	Validity	Validity of the measurement value.

6.14.23 SetPoint

A SetPoint is an analog control used for supervisory control.

Attributes

name	type	note
value	Float	The value representing the actuator output.
maxValue	Float	Normal value range maximum for any of the Control.value. Used for scaling, e.g. in bar graphs.
minValue	Float	Normal value range minimum for any of the Control.value. Used for scaling, e.g. in bar graphs.
normalValue	Float	Normal value for Control.value e.g. used for percentage scaling.
timeStamp	AbsoluteDateTime	inherited from: Control
operationInProgress	Boolean	inherited from: Control
mRID	String	inherited from: IdentifiedObject
name	String	inherited from: IdentifiedObject
localName	String	inherited from: IdentifiedObject
pathName	String	inherited from: IdentifiedObject
aliasName	String	inherited from: IdentifiedObject
description	String	inherited from: IdentifiedObject

Association ends

Mult from	[Mult] name (type)	note
0..1	[0..1] MeasuredBy_Measurement (Analog)	The Measurement variable used for control
0..*	[1] ControlType (ControlType)	inherited from: Control
1..*	[0..1] ControlledBy_RegulatingCondEq (RegulatingCondEq)	inherited from: Control
1	[0..1] RemoteControl (RemoteControl)	inherited from: Control
0..*	[1] Unit (Unit)	inherited from: Control
1..*	[0..1] ModelingAuthoritySet (ModelingAuthoritySet)	inherited from: IdentifiedObject

6.14.24 StringMeasurement

StringMeasurement represents a measurement with values of type string.

Attributes

name	type	note
mRID	String	inherited from: IdentifiedObject
name	String	inherited from: IdentifiedObject
localName	String	inherited from: IdentifiedObject
pathName	String	inherited from: IdentifiedObject
aliasName	String	inherited from: IdentifiedObject
description	String	inherited from: IdentifiedObject

Association ends

Mult from	[Mult] name (type)	note
1	[1..*] Contains_MeasurementValues (StringMeasurementValue)	The values connected to this Measurement
0..*	[1] MeasurementType (MeasurementType)	inherited from: Measurement
0..*	[1] MemberOf_PSR (PowerSystemResource)	inherited from: Measurement
0..*	[0..1] Terminal (Terminal)	inherited from: Measurement
0..*	[1] Unit (Unit)	inherited from: Measurement
1..*	[0..1] ModelingAuthoritySet (ModelingAuthoritySet)	inherited from: IdentifiedObject

6.14.25 StringMeasurementValue

StringMeasurementValue represents a measurement value of type string.

Attributes

name	type	note
value	String	The value to supervise
timeStamp	AbsoluteDateTime	inherited from: MeasurementValue
sensorAccuracy	PerCent	inherited from: MeasurementValue
mRID	String	inherited from: IdentifiedObject
name	String	inherited from: IdentifiedObject
localName	String	inherited from: IdentifiedObject
pathName	String	inherited from: IdentifiedObject
aliasName	String	inherited from: IdentifiedObject
description	String	inherited from: IdentifiedObject

Association ends

Mult from	[Mult] name (type)	note
1..*	[1] MemberOf_Measurement (StringMeasurement)	Measurement to which this value is connected
1	[1] MeasurementValueQuality (MeasurementValueQuality)	inherited from: MeasurementValue
0..*	[1] MeasurementValueSource (MeasurementValueSource)	inherited from: MeasurementValue
1	[0..1] RemoteSource (RemoteSource)	inherited from: MeasurementValue
1..*	[0..1] ModelingAuthoritySet (ModelingAuthoritySet)	inherited from: IdentifiedObject

6.14.26 Validity enumeration

Validity for MeasurementValue.

Enums

name	note
GOOD	The value is marked good if no abnormal condition of the acquisition function or the information source is detected.
QUESTIONABLE	The value is marked questionable if a supervision function detects an abnormal behaviour, however the value could still be valid. The client is responsible for determining whether or not values marked "questionable" should be used.
INVALID	The value is marked invalid when a supervision function recognizes abnormal conditions of the acquisition function or the information source (missing or non-operating updating devices). The value is not defined under this condition. The mark invalid is used to indicate to the client that the value may be incorrect and shall not be used.

6.14.27 ValueAliasSet

Describes the translation of a set of values into a name and is intended to facilitate custom translations. Each ValueAliasSet has a name, description etc. A specific Measurement may represent a discrete state like Open, Closed, Intermediate etc. This requires a translation from the MeasurementValue.value number to a string, e.g. 0->"Invalid", 1->"Open", 2->"Closed", 3->"Intermediate". Each ValueToAlias member in ValueAliasSet.Value describes a mapping for one particular value to a name.

Attributes

name	type	note
mRID	String	inherited from: IdentifiedObject
name	String	inherited from: IdentifiedObject
localName	String	inherited from: IdentifiedObject
pathName	String	inherited from: IdentifiedObject
aliasName	String	inherited from: IdentifiedObject
description	String	inherited from: IdentifiedObject

Association ends

Mult from	[Mult] name (type)	note
0..1	[0..*] Commands (Command)	The ValueAliasSet used for translation of a Control value to a name
0..1	[0..*] Measurements (Discrete)	The Measurements using the set for translation
1	[1..*] Values (ValueToAlias)	The ValueToAlias mappings included in the set
1..*	[0..1] ModelingAuthoritySet (ModelingAuthoritySet)	inherited from: IdentifiedObject

6.14.28 ValueToAlias

Describes the translation of one particular value into a name, e.g. 1->"Open".

Attributes

name	type	note
value	Integer	The value that is mapped
mRID	String	inherited from: IdentifiedObject
name	String	inherited from: IdentifiedObject
localName	String	inherited from: IdentifiedObject
pathName	String	inherited from: IdentifiedObject
aliasName	String	inherited from: IdentifiedObject
description	String	inherited from: IdentifiedObject

Association ends

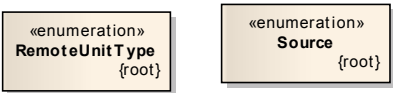
Mult from	[Mult] name (type)	note
1..*	[1] ValueAliasSet (ValueAliasSet)	The ValueAliasSet having the ValueToAlias mappings
1..*	[0..1] ModelingAuthoritySet (ModelingAuthoritySet)	inherited from: IdentifiedObject

6.15 SCADA

6.15.1 SCADA package summary

Contains entities to model information used by supervisory control and data acquisition (SCADA) applications. Supervisory control supports operator control of equipment, such as opening or closing a breaker. Data acquisition gathers telemetered data from various sources. The subtypes of the Telemetry entity deliberately match the UCA and IEC 61850 definitions.

This package also supports alarm presentation but it is not expected to be used by other applications.



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Figure 65 – Datatypes

Figure 65 is not documented.

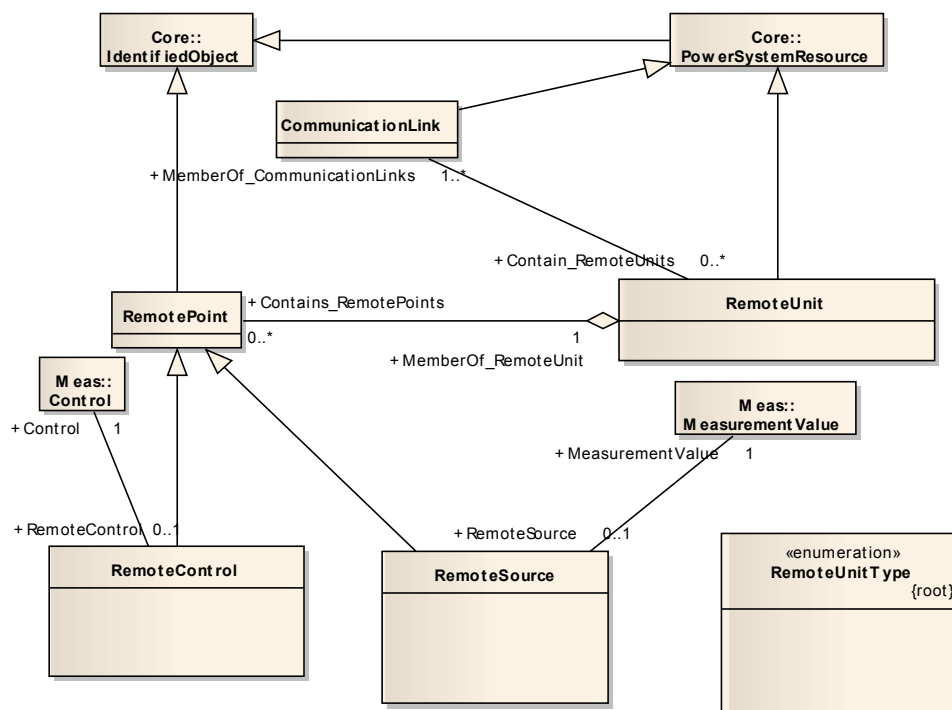


Figure 66 – Main

Figure 66 is documented as follows. This diagram shows all classes included in the SCADA package as well as the key external classes that have associations with SCADA classes.

6.15.2 CommunicationLink

The connection to remote units is through one or more communication links. Redundant links may exist. The CommunicationLink class inherits PowerSystemResource. The intention is to allow CommunicationLinks to have Measurements. These Measurements can be used to model link status as operational, out of service, unit failure etc.

Attributes

name	type	note
mRID	String	inherited from: IdentifiedObject
name	String	inherited from: IdentifiedObject
localName	String	inherited from: IdentifiedObject
pathName	String	inherited from: IdentifiedObject
aliasName	String	inherited from: IdentifiedObject
description	String	inherited from: IdentifiedObject

Association ends

Mult from	[Mult] name (type)	note
1..*	[0..*] Contain_RemoteUnits (RemoteUnit)	RTUs may be attached to communication links.
0..*	[0..*] OperatedBy_Companies (Company)	inherited from: PowerSystemResource
1	[0..*] Contains_Measurements (Measurement)	inherited from: PowerSystemResource

1	[0..*] OperatingShare (OperatingShare)	inherited from: PowerSystemResource
1	[0..1] OutageSchedule (OutageSchedule)	inherited from: PowerSystemResource
0..*	[0..*] PsrLists (PsrList)	inherited from: PowerSystemResource
0..*	[0..1] PSRTYPE (PSRTYPE)	inherited from: PowerSystemResource
0..*	[0..*] ReportingGroup (ReportingGroup)	inherited from: PowerSystemResource
1..*	[0..1] ModelingAuthoritySet (ModelingAuthoritySet)	inherited from: IdentifiedObject

6.15.3 RemoteControl

Remote controls are outputs that are sent by the remote unit to actuators in the process.

Attributes

name	type	note
remoteControlled	Boolean	Set to true if the actuator is remotely controlled
actuatorMaximum	Float	The maximum set point value accepted by the remote control point
actuatorMinimum	Float	The minimum set point value accepted by the remote control point
mRID	String	inherited from: IdentifiedObject
name	String	inherited from: IdentifiedObject
localName	String	inherited from: IdentifiedObject
pathName	String	inherited from: IdentifiedObject
aliasName	String	inherited from: IdentifiedObject
description	String	inherited from: IdentifiedObject

Association ends

Mult from	[Mult] name (type)	note
0..1	[1] Control (Control)	The Control for the RemoteControl point.
0..*	[1] MemberOf_RemoteUnit (RemoteUnit)	inherited from: RemotePoint
1..*	[0..1] ModelingAuthoritySet (ModelingAuthoritySet)	inherited from: IdentifiedObject

6.15.4 RemotePoint

For a RTU remote points correspond to telemetered values or control outputs. Other units (e.g. control centers) usually also contain calculated values.

Attributes

name	type	note
mRID	String	inherited from: IdentifiedObject
name	String	inherited from: IdentifiedObject
localName	String	inherited from: IdentifiedObject
pathName	String	inherited from: IdentifiedObject
aliasName	String	inherited from: IdentifiedObject
description	String	inherited from: IdentifiedObject

Association ends

Mult from	[Mult] name (type)	note
0..*	[1] MemberOf_RemoteUnit (RemoteUnit)	Remote unit this point belongs to
1..*	[0..1] ModelingAuthoritySet (ModelingAuthoritySet)	inherited from: IdentifiedObject

6.15.5 RemoteSource

Remote sources are state variables that are telemetered or calculated within the remote unit.

Attributes

name	type	note
sensorMaximum	Float	The maximum value the telemetry item can return
sensorMinimum	Float	The minimum value the telemetry item can return
scanInterval	Seconds	The time interval between scans
deadband	Float	The smallest change in value to be reported
mRID	String	inherited from: IdentifiedObject
name	String	inherited from: IdentifiedObject
localName	String	inherited from: IdentifiedObject
pathName	String	inherited from: IdentifiedObject
aliasName	String	inherited from: IdentifiedObject
description	String	inherited from: IdentifiedObject

Association ends

Mult from	[Mult] name (type)	note
0..1	[1] MeasurementValue (MeasurementValue)	Link to the physical telemetered point associated with this measurement
0..*	[1] MemberOf_RemoteUnit (RemoteUnit)	inherited from: RemotePoint
1..*	[0..1] ModelingAuthoritySet (ModelingAuthoritySet)	inherited from: IdentifiedObject

6.15.6 RemoteUnit

A remote unit can be a RTU, IED, substation control system, control center etc. The communication with the remote unit can be through various standard protocols (e.g. IEC 61850) or non standard protocols (e.g. DNP, RP570 etc.). A remote unit contain remote data points that might be telemetered, collected or calculated. The RemoteUnit class inherit PowerSystemResource. The intention is to allow RemotUnits to have Measurements. These Measurements can be used to model unit status as operational, out of service, unit failure etc.

Attributes

name	type	note
remoteUnitType	RemoteUnitType	Type of remote unit
mRID	String	inherited from: IdentifiedObject
name	String	inherited from: IdentifiedObject
localName	String	inherited from: IdentifiedObject
pathName	String	inherited from: IdentifiedObject
aliasName	String	inherited from: IdentifiedObject

description	String	inherited from: IdentifiedObject
-------------	--------	----------------------------------

Association ends

Mult from	[Mult] name (type)	note
0..*	[1..*] MemberOf_CommunicationLinks (CommunicationLink)	RTUs may be attached to communication links.
1	[0..*] Contains_RemotePoints (RemotePoint)	Remote points this Remote unit contains.
0..*	[0..*] OperatedBy_Companies (Company)	inherited from: PowerSystemResource
1	[0..*] Contains_Measurements (Measurement)	inherited from: PowerSystemResource
1	[0..*] OperatingShare (OperatingShare)	inherited from: PowerSystemResource
1	[0..1] OutageSchedule (OutageSchedule)	inherited from: PowerSystemResource
0..*	[0..*] PsrLists (PsrList)	inherited from: PowerSystemResource
0..*	[0..1] PSRType (PSRType)	inherited from: PowerSystemResource
0..*	[0..*] ReportingGroup (ReportingGroup)	inherited from: PowerSystemResource
1..*	[0..1] ModelingAuthoritySet (ModelingAuthoritySet)	inherited from: IdentifiedObject

6.15.7 RemoteUnitType enumeration

Type of remote unit.

Enums

name	note
RTU	
SubstationControlSystem	
ControlCenter	
IED	

6.15.8 Source enumeration

Source gives information related to the origin of a value.

Enums

name	note
PROCESS	The value is provided by input from the process I/O or being calculated from some function.
DEFAULTED	The value contains a default value.
SUBSTITUTED	The value is provided by input of an operator or by an automatic source.

6.16 ControlArea

6.16.1 ControlArea package summary

The ControlArea package models area specifications which can be used for a variety of purposes. The package as a whole models potentially overlapping control area specifications for the purpose of actual generation control, load forecast area load capture, or powerflow based analysis.

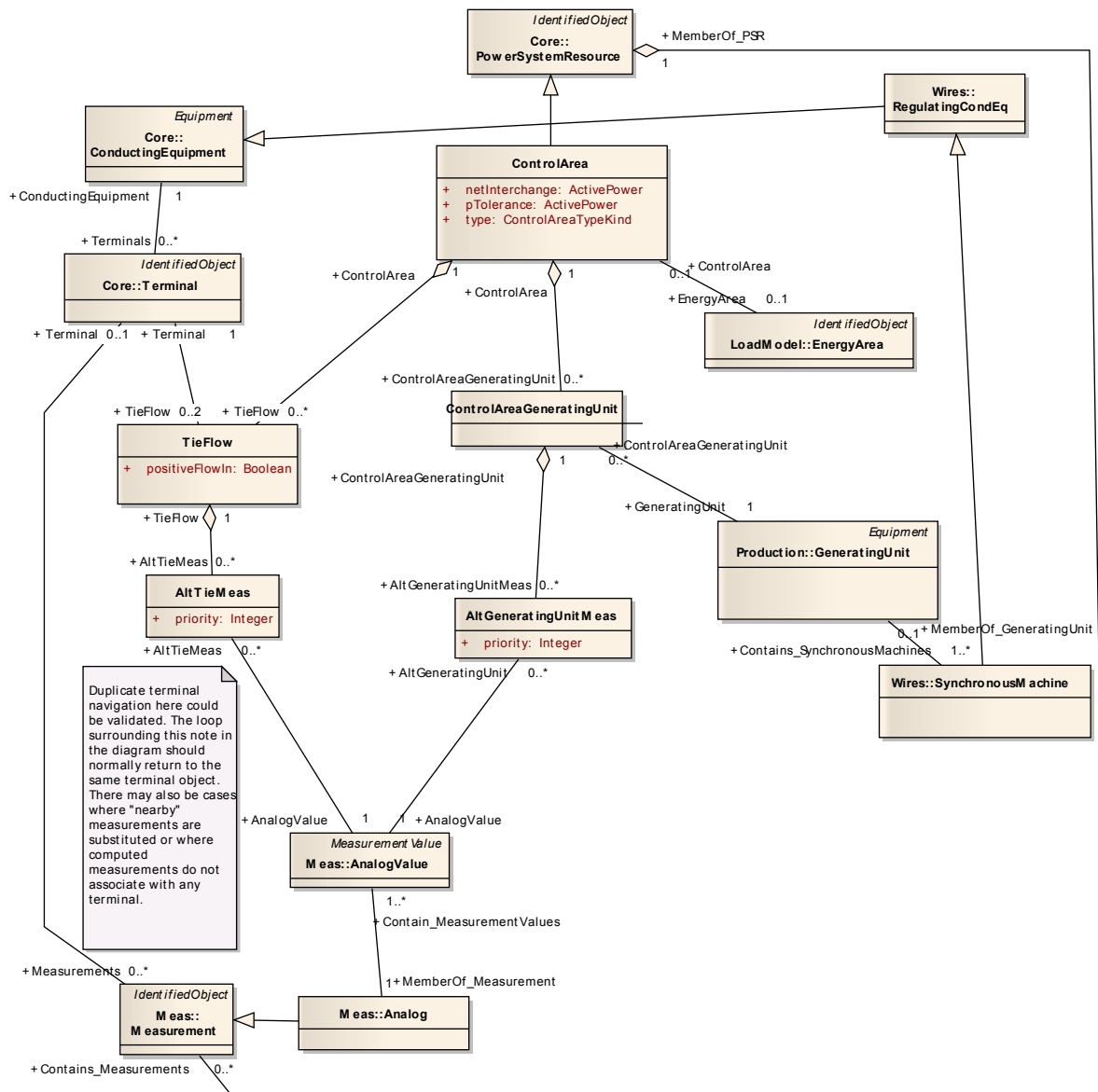


Figure 67 – ControlArea

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Figure 67 is documented as follows. This diagram shows control area specification and some related classes. The Terminal to AnalogValue linkages are shown for clarity in understanding the control area specification. The GeneratingUnit to Terminal linkages are also shown to illustrate how generation flows are specifically tied to the network.

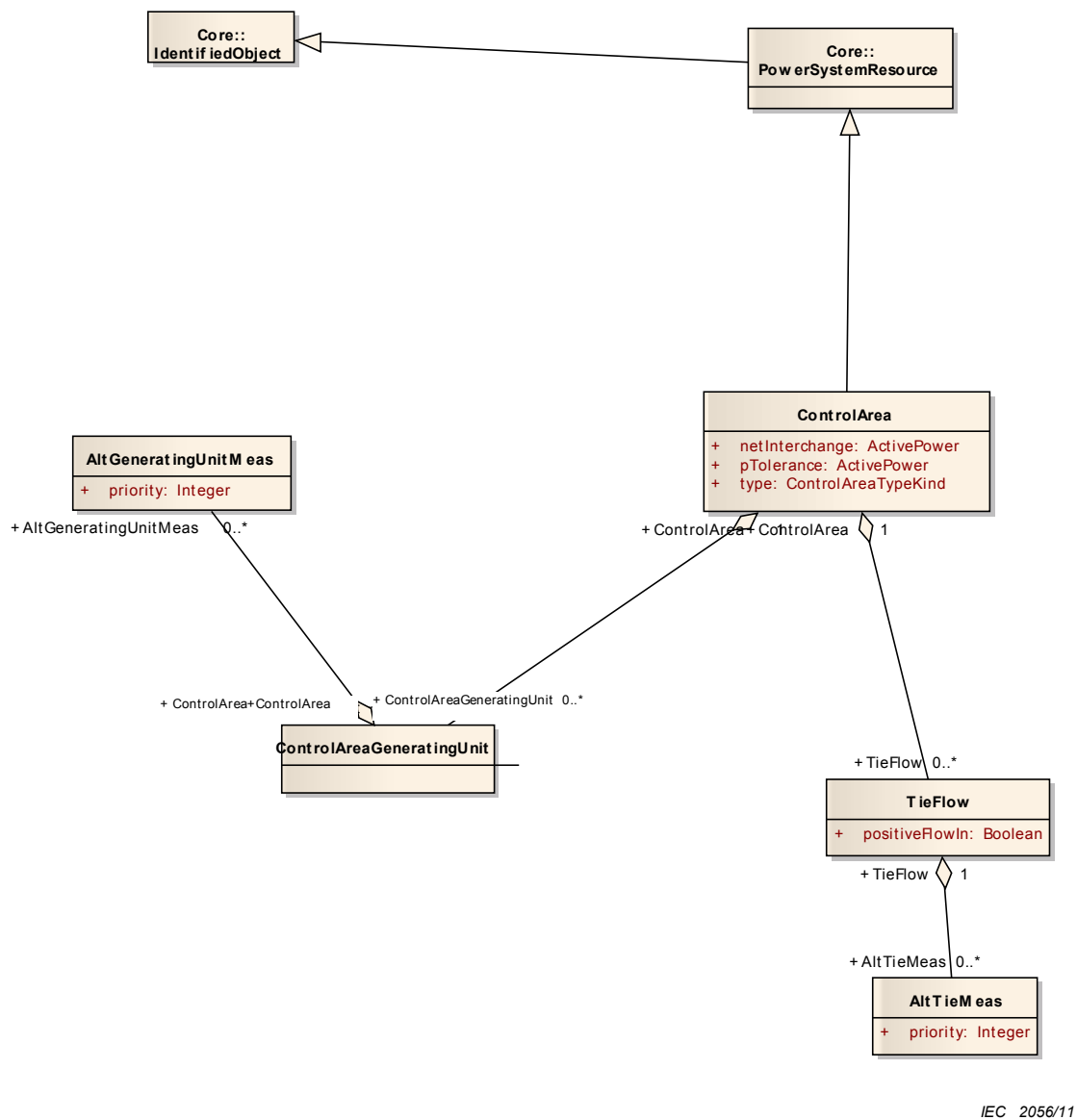


Figure 68 – ControlAreaInheritance

Figure 68 is documented as follows. Shows the inheritance of classes in this package.

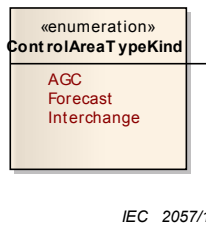


Figure 69 – Datatypes

Figure 69 is not documented.

6.16.2 AltGeneratingUnitMeas

A prioritized measurement to be used for the generating unit in the control area specificaiton.

Attributes

name	type	note
priority	Integer	Priority of a measurement usage. Lower numbers have first priority.

Association ends

Mult from	[Mult] name (type)	note
0..*	[1] AnalogValue (AnalogValue)	The specific analog value used as a source
0..*	[1] ControlAreaGeneratingUnit (ControlAreaGeneratingUnit)	The control area generating unit to which the prioritized measurement assignment is applied

6.16.3 AltTieMeas

A prioritized measurement to be used for the tie flow as part of the control area specification.

Attributes

name	type	note
priority	Integer	Priority of a measurement usage. Lower numbers have first priority.

Association ends

Mult from	[Mult] name (type)	note
0..*	[1] AnalogValue (AnalogValue)	The specific analog value used as a source
0..*	[1] TieFlow (TieFlow)	The tie flow of the alternate measurements

6.16.4 ControlArea

A control area is a grouping of generating units and/or loads and a cutset of tie lines (as terminals) which may be used for a variety of purposes including automatic generation control, 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.

Attributes

name	type	note
netInterchange	ActivePower	The specified positive net interchange into the control area
pTolerance	ActivePower	Active power net interchange tolerance
type	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
mRID	String	inherited from: IdentifiedObject
name	String	inherited from: IdentifiedObject
localName	String	inherited from: IdentifiedObject
pathName	String	inherited from: IdentifiedObject
aliasName	String	inherited from: IdentifiedObject
description	String	inherited from: IdentifiedObject

Association ends

Mult from	[Mult] name (type)	note
0..1	[0..*] BusNameMarker (BusNameMarker)	BusNameMarker objects that belong to the control area
1	[0..*] ControlAreaGeneratingUnit (ControlAreaGeneratingUnit)	The generating unit specifications for the control area
0..1	[0..1] EnergyArea (EnergyArea)	The energy area that is forecast from this control area specification
1	[0..*] TieFlow (TieFlow)	The tie flows associated with the control area
0..1	[0..*] TopologicalNode (TopologicalNode)	The topological nodes included in the control area
0..*	[0..*] OperatedBy_Companies (Company)	inherited from: PowerSystemResource
1	[0..*] Contains_Measurements (Measurement)	inherited from: PowerSystemResource
1	[0..*] OperatingShare (OperatingShare)	inherited from: PowerSystemResource
1	[0..1] OutageSchedule (OutageSchedule)	inherited from: PowerSystemResource
0..*	[0..*] PsrLists (PsrList)	inherited from: PowerSystemResource
0..*	[0..1] PSRTtype (PSRTtype)	inherited from: PowerSystemResource
0..*	[0..*] ReportingGroup (ReportingGroup)	inherited from: PowerSystemResource
1..*	[0..1] ModelingAuthoritySet (ModelingAuthoritySet)	inherited from: IdentifiedObject

6.16.5 ControlAreaGeneratingUnit

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.

Association ends

Mult from	[Mult] name (type)	note
1	[0..*] AltGeneratingUnitMeas (AltGeneratingUnitMeas)	The link to prioritized measurements for this GeneratingUnit.
0..*	[1] ControlArea (ControlArea)	The parent control area for the generating unit specifications.
0..*	[1] GeneratingUnit (GeneratingUnit)	The generating unit specified for this control area. Note that a control area should include a GeneratingUnit only once.

6.16.6 ControlAreaTypeKind enumeration

The type of control area.

Enums

name	note
AGC	Used for automatic generation control
Forecast	Used for load forecast
Interchange	Used for interchange specification or control

6.16.7 TieFlow

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

Attributes

name	type	note
positiveFlowIn	Boolean	The flow is positive into the terminal. A flow is positive if it is an import into the control area.

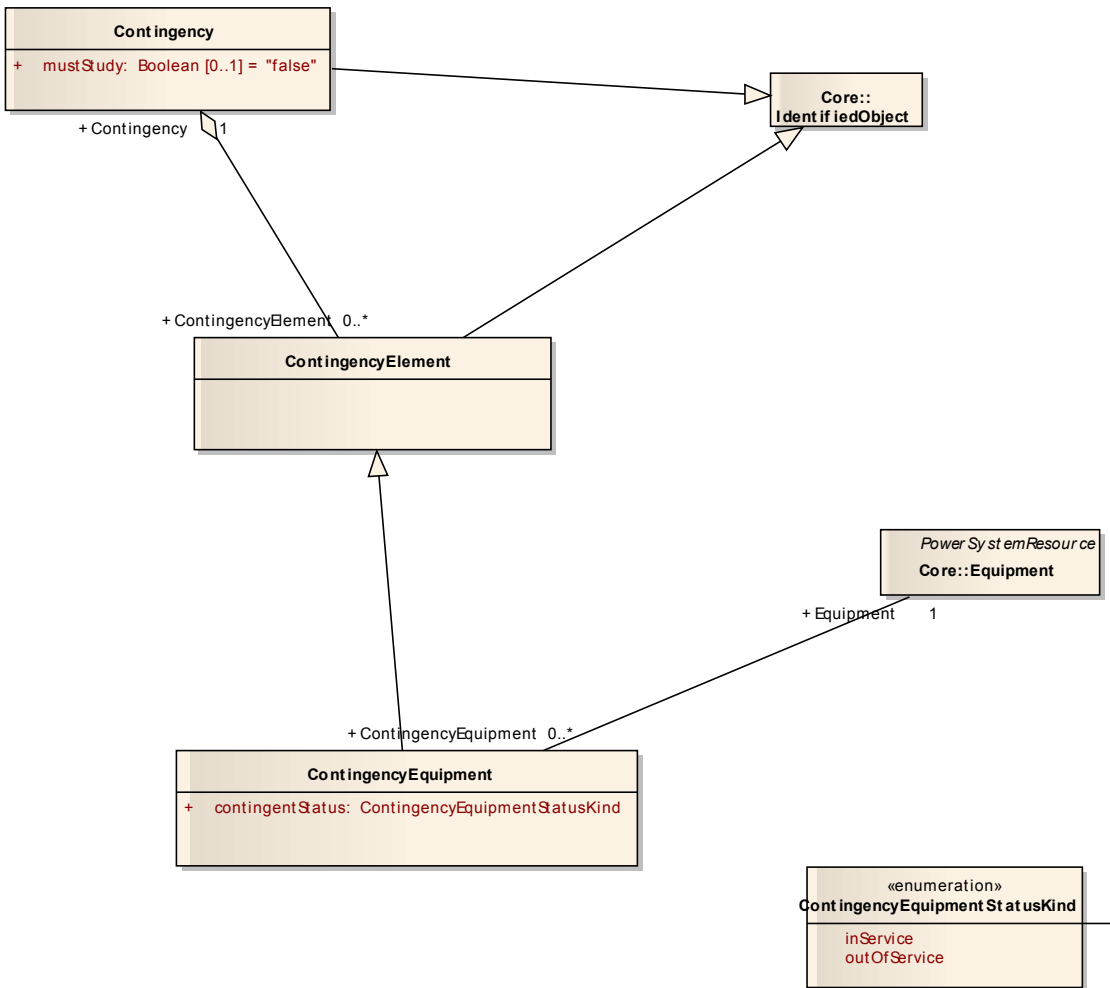
Association ends

Mult from	[Mult] name (type)	note
1	[0..*] AltTieMeas (AltTieMeas)	The primary and alternate tie flow measurements associated with the tie flow
0..*	[1] ControlArea (ControlArea)	The control area of the tie flows
0..2	[1] Terminal (Terminal)	The terminal to which this tie flow belongs

6.17 Contingency

6.17.1 Contingency package summary

Contingencies to be studied.



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Figure 70 – Contingency

Figure 70 is not documented.

6.17.2 Contingency

An event threatening system reliability, consisting of one or more contingency elements.

Attributes

name	type	note
mustStudy="false"	Boolean	Set true if must study this contingency
mRID	String	inherited from: IdentifiedObject
name	String	inherited from: IdentifiedObject
localName	String	inherited from: IdentifiedObject
pathName	String	inherited from: IdentifiedObject
aliasName	String	inherited from: IdentifiedObject
description	String	inherited from: IdentifiedObject

Association ends

Mult from	[Mult] name (type)	note
1	[0..*] ContingencyElement (ContingencyElement)	A contingency can have any number of contingency elements.
1..*	[0..1] ModelingAuthoritySet (ModelingAuthoritySet)	inherited from: IdentifiedObject

6.17.3 ContingencyElement

An element of a system event to be studied by contingency analysis, representing a change in status of a single piece of equipment.

Attributes

name	type	note
mRID	String	inherited from: IdentifiedObject
name	String	inherited from: IdentifiedObject
localName	String	inherited from: IdentifiedObject
pathName	String	inherited from: IdentifiedObject
aliasName	String	inherited from: IdentifiedObject
description	String	inherited from: IdentifiedObject

Association ends

Mult from	[Mult] name (type)	note
0..*	[1] Contingency (Contingency)	A contingency element belongs to one contingency.
1..*	[0..1] ModelingAuthoritySet (ModelingAuthoritySet)	inherited from: IdentifiedObject

6.17.4 ContingencyEquipment

A equipment to which the in service status is to change such as a power transformer or AC line segment.

Attributes

name	type	note
contingentStatus	ContingencyEquipmentStatusKind	The status for the associated equipment when in the contingency state. This status is independent of the case to which the contingency is originally applied, but defines the equipment status when the contingency is applied.
mRID	String	inherited from: IdentifiedObject
name	String	inherited from: IdentifiedObject
localName	String	inherited from: IdentifiedObject
pathName	String	inherited from: IdentifiedObject
aliasName	String	inherited from: IdentifiedObject
description	String	inherited from: IdentifiedObject

Association ends

Mult from	[Mult] name (type)	note
0..*	[1] Equipment (Equipment)	The single piece of equipment to which to apply the contingency
0..*	[1] Contingency (Contingency)	inherited from: ContingencyElement
1..*	[0..1] ModelingAuthoritySet (ModelingAuthoritySet)	inherited from: IdentifiedObject

6.17.5 ContingencyEquipmentStatusKind enumeration

Indicates the state which the contingency equipment is to be in when the contingency is applied.

Enums

name	note
inService	The equipment is in service.
outOfService	The equipment is to be taken out of service.

Bibliography

IEC 60050 (all parts), *International Electrotechnical Vocabulary*

IEC 61850-7-3, *Communication networks and systems for power utility automation – Part 7-3: Basic communication structure – Common data classes*

NOTE Harmonized as EN 61850-7-3.

IEC 61968-11:2010, *Application integration at electric utilities – System interfaces for distribution management – Part 11: Common information model (CIM) extensions for distribution*

NOTE Harmonized as EN 61968-11:2010 (not modified).

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

NOTE Harmonized as EN 61970-501.

RP-3654-1 EPRI Control Center API (CCAPI) research project

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W3C: RDF/XML Syntax Specification [cited 2011-03-07], Available from Internet <http://www.w3.org/RDF/>

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<http://www.w3.org/XML/>

Annex ZA (normative)

Normative references to international publications with their corresponding European publications

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

NOTE When an international publication has been modified by common modifications, indicated by (mod), the relevant EN/HD applies.

<u>Publication</u>	<u>Year</u>	<u>Title</u>	<u>EN/HD</u>	<u>Year</u>
IEC 61850	Series	Communication networks and systems in substations	EN 61850	Series
IEC 61850-7-4	2010	Communication networks and systems for power utility automation – Part 7-4: Basic communication structure – Compatible logical node classes and data object classes	EN 61850-7-4	2010
IEC 61968	Series	Application integration at electric utilities – System interfaces for distribution management	EN 61968	Series
IEC/TS 61970-2	–	Energy management system application program interface (EMS-API) – Part 2: Glossary	CLC/TS 61970-2	–
ISO 8601	2004	Data elements and interchange formats – Information interchange – Representation of dates and times	–	–