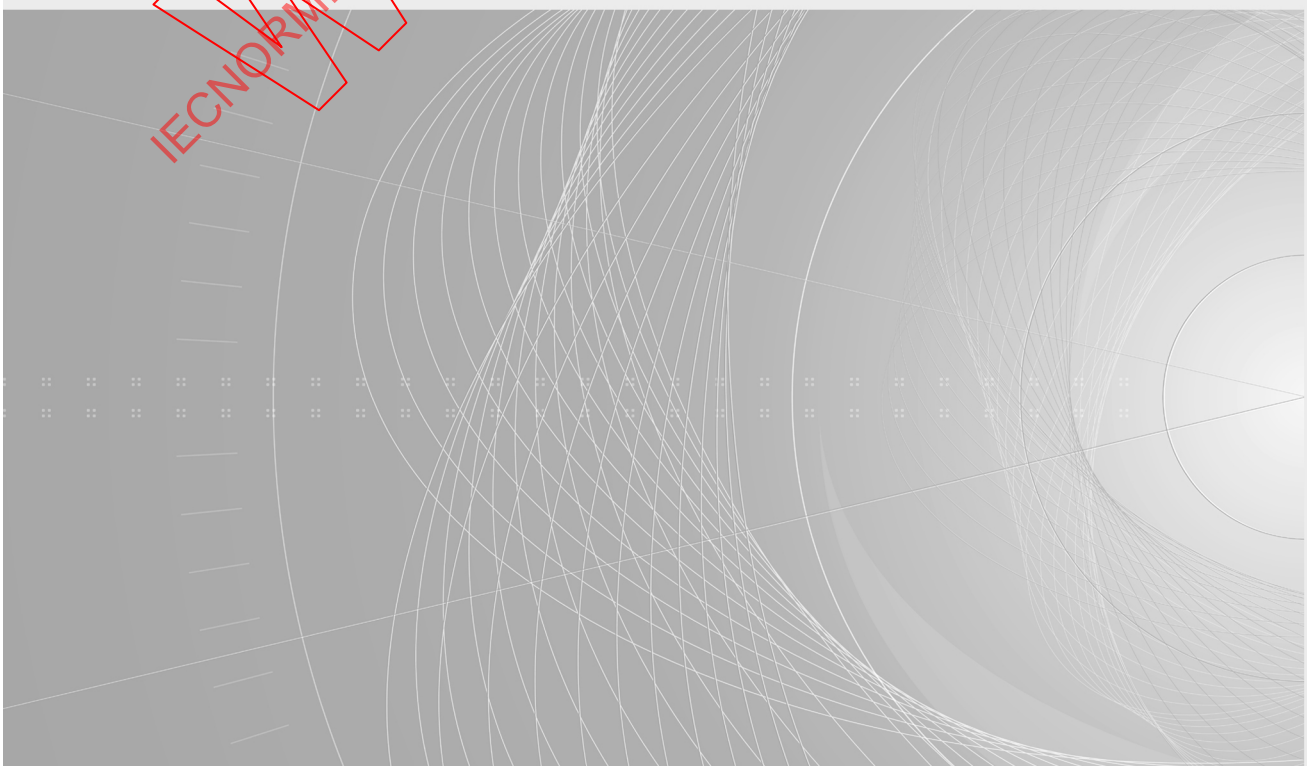
IEC 61970-301

Edition 2.0 2009-04

INTERNATIONAL STANDARD

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



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CONTENTS

INTERNATIONAL ELECTROTECHNICAL COMMISSION

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

Part 301: Common information model (CIM) base

FOREWORD

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

This second edition cancels and replaces the first edition published in 2005. This edition constitutes a technical revision [1].

The second edition contains the following changes from the first edition:

- First edition Annex A which contained the description of the CIM UML model is now a part of the main body of the standard – Clauses 5 and 6.

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[1] Note that the third edition with the updates made to the CIM UML model in 2007 will be available shortly after publication of this second edition. For the third edition of this publication the units will be based on the "International System of Units" (SI).

- A new Annex A was added providing a model of a circuit breaker in the CIM as an example of how the CIM can be used to model network devices.
- Significantly reorganized and expanded Subclause 4.4 Examples to explain:
  - Containment, equipment hierarchies, connectivity, and naming
  - Measurements and controls
  - Role of the new IdentifiedObject class, which replaces the old Naming class.
- The naming hierarchy was changed. New classes GeographicalRegion and SubGeographicalRegion replaced HostControlArea and SubControlArea.
- ModelingAuthority and ModelingAuthoritySet classes were added to represent ownership of models. A ModelingAuthority is a role responsible for a model and is used to break down a large model in manageable pieces with clear ownership.
- A new schedules data model was added to replace the use of the curve model for time series data. New base classes IrregularSchedule and RegularSchedule replaced the class CurveSchedule.
- The measurement value attributes were sub-typed into classes Analog, Discrete and Accumulator.
- The class naming was renamed to IdentifiedObject.
- The Line class was changed to be a specialization of the classes Equipment and EquipmentContainer, so that Line is now a container able to contain all necessary objects to model multiple interconnected ACLineSegments as found in the real world.
- Many editorial corrections, including several cardinality and attribute changes to resolve issues submitted on the first edition.

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

FDIS	Report on voting
57/986/FDIS	57/995/RVD

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

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

The committee has decided that the contents of this publication will remain unchanged until the maintenance result date indicated on the IEC web site under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

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

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

INTRODUCTION

This standard is one 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.

IEC 61970-301 defines the CIM base set of packages which provide a logical view of the physical aspects of an energy management system including SCADA (Supervisory Control and Data Acquisition). IEC 61968 series of standards describes additional parts of the CIM that deal with other logical views of utility operations including assets, location, activities, documentation, and work management. However, 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 standards documents.

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.

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

The holder of this patent right has assured IEC that it is willing to negotiate licences under reasonable and non-discriminatory terms and conditions with applicants throughout the world. In this respect, the statement of the holders of these patent rights is registered with IEC. Information may be obtained from:

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Attention is drawn to the possibility that some of the elements of this standard may be the subject of patent rights other than those identified above. IEC shall not be held responsible for identifying any or all such patent rights.

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

Part 301: Common information model (CIM) base

1 Scope

The common information model (CIM) is an abstract model that represents all the major objects in an electric utility enterprise typically involved in utility operations. By providing a standard way of representing power system resources as object classes and attributes, along with their relationships, the CIM facilitates the integration 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 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.

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.

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 physical 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 below provides the current grouping of packages into standards 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 60870 (all parts), *Telecontrol equipment and systems*

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

IEC 61850-7-3, *Communication networks and systems in substations – Part 7-3: Basic communication structure for substation and feeder equipment – Common data classes*

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

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

IEEE 754-1985, Standard for Binary Floating-Point Arithmetic

3 Terms, definitions and abbreviations

For the purposes of this document, the terms and definitions given in Clause 6 and the following apply. Refer to IEC 60050 for general glossary definitions and to IEC 61970-2 for a glossary specific to the IEC 61970 standards.

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

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 the following packages for convenience, where packages are grouped to be handled as a single standard document as shown:

IEC 61970- 301 (this document):

- Core
- Domain
- Generation
- Generation Dynamics
- LoadModel

- Meas
- Outage
- Production
- Protection
- Topology
- Wires
- SCADA

Note that the package boundaries do not imply application boundaries. An application may use CIM entities from several packages.

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.

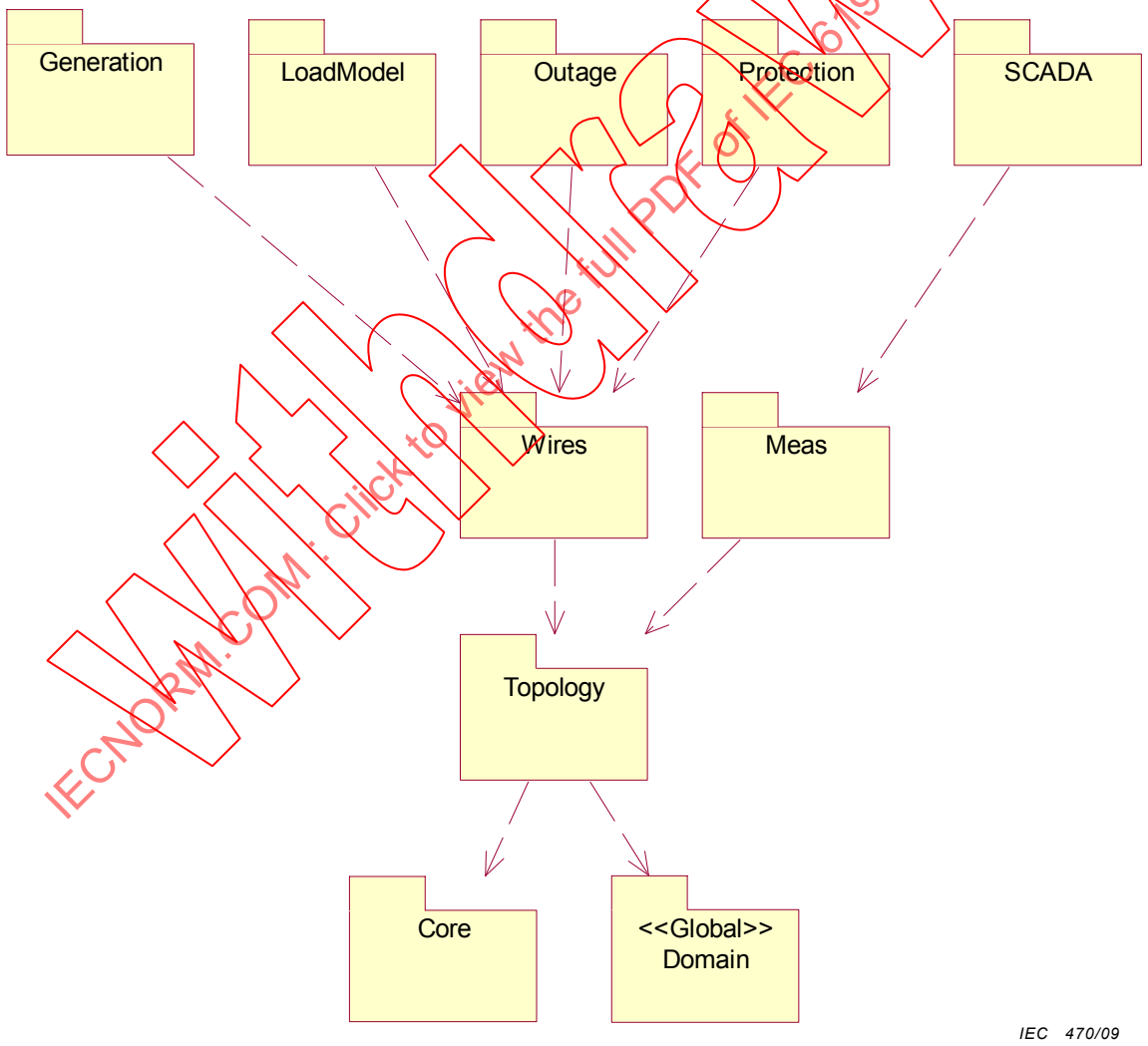

Figure 1 – CIM Part 301 package diagram

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

4.2.1 Core

This package contains the core Naming, PowerSystemResource, EquipmentContainer, 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, but most of the other packages have associations and generalizations that depend on it.

4.2.2 Topology

This package is 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.

4.2.3 Wires

The Wires package is 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.

4.2.4 Outage

This package is 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.

4.2.5 Protection

This package is 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.

4.2.6 Meas

The Meas package contains entities that describe dynamic measurement data exchanged between applications.

4.2.7 LoadModel

This package provides models for the energy consumers and the system load as curves and associated curve data. Special circumstances that may affect the load, such as seasons and day types, are also included here.

This information is used by Load Forecasting and Load Management.

4.2.8 Generation

The Generation package is divided into two subpackages: Production and GenerationDynamics.

4.2.8.1 Production

This package provides models for various kinds of generators. It also models production costing information which is used to economically allocate demand among committed units and calculate reserve quantities.

This information is used by Unit Commitment and Economic Dispatch of Hydro and Thermal Generating Units, Load Forecasting, and Automatic Generation Control applications.

4.2.8.2 Generation Dynamics

This package provides models for prime movers, such as turbines and boilers, which are needed for simulation and educational purposes.

This information is used by the Unit Modeling for Dynamic Training Simulator applications.

4.2.9 SCADA

The SCADA package contains models of data points located in remote units, such as RTUs, substation control systems, and remote control centers, as well as the communications links to the remote units, to the extent necessary to support power system simulation (specifically the effect of telemetry outages) and inter-control center communications.

4.2.10 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. Permissible values for enumerations are listed in the documentation for the attribute using UML constraint syntax inside curly braces. String lengths are listed in the documentation and are also specified as a length property.

4.3 CIM classes and relationships

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 other than default create, delete, update and read. 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,

Compensator has a MaximumkV attribute of type voltage. The definition of data types is contained in the Domain Package described in 4.2.10.

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 clauses below.

4.3.1 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 Power Transformer 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.

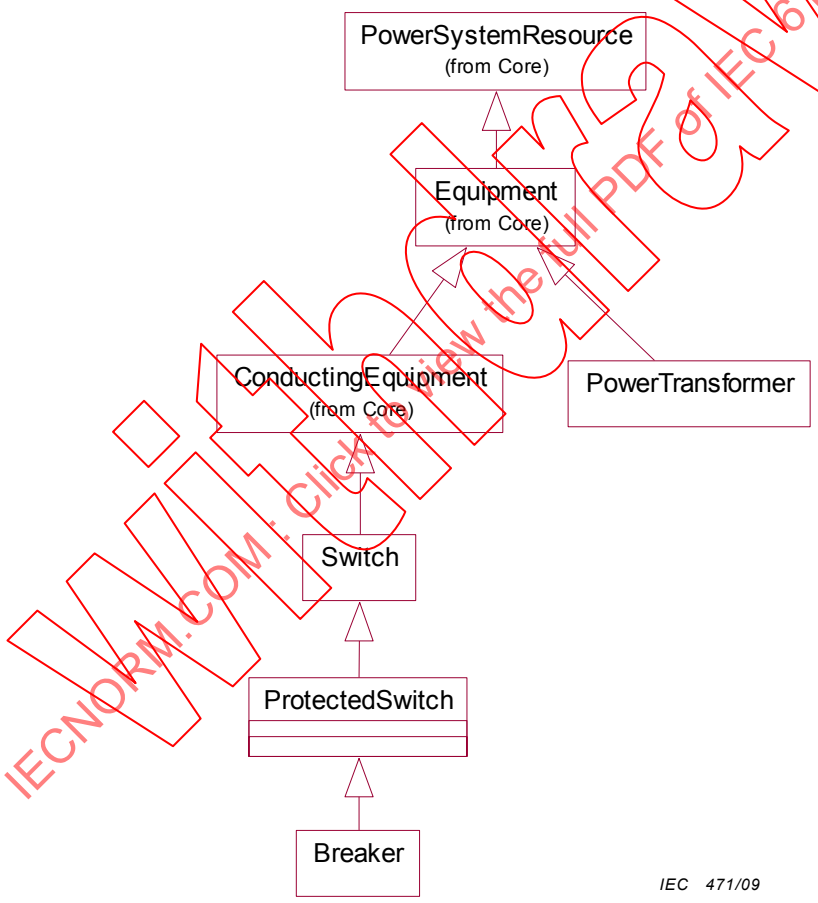

Figure 2 – Example of generalization

4.3.2 Simple association

An association is a conceptual connection between classes. Each association has two roles. Each role is a direction on the association that describes the role the target class (i.e. the class the role goes *to*) has in relation to the source class (i.e. the class the role goes *from*). Roles are given the name of the target class with or without a verb phrase. Each role 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.

For example, in the CIM there is an association between a TapChanger and a RegulationSchedule (see Figure 3 which is taken from the Wires package).

Multiplicity is shown at both ends of the association. In this example, a TapChanger object may have 0 or 1 RegulationSchedules, and a RegulationSchedule may belong to 0, 1, or more TapChanger objects.

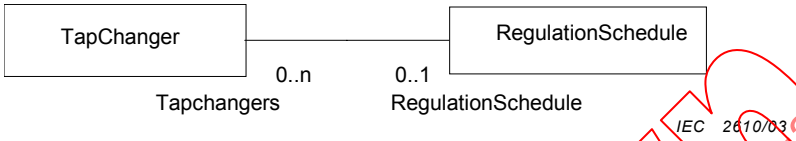

Figure 3 – Example of simple association

4.3.3 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 TopologicalIsland class and the TopologicalNode class, which is taken from the Topology package. As shown, a TopologicalNode can be a member of exactly one TopologicalIsland, but a TopologicalIsland can contain any number (but at least one) of TopologicalNodes.

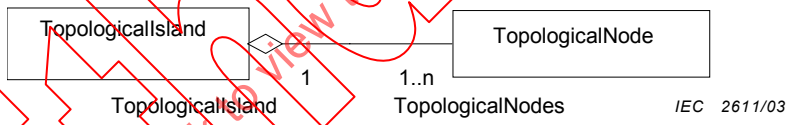

Figure 4 – Example of aggregation

4.4 CIM Model concepts and examples

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. First is the concept of equipment containment and how the hierarchical structure of power systems is modeled. The second illustrates the important concept of connectivity and how it is modeled in the CIM. Third is the use of inheritance to model and classify equipment. Next is an example or a Transformer to show how a specific type of equipment is modeled in the CIM. Lastly the concept of measurements and how they are used to model status and analog values associated with power system networks.

4.4.1 Containment, equipment hierarchies and naming

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. 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).

4.4.1.1 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 must 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.

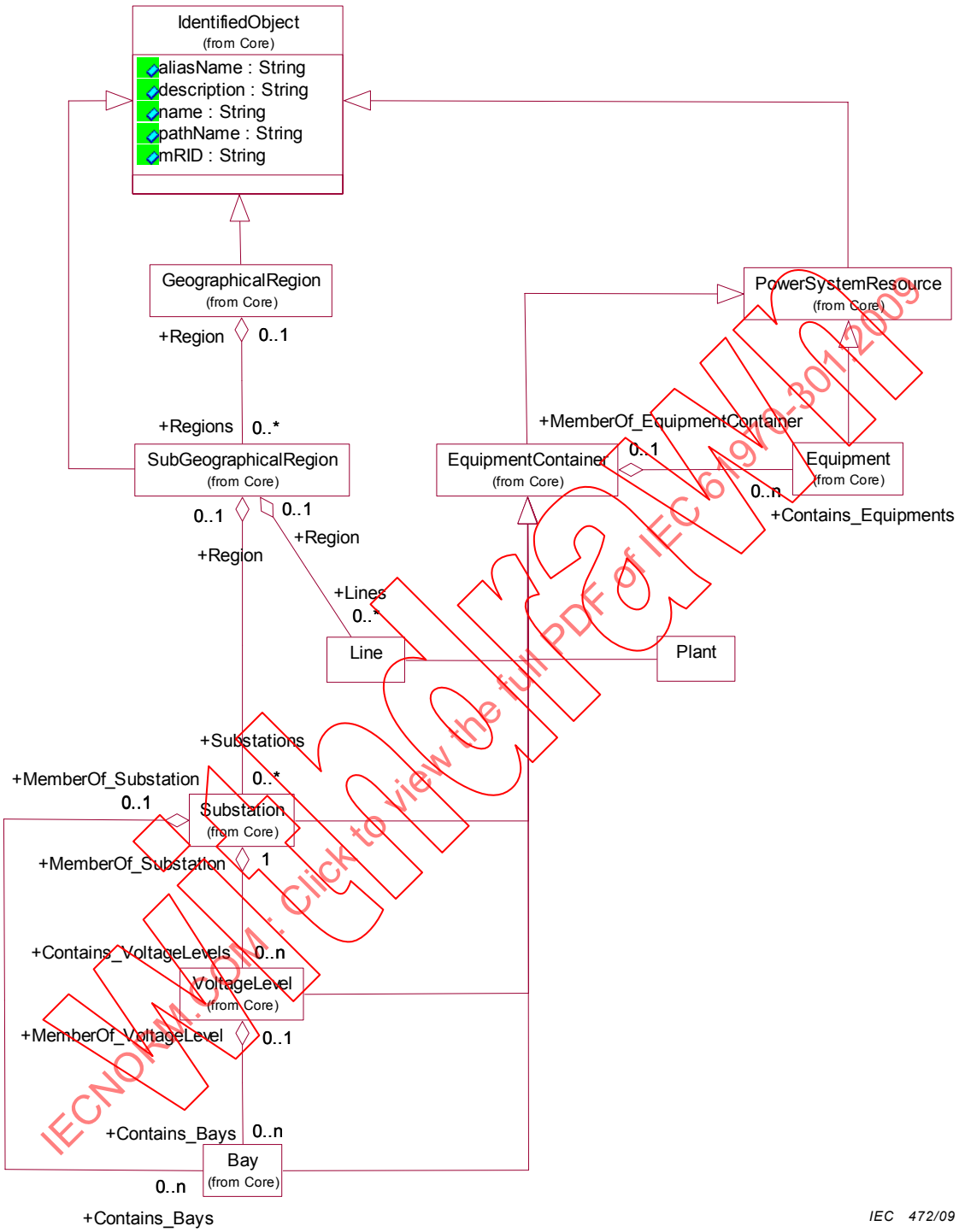

Figure 5 – Equipment containers

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).

4.4.2 Connectivity model

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.

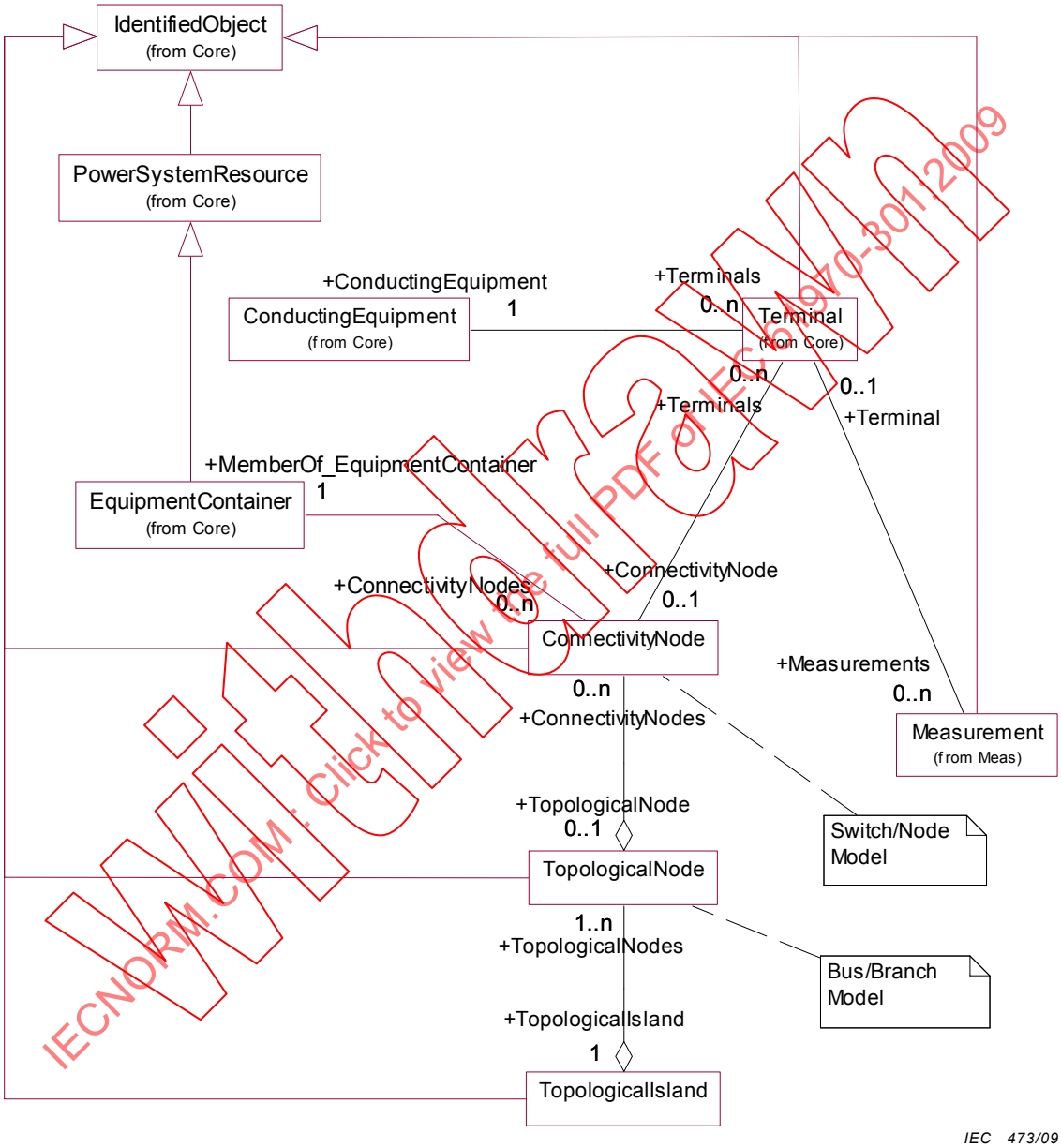

Figure 6 – Connectivity model

To model connectivity, Terminal and Connectivity 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.

EquipmentContainers, which are a specialization of a PowerSystemResource, 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 ConectivityNode identify the ConductingEquipment object(s) that are electrically connected.

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.

4.4.2.1 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.

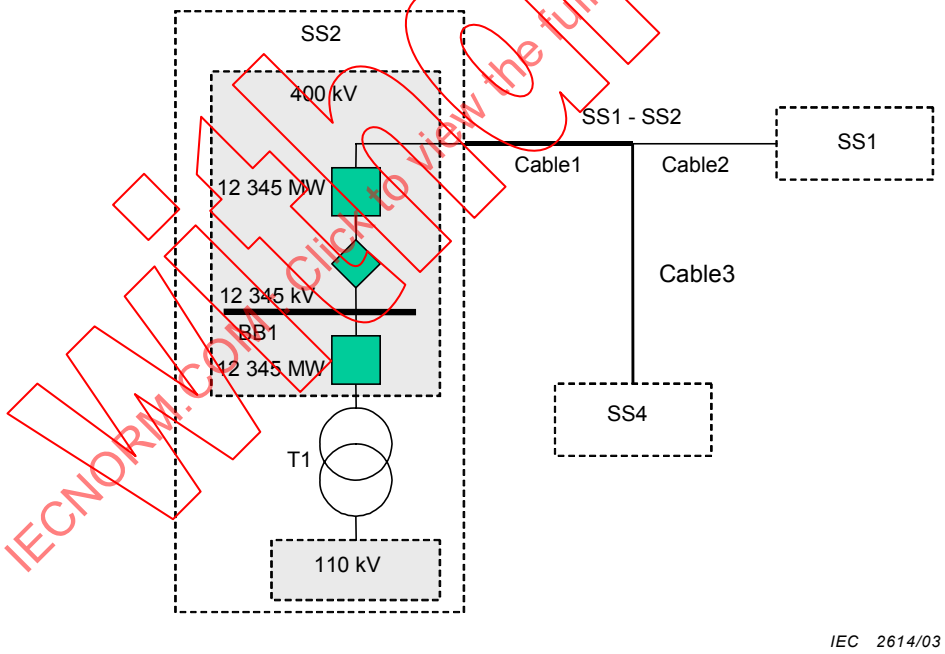

Figure 7 – Simple network example

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.

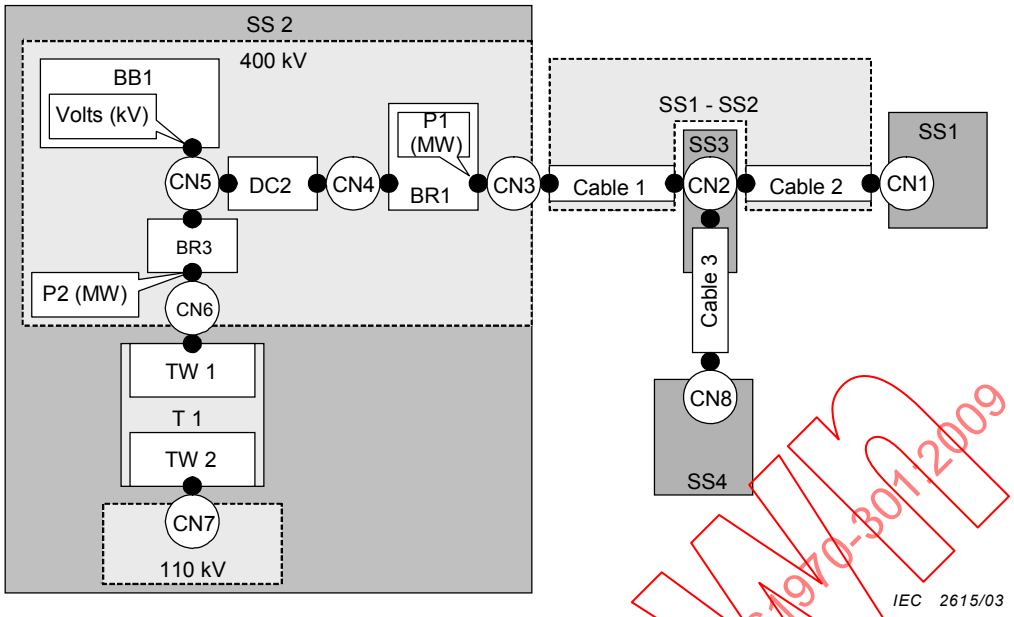

Figure 8 – Simple network connectivity modeled with CIM topology

The Line SS1-SS2 contains three ACLineSegments (Cable1, Cable2, and Cable 3) 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 400 kV. The breaker BR1 has two terminals of which one is connected to CN3. The rest is left to the interested reader to trace.

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

4.4.3 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.

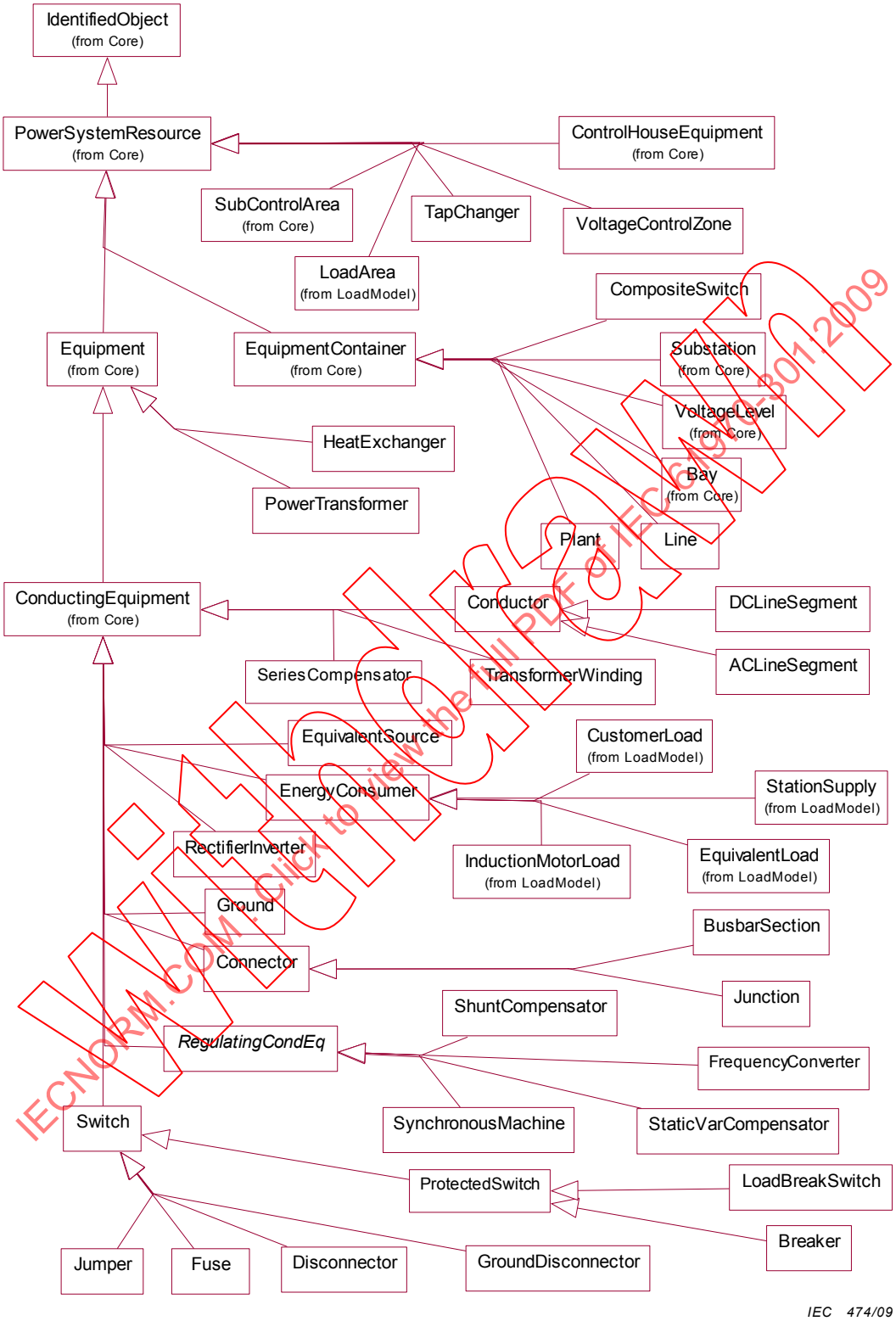

Figure 9 – Equipment inheritance hierarchy

4.4.4 Transformer model

Figure 10 shows a portion of the Wires class diagram which models a PowerTransformer device.

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.

A PowerTransformer also has a TransformerWinding, which is modeled with an aggregation-type of relationship using a diamond symbol to point from the part class to the whole class. As shown, a 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.

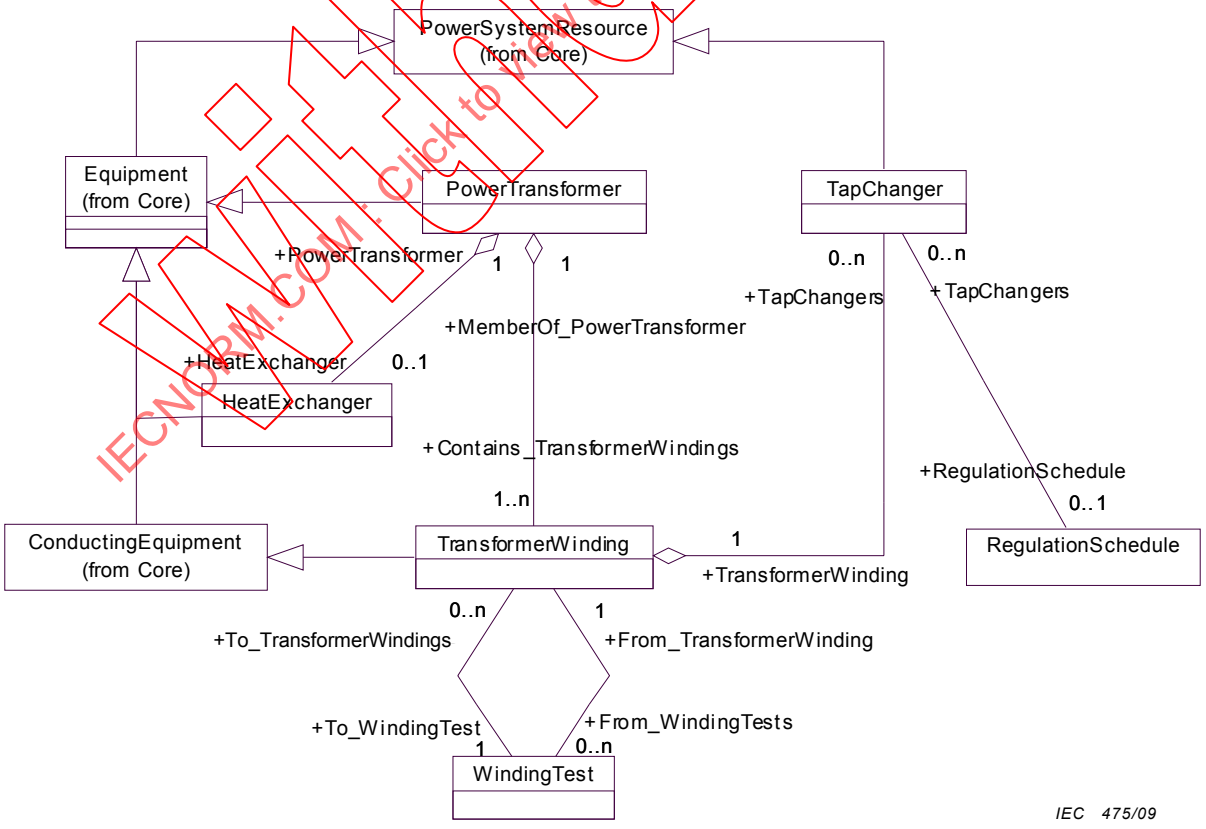

Figure 10 – Transformer model

4.4.5 Measurements and controls

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.

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 support control variables with the Control model.

4.4.5.1 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

   – MeasurementType[2)] 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.

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2) MeasurementType is different from Unit, which is part of the Domain package described in 4.2.10. MeasurementType describes “what” is measured rather than the unit of measure including scaling, which is the purpose of Unit.

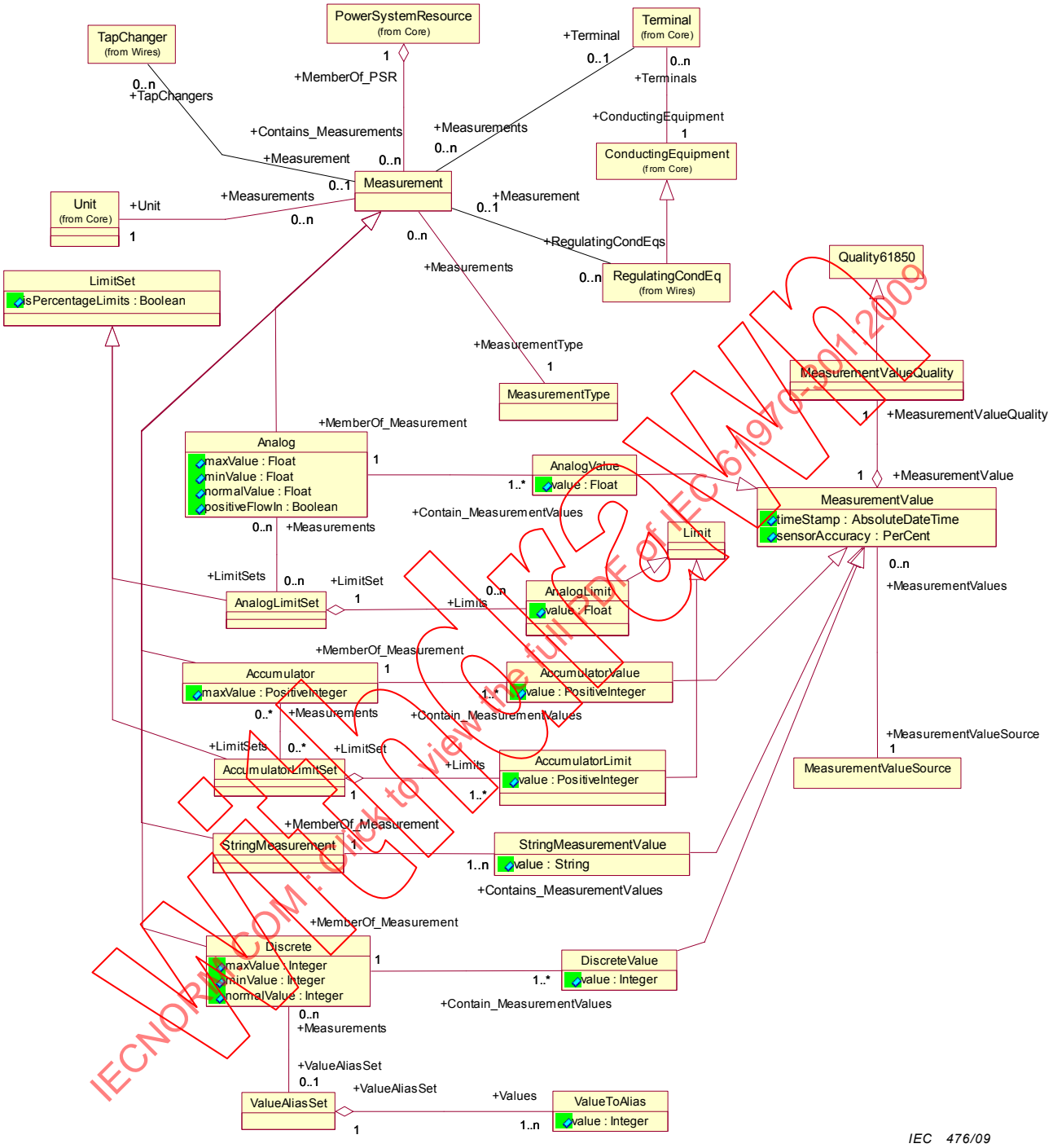


Figure 11 – Navigating from PSR to MeasurementValue

Table 1 – MeasurementType naming conventions

name	aliasName	description
Current	Amp	Current I (rms) of a non-three phase circuit
ThreePhaseCurrent	AvAmps	Total current I (rms) in a three phase circuit
PhaseCurrent	A	Measured phase current
Frequency	Hz	Frequency (f)
PowerFactor	PwrFact	Power Factor not allocated to a phase
ThreePhasePowerFactor	TotPF	Average power factor (pf) in a three phase circuit
ThreePhaseApparentPower	TotVA	Total apparent power (S) in a three phase circuit
ThreePhaseReactivePower	TotVAr	Total reactive power (Q) in a three phase circuit
ThreePhaseActivePower	TotW	Total real power (P) in a three phase circuit
ApparentPower	VoltAmp	Apparent power (S) in a non-three phase circuit
ReactivePower	VoltAmpr	Reactive power (Q) in a non-three phase circuit
Voltage	Vol	Voltage (V) (rms) not allocated to a phase
ActivePower	Watt	Real power (P) 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 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

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

– name (MeasurementType.name) is the IEC 61970 measurement type name;
– aliasName (MeasurementType.aliasName) is the name assigned to the data in IEC 61850-7-4 Clause 6 Data 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.

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.

4.4.5.2 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 that the flow direction is evident from the placement.

Figure 12 shows two examples of the placement of Measurements.

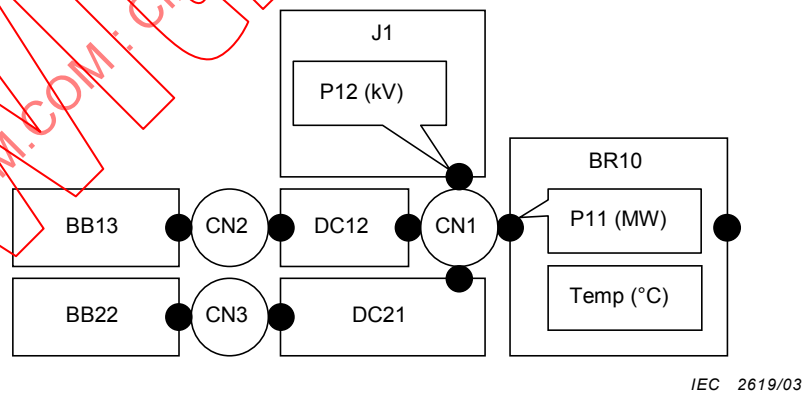


Figure 12 – Measurement placement

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

4.5 Modeling guidelines

This subclause provides 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.

4.5.1 Amendments to the CIM

From time to time 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.

4.5.1.1 Changes to the CIM UML ROSE model

From a modeling perspective, when the CIM is extended, the approach is to start with the existing CIM UML model in Rational ROSE format. 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 values to existing attributes in a class,
– adding additional attributes 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 ROSE model file.

4.5.1.2 Changes to the CIM standards documents

From a documentation perspective, when the CIM is extended, a decision must 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.

4.5.2 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 must be included (i.e. mandatory elements) in a particular use of the CIM, as well as which are optional. These profiles will be defined in the Part 4xx series of standards.

An example is the profile for exchanging power system models, which is the subject of the draft Part 452 CIM Model Exchange Specification. This document 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 as required by NERC (North American Electric Reliability Council). The CIM version 11 UML model includes this profile information in the form of a special tab labeled "CIM" in the specification for each class, attribute, and association to indicate if the item is included or not in this profile. Under this tab for a given item is a list of the profiles currently defined and the value assigned to that item (i.e. included or not in the identified profile). For example, in the measurement class, there is one entry "NercProfile" with the value "True", indicating that this class is mandatory for exchanging power system models that are based on the NERC Profile specification. As new profiles are defined, entries can be made for them as well.

4.6 Modeling tools

The CIM was constructed and is maintained using IBM's Rational ROSE. The entire CIM exists as a .mdl file viewable with Rational ROSE 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. Each top level package is also distributed as a .cat file, allowing new models to be constructed from the CIM packages.

All future changes to the CIM specification, resulting in new versions of this standard, will be incorporated first into the Rational ROSE model description to ensure a single source for the CIM model data.

Clause 6 of this document was auto-generated using IBM's Rational SoDA, another modeling tool from IBM. SoDA generates Word documents from the ROSE model file based on a custom template created in Word that incorporates the IEC format and styles.

4.7 User implementation conventions

This subclause provides recommended user conventions when using the CIM in actual system implementations.

4.7.1 Number of terminals for ConductingEquipment objects

The following ConductingEquipment classes have two terminals: ACLineSegment, DCLineSegment, Jumper, Fuse, Breaker, Disconnector, LoadBreakSwitch. All other ConductingEquipment leaf classes have a single terminal, except for the Compensator class, which has one terminal if of compensatorType shunt, and two terminals if of compensatorType series.

For instances of ConductingEquipment that are not electrically connected to other equipment (i.e. as when treated as an asset in inventory), it is acceptable to have no terminals specified.

4.8 CIM modeling examples

Annex A contains a comprehensive UML model for a circuit breaker to illustrate how the CIM can be used to represent many different aspects of a device, including its electrical characteristics, its role as a device electrically connected to other electrical devices in an electrical network model, and its role as an asset in a utility enterprise operation.

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). 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 ROSE model file using a software tool 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 files used for CIM XML interoperability testing. (see the Bibliography for published reports of these recent interoperability tests and the model files used)[3].

5 Detailed model (normative)

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 between them.

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. Native associations are listed first for each class, followed by inherited associations. The associations are described according to the role of each class participating in the association. Aggregations are listed only for the role that contains the aggregation.

Figure 13 shows the top level packages included in this document.

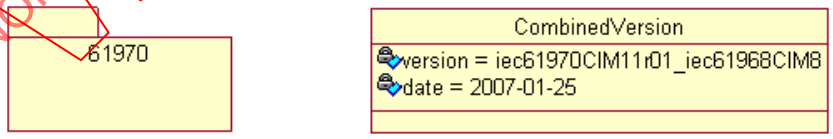


Figure 13 – CIM Top level packages

3) 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.

For each package, the model information for each class is fully described. Attribute information for native attributes is listed as:

Name Type Documentation

Attribute information for inherited attributes is listed as:

Name Type Parent class name

The classes in the Domain package include an optional unit of measure for the attribute type.

The associations are listed according to the role the class participates in for that association. The role information for native roles is listed as:

Multiplicity From	*RoleTo. Name*	Multiplicity To	Role.To. Name	Role To Documentation

The role information for inherited roles is listed as:

Multiplicity From	*RoleTo. Name*	Multiplicity To	Role.To. Name	Parent class name

The MultiplicityFrom indicates the multiplicity from the class that is being described. A value of zero indicates an optional association. A value of n means that an unspecified number of associations are permitted. The RoleTo.Name is the role of the target class on the other side of the association. The MultiplicityTo and Role.ToClass.Name indicate the multiplicity and name of the class on the other side of the association.

6 Package architecture (normative)

This specification is autogenerated from the CIM model file iec61970CIM11r01.mdl. Figure 14 shows the package architecture for IEC 61970-301.

6.1 IEC 61970

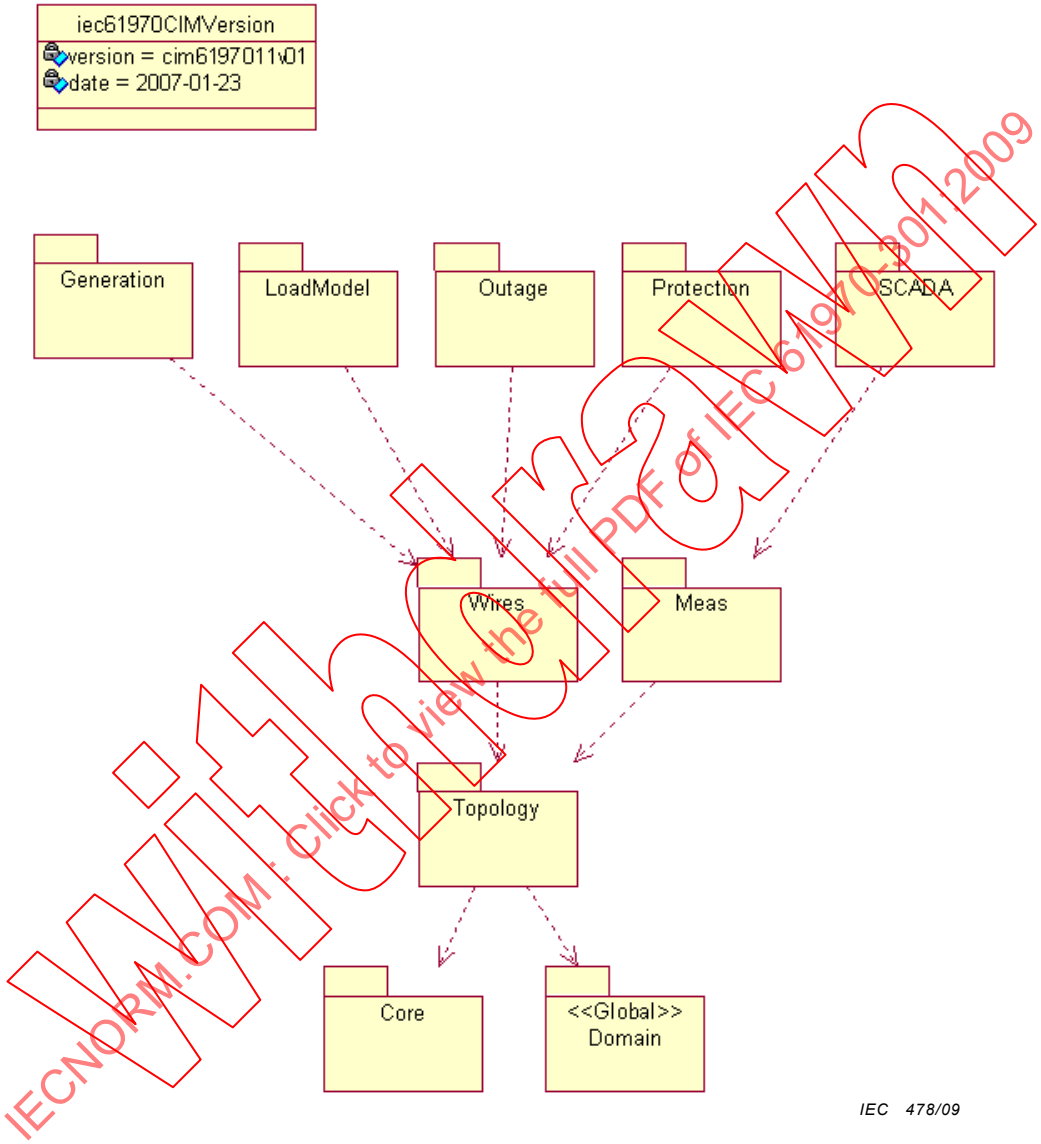


Figure 14 – Main

6.1.1 IEC 61970CIMVersion

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

cim61970_v002 was created from cim10_v000_WG13cimIssues_61968_Rev6_22Feb2005 that is the merged wg13 and wg14 models. The content has a number of wg13 issue resolutions.

Native Attributes

version
date

6.2 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.

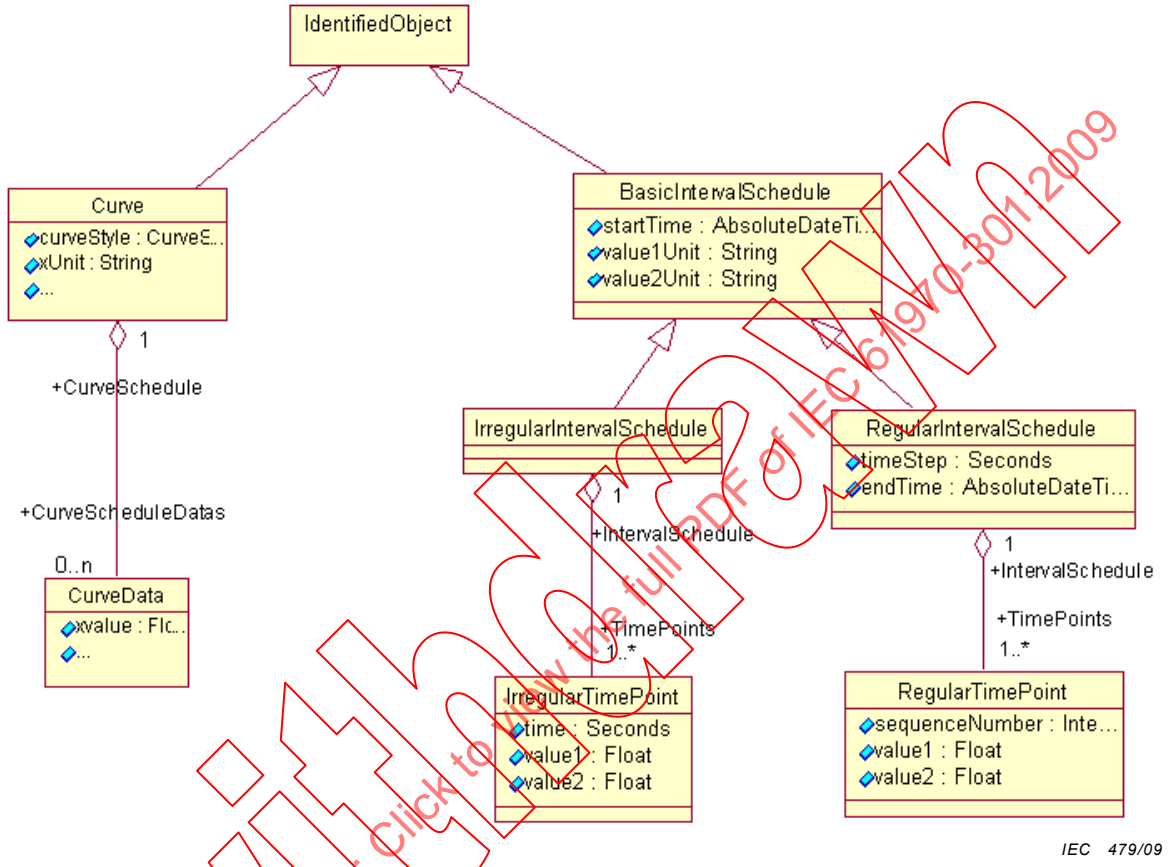


Figure 15 – CurveSchedule

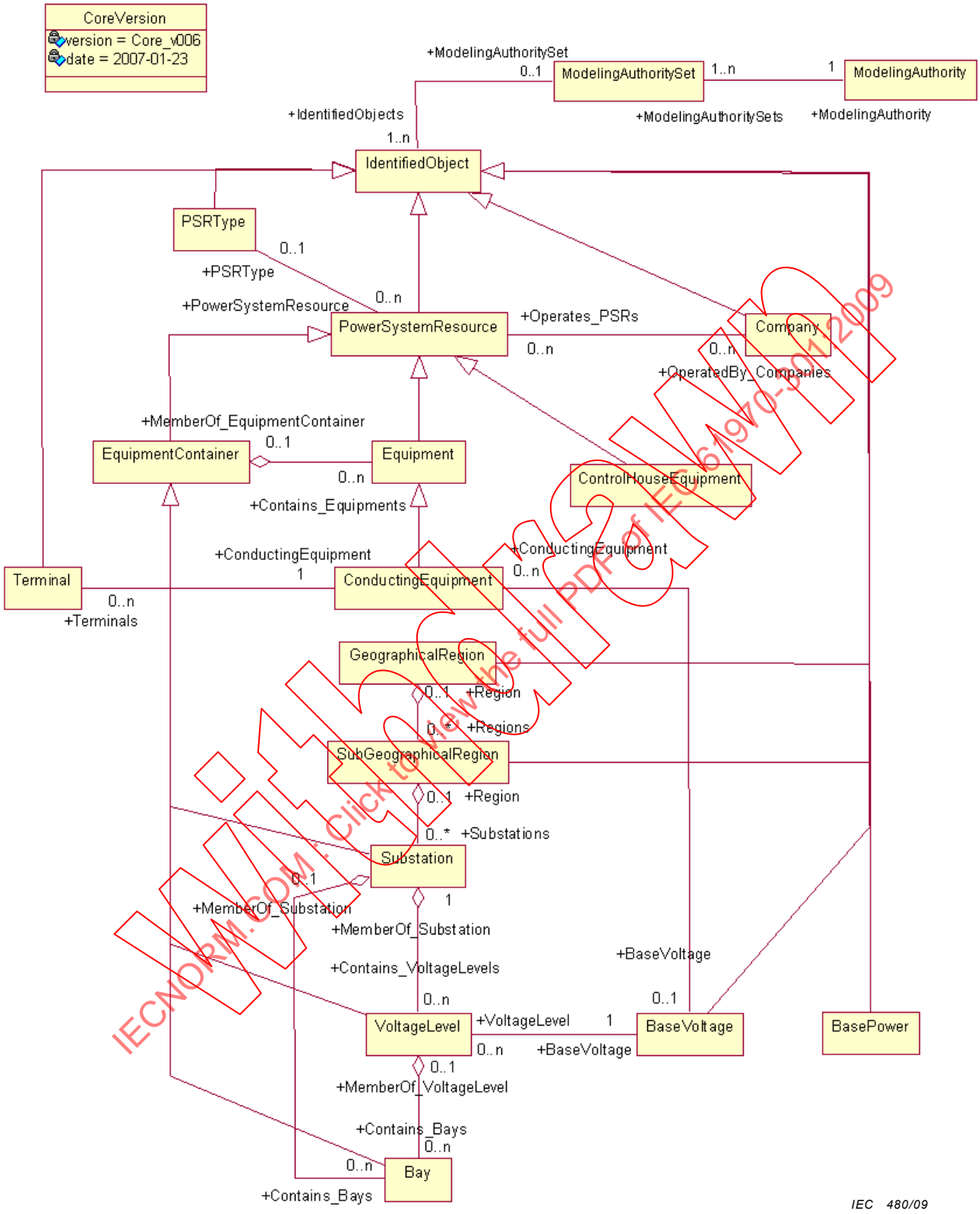


Figure 16 – Main

Figures 15 and 16 are intended to show all classes needed for any application of the CIM for modeling transmission and generation systems.

6.2.1 BasePower

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

Native Attributes

basePower	ApparentPower	Definition of base power.

Inherited Attributes

mRID	String	IdentifiedObject
name	String	IdentifiedObject
localName	String	IdentifiedObject
pathName	String	IdentifiedObject
aliasName	String	IdentifiedObject
description	String	IdentifiedObject

Roles Inherited From IdentifiedObject

1..n	*ModelingAuthoritySet*	0..1	ModelingAuthoritySet	IdentifiedObject

6.2.2 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.

Native Attributes

nominalVoltage	Voltage	The PowerSystemResource's base voltage.

Inherited Attributes

mRID	String	IdentifiedObject
name	String	IdentifiedObject
localName	String	IdentifiedObject
pathName	String	IdentifiedObject
aliasName	String	IdentifiedObject
description	String	IdentifiedObject

Native Roles

0..1	*ConductingEquipment*	0..n	ConductingEquipment
1	*VoltageLevel*	0..n	VoltageLevel

Roles Inherited From IdentifiedObject

1..n	*ModelingAuthoritySet*	0..1	ModelingAuthoritySet	IdentifiedObject

6.2.3 BasicIntervalSchedule

Schedule of values at points in time.

Native Attributes

startTime	AbsoluteDateTime
value1Unit	String
value2Unit	String

Inherited Attributes

mRID	String	IdentifiedObject
name	String	IdentifiedObject
localName	String	IdentifiedObject
pathName	String	IdentifiedObject
aliasName	String	IdentifiedObject
description	String	IdentifiedObject

Roles Inherited From IdentifiedObject

1..n	*ModelingAuthoritySet*	0..1	ModelingAuthoritySet	IdentifiedObject

6.2.4 Bay

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

Native Attributes

bayEnergyMeasFlag	Boolean	Indicates the presence/absence of kWh/kvarh measurements.
bayPowerMeasFlag	Boolean	Indicates the presence/absence of MW/MVAr measurements.
breakerConfiguration	BreakerConfiguration	Breaker configuration.
busBarConfiguration	BusbarConfiguration	Bus bar configuration.

Inherited Attributes

mRID	String	IdentifiedObject
name	String	IdentifiedObject
localName	String	IdentifiedObject
pathName	String	IdentifiedObject
aliasName	String	IdentifiedObject
description	String	IdentifiedObject

Native Roles

0..n	*MemberOf_VoltageLevel*	0..1	VoltageLevel	The association is used in the naming hierarchy.
0..n	*MemberOf_Substation*	0..1	Substation	The association is used in the naming hierarchy.

Roles Inherited From EquipmentContainer

1	*ConnectivityNodes*	0..n	ConnectivityNode	EquipmentContainer
0..1	*Contains_Equipments*	0..n	Equipment	EquipmentContainer

Roles Inherited From PowerSystemResource

0..n	*OperatedBy_Companies*	0..n	Company	PowerSystemResource
0..n	*PSRType*	0..1	PSRType	PowerSystemResource
1	*Contains_Measurements*	0..n	Measurement	PowerSystemResource
1	*OutageSchedule*	0..1	OutageSchedule	PowerSystemResource

Roles Inherited From IdentifiedObject

1..n	*ModelingAuthoritySet*	0..1	ModelingAuthority Set	IdentifiedObject

6.2.5 Company

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

Native Attributes

companyType	CompanyType	The type of company, e.g.: pool, municipal, private

Inherited Attributes

mRID	String	IdentifiedObject
name	String	IdentifiedObject
localName	String	IdentifiedObject
pathName	String	IdentifiedObject
aliasName	String	IdentifiedObject
description	String	IdentifiedObject

Native Roles

0..n	*Operates_PSRs*	0..n	PowerSystemResource	A power system resource may be part of one or more companies.

Roles Inherited From IdentifiedObject

1..n	*ModelingAuthoritySet*	0..1	ModelingAuthority Set	IdentifiedObject

6.2.6 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.

Native Attributes

phases	PhaseCode	Describes the phases carried by a conducting equipment. Possible values { ABCN , ABC, ABN, ACN, BCN, AB, AC, BC, AN, BN, CN, A, B, C, N }.

Inherited Attributes

mRID	String	IdentifiedObject
name	String	IdentifiedObject
localName	String	IdentifiedObject
pathName	String	IdentifiedObject
aliasName	String	IdentifiedObject
description	String	IdentifiedObject

Native Roles

1	*Terminals*	0..n	Terminal	ConductingEquipment has 1 or 2 terminals that may be connected to other ConductingEquipment terminals via ConnectivityNodes.
0..n	*BaseVoltage*	0..1	BaseVoltage	
1	*ClearanceTags*	0..n	ClearanceTag	Conducting equipment may have multiple clearance tags for authorized field work.
0..n	*ProtectionEquipments*	0..n	ProtectionEquipment	Protection equipment may be used to protect specific Conducting Equipment. Multiple equipment may be protected or monitored by multiple protection equipment.

Roles Inherited From Equipment

0..n	*MemberOf_Equipment Container*	0..1	EquipmentContainer	Equipment

Roles Inherited From PowerSystemResource

0..n	*OperatedBy_Companies*	0..n	Company	PowerSystemResource
0..n	*PSRType*	0..1	PSRType	PowerSystemResource
1	*Contains_Measurements*	0..n	Measurement	PowerSystemResource
1	*OutageSchedule*	0..1	OutageSchedule	PowerSystemResource

Roles Inherited From IdentifiedObject

1..n	*ModelingAuthoritySet*	0..1	ModelingAuthority Set	IdentifiedObject

6.2.7 ControlHouseEquipment

Equipment in a substation control house. Covers things such as fire alarms, ambient temperature, door alarms, and spares.

Native Attributes

controlHouseEquipType	ControlHouseEquipmentType	Type of control house equipment.

Inherited Attributes

mRID	String	IdentifiedObject
name	String	IdentifiedObject
localName	String	IdentifiedObject
pathName	String	IdentifiedObject
aliasName	String	IdentifiedObject
description	String	IdentifiedObject

Roles Inherited From PowerSystemResource

0..n	*OperatedBy_Companies*	0..n	Company	PowerSystemResource
0..n	*PSRType*	0..1	PSRType	PowerSystemResource
1	*Contains_Measurements*	0..n	Measurement	PowerSystemResource
1	*OutageSchedule*	0..1	OutageSchedule	PowerSystemResource

Roles Inherited From IdentifiedObject

1..n	*ModelingAuthoritySet*	0..1	ModelingAuthoritySet	IdentifiedObject

6.2.8 CoreVersion

Native Attributes

version	
date	

6.2.9 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.

Native Attributes

curveStyle	CurveStyle	The style or shape of the curve.
xUnit	String	
y1Unit	String	The Y1-axis units of measure.
y2Unit	String	The Y2-axis units of measure.

Inherited Attributes

mRID	String	IdentifiedObject
name	String	IdentifiedObject
localName	String	IdentifiedObject
pathName	String	IdentifiedObject
aliasName	String	IdentifiedObject
description	String	IdentifiedObject

Native Roles

1	*CurveScheduleDatas*	0..n	CurveData	The point data values that define a curve.

Roles Inherited From IdentifiedObject

1..n	*ModelingAuthoritySet*	0..1	ModelingAuthority Set	IdentifiedObject

6.2.10 CurveData

Data point values for defining a curve or schedule

Native Attributes

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.

Native Roles

0..n	*CurveSchedule*	1	Curve	The point data values that define a curve.

6.2.11 Equipment

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

Inherited Attributes

mRID	String	IdentifiedObject
name	String	IdentifiedObject
localName	String	IdentifiedObject
pathName	String	IdentifiedObject
aliasName	String	IdentifiedObject
description	String	IdentifiedObject

Native Roles

0..n	*MemberOf_EquipmentContainer*	0..1	EquipmentContainer	The association is used in the naming hierarchy.

Roles Inherited From PowerSystemResource

0..n	*OperatedBy_Companies*	0..n	Company	PowerSystemResource
0..n	*PSRType*	0..1	PSRType	PowerSystemResource
1	*Contains_Measurements*	0..n	Measurement	PowerSystemResource
1	*OutageSchedule*	0..1	OutageSchedule	PowerSystemResource

Roles Inherited From IdentifiedObject

1..n	*ModelingAuthoritySet*	0..1	ModelingAuthority Set	IdentifiedObject

6.2.12 EquipmentContainer

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

Inherited Attributes

mRID	String	IdentifiedObject
name	String	IdentifiedObject
localName	String	IdentifiedObject
pathName	String	IdentifiedObject
aliasName	String	IdentifiedObject
description	String	IdentifiedObject

Native Roles

1	*ConnectivityNodes*	0..n	ConnectivityNode	
0..1	*Contains_Equipments*	0..n	Equipment	The association is used in the naming hierarchy.

Roles Inherited From PowerSystemResource

0..n	*OperatedBy_Companies*	0..n	Company	PowerSystemResource
0..n	*PSRType*	0..1	PSRType	PowerSystemResource
1	*Contains_Measurements*	0..n	Measurement	PowerSystemResource
1	*OutageSchedule*	0..1	OutageSchedule	PowerSystemResource

Roles Inherited From IdentifiedObject

1..n	*ModelingAuthoritySet*	0..1	ModelingAuthority Set	IdentifiedObject

6.2.13 GeographicalRegion

A geographical region of a power system network model.

Inherited Attributes

mRID	String	IdentifiedObject
name	String	IdentifiedObject
localName	String	IdentifiedObject
pathName	String	IdentifiedObject
aliasName	String	IdentifiedObject
description	String	IdentifiedObject

Native Roles

0..1	*Regions*	0..*	SubGeographical Region	The association is used in the naming hierarchy.

Roles Inherited From IdentifiedObject

1..n	*ModelingAuthoritySet*	0..1	ModelingAuthority Set	IdentifiedObject

6.2.14 IdentifiedObject

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

Native Attributes

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 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.

Native Roles

1..n	*ModelingAuthoritySet*	0..1	ModelingAuthoritySet

6.2.15 IrregularIntervalSchedule

The schedule has TimePoints where the time between them varies.

Inherited Attributes

startTime	AbsoluteDateTime	BasicIntervalSchedule
value1Unit	String	BasicIntervalSchedule
value2Unit	String	BasicIntervalSchedule
mRID	String	IdentifiedObject
name	String	IdentifiedObject
localName	String	IdentifiedObject
pathName	String	IdentifiedObject
aliasName	String	IdentifiedObject
description	String	IdentifiedObject

Native Roles

1	*TimePoints*	1..*	IrregularTimePoint	The point data values that define a curve.

Roles Inherited From BasicIntervalSchedule

Roles Inherited From IdentifiedObject

1..n	*ModelingAuthoritySet*	0..1	ModelingAuthoritySet	IdentifiedObject

6.2.16 IrregularTimePoint

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

Native Attributes

time	Seconds	The time is relative the BasicTimeSchedule.startTime.
value1	Float	
value2	Float	

Native Roles

1..*	*IntervalSchedule*	1	IrregularIntervalSchedule	The point data values that define a curve.

6.2.17 ModelingAuthority

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

Inherited Attributes

mRID	String	IdentifiedObject
name	String	IdentifiedObject
localName	String	IdentifiedObject
pathName	String	IdentifiedObject
aliasName	String	IdentifiedObject
description	String	IdentifiedObject

Native Roles

1	*ModelingAuthoritySets*	1..n	ModelingAuthority Set	

Roles Inherited From IdentifiedObject

1..n	*ModelingAuthoritySet*	0..1	ModelingAuthority Set	IdentifiedObject

6.2.18 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.

Inherited Attributes

mRID	String	IdentifiedObject
name	String	IdentifiedObject
localName	String	IdentifiedObject
pathName	String	IdentifiedObject
aliasName	String	IdentifiedObject
description	String	IdentifiedObject

Native Roles

0..1	*IdentifiedObjects*	1..n	IdentifiedObject
1..n	*ModelingAuthority*	1	ModelingAuthority

Roles Inherited From IdentifiedObject

1..n	*ModelingAuthoritySet*	0..1	ModelingAuthority Set	IdentifiedObject

6.2.19 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.

Inherited Attributes

mRID	String	IdentifiedObject
name	String	IdentifiedObject
localName	String	IdentifiedObject
pathName	String	IdentifiedObject
aliasName	String	IdentifiedObject
description	String	IdentifiedObject

Native Roles

0..n	*OperatedBy_Companies*	0..n	Company	A power system resource may be part of one or more companies.
0..n	*PSRType*	0..1	PSRType	
1	*Contains_Measurements*	0..n	Measurement	The Measurements that are included in the naming hierarchy where the PSR is the containing object.
1	*OutageSchedule*	0..1	OutageSchedule	A power system resource may have an outage schedule.

Roles Inherited From IdentifiedObject

1..n	*ModelingAuthoritySet*	0..1	ModelingAuthority Set	IdentifiedObject

6.2.20 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.

Inherited Attributes

mRID	String	IdentifiedObject
name	String	IdentifiedObject
localName	String	IdentifiedObject
pathName	String	IdentifiedObject
aliasName	String	IdentifiedObject
description	String	IdentifiedObject

Native Roles

0..1	*PowerSystemResource*	0..n	PowerSystemResource	

Roles Inherited From IdentifiedObject

1..n	*ModelingAuthoritySet*	0..1	ModelingAuthority Set	IdentifiedObject

6.2.21 RegularIntervalSchedule

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

Native Attributes

timeStep	Seconds
endTime	AbsoluteDateTime

Inherited Attributes

startTime	AbsoluteDateTime	BasicIntervalSchedule
value1Unit	String	BasicIntervalSchedule
value2Unit	String	BasicIntervalSchedule
mRID	String	IdentifiedObject
name	String	IdentifiedObject
localName	String	IdentifiedObject
pathName	String	IdentifiedObject

aliasName	String	IdentifiedObject
description	String	IdentifiedObject

Native Roles

1	*TimePoints*	1..*	RegularTimePoint	The point data values that define a curve.

Roles Inherited From BasicIntervalSchedule

Roles Inherited From IdentifiedObject

1..n	*ModelingAuthoritySet*	0..1	ModelingAuthoritySet	IdentifiedObject

6.2.22 RegularTimePoint

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

Native Attributes

sequenceNumber	Integer
value1	Float
value2	Float

Native Roles

1..*	*IntervalSchedule*	1	RegularIntervalSchedule	The point data values that define a curve.

6.2.23 SubControlArea

An area defined for the purpose of tracking interchange with surrounding areas via tie points; may or may not serve as a control area.

Inherited Attributes

mRID	String	IdentifiedObject
name	String	IdentifiedObject
localName	String	IdentifiedObject
pathName	String	IdentifiedObject
aliasName	String	IdentifiedObject
description	String	IdentifiedObject

Native Roles

0..1	*GeneratingUnits*	0..n	GeneratingUnit	A GeneratingUnit injects energy into a SubControlArea.

Roles Inherited From PowerSystemResource

0..n	*OperatedBy_Companies*	0..n	Company	PowerSystemResource
0..n	*PSRType*	0..1	PSRType	PowerSystemResource
1	*Contains_Measurements*	0..n	Measurement	PowerSystemResource
1	*OutageSchedule*	0..1	OutageSchedule	PowerSystemResource

Roles Inherited From IdentifiedObject

1..n	*ModelingAuthoritySet*	0..1	ModelingAuthoritySet	IdentifiedObject

6.2.24 SubGeographicalRegion

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

Inherited Attributes

mRID	String	IdentifiedObject
name	String	IdentifiedObject
localName	String	IdentifiedObject
pathName	String	IdentifiedObject
aliasName	String	IdentifiedObject
description	String	IdentifiedObject

Native Roles

0..1	*Substations*	0..*	Substation	The association is used in the naming hierarchy.
0..*	*Region*	0..1	GeographicalRegion	The association is used in the naming hierarchy.
0..1	*Lines*	0..*	Line	

Roles Inherited From IdentifiedObject

1..n	*ModelingAuthoritySet*	0..1	ModelingAuthoritySet	IdentifiedObject

6.2.25 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.

Inherited Attributes

mRID	String	IdentifiedObject
name	String	IdentifiedObject
localName	String	IdentifiedObject
pathName	String	IdentifiedObject
aliasName	String	IdentifiedObject
description	String	IdentifiedObject

Native Roles

0..*	*Region*	0..1	SubGeographicalRegion	The association is used in the naming hierarchy.
1	*Contains_VoltageLevels*	0..n	VoltageLevel	The association is used in the naming hierarchy.
0..1	*Contains_Bays*	0..n	Bay	The association is used in the naming hierarchy.
0..1	*Contains_CompositeSwitches*	0..n	CompositeSwitch	

Roles Inherited From EquipmentContainer

1	*ConnectivityNodes*	0..n	ConnectivityNode	EquipmentContainer
0..1	*Contains_Equipments*	0..n	Equipment	EquipmentContainer

Roles Inherited From PowerSystemResource

0..n	*OperatedBy_Companies*	0..n	Company	PowerSystemResource
0..n	*PSRType*	0..1	PSRType	PowerSystemResource
1	*Contains_Measurements*	0..n	Measurement	PowerSystemResource
1	*OutageSchedule*	0..1	OutageSchedule	PowerSystemResource

Roles Inherited From IdentifiedObject

1..n	*ModelingAuthoritySet*	0..1	ModelingAuthority Set	IdentifiedObject

6.2.26 Terminal

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

Inherited Attributes

mRID	String	IdentifiedObject
name	String	IdentifiedObject
localName	String	IdentifiedObject
pathName	String	IdentifiedObject
aliasName	String	IdentifiedObject
description	String	IdentifiedObject

Native Roles

0..n	*ConductingEquipment*	1	ConductingEquipment	ConductingEquipment has 1 or 2 terminals that may be connected to other ConductingEquipment terminals via ConnectivityNodes.
0..1	*Measurements*	0..n	Measurement	One or more measurements may be associated with a terminal in the network.
0..n	*ConnectivityNode*	0..1	ConnectivityNode	Terminals interconnect with zero impedance at a node. Measurements on a node apply to all of its terminals.

Roles Inherited From IdentifiedObject

1..n	*ModelingAuthoritySet*	0..1	ModelingAuthority Set	IdentifiedObject

6.2.27 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.

Inherited Attributes

mRID	String	IdentifiedObject
name	String	IdentifiedObject
localName	String	IdentifiedObject
pathName	String	IdentifiedObject
aliasName	String	IdentifiedObject
description	String	IdentifiedObject

Native Roles

1	*Measurements*	0..n	Measurement	The Measurements having the Unit.
1	*Controls*	0..n	Control	
1	*ProtectionEquipments*	0..n	ProtectionEquipment	

Roles Inherited From IdentifiedObject

1..n	*ModelingAuthoritySet*	0..1	ModelingAuthority Set	IdentifiedObject

6.2.28 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.

Native Attributes

highVoltageLimit	Voltage	The bus bar's high voltage limit in kV.
lowVoltageLimit	Voltage	The bus bar's low voltage limit in kV.

Inherited Attributes

mRID	String	IdentifiedObject
name	String	IdentifiedObject
localName	String	IdentifiedObject
pathName	String	IdentifiedObject
aliasName	String	IdentifiedObject
description	String	IdentifiedObject

Native Roles

0..n	*MemberOf_Substation*	1	Substation	The association is used in the naming hierarchy.
0..1	*Contains_Bays*	0..n	Bay	The association is used in the naming hierarchy.
0..n	*BaseVoltage*	1	BaseVoltage	

Roles Inherited From EquipmentContainer

1	*ConnectivityNodes*	0..n	ConnectivityNode	EquipmentContainer
0..1	*Contains_Equipments*	0..n	Equipment	EquipmentContainer

Roles Inherited From PowerSystemResource

0..n	*OperatedBy_Companies*	0..n	Company	PowerSystemResource
0..n	*PSRType*	0..1	PSRType	PowerSystemResource
1	*Contains_Measurements*	0..n	Measurement	PowerSystemResource
1	*OutageSchedule*	0..1	OutageSchedule	PowerSystemResource

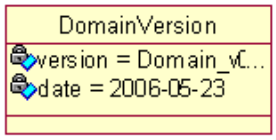
Roles Inherited From IdentifiedObject

1..n	*ModelingAuthoritySet*	0..1	ModelingAuthority Set	IdentifiedObject

6.3 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.

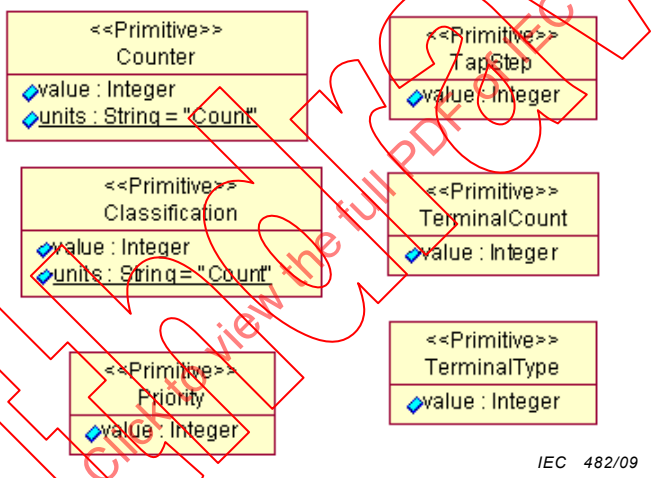
This package contains the definition of primitive datatypes, including units of measure and permissible values. Each datatype contains a value attribute and an optional unit of measure, which is specified as a static variable initialized to the textual description of the unit of measure. The value of 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.



IEC 481/09

Figure 17 – Main

Figure 17 shows the version number of the Domain Package.



IEC 482/09

Figure 18 – Integer Datatypes

Figure 18 shows all Integer data types.

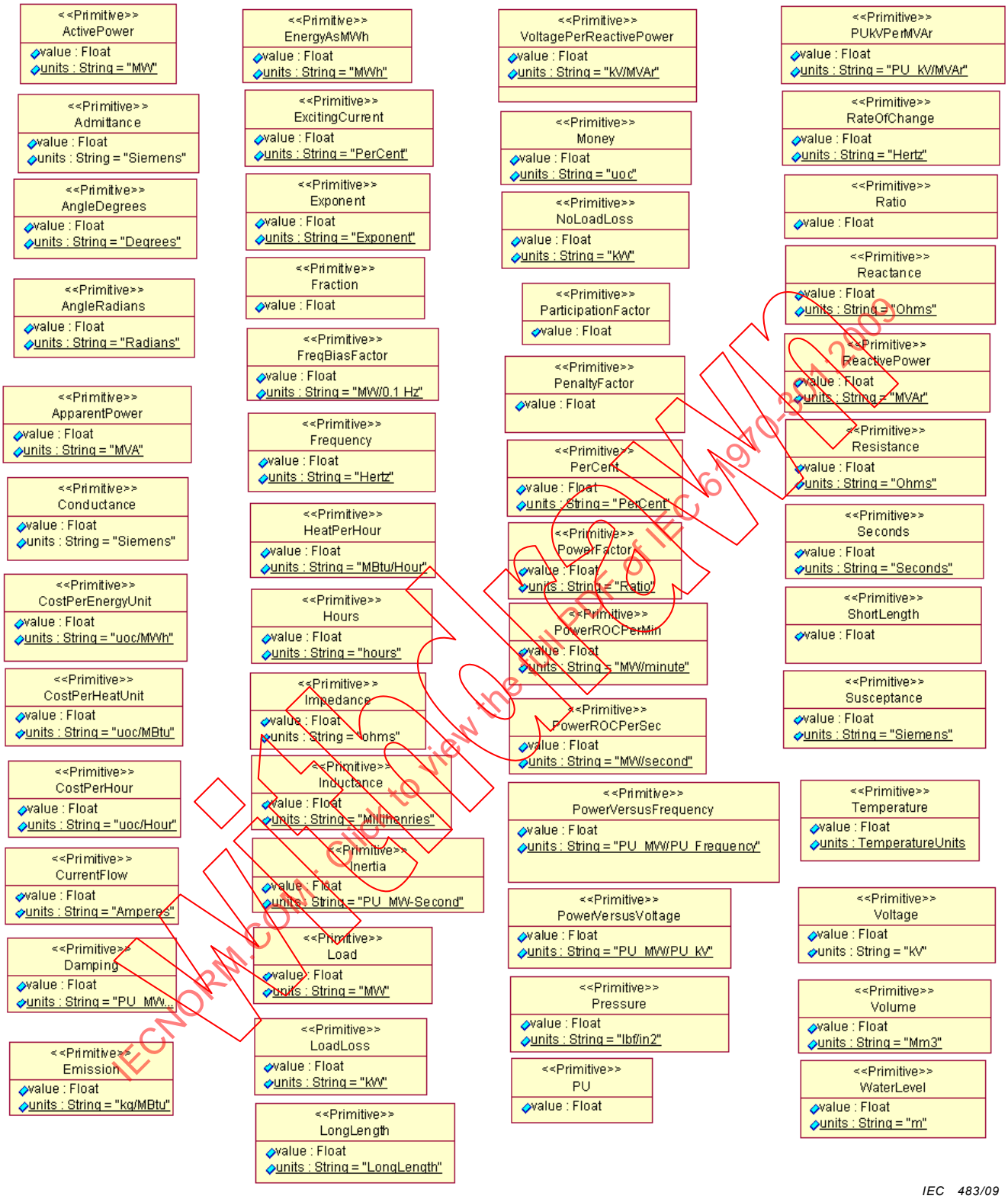


Figure 19 – Float Datatypes

Figure 19 shows all Float data types.

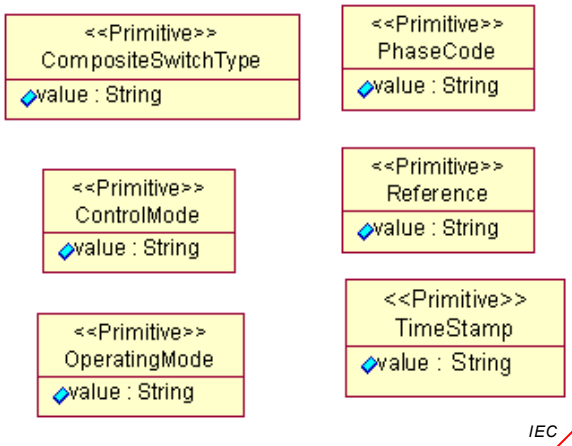


Figure 20 – String Datatypes

Figure 20 shows all String data types.

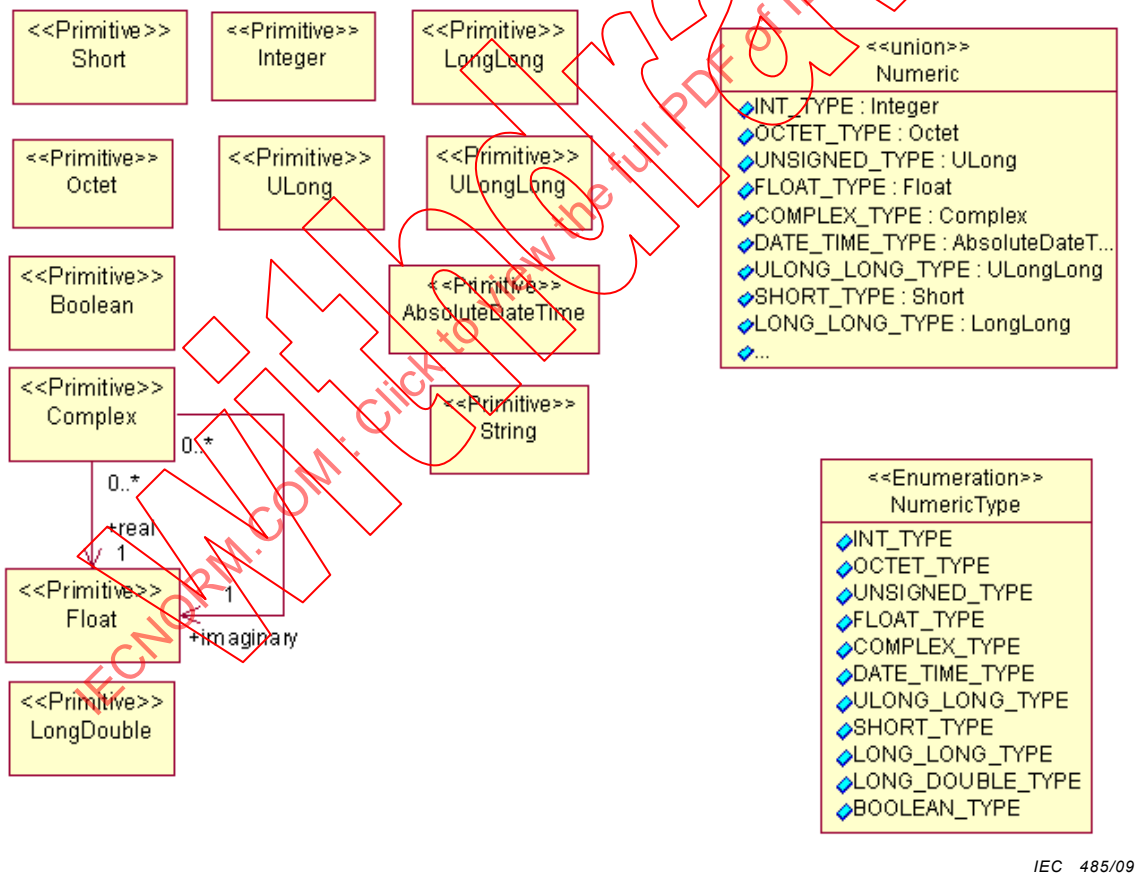


Figure 21 – Primitive Datatypes

Figure 21 shows primitive datatypes that are the basis for all other datatypes.

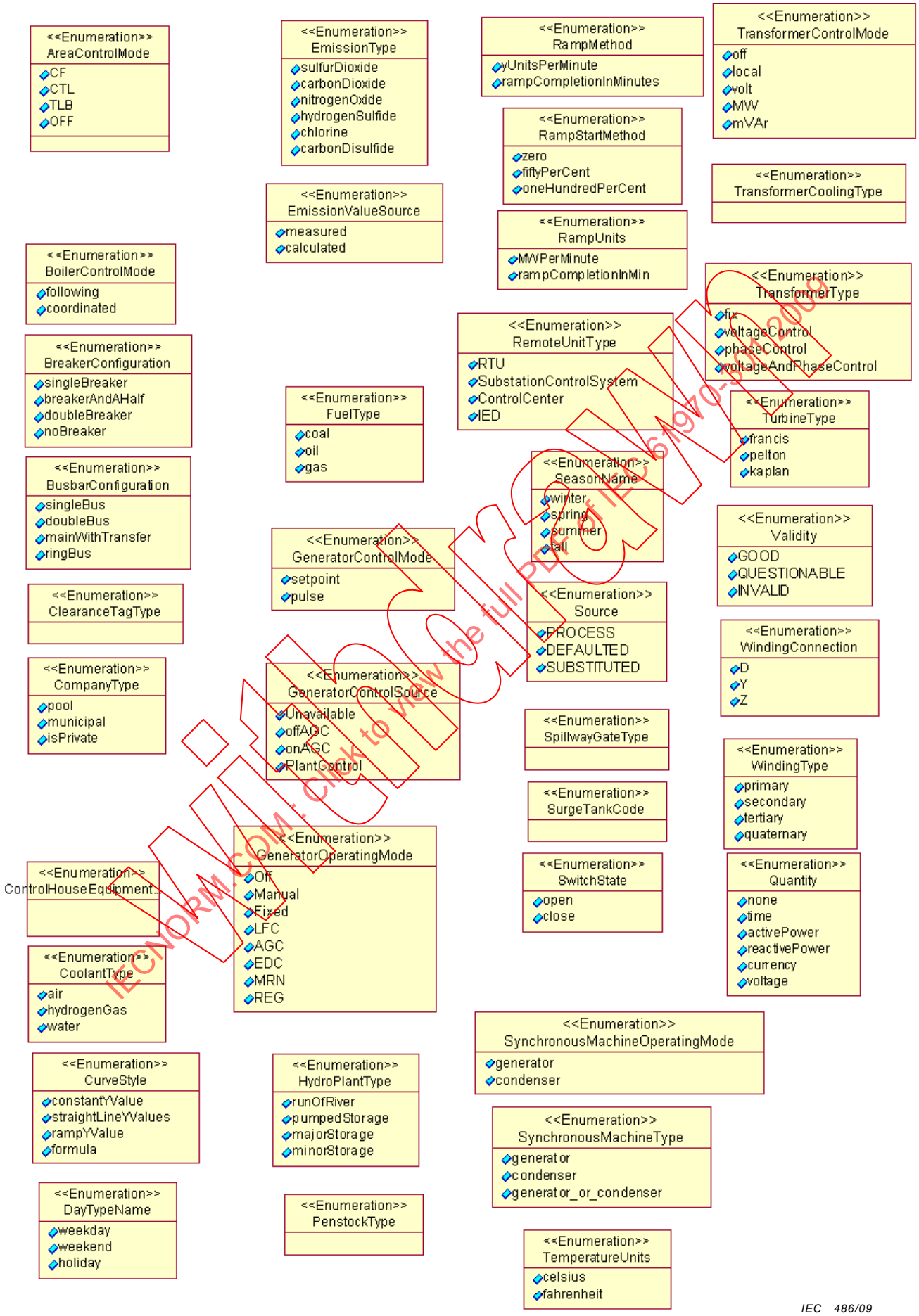


Figure 22 – Enumeration Datatypes

Figure 22 shows all Enumeration data types. The member "none" means that this axis is not used, only valid for y1Axis or y2Axis.

6.3.1 AbsoluteDateTime*Primitive*

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

6.3.2 ActivePower*Primitive*

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

Native Attributes

value	Float
units	String

6.3.3 Admittance*Primitive*

Ratio of current to voltage.

Native Attributes

value	Float
units	String

6.3.4 AngleDegrees*Primitive*

Measurement of angle in degrees.

Native Attributes

value	Float
units	String

6.3.5 AngleRadians*Primitive*

Phase angle in radians.

Native Attributes

value	Float
units	String

6.3.6 ApparentPower*Primitive*

Product of the RMS value of the voltage and the RMS value of the current (MegaVoltAmperes)

Native Attributes

value	Float
units	String

6.3.7 AreaControlMode*Enumeration*

Native Attributes

CF	Constant frequency
CTL	Constant tie-line
TLB	Tie-line bias
OFF	Off control

6.3.8 BoilerControlMode*Enumeration*

Boiler { Following, Coordinated}

Native Attributes

following
coordinated

6.3.9 Boolean*Primitive*

A type with the value space 0..1 where 0 means false and 1 means true.

6.3.10 BreakerConfiguration*Enumeration*

Switching arrangement for Bay.

Native Attributes

singleBreaker
breakerAndAHalf
doubleBreaker
noBreaker

6.3.11 BusbarConfiguration*Enumeration*

Busbar layout for Bay.

Native Attributes

singleBus
doubleBus
mainWithTransfer
ringBus

6.3.12 Classification*Primitive*

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

Native Attributes

value	Integer
units	String

6.3.13 ClearanceTagType*Enumeration*

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

6.3.14 CompanyType*Enumeration*

Type of company.

Native Attributes

pool
municipal
isPrivate

6.3.15 Complex*Primitive*

A real and imaginary pair of Float values.

Native Roles

0..*	*real*	1	Float
0..*	*imaginary*	1	Float

6.3.16 CompositeSwitchType*Primitive*

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

Native Attributes

value	String

6.3.17 Conductance*Primitive*

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

Native Attributes

value	Float
units	String

6.3.18 ControlHouseEquipmentType*Enumeration*

Type of control house equipment.

6.3.19 ControlMode*Primitive*

Textual name for a control mode

Native Attributes

value	String

6.3.20 CoolantType*Enumeration*

Method of cooling a machine.

Native Attributes

air
hydrogenGas
water

6.3.21 CostPerEnergyUnit*Primitive*

Cost, in units of currency, per megawatt hour of electricity generated.

Native Attributes

value	Float
units	String

6.3.22 CostPerHeatUnit*Primitive*

Cost, in units of currency, per million Btus of heat generated.

Native Attributes

value	Float
units	String

6.3.23 CostPerHour*Primitive*

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

Native Attributes

value	Float
units	String

6.3.24 Counter*Primitive*

Measurement of quantity (must be greater than or equal to zero).

Native Attributes

value	Integer	Value must be greater than or equal to 0.
units	String	

6.3.25 CurrentFlow*Primitive*

Current flow in amperes (positive flow is out of the ConductingEquipment into the ConnectivityNode).

Native Attributes

value	Float
units	String

6.3.26 CurveStyle*Enumeration*

Style or shape of curve.

Native Attributes

constantYValue
straightLineYValues
rampYValue
formula

6.3.27 Damping*Primitive*

Per-unit megawatt variation with per-unit frequency referenced on the system MVA base. Typical values in range 1,0 – 2,0.

Native Attributes

value	Float
units	String

6.3.28 DayTypeName*Enumeration*

Name of day type.

Native Attributes

weekday
weekend
holiday

6.3.29 DomainVersion

Native Attributes

version
date

6.3.30 Emission*Primitive*

Quantity of emission per fuel heat content.

Native Attributes

value	Float
units	String

6.3.31 EmissionType*Enumeration*

The type of emission.

Native Attributes

sulfurDioxide
carbonDioxide
nitrogenOxide
hydrogenSulfide
chlorine
carbonDisulfide

6.3.32 EmissionValueSource*Enumeration*

The source of the emission value.

Native Attributes

measured
calculated

6.3.33 EnergyAsMWh*Primitive*

Electric energy, in megawatt-hours.

Native Attributes

value	Float
units	String

6.3.34 ExcitingCurrent*Primitive*

The exciting current on open-circuit test, expressed as a percentage of rated current, at nominal voltage.

Native Attributes

value	Float
units	String

6.3.35 Exponent*Primitive*

Exponentiation amount.

Native Attributes

value	Float
units	String

6.3.36 Float*Primitive*

A type defined by IEEE 754-1985 as double (OBSERVE, not as the IEEE 754-1985 float). The value range is m*2**e where the range of m is –2**52..2**52 –1 and the range of e is –1075..970.

Native Roles

1	0..*	Complex
1	0..*	Complex

6.3.37 Fraction*Primitive*

Fractional amount. Sum of all fractions of the same quantity should be 1,0.

Native Attributes

value	Float

6.3.38 FreqBiasFactor*Primitive*

A control area's frequency bias factor.

Native Attributes

value	Float
units	String

6.3.39 Frequency*Primitive*

Cycles per second.

Native Attributes

value	Float
units	String

6.3.40 FuelType*Enumeration*

Type of fuel.

Native Attributes

coal
oil
gas

6.3.41 GeneratorControlMode*Enumeration*

Unit control modes, i.e. Setpoint or Pulse.

Native Attributes

setpoint
pulse

6.3.42 GeneratorControlSource*Enumeration*

The source of controls for a generating unit, i.e. Unavailable, Off-AGC, On-AGC, Plant Control.

Native Attributes

Unavailable
offAGC
onAGC
PlantControl

6.3.43 GeneratorOperatingMode*Enumeration*

Operating mode for secondary generator control, e.g.: Unavailable, Manual, Fixed, Load Frequency Control, AGC, EDC, RPN, MRN, or REG.

Native Attributes

Off
Manual
Fixed
LFC
AGC
EDC
MRN
REG

6.3.44 HeatPerHour*Primitive*

Heat generated, in millions of Btus, per hour of elapsed time.

Native Attributes

value	Float
units	String

6.3.45 Hours*Primitive*

Time, in hours.

Native Attributes

value	Float
units	String

6.3.46 HydroPlantType*Enumeration*

The type of hydro power plant, e.g.: Run-of-River, Pumped Storage, Major Storage, Minor Storage.

Native Attributes

runOfRiver
pumpedStorage
majorStorage
minorStorage

6.3.47 Impedance*Primitive*

Ratio of voltage to current.

Native Attributes

value	Float
units	String

6.3.48 Inductance*Primitive*

Inductance, in millihenries.

Native Attributes

value	Float
units	String

6.3.49 Inertia*Primitive*

Megawatt-seconds per megavolt-ampere rating of the unit referenced on the system MVA base. Typical values in range 3,0 – 5,0.

Native Attributes

value	Float
units	String

6.3.50 Integer*Primitive*

A type with the value range –2**–31..2**31 –1.

6.3.51 Load*Primitive*

Load in MW, greater than 0.

Native Attributes

value	Float
units	String

6.3.52 LoadLoss*Primitive*

The loss on short-circuit test at rated current.

Native Attributes

value	Float
units	String

6.3.53 LongDouble*Primitive*

A type defined by IEEE 754-1985 as a long double.

6.3.54 LongLength*Primitive*

Long unit of length (e.g. mile; kilometer).

Native Attributes

value	Float
units	String

6.3.55 LongLong*Primitive*

A type with the value range –2**63..2**63 –1.

6.3.56 Money*Primitive*

Amount of money.

Native Attributes

value	Float	
units	String	Unit of Currency

6.3.57 NoLoadLoss*Primitive*

The loss on open-circuit test at nominal voltage.

Native Attributes

value	Float
units	String

6.3.58 NumericUnion

Numeric is a union that may hold any of the primitive datatypes. The union has a descriptor of type NumericType that tells the type of an actual Numeric value.

Native Attributes

INT_TYPE	Integer
OCTET_TYPE	Octet
UNSIGNED_TYPE	ULong
FLOAT_TYPE	Float
COMPLEX_TYPE	Complex
DATE_TIME_TYPE	AbsoluteDateTime
ULONG_LONG_TYPE	ULongLong
SHORT_TYPE	Short
LONG_LONG_TYPE	LongLong
LONG_DOUBLE_TYPE	LongDouble
BOOLEAN_TYPE	Boolean

6.3.59 NumericType*Enumeration*

NumericType is an enumeration of the defined Numeric value types.

Native Attributes

INT_TYPE
OCTET_TYPE
UNSIGNED_TYPE
FLOAT_TYPE
COMPLEX_TYPE
DATE_TIME_TYPE
ULONG_LONG_TYPE
SHORT_TYPE
LONG_LONG_TYPE
LONG_DOUBLE_TYPE
BOOLEAN_TYPE

6.3.60 Octet*Primitive*

A type with the value range 0..255.

6.3.61 OperatingMode*Primitive*

Textual name for an operating mode.

Native Attributes

value	String

6.3.62 ParticipationFactor*Primitive*

Generating unit economic participation factor.

Native Attributes

value	Float

6.3.63 PenaltyFactor*Primitive*

Defined as: 1 / (1 – Incremental Transmission Loss); with the Incremental Transmission Loss expressed as a plus or minus value. The typical range of penalty factors is (0,9 to 1,1).

Native Attributes

value	Float

6.3.64 PenstockType*Enumeration*

Type of hydro plant penstock.

6.3.65 PerCent*Primitive*

Normally 0 - 100 on a defined base.

Native Attributes

value	Float	Normally 0 - 100 on a defined base
units	String	

6.3.66 PhaseCode*Primitive*

Collection of phase identifiers.

Native Attributes

value	String

6.3.67 PowerFactor*Primitive*

Ratio of ActivePower to ApparentPower.

Native Attributes

value	Float
units	String

6.3.68 PowerROCPerMin*Primitive*

Megawatt rate of change per minute.

Native Attributes

value	Float
units	String

6.3.69 PowerROCPerSec*Primitive*

Megawatt rate of change per second.

Native Attributes

value	Float
units	String

6.3.70 PowerVersusFrequency*Primitive*

Per unit real power variation versus per unit frequency variation.

Native Attributes

value	Float
units	String

6.3.71 PowerVersusVoltage*Primitive*

Per unit real power variation versus per unit voltage variation.

Native Attributes

value	Float
units	String

6.3.72 Pressure*Primitive*

Pressure given in terms of pound-force per square inch.

Native Attributes

value	Float
units	String

6.3.73 Priority*Primitive*

Defines levels of priority as a numeric value with zero being the highest priority level.

Native Attributes

value	Integer

6.3.74 PU*Primitive*

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

Native Attributes

value	Float

6.3.75 PUkVPerMVAr*Primitive*

Per unit voltage variation with reactive power.

Native Attributes

value	Float
units	String

6.3.76 Quantity*Enumeration*

The quantities that can be used at the CurveSchedule axes.

Native Attributes

none
time
activePower
reactivePower
currency
voltage

6.3.77 RampMethod*Enumeration*

The deltaY versus deltaX units of measure.

Native Attributes

yUnitsPerMinute
rampCompletionInMinutes

6.3.78 RampStartMethod*Enumeration*

The method of applying the ramp.

Native Attributes

zero
fiftyPerCent
oneHundredPerCent

6.3.79 RampUnits*Enumeration*

The deltaY versus deltaX units of measure.

Native Attributes

MWPerMinute
rampCompletionInMin

6.3.80 RateOfChange*Primitive*

Rate of change of dimensionless variable.

Native Attributes

value	Float
units	String

6.3.81 Ratio*Primitive*

Ratio of two values with the same units.

Native Attributes

value	Float

6.3.82 Reactance*Primitive*

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

Native Attributes

value	Float
units	String

6.3.83 ReactivePower*Primitive*

Product of RMS value of the voltage and the RMS value of the quadrature component of the current (Megavoltamperes Reactive).

Native Attributes

value	Float
units	String

6.3.84 Reference*Primitive*

Reference to external text.

Native Attributes

value	String

6.3.85 RemoteUnitType*Enumeration*

Native Attributes

RTU
SubstationControlSystem
ControlCenter
IED

6.3.86 Resistance*Primitive*

Resistance (real part of impedance), in ohms.

Native Attributes

value	Float
units	String

6.3.87 SeasonName*Enumeration*

Name of season.

Native Attributes

winter
spring
summer
fall

6.3.88 Seconds*Primitive*

Time, in seconds.

Native Attributes

value	Float	Time, in seconds
units	String	

6.3.89 Short*Primitive*

A type with the value range –2**15..2**15 –1.

6.3.90 ShortLength*Primitive*

Short unit of length (e.g. foot; meter).

Native Attributes

value	Float

6.3.91 Source*Enumeration*

Source gives information related to the origin of a value. The value may be acquired from the process, defaulted or substituted.

Native Attributes

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.

6.3.92 SpillwayGateType*Enumeration*

Type of spillway gate.

6.3.93 String*Primitive*

A type consisting of a sequence of 8 bit characters. The character encoding is UTF-8.

6.3.94 SurgeTankCode*Enumeration*

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

6.3.95 Susceptance*Primitive*

Imaginary part of admittance.

Native Attributes

value	Float
units	String

6.3.96 SwitchState*Enumeration*

Possible states for a switch.

Native Attributes

open
close

6.3.97 SynchronousMachineOperatingMode*Enumeration*

Native Attributes

generator
condenser

6.3.98 SynchronousMachineType*Enumeration*

Native Attributes

generator
condenser
generator_or_condenser

6.3.99 TapStep*Primitive*

Transformer tap step position. Positions are always numbered sequentially starting with "1" at the lowest tap position and progressing through the highest tap position.

Native Attributes

value	Integer

6.3.100 Temperature*Primitive*

Value of temperature in TemperatureUnits.

Native Attributes

value	Float
units	TemperatureUnits

6.3.101 TemperatureUnits*Enumeration*

Units for temperature measurement {celsius, fahrenheit}.

Native Attributes
celsius
fahrenheit

6.3.102 TerminalCount*Primitive*

Maximum number of terminals for a conducting equipment.

Native Attributes

value	Integer	Maximum number of terminals for a conducting equipment.

6.3.103 TerminalType*Primitive*

A designation of the function of a terminal on its associated conducting equipment.

Native Attributes

value	Integer

6.3.104 TimeStamp*Primitive*

Date and time as "yyyy-mm-ddThh:mm:ss", which conforms with ISO 8601 using the extended form and any of the zone options.

Native Attributes

value	String

6.3.105 TransformerControlMode*Enumeration*

Control modes for a transformer, i.e. Off, Local, Volt, MVAr.

Native Attributes
off
local
volt
MW
mVAr

6.3.106 TransformerCoolingType*Enumeration*

Type of transformer cooling.

6.3.107 TransformerType*Enumeration*

Native Attributes
fix
voltageControl

phaseControl
voltageAndPhaseControl

6.3.108 TurbineType*Enumeration*

Type of turbine.

Native Attributes
francis
pelton
kaplan

6.3.109 ULong*Primitive*

A type with the value range 0..2**32 –1.

6.3.110 ULongLong*Primitive*

A type with the value range 0..2**64 –1.

6.3.111 Validity*Enumeration*

Native Attributes

GOOD	The value is marked good if no abnormal condition of the acquisition function or the information source is detected.
QUESTIONABLE	The value is marked questionable if a supervision function detects an abnormal behaviour, however the value could still be valid. The client is responsible for determining whether or not values marked "questionable" should be used.
INVALID	The value is marked invalid when a supervision function recognises abnormal conditions of the acquisition function or the information source (missing or non-operating updating devices). The value is not defined under this condition. The mark invalid is used to indicate to the client that the value may be incorrect and shall not be used.

6.3.112 WaterLevel*Primitive*

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

Native Attributes

value	Float
units	String

6.3.113 WindingConnection*Enumeration*

D | Y | Z for Delta | Wye | ZigZag winding connections.

Native Attributes

D	Delta
Y	Wye
Z	ZigZag

6.3.114 WindingType*Enumeration*

The winding type, i.e. Primary, Secondary, Tertiary, Quaternary.

Native Attributes

primary
secondary
tertiary
quaternary

6.3.115 Voltage*Primitive*

Value representing kV.

Native Attributes

value	Float	Value representing kV
units	String	

6.3.116 VoltagePerReactivePower*Primitive*

Voltage variation with reactive power.

Native Attributes

value	Float
units	String

6.3.117 Volume*Primitive*

Reservoir water volume, given in millions of cubic meters.

Native Attributes

value	Float
units	String

6.3.118 YAxisType*Enumeration*

The type of dependent variable.

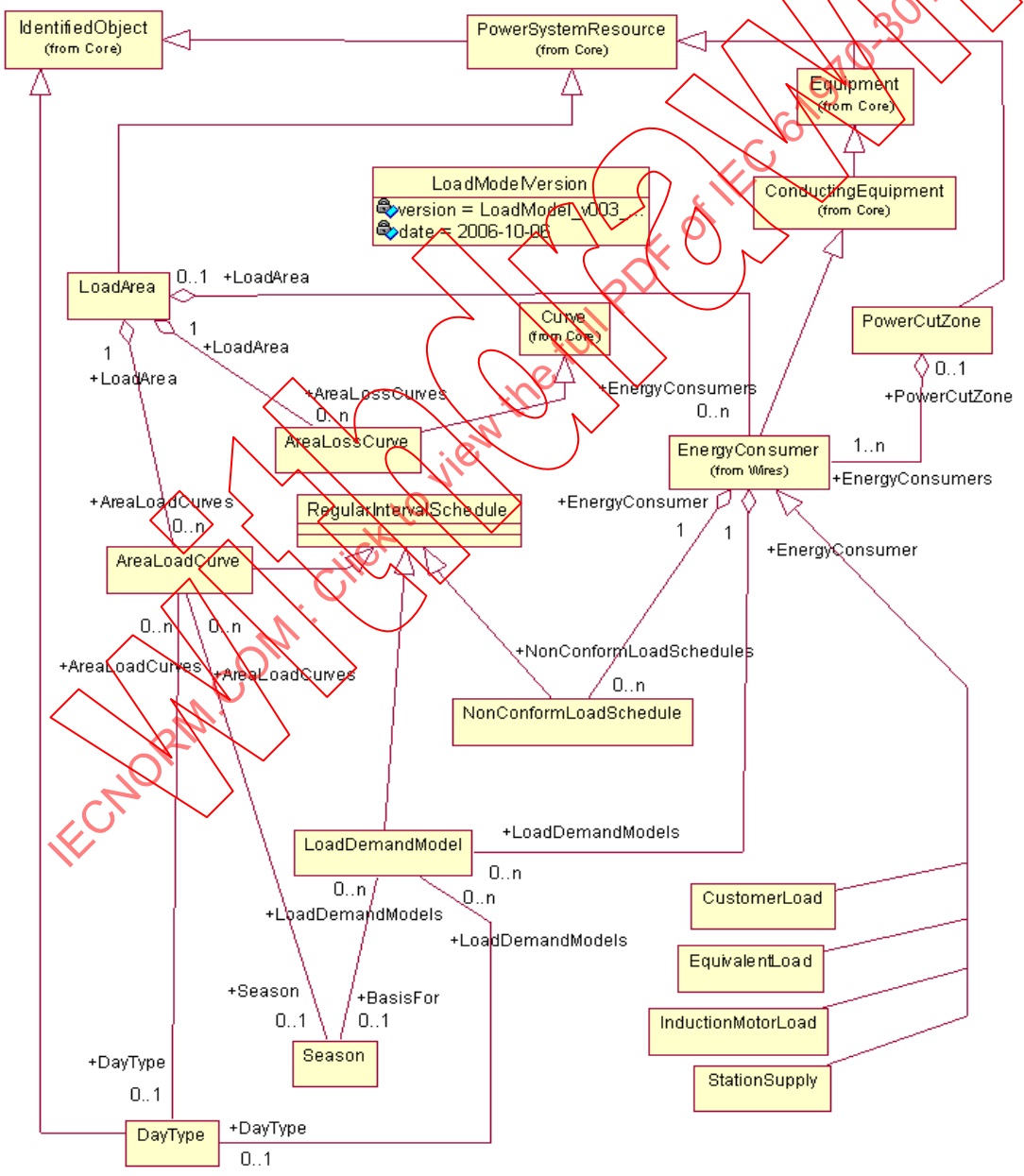
Native Attributes

singleYValue
twoYValues

6.4 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.



IEC 487/09

Figure 23 – Main

Figure 23 shows all classes included in the LoadModel package as well as the key external classes that have associations with LoadModel classes.

6.4.1 AreaLoadCurve

A curve relating power versus time showing the values of a specific load for each unit of the period covered. The curve can be based on "absolute" time or on "normalized' time. An instance of this curve could represent the absolute area load forecast. An other instance could represent a normalized daily load curve for a particular day type.

Inherited Attributes

timeStep	Seconds	RegularIntervalSchedule
endTime	AbsoluteDateTime	RegularIntervalSchedule
startTime	AbsoluteDateTime	BasicIntervalSchedule
value1Unit	String	BasicIntervalSchedule
value2Unit	String	BasicIntervalSchedule
mRID	String	IdentifiedObject
name	String	IdentifiedObject
localName	String	IdentifiedObject
pathName	String	IdentifiedObject
aliasName	String	IdentifiedObject
description	String	IdentifiedObject

Native Roles

0..n	*LoadArea*	1	LoadArea	A load area can have one or more area load curves.
0..n	*DayType*	0..1	DayType	A load model may be classified by the day type.
0..n	*Season*	0..1	Season	A system load model may be classified as seasonal.

Roles Inherited From RegularIntervalSchedule

1	*TimePoints*	1..*	RegularTimePoint	RegularIntervalSchedule

Roles Inherited From BasicIntervalSchedule

Roles Inherited From IdentifiedObject

1..n	*ModelingAuthoritySet*	0..1	ModelingAuthority Set	IdentifiedObject

6.4.2 AreaLossCurve

The relationship between total area MW losses (Y-axis) and total area MW load (X-axis).

Inherited Attributes

curveStyle	CurveStyle	Curve
xUnit	String	Curve
y1Unit	String	Curve
y2Unit	String	Curve
mRID	String	IdentifiedObject
name	String	IdentifiedObject
localName	String	IdentifiedObject
pathName	String	IdentifiedObject
aliasName	String	IdentifiedObject
description	String	IdentifiedObject

Native Roles

0..n	*LoadArea*	1	LoadArea	A load area can have one or more area loss curves.

Roles Inherited From Curve

1	*CurveScheduleDatas*	0..n	CurveData	Curve

Roles Inherited From IdentifiedObject

1..n	*ModelingAuthoritySet*	0..1	ModelingAuthority Set	IdentifiedObject

6.4.3 CustomerLoad

A meter for measuring customer energy consumption. The typeName attribute indicates the type of customer meter.

Inherited Attributes

conformingLoadFlag	Boolean	EnergyConsumer
customerCount	Counter	EnergyConsumer
pFexp	Exponent	EnergyConsumer
pfixed	ActivePower	EnergyConsumer
pfixedPct	PerCent	EnergyConsumer
pnom	ActivePower	EnergyConsumer
pnomPct	PerCent	EnergyConsumer
powerFactor	PowerFactor	EnergyConsumer
pVexp	Exponent	EnergyConsumer
qFexp	Exponent	EnergyConsumer
qfixed	ReactivePower	EnergyConsumer
qfixedPct	PerCent	EnergyConsumer
qnom	ReactivePower	EnergyConsumer
qnomPct	PerCent	EnergyConsumer
qVexp	Exponent	EnergyConsumer
phases	PhaseCode	ConductingEquipment
mRID	String	IdentifiedObject
name	String	IdentifiedObject
localName	String	IdentifiedObject
pathName	String	IdentifiedObject
aliasName	String	IdentifiedObject
description	String	IdentifiedObject

Roles Inherited From EnergyConsumer

1	*LoadDemandModels*	0..n	LoadDemandModel	EnergyConsumer
1	*NonConformLoadSchedules*	0..n	NonConformLoadSchedule	EnergyConsumer
0..n	*LoadArea*	0..1	LoadArea	EnergyConsumer
1..n	*PowerCutZone*	0..1	PowerCutZone	EnergyConsumer

Roles Inherited From ConductingEquipment

1	*Terminals*	0..n	Terminal	ConductingEquipment
0..n	*BaseVoltage*	0..1	BaseVoltage	ConductingEquipment
1	*ClearanceTags*	0..n	ClearanceTag	ConductingEquipment
0..n	*ProtectionEquipments*	0..n	ProtectionEquipment	ConductingEquipment

Roles Inherited From Equipment

0..n	*MemberOf_EquipmentContainer*	0..1	EquipmentContainer	Equipment

Roles Inherited From PowerSystemResource

0..n	*OperatedBy_Companies*	0..n	Company	PowerSystemResource
0..n	*PSRType*	0..1	PSRType	PowerSystemResource
1	*Contains_Measurements*	0..n	Measurement	PowerSystemResource
1	*OutageSchedule*	0..1	OutageSchedule	PowerSystemResource

Roles Inherited From IdentifiedObject

1..n	*ModelingAuthoritySet*	0..1	ModelingAuthoritySet	IdentifiedObject

6.4.4 DayType

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

Inherited Attributes

mRID	String	IdentifiedObject
name	String	IdentifiedObject
localName	String	IdentifiedObject
pathName	String	IdentifiedObject
aliasName	String	IdentifiedObject
description	String	IdentifiedObject

Native Roles

0..1	*AreaLoadCurves*	0..n	AreaLoadCurve	A load model may be classified by the day type.
0..1	*LoadDemandModels*	0..n	LoadDemandModel	Load demand models can be based on day type.

Roles Inherited From IdentifiedObject

1..n	*ModelingAuthoritySet*	0..1	ModelingAuthoritySet	IdentifiedObject

6.4.5 EquivalentLoad

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.

Native Attributes

feederLoadMgtFactor	PerCent	The feeder's contribution to load management, in percent.
mVArColdPickUpFactor	PerCent	The amount of nominal feeder MVAr that is picked up cold, in percent.
mWColdPickUpFactor	PerCent	The amount of nominal feeder MW that is picked up cold, in percent.
phaseAmpRating	CurrentFlow	The rated individual phase amperes.
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.

Inherited Attributes

conformingLoadFlag	Boolean	EnergyConsumer
customerCount	Counter	EnergyConsumer
pFexp	Exponent	EnergyConsumer
pfixed	ActivePower	EnergyConsumer
pfixedPct	PerCent	EnergyConsumer
pnom	ActivePower	EnergyConsumer
pnomPct	PerCent	EnergyConsumer
powerFactor	PowerFactor	EnergyConsumer
pVexp	Exponent	EnergyConsumer
qFexp	Exponent	EnergyConsumer
qfixed	ReactivePower	EnergyConsumer
qfixedPct	PerCent	EnergyConsumer
qnom	ReactivePower	EnergyConsumer
qnomPct	PerCent	EnergyConsumer
qVexp	Exponent	EnergyConsumer
phases	PhaseCode	ConductingEquipment
mRID	String	IdentifiedObject
name	String	IdentifiedObject
localName	String	IdentifiedObject
pathName	String	IdentifiedObject
aliasName	String	IdentifiedObject
description	String	IdentifiedObject

Roles Inherited From EnergyConsumer

1	*LoadDemandModels*	0..n	LoadDemandModel	EnergyConsumer
1	*NonConformLoadSchedules*	0..n	NonConformLoadSchedule	EnergyConsumer
0..n	*LoadArea*	0..1	LoadArea	EnergyConsumer
1..n	*PowerCutZone*	0..1	PowerCutZone	EnergyConsumer

Roles Inherited From ConductingEquipment

1	*Terminals*	0..n	Terminal	ConductingEquipment
0..n	*BaseVoltage*	0..1	BaseVoltage	ConductingEquipment
1	*ClearanceTags*	0..n	ClearanceTag	ConductingEquipment
0..n	*ProtectionEquipments*	0..n	ProtectionEquipment	ConductingEquipment

Roles Inherited From Equipment

0..n	*MemberOf_EquipmentContainer*	0..1	EquipmentContainer	Equipment

Roles Inherited From PowerSystemResource

0..n	*OperatedBy_Companies*	0..n	Company	PowerSystemResource
0..n	*PSRType*	0..1	PSRType	PowerSystemResource
1	*Contains_Measurements*	0..n	Measurement	PowerSystemResource
1	*OutageSchedule*	0..1	OutageSchedule	PowerSystemResource

Roles Inherited From IdentifiedObject

1..n	*ModelingAuthoritySet*	0..1	ModelingAuthoritySet	IdentifiedObject

6.4.6 InductionMotorLoad

Large three phase induction motor load. The typeName attribute indicates the type of induction motor (1 = wound rotor) (2 = squirrel cage).

Inherited Attributes

conformingLoadFlag	Boolean	EnergyConsumer
customerCount	Counter	EnergyConsumer
pFexp	Exponent	EnergyConsumer
pfixed	ActivePower	EnergyConsumer
pfixedPct	PerCent	EnergyConsumer
pnom	ActivePower	EnergyConsumer
pnomPct	PerCent	EnergyConsumer
powerFactor	PowerFactor	EnergyConsumer
pVexp	Exponent	EnergyConsumer
qFexp	Exponent	EnergyConsumer
qfixed	ReactivePower	EnergyConsumer
qfixedPct	PerCent	EnergyConsumer
qnom	ReactivePower	EnergyConsumer
qnomPct	PerCent	EnergyConsumer
qVexp	Exponent	EnergyConsumer
phases	PhaseCode	ConductingEquipment
mRID	String	IdentifiedObject
name	String	IdentifiedObject
localName	String	IdentifiedObject
pathName	String	IdentifiedObject
aliasName	String	IdentifiedObject
description	String	IdentifiedObject

Roles Inherited From EnergyConsumer

1	*LoadDemandModels*	0..n	LoadDemandModel	EnergyConsumer
1	*NonConformLoadSchedules*	0..n	NonConformLoadSchedule	EnergyConsumer
0..n	*LoadArea*	0..1	LoadArea	EnergyConsumer
1..n	*PowerCutZone*	0..1	PowerCutZone	EnergyConsumer

Roles Inherited From ConductingEquipment

1	*Terminals*	0..n	Terminal	ConductingEquipment
0..n	*BaseVoltage*	0..1	BaseVoltage	ConductingEquipment
1	*ClearanceTags*	0..n	ClearanceTag	ConductingEquipment
0..n	*ProtectionEquipments*	0..n	ProtectionEquipment	ConductingEquipment

Roles Inherited From Equipment

0..n	*MemberOf_EquipmentContainer*	0..1	EquipmentContainer	Equipment

Roles Inherited From PowerSystemResource

0..n	*OperatedBy_Companies*	0..n	Company	PowerSystemResource
0..n	*PSRType*	0..1	PSRType	PowerSystemResource
1	*Contains_Measurements*	0..n	Measurement	PowerSystemResource
1	*OutageSchedule*	0..1	OutageSchedule	PowerSystemResource

Roles Inherited From IdentifiedObject

1..n	*ModelingAuthoritySet*	0..1	ModelingAuthority Set	IdentifiedObject

6.4.7 LoadArea

Group of loads (i.e. energy consumers).

Inherited Attributes

mRID	String	IdentifiedObject
name	String	IdentifiedObject
localName	String	IdentifiedObject
pathName	String	IdentifiedObject
aliasName	String	IdentifiedObject
description	String	IdentifiedObject

Native Roles

0..1	*EnergyConsumers*	0..n	EnergyConsumer	Consumers may be assigned to a load area.
1	*AreaLossCurves*	0..n	AreaLossCurve	A load area can have one or more area loss curves.
1	*AreaLoadCurves*	0..n	AreaLoadCurve	A load area can have one or more area load curves.

Roles Inherited From PowerSystemResource

0..n	*OperatedBy_Companies*	0..n	Company	PowerSystemResource
0..n	*PSRType*	0..1	PSRType	PowerSystemResource
1	*Contains_Measurements*	0..n	Measurement	PowerSystemResource
1	*OutageSchedule*	0..1	OutageSchedule	PowerSystemResource

Roles Inherited From IdentifiedObject

1..n	*ModelingAuthoritySet*	0..1	ModelingAuthority Set	IdentifiedObject

6.4.8 LoadDemandModel

A curve of load versus time (X-axis) showing the values of MW (Y1-axis) and MVAr (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.

Inherited Attributes

timeStep	Seconds	RegularIntervalSchedule
endTime	AbsoluteDateTime	RegularIntervalSchedule
startTime	AbsoluteDateTime	BasicIntervalSchedule
value1Unit	String	BasicIntervalSchedule
value2Unit	String	BasicIntervalSchedule
mRID	String	IdentifiedObject
name	String	IdentifiedObject
localName	String	IdentifiedObject
pathName	String	IdentifiedObject
aliasName	String	IdentifiedObject
description	String	IdentifiedObject

Native Roles

0..n	*EnergyConsumer*	1	EnergyConsumer	An energy consumer may have one or more load demand models.
0..n	*BasisFor*	0..1	Season	Load demand models can be based on seasons.
0..n	*DayType*	0..1	DayType	Load demand models can be based on day type.

Roles Inherited From RegularIntervalSchedule

1	*TimePoints*	1..*	RegularTimePoint	RegularIntervalSchedule

Roles Inherited From BasicIntervalSchedule

Roles Inherited From IdentifiedObject

1..n	*ModelingAuthoritySet*	0..1	ModelingAuthority Set	IdentifiedObject

6.4.9 LoadModelVersion

Native Attributes

version
date

6.4.10 NonConformLoadSchedule

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

Inherited Attributes

timeStep	Seconds	RegularIntervalSchedule
endTime	AbsoluteDateTime	RegularIntervalSchedule
startTime	AbsoluteDateTime	BasicIntervalSchedule
value1Unit	String	BasicIntervalSchedule
value2Unit	String	BasicIntervalSchedule
mRID	String	IdentifiedObject
name	String	IdentifiedObject
localName	String	IdentifiedObject
pathName	String	IdentifiedObject
aliasName	String	IdentifiedObject
description	String	IdentifiedObject

Native Roles

0..n	*EnergyConsumer*	1	EnergyConsumer	An energy consumer may have a non-conforming load schedule.

Roles Inherited From RegularIntervalSchedule

1	*TimePoints*	1..*	RegularTimePoint	RegularIntervalSchedule

Roles Inherited From BasicIntervalSchedule

Roles Inherited From IdentifiedObject

1..n	*ModelingAuthoritySet*	0..1	ModelingAuthority Set	IdentifiedObject

6.4.11 PowerCutZone

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

Native Attributes

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.

Inherited Attributes

mRID	String	IdentifiedObject
name	String	IdentifiedObject
localName	String	IdentifiedObject
pathName	String	IdentifiedObject
aliasName	String	IdentifiedObject
description	String	IdentifiedObject

Native Roles

0..1	*EnergyConsumers*	1..n	EnergyConsumer	An energy consumer is assigned to a power cut zone

Roles Inherited From PowerSystemResource

0..n	*OperatedBy_Companies*	0..n	Company	PowerSystemResource
0..n	*PSRType*	0..1	PSRType	PowerSystemResource
1	*Contains_Measurements*	0..n	Measurement	PowerSystemResource
1	*OutageSchedule*	0..1	OutageSchedule	PowerSystemResource

Roles Inherited From IdentifiedObject

1..n	*ModelingAuthoritySet*	0..1	ModelingAuthoritySet	IdentifiedObject

6.4.12 Season

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

Native Attributes

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

Native Roles

0..1	*AreaLoadCurves*	0..n	AreaLoadCurve	A system load model may be classified as seasonal.
0..1	*LoadDemandModels*	0..n	LoadDemandModel	Load demand models can be based on seasons.

6.4.13 StationSupply

Station supply.

Inherited Attributes

conformingLoadFlag	Boolean	EnergyConsumer
customerCount	Counter	EnergyConsumer
pFexp	Exponent	EnergyConsumer
pfixed	ActivePower	EnergyConsumer
pfixedPct	PerCent	EnergyConsumer
pnom	ActivePower	EnergyConsumer
pnomPct	PerCent	EnergyConsumer
powerFactor	PowerFactor	EnergyConsumer
pVexp	Exponent	EnergyConsumer
qFexp	Exponent	EnergyConsumer
qfixed	ReactivePower	EnergyConsumer
qfixedPct	PerCent	EnergyConsumer
qnom	ReactivePower	EnergyConsumer
qnomPct	PerCent	EnergyConsumer
qVexp	Exponent	EnergyConsumer
phases	PhaseCode	ConductingEquipment
mRID	String	IdentifiedObject
name	String	IdentifiedObject
localName	String	IdentifiedObject
pathName	String	IdentifiedObject
aliasName	String	IdentifiedObject
description	String	IdentifiedObject

Roles Inherited From EnergyConsumer

1	*LoadDemandModels*	0..n	LoadDemandModel	EnergyConsumer
1	*NonConformLoadSchedules*	0..n	NonConformLoadSchedule	EnergyConsumer
0..n	*LoadArea*	0..1	LoadArea	EnergyConsumer
1..n	*PowerCutZone*	0..1	PowerCutZone	EnergyConsumer

Roles Inherited From ConductingEquipment

1	*Terminals*	0..n	Terminal	ConductingEquipment
0..n	*BaseVoltage*	0..1	BaseVoltage	ConductingEquipment
1	*ClearanceTags*	0..n	ClearanceTag	ConductingEquipment
0..n	*ProtectionEquipments*	0..n	ProtectionEquipment	ConductingEquipment

Roles Inherited From Equipment

0..n	*MemberOf_EquipmentContainer*	0..1	EquipmentContainer	Equipment

Roles Inherited From PowerSystemResource

0..n	*OperatedBy_Companies*	0..n	Company	PowerSystemResource
0..n	*PSRType*	0..1	PSRType	PowerSystemResource
1	*Contains_Measurements*	0..n	Measurement	PowerSystemResource
1	*OutageSchedule*	0..1	OutageSchedule	PowerSystemResource

Roles Inherited From IdentifiedObject

1..n	*ModelingAuthoritySet*	0..1	ModelingAuthoritySet	IdentifiedObject

6.5 Meas

Contains entities that describe dynamic measurement data exchanged between applications.

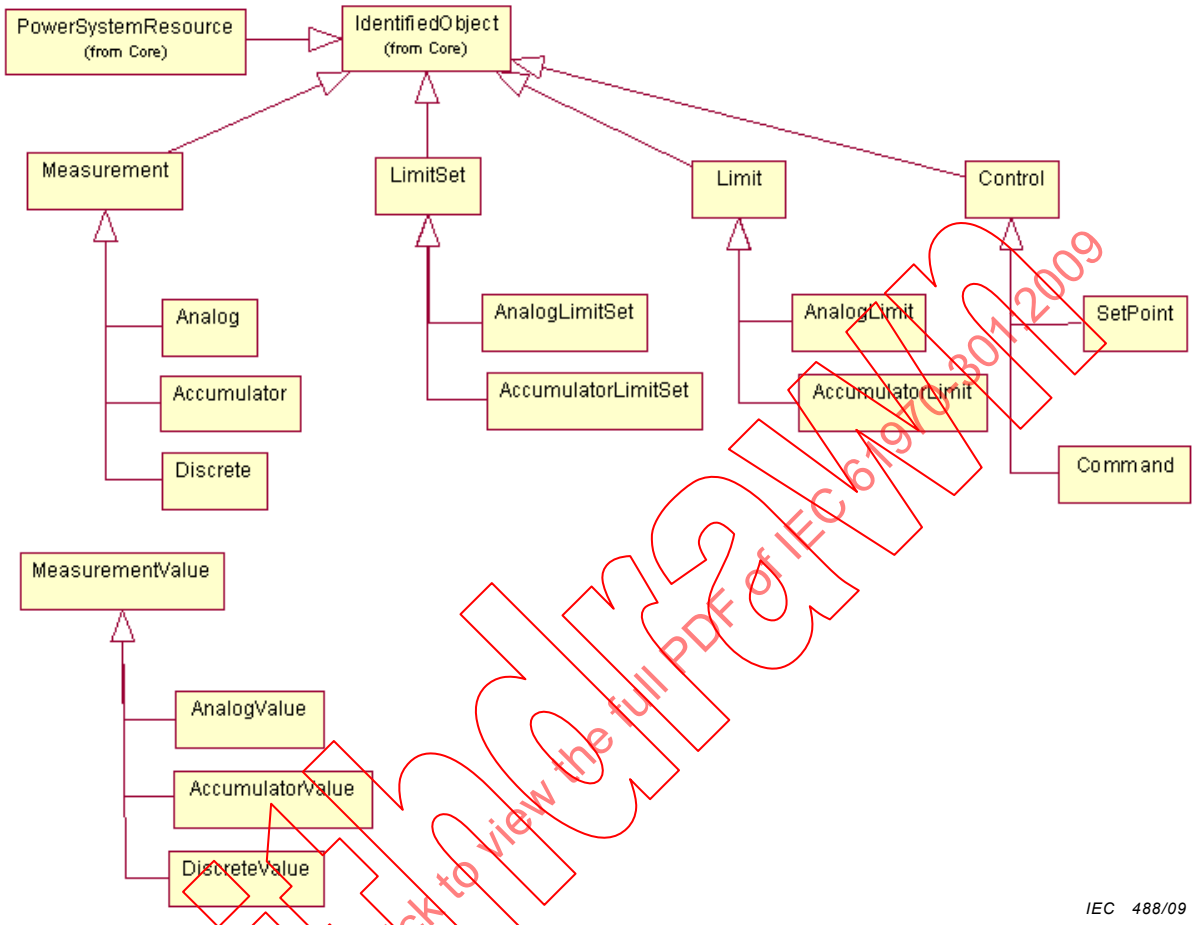


Figure 24 – InheritanceStructure

Figure 24 shows the measurement classes inherit basic classes.

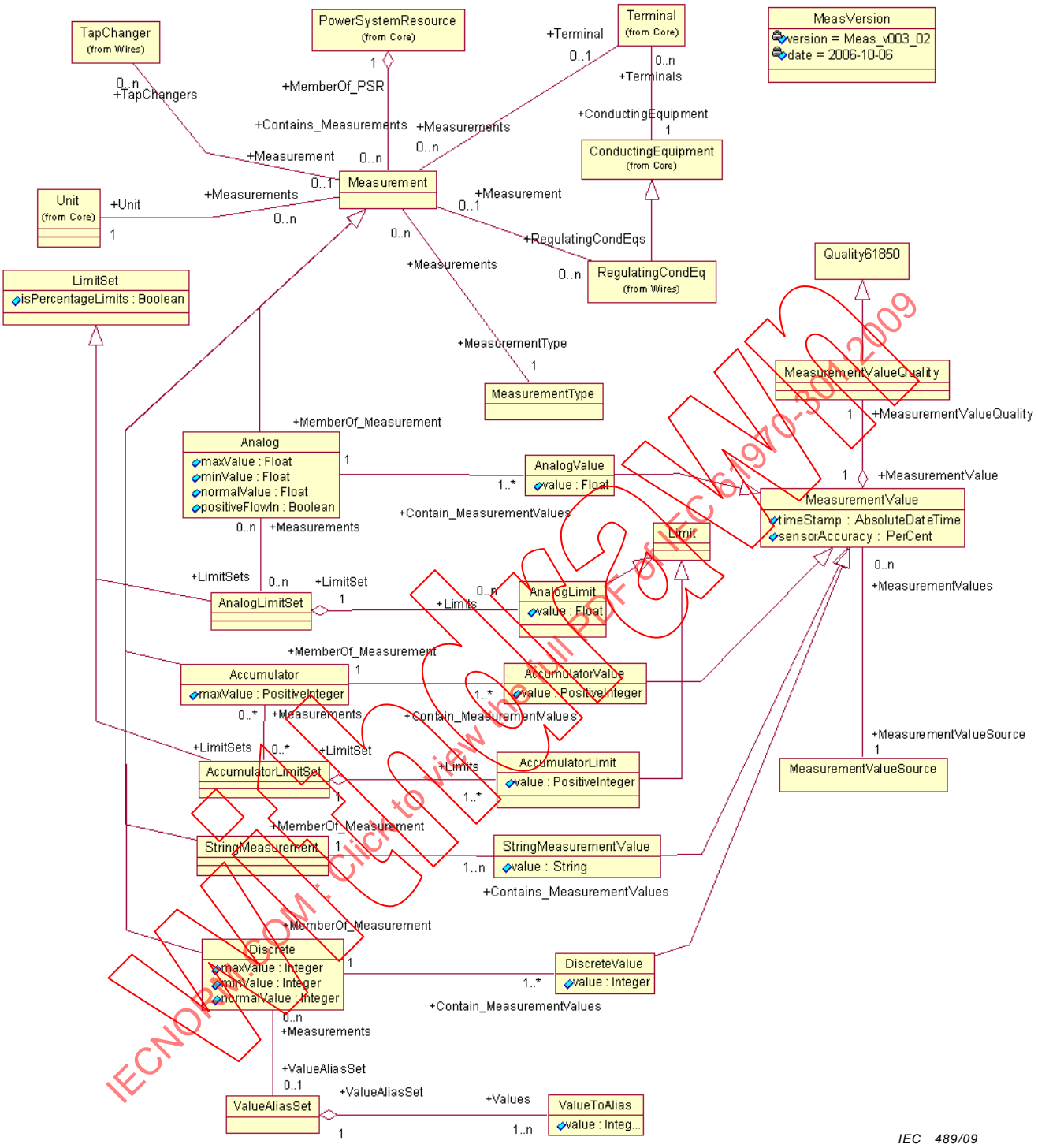


Figure 25 – Mesurement

Figure 25 shows classes central to the Measurement package and connections to some external classes.

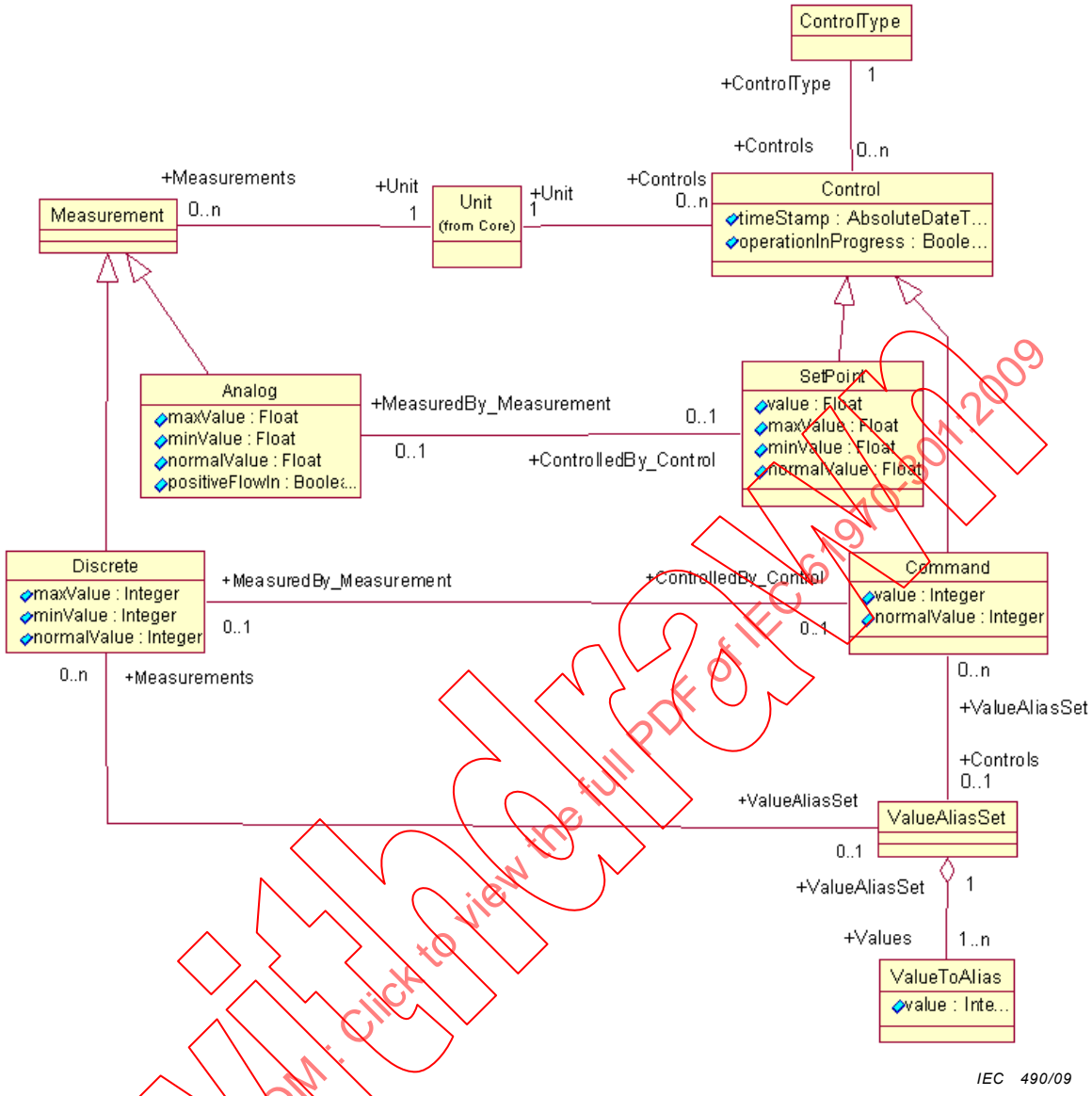


Figure 26 – Control

Figure 26 shows all classes included in the Meas package

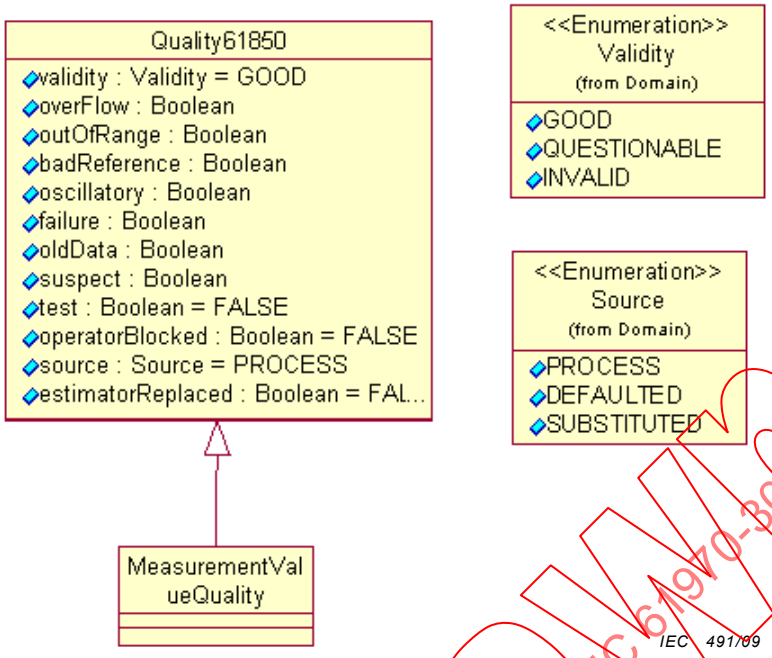


Figure 27 – Quality

Figure 27 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.

6.5.1 Accumulator

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

Native Attributes

maxValue	PositiveInteger	Normal value range maximum for any of the MeasurementValue.values. Used for scaling, e.g. in bar graphs or of telemetered raw values.

Inherited Attributes

mRID	String	IdentifiedObject
name	String	IdentifiedObject
localName	String	IdentifiedObject
pathName	String	IdentifiedObject
aliasName	String	IdentifiedObject
description	String	IdentifiedObject

Native Roles

1	*Contain_MeasurementValues*	1..*	AccumulatorValue
0..*	*LimitSets*	0..*	AccumulatorLimitSet

Roles Inherited From Measurement

0..n	*MeasurementType*	1	MeasurementType	Measurement
0..n	*Terminal*	0..1	Terminal	Measurement
0..n	*MemberOf_PSR*	1	PowerSystemResource	Measurement
0..n	*Unit*	1	Unit	Measurement
0..1	*RegulatingCondEqs*	0..n	RegulatingCondEq	Measurement
0..1	*TapChangers*	0..n	TapChanger	Measurement

Roles Inherited From IdentifiedObject

1..n	*ModelingAuthoritySet*	0..1	ModelingAuthoritySet	IdentifiedObject

6.5.2 AccumulatorLimit

Limit values for Accumulator measurements.

Native Attributes

value	PositiveInteger	The value to supervise against.

Inherited Attributes

mRID	String	IdentifiedObject
name	String	IdentifiedObject
localName	String	IdentifiedObject
pathName	String	IdentifiedObject
aliasName	String	IdentifiedObject
description	String	IdentifiedObject

Native Roles

1..*	*LimitSet*	1	AccumulatorLimitSet	

Roles Inherited From Limit

Roles Inherited From IdentifiedObject

1..n	*ModelingAuthoritySet*	0..1	ModelingAuthoritySet	IdentifiedObject

6.5.3 AccumulatorLimitSet

An AccumulatorLimitSet specifies a set of Limits that are associated with an Accumulator measurement.

Inherited Attributes

isPercentageLimits	Boolean	LimitSet
mRID	String	IdentifiedObject
name	String	IdentifiedObject
localName	String	IdentifiedObject
pathName	String	IdentifiedObject
aliasName	String	IdentifiedObject
description	String	IdentifiedObject

Native Roles

1	*Limits*	1..*	AccumulatorLimit
0..*	*Measurements*	0..*	Accumulator

Roles Inherited From LimitSet

Roles Inherited From IdentifiedObject

1..n	*ModelingAuthoritySet*	0..1	ModelingAuthoritySet	IdentifiedObject

6.5.4 AccumulatorValue

AccumulatorValue represents an accumulated (counted) MeasurementValue.

Native Attributes

value	PositiveInteger	

Inherited Attributes

timeStamp	AbsoluteDateTime	MeasurementValue
sensorAccuracy	PerCent	MeasurementValue

Native Roles

1..*	*MemberOf_Measurement*	1	Accumulator	

Roles Inherited From MeasurementValue

1	*MeasurementValueQuality*	1	MeasurementValueQuality	MeasurementValue
0..n	*MeasurementValueSource*	1	MeasurementValueSource	MeasurementValue
1	*RemoteSource*	0..1	RemoteSource	MeasurementValue

6.5.5 Analog

Analog represents an analog Measurement.

Native Attributes

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 a MW, MVAR or AMPS with the convention that a positive value measured at the Terminal means power is flowing into the related PowerSystemResource.

Inherited Attributes

mRID	String	IdentifiedObject
name	String	IdentifiedObject
localName	String	IdentifiedObject
pathName	String	IdentifiedObject
aliasName	String	IdentifiedObject
description	String	IdentifiedObject

Native Roles

0..n	*LimitSets*	0..n	AnalogLimitSet	A measurement may have zero or more limit ranges defined for it.
1	*Contain_MeasurementValues*	1..*	AnalogValue	
0..1	*ControlledBy_Control*	0..1	SetPoint	The Control variable associated with the Measurement.

Roles Inherited From Measurement

0..n	*MeasurementType*	1	MeasurementType	Measurement
0..n	*Terminal*	0..1	Terminal	Measurement
0..n	*MemberOf_PSR*	1	PowerSystemResource	Measurement
0..n	*Unit*	1	Unit	Measurement

0..1	*RegulatingCondEqs*	0..n	RegulatingCondEq	Measurement
0..1	*TapChangers*	0..n	TapChanger	Measurement

Roles Inherited From IdentifiedObject

1..n	*ModelingAuthoritySet*	0..1	ModelingAuthority Set	IdentifiedObject

6.5.6 AnalogLimit

Limit values for Analog measurements.

Native Attributes

value	Float	The value to supervise against.

Inherited Attributes

mRID	String	IdentifiedObject
name	String	IdentifiedObject
localName	String	IdentifiedObject
pathName	String	IdentifiedObject
aliasName	String	IdentifiedObject
description	String	IdentifiedObject

Native Roles

0..n	*LimitSet*	1	AnalogLimitSet

Roles Inherited From Limit

Roles Inherited From IdentifiedObject

1..n	*ModelingAuthoritySet*	0..1	ModelingAuthority Set	IdentifiedObject

6.5.7 AnalogLimitSet

An AnalogLimitSet specifies a set of Limits that are associated with an Analog measurement.

Inherited Attributes

isPercentageLimits	Boolean	LimitSet
mRID	String	IdentifiedObject
name	String	IdentifiedObject
localName	String	IdentifiedObject
pathName	String	IdentifiedObject
aliasName	String	IdentifiedObject
description	String	IdentifiedObject

Native Roles

0..n	*Measurements*	0..n	Analog	A measurement may have zero or more limit ranges defined for it.
1	*Limits*	0..n	AnalogLimit	The Limits used for supervision. The name of each Limit shall reflect their ordering, e.g. HighAlarm, HighWarning, LowWarning, LowAlarm, etc.

Roles Inherited From LimitSet

Roles Inherited From IdentifiedObject

1..n	*ModelingAuthoritySet*	0..1	ModelingAuthoritySet	IdentifiedObject

6.5.8 AnalogValue

AnalogValue represents an analog MeasurementValue.

Native Attributes

value	Float	

Inherited Attributes

timeStamp	AbsoluteDateTime	MeasurementValue
sensorAccuracy	PerCent	MeasurementValue

Native Roles

1..*	*MemberOf_Measurement*	1	Analog	

Roles Inherited From MeasurementValue

1	*MeasurementValueQuality*	1	MeasurementValueQuality	MeasurementValue
0..n	*MeasurementValueSource*	1	MeasurementValueSource	MeasurementValue
1	*RemoteSource*	0..1	RemoteSource	MeasurementValue

6.5.9 Command

A Command is a discrete control used for supervisory control.

Native Attributes

value	Integer	The value representing the actuator output.
normalValue	Integer	Normal value for Control.value, e.g. used for percentage scaling.

Inherited Attributes

timeStamp	AbsoluteDateTime	Control
operationInProgress	Boolean	Control
mRID	String	IdentifiedObject
name	String	IdentifiedObject
localName	String	IdentifiedObject
pathName	String	IdentifiedObject
aliasName	String	IdentifiedObject
description	String	IdentifiedObject

Native Roles

0..n	*ValueAliasSet*	0..1	ValueAliasSet	The ValueAliasSet used for translation of a Control value to a name.
0..1	*MeasuredBy_Measurement*	0..1	Discrete	

Roles Inherited From Control

1..n	*ControlledBy_RegulatingCondEq*	0..1	RegulatingCondEq	Control
0..n	*Unit*	1	Unit	Control
0..n	*ControlType*	1	ControlType	Control
1	*RemoteControl*	0..1	RemoteControl	Control

Roles Inherited From IdentifiedObject

1..n	*ModelingAuthoritySet*	0..1	ModelingAuthoritySet	IdentifiedObject

6.5.10 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.

Native Attributes

timeStamp	AbsoluteDateTime	The last time a control output was sent.
operationInProgress	Boolean	Indicates that a client is currently sending control commands that have not completed.

Inherited Attributes

mRID	String	IdentifiedObject
name	String	IdentifiedObject
localName	String	IdentifiedObject
pathName	String	IdentifiedObject
aliasName	String	IdentifiedObject
description	String	IdentifiedObject

Native Roles

1..n	*ControlledBy_RegulatingCondEq*	0..1	RegulatingCondEq	
0..n	*Unit*	1	Unit	
0..n	*ControlType*	1	ControlType	The type of Control
1	*RemoteControl*	0..1	RemoteControl	

Roles Inherited From IdentifiedObject

1..n	*ModelingAuthoritySet*	0..1	ModelingAuthoritySet	IdentifiedObject

6.5.11 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.

Inherited Attributes

mRID	String	IdentifiedObject
name	String	IdentifiedObject
localName	String	IdentifiedObject
pathName	String	IdentifiedObject
aliasName	String	IdentifiedObject
description	String	IdentifiedObject

Native Roles

1	*Controls*	0..n	Control	The Controls having the ControlType.

Roles Inherited From IdentifiedObject

1..n	*ModelingAuthoritySet*	0..1	ModelingAuthoritySet	IdentifiedObject

6.5.12 Discrete

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

Native Attributes

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.

Inherited Attributes

mRID	String	IdentifiedObject
name	String	IdentifiedObject
localName	String	IdentifiedObject
pathName	String	IdentifiedObject
aliasName	String	IdentifiedObject
description	String	IdentifiedObject

Native Roles

1	*Contain_MeasurementValues*	1..*	DiscreteValue	
0..n	*ValueAliasSet*	0..1	ValueAliasSet	The ValueAliasSet used for translation of a MeasurementValue.value to a name.
0..1	*ControlledBy_Control*	0..1	Command	

Roles Inherited From Measurement

0..n	*MeasurementType*	1	MeasurementType	Measurement
0..n	*Terminal*	0..1	Terminal	Measurement
0..n	*MemberOf_PSR*	1	PowerSystemResource	Measurement
0..n	*Unit*	1	Unit	Measurement
0..1	*RegulatingCondEqs*	0..n	RegulatingCondEq	Measurement
0..1	*TapChangers*	0..n	TapChanger	Measurement

Roles Inherited From IdentifiedObject

1..n	*ModelingAuthoritySet*	0..1	ModelingAuthoritySet	IdentifiedObject

6.5.13 DiscreteValue

DiscreteValue represents a discrete MeasurementValue.

Native Attributes

value	Integer

Inherited Attributes

timeStamp	AbsoluteDateTime	MeasurementValue
sensorAccuracy	PerCent	MeasurementValue

Native Roles

1..*	*MemberOf_Measurement*	1	Discrete

Roles Inherited From MeasurementValue

1	*MeasurementValueQuality*	1	MeasurementValueQuality	MeasurementValue
0..n	*MeasurementValueSource*	1	MeasurementValueSource	MeasurementValue
1	*RemoteSource*	0..1	RemoteSource	MeasurementValue

6.5.14 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.

Inherited Attributes

mRID	String	IdentifiedObject
name	String	IdentifiedObject
localName	String	IdentifiedObject
pathName	String	IdentifiedObject
aliasName	String	IdentifiedObject
description	String	IdentifiedObject

Roles Inherited From IdentifiedObject

1..n	*ModelingAuthoritySet*	0..1	ModelingAuthoritySet	IdentifiedObject

6.5.15 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.

Native Attributes

isPercentageLimits	Boolean	Tells if the limit values are in percentage of normalValue or the specified Unit for Measurements and Controls.

Inherited Attributes

mRID	String	IdentifiedObject
name	String	IdentifiedObject
localName	String	IdentifiedObject
pathName	String	IdentifiedObject
aliasName	String	IdentifiedObject
description	String	IdentifiedObject

Roles Inherited From IdentifiedObject

1..n	*ModelingAuthoritySet*	0..1	ModelingAuthoritySet	IdentifiedObject

6.5.16 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:

a) Measurement-Terminal- ConnectivityNode-Terminal-ConductingEquipment

b) 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.

Inherited Attributes

mRID	String	IdentifiedObject
name	String	IdentifiedObject
localName	String	IdentifiedObject
pathName	String	IdentifiedObject
aliasName	String	IdentifiedObject
description	String	IdentifiedObject

Native Roles

0..n	*MeasurementType*	1	MeasurementType	The type for the Measurement.
0..n	*Terminal*	0..1	Terminal	One or more measurements may be associated with a terminal in the network.
0..n	*MemberOf_PSR*	1	PowerSystemResource	The PowerSystemResource that contains the Measurement in the naming hierarchy.
0..n	*Unit*	1	Unit	The Unit for the Measurement.
0..1	*RegulatingCondEqs*	0..n	RegulatingCondEq	A type of conducting equipment that may be used to regulate a network measurement, typically voltage.
0..1	*TapChangers*	0..n	TapChanger	An LTC may regulate a specific measurement from the network, typically voltage. A phase shifter would typically be used to regulate a real power (MW) flow measurement. An LTC with significant phase shift characteristics could be used to regulate MW flow instead of voltage.

Roles Inherited From IdentifiedObject

1..n	*ModelingAuthoritySet*	0..1	ModelingAuthority	IdentifiedObject

Set

6.5.17 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.

Inherited Attributes

mRID	String	IdentifiedObject
name	String	IdentifiedObject
localName	String	IdentifiedObject
pathName	String	IdentifiedObject
aliasName	String	IdentifiedObject
description	String	IdentifiedObject

Native Roles

1	*Measurements*	0..n	Measurement	The measurement associated with the Type.

Roles Inherited From IdentifiedObject

1..n	*ModelingAuthoritySet*	0..1	ModelingAuthority Set	IdentifiedObject

6.5.18 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.

Native Attributes

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.

Native Roles

1	*MeasurementValueQuality*	1	MeasurementValueQuality	A MeasurementValue has a MeasurementValue Quality associated with it.
0..n	*MeasurementValueSource*	1	MeasurementValueSource	A reference to the type of source that updates the MeasurementValue, e.g. SCADA, CCLink, manual, etc. User conventions for the names of sources are contained in the introduction to IEC 61970-301.
1	*RemoteSource*	0..1	RemoteSource	Links to the physical telemetered point associated with this

measurement.

6.5.19 MeasurementValueQuality

Measurement quality flags. Bits 0-10 are defined for substation automation in IEC 61850-7-3. Bits 11-15 are reserved for future expansion by that document. Bits 16-31 are reserved for EMS applications.

Inherited Attributes

validity	Validity	Quality61850
overFlow	Boolean	Quality61850
outOfRange	Boolean	Quality61850
badReference	Boolean	Quality61850
oscillatory	Boolean	Quality61850
failure	Boolean	Quality61850
oldData	Boolean	Quality61850
suspect	Boolean	Quality61850
test	Boolean	Quality61850
operatorBlocked	Boolean	Quality61850
source	Source	Quality61850
estimatorReplaced	Boolean	Quality61850
mRID	String	IdentifiedObject
name	String	IdentifiedObject
localName	String	IdentifiedObject
pathName	String	IdentifiedObject
aliasName	String	IdentifiedObject
description	String	IdentifiedObject

Native Roles

1	*MeasurementValue*	1	MeasurementValue	A MeasurementValue has a MeasurementValueQuality associated with it.

Roles Inherited From Quality61850

Roles Inherited From IdentifiedObject

1..n	*ModelingAuthoritySet*	0..1	ModelingAuthority Set	IdentifiedObject

6.5.20 MeasurementValueSource

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

Inherited Attributes

mRID	String	IdentifiedObject
name	String	IdentifiedObject
localName	String	IdentifiedObject
pathName	String	IdentifiedObject
aliasName	String	IdentifiedObject
description	String	IdentifiedObject

Native Roles

1	*MeasurementValues*	0..n	MeasurementValue	The MeasurementValues updated by the source

Roles Inherited From IdentifiedObject

1..n	*ModelingAuthoritySet*	0..1	ModelingAuthoritySet	IdentifiedObject

6.5.21 MeasVersion

Native Attributes

version
date

6.5.22 Quality61850

Quality flags in this class are as defined in IEC 61850, except for estimatorReplaced, which has been included in this class for convenience.

Native Attributes

validity	Validity	Validity may be good, questionable or invalid. Refer to the Validity enumeration for more details.
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.
outOfRange	Boolean	Measurement value is beyond a predefined range of value.
badReference	Boolean	Measurement value may be incorrect due to a reference being out of calibration.
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).
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.
suspect	Boolean	A correlation function has detected that the value is not consistent with other values. Typically set by a network State Estimator.
test	Boolean	Measurement value is transmitted for test purposes.
operatorBlocked	Boolean	Measurement value is blocked and hence unavailable for transmission.
source	Source	Source gives information related to the origin of a value. The value may be acquired from the process, defaulted or substituted.
estimatorReplaced	Boolean	Value has been replaced by State Estimator. estimatorReplaced is not an IEC61850 quality bit but has been put in this class for convenience.

Inherited Attributes

mRID	String	IdentifiedObject
name	String	IdentifiedObject
localName	String	IdentifiedObject
pathName	String	IdentifiedObject
aliasName	String	IdentifiedObject
description	String	IdentifiedObject

Roles Inherited From IdentifiedObject

1..n	*ModelingAuthoritySet*	0..1	ModelingAuthoritySet	IdentifiedObject

6.5.23 SetPoint

A SetPoint is an analog control used for supervisory control.

Native Attributes

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.

Inherited Attributes

timeStamp	AbsoluteDateTime	Control
operationInProgress	Boolean	Control
mRID	String	IdentifiedObject
name	String	IdentifiedObject
localName	String	IdentifiedObject
pathName	String	IdentifiedObject
aliasName	String	IdentifiedObject
description	String	IdentifiedObject

Native Roles

0..1	*MeasuredBy_Measurement*	0..1	Analog	The Measurement variable used for control

Roles Inherited From Control

1..n	*ControlledBy_RegulatingCondEq*	0..1	RegulatingCondEq	Control
0..n	*Unit*	1	Unit	Control
0..n	*ControlType*	1	ControlType	Control
1	*RemoteControl*	0..1	RemoteControl	Control

Roles Inherited From IdentifiedObject

1..n	*ModelingAuthoritySet*	0..1	ModelingAuthoritySet	IdentifiedObject

6.5.24 StringMeasurement

StringMeasurement represents a measurement with values of type string.

Inherited Attributes

mRID	String	IdentifiedObject
name	String	IdentifiedObject
localName	String	IdentifiedObject
pathName	String	IdentifiedObject
aliasName	String	IdentifiedObject
description	String	IdentifiedObject

Native Roles

1	*Contains_MeasurementValues*	1..n	StringMeasurementValue

Roles Inherited From Measurement

0..n	*MeasurementType*	1	MeasurementType	Measurement
0..n	*Terminal*	0..1	Terminal	Measurement
0..n	*MemberOf_PSR*	1	PowerSystemResource	Measurement
0..n	*Unit*	1	Unit	Measurement
0..1	*RegulatingCondEqs*	0..n	RegulatingCondEq	Measurement
0..1	*TapChangers*	0..n	TapChanger	Measurement

Roles Inherited From IdentifiedObject

1..n	*ModelingAuthoritySet*	0..1	ModelingAuthoritySet	IdentifiedObject

6.5.25 StringMeasurementValue

StringMeasurementValue represents a measurement value of type string.

Native Attributes

value	String

Inherited Attributes

timeStamp	AbsoluteDateTime	MeasurementValue
sensorAccuracy	PerCent	MeasurementValue

Native Roles

1..n	*MemberOf_Measurement*	1	StringMeasurement	

Roles Inherited From MeasurementValue

1	*MeasurementValueQuality*	1	MeasurementValueQuality	MeasurementValue
0..n	*MeasurementValueSource*	1	MeasurementValueSource	MeasurementValue
1	*RemoteSource*	0..1	RemoteSource	MeasurementValue

6.5.26 ValueAliasSet

Describes the translation of a set of values into a name and is intendend to facilitate cusom 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.

Inherited Attributes

mRID	String	IdentifiedObject
name	String	IdentifiedObject
localName	String	IdentifiedObject
pathName	String	IdentifiedObject
aliasName	String	IdentifiedObject
description	String	IdentifiedObject

Native Roles

1	*Values*	1..n	ValueToAlias	The ValueToAlias mappings included in the set.
0..1	*Controls*	0..n	Command	The Controls using the set for translation.
0..1	*Measurements*	0..n	Discrete	The Measurements using the set for translation.

Roles Inherited From IdentifiedObject

1..n	*ModelingAuthoritySet*	0..1	ModelingAuthority Set	IdentifiedObject

6.5.27 ValueToAlias

Describes the translation of one particular value into a name, e.g. 1->"Open".

Native Attributes

value	Integer	The value that is mapped.

Inherited Attributes

mRID	String	IdentifiedObject
name	String	IdentifiedObject
localName	String	IdentifiedObject
pathName	String	IdentifiedObject
aliasName	String	IdentifiedObject
description	String	IdentifiedObject

Native Roles

1..n	*ValueAliasSet*	1	ValueAliasSet	The ValueAliasSet having the ValueToAlias mappings

Roles Inherited From IdentifiedObject

1..n	*ModelingAuthoritySet*	0..1	ModelingAuthority Set	IdentifiedObject

6.6 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.

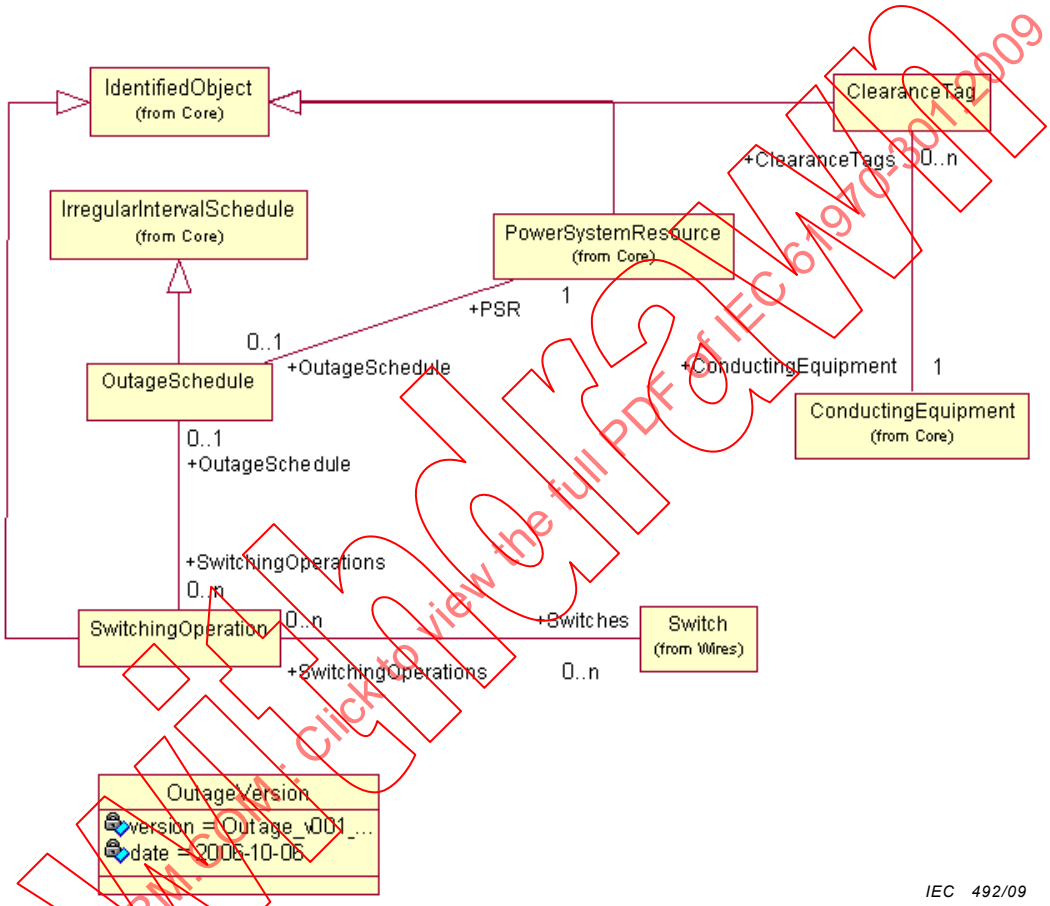


Figure 28 – Main

Figure 28 shows all classes included in the Outage package as well as the key external classes that have associations with Outage classes.

6.6.1 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.

Native Attributes

authorityName	Name	The name of the person who is authorized to issue the tag.
clearanceTagType	ClearanceTagType	The type of tag, depending on the purpose of the work to be performed and/or the type of supervisory control allowed.

deenergizeReqFlag	Boolean	Flag = YES if equipment must be deenergized.
groundReqFlag	Boolean	Flag = YES if equipment must be grounded.
phaseCheckReqFlag	Boolean	Flag = YES if equipment phasing must be checked.
tagIssueTime	AbsoluteDateTime	The time at which the clearance tag was issued.
workDescription	Description	Description of the work to be performed.
workEndTime	AbsoluteDateTime	The time at which the clearance tag is scheduled to be removed.
workStartTime	AbsoluteDateTime	WorkStartTime.

Inherited Attributes

mRID	String	IdentifiedObject
name	String	IdentifiedObject
localName	String	IdentifiedObject
pathName	String	IdentifiedObject
aliasName	String	IdentifiedObject
description	String	IdentifiedObject

Native Roles

0..n	*ConductingEquipment*	1	ConductingEquipment	Conducting equipment may have multiple clearance tags for authorized field work.

Roles Inherited From IdentifiedObject

1..n	*ModelingAuthoritySet*	0..1	ModelingAuthoritySet	IdentifiedObject

6.6.2 OutageSchedule

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

Inherited Attributes

startTime	AbsoluteDateTime	BasicIntervalSchedule
value1Unit	String	BasicIntervalSchedule
value2Unit	String	BasicIntervalSchedule
mRID	String	IdentifiedObject
name	String	IdentifiedObject
localName	String	IdentifiedObject
pathName	String	IdentifiedObject
aliasName	String	IdentifiedObject
description	String	IdentifiedObject

Native Roles

0..1	*SwitchingOperations*	0..n	SwitchingOperation	An OutageSchedule may operate many switches.
0..1	*PSR*	1	PowerSystemResource	A power system resource may have an outage schedule.

Roles Inherited From IrregularIntervalSchedule

1	*TimePoints*	1..*	IrregularTimePoint	IrregularIntervalSchedule

Roles Inherited From BasicIntervalSchedule

Roles Inherited From IdentifiedObject

1..n	*ModelingAuthoritySet*	0..1	ModelingAuthoritySet	IdentifiedObject

6.6.3 OutageVersion

Native Attributes

version
date

6.6.4 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.

Native Attributes

operationTime	AbsoluteDateTime	Time of operation in same units as OutageSchedule.xAxixUnits.
newState	SwitchState	

Inherited Attributes

mRID	String	IdentifiedObject
name	String	IdentifiedObject
localName	String	IdentifiedObject
pathName	String	IdentifiedObject
aliasName	String	IdentifiedObject
description	String	IdentifiedObject

Native Roles

0..n	*OutageSchedule*	0..1	OutageSchedule	An OutageSchedule may operate many switches.
0..n	*Switches*	0..n	Switch	A switch may be operated by many schedules.

Roles Inherited From IdentifiedObject

1..n	*ModelingAuthoritySet*	0..1	ModelingAuthoritySet	IdentifiedObject

6.7 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.

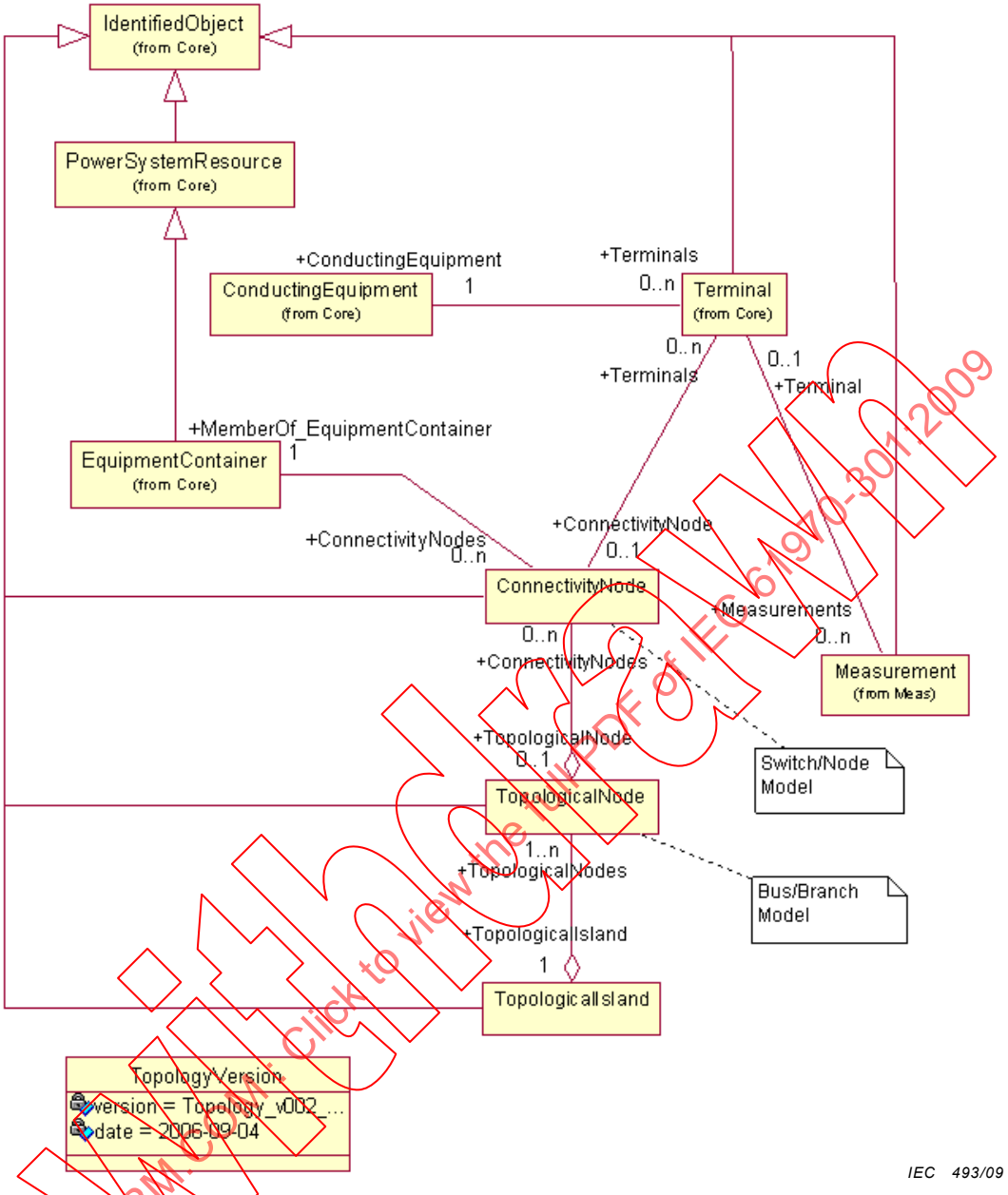


Figure 29 – Main

Figure 29 shows all classes included in the Topology package as well as the key external classes that have associations with Topology classes.

6.7.1 ConnectivityNode

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

Inherited Attributes

mRID	String	IdentifiedObject
name	String	IdentifiedObject
localName	String	IdentifiedObject
pathName	String	IdentifiedObject
aliasName	String	IdentifiedObject
description	String	IdentifiedObject

Native Roles

0..n	*TopologicalNode*	0..1	TopologicalNode	Several ConnectivityNode(s) may combine together to form a single TopologicalNode, depending on the current state of the network.
0..1	*Terminals*	0..n	Terminal	Terminals interconnect with zero impedance at a node. Measurements on a node apply to all of its terminals.
0..n	*MemberOf_EquipmentContainer*	1	EquipmentContainer	

Roles Inherited From IdentifiedObject

1..n	*ModelingAuthoritySet*	0..1	ModelingAuthoritySet	IdentifiedObject

6.7.2 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).

Inherited Attributes

mRID	String	IdentifiedObject
name	String	IdentifiedObject
localName	String	IdentifiedObject
pathName	String	IdentifiedObject
aliasName	String	IdentifiedObject
description	String	IdentifiedObject

Native Roles

1	*TopologicalNodes*	1..n	TopologicalNode	A topological node belongs to a topological island.

Roles Inherited From IdentifiedObject

1..n	*ModelingAuthoritySet*	0..1	ModelingAuthoritySet	IdentifiedObject

6.7.3 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).

Native Attributes

energized	Boolean	True if node energized
loadCarrying	Boolean	True if node is load carrying
netInjectionMVar	ReactivePower	Net injection MVAr
netInjectionMW	ActivePower	Net injection MW
observabilityFlag	Boolean	The observability status of the node
phaseAngle	AngleRadians	Phase angle of node
voltage	Voltage	Voltage of node

Inherited Attributes

mRID	String	IdentifiedObject
name	String	IdentifiedObject

localName	String	IdentifiedObject
pathName	String	IdentifiedObject
aliasName	String	IdentifiedObject
description	String	IdentifiedObject

Native Roles

0..1	*ConnectivityNodes*	0..n	ConnectivityNode	Several ConnectivityNode(s) may combine together to form a single TopologicalNode, depending on the current state of the network.
1..n	*TopologicalIsland*	1	TopologicalIsland	A topological node belongs to a topological island.

Roles Inherited From IdentifiedObject

1..n	*ModelingAuthoritySet*	0..1	ModelingAuthority Set	IdentifiedObject

6.7.4 TopologyVersion

Native Attributes

version
date

6.8 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.

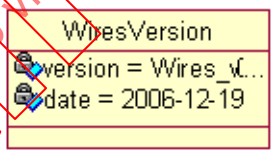


Figure 30 – Main

Figure 30 shows the version number of the Wires Package.

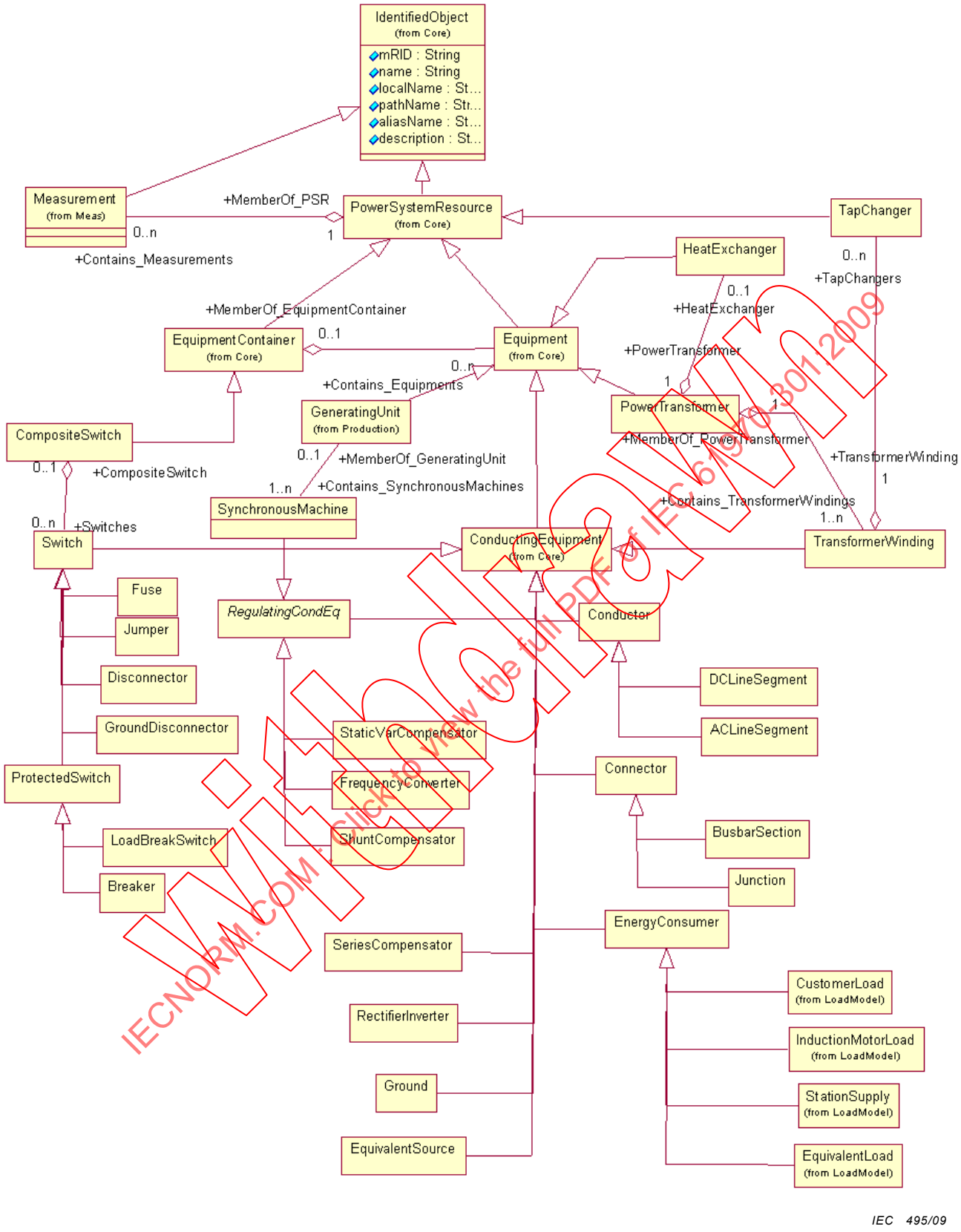


Figure 31 – NamingHierarchyPart2

Figure 31 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.

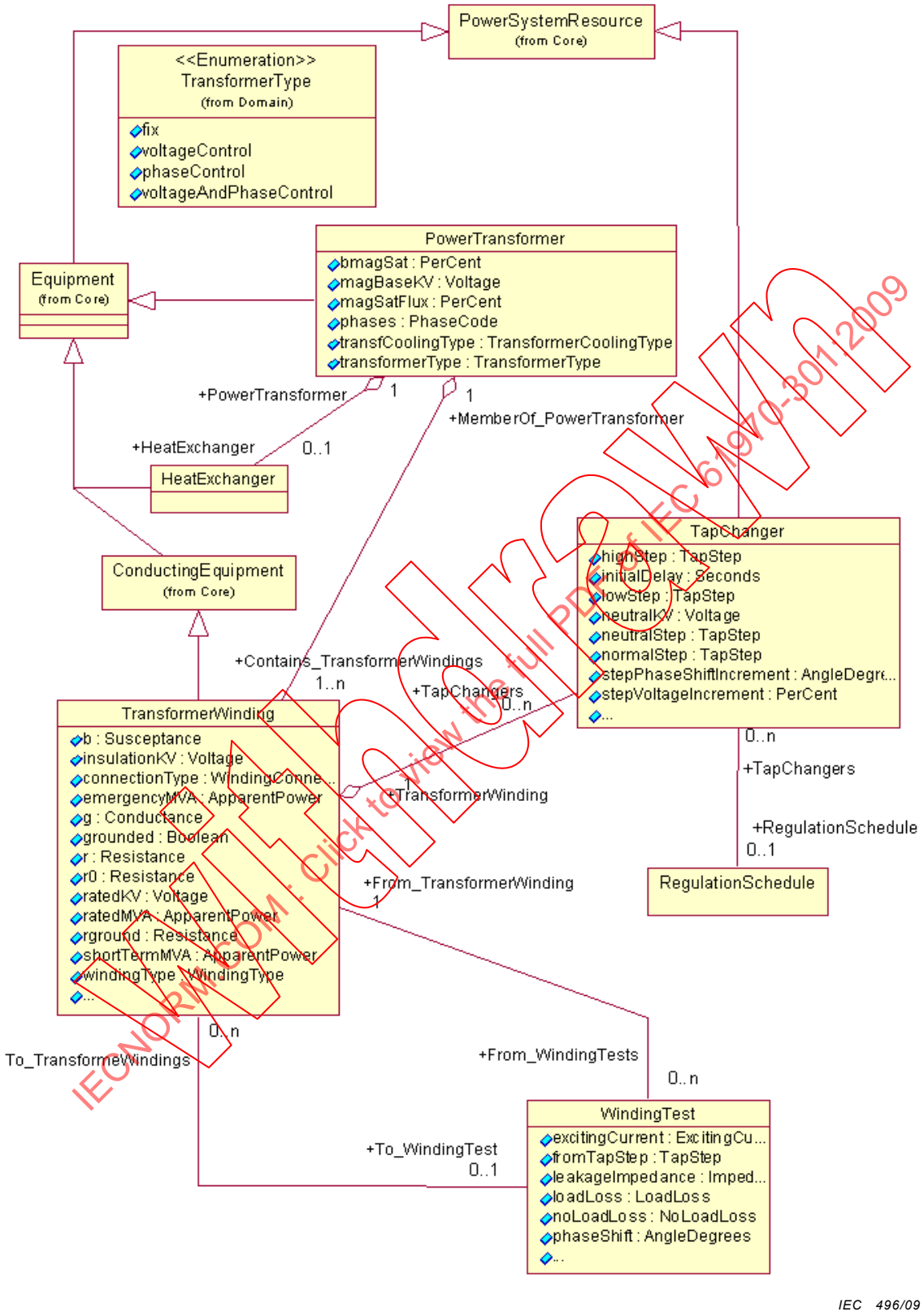


Figure 32 – Transformer model

Figure 32 shows all classes related to the transformer model.

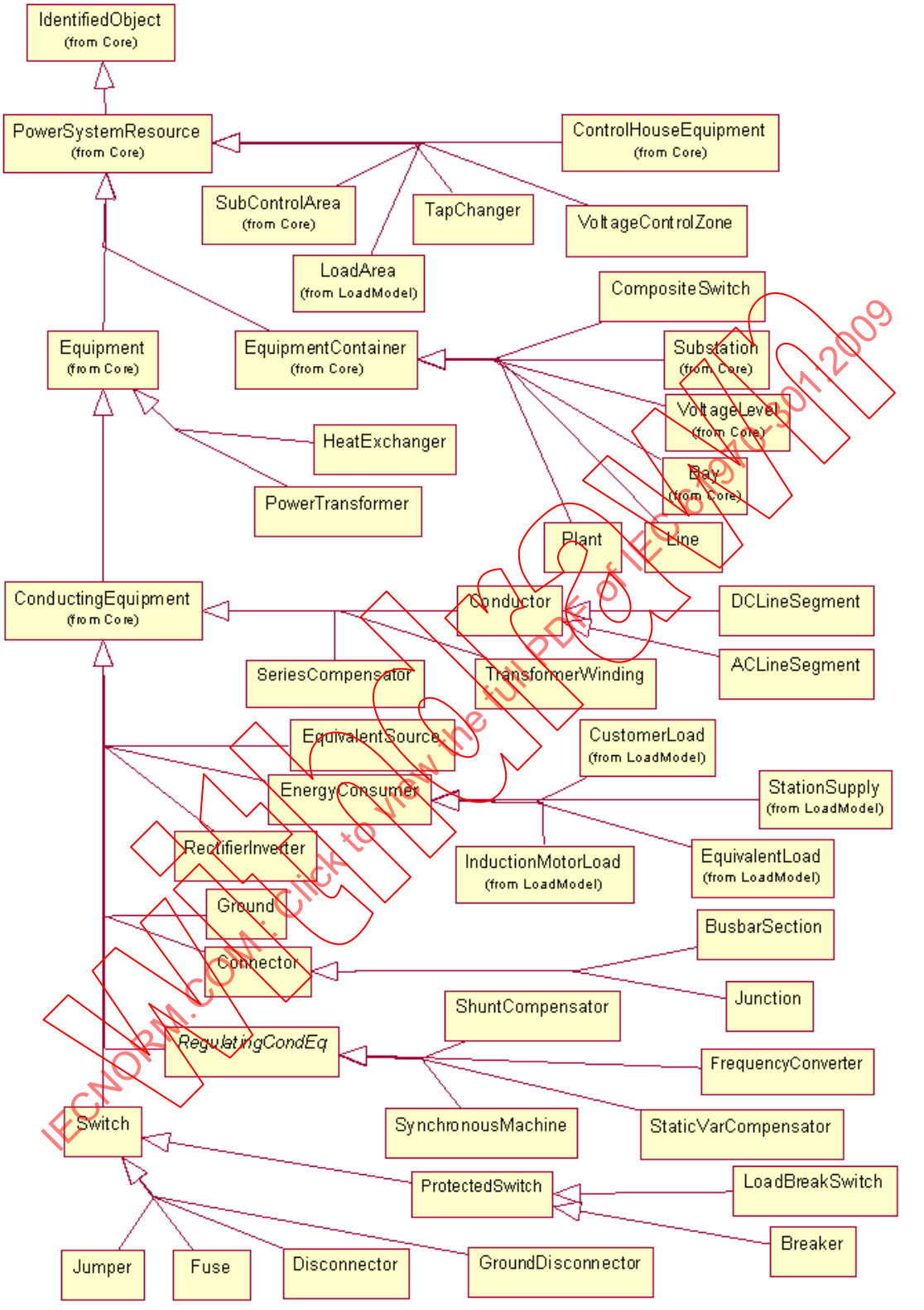


Figure 33 – InheritanceHierarchy

Figure 33 describes inheritance between classes in and related to the Wires package.

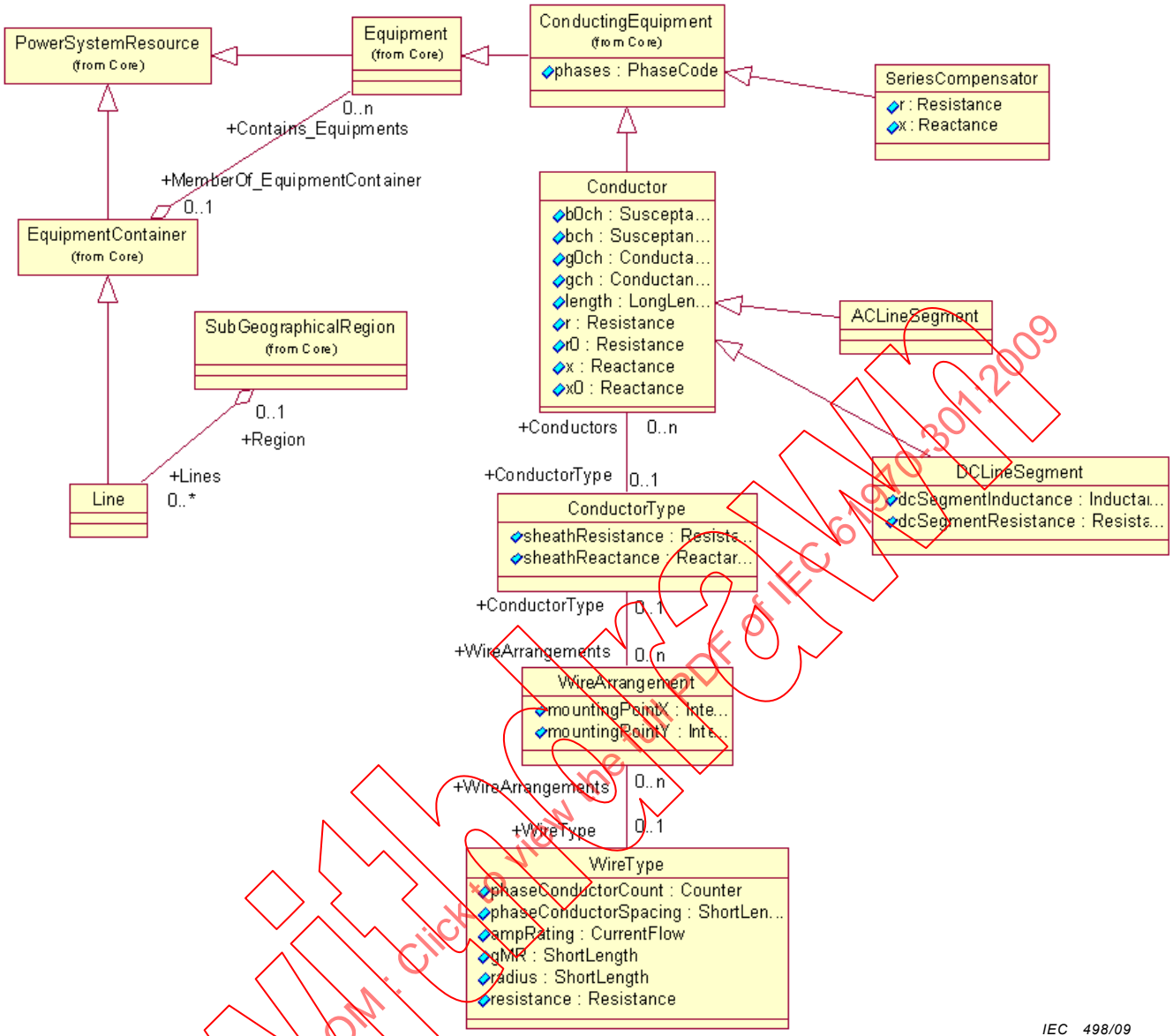


Figure 34 – LineModel

Figure 34 shows all classes related to the transmission line model.

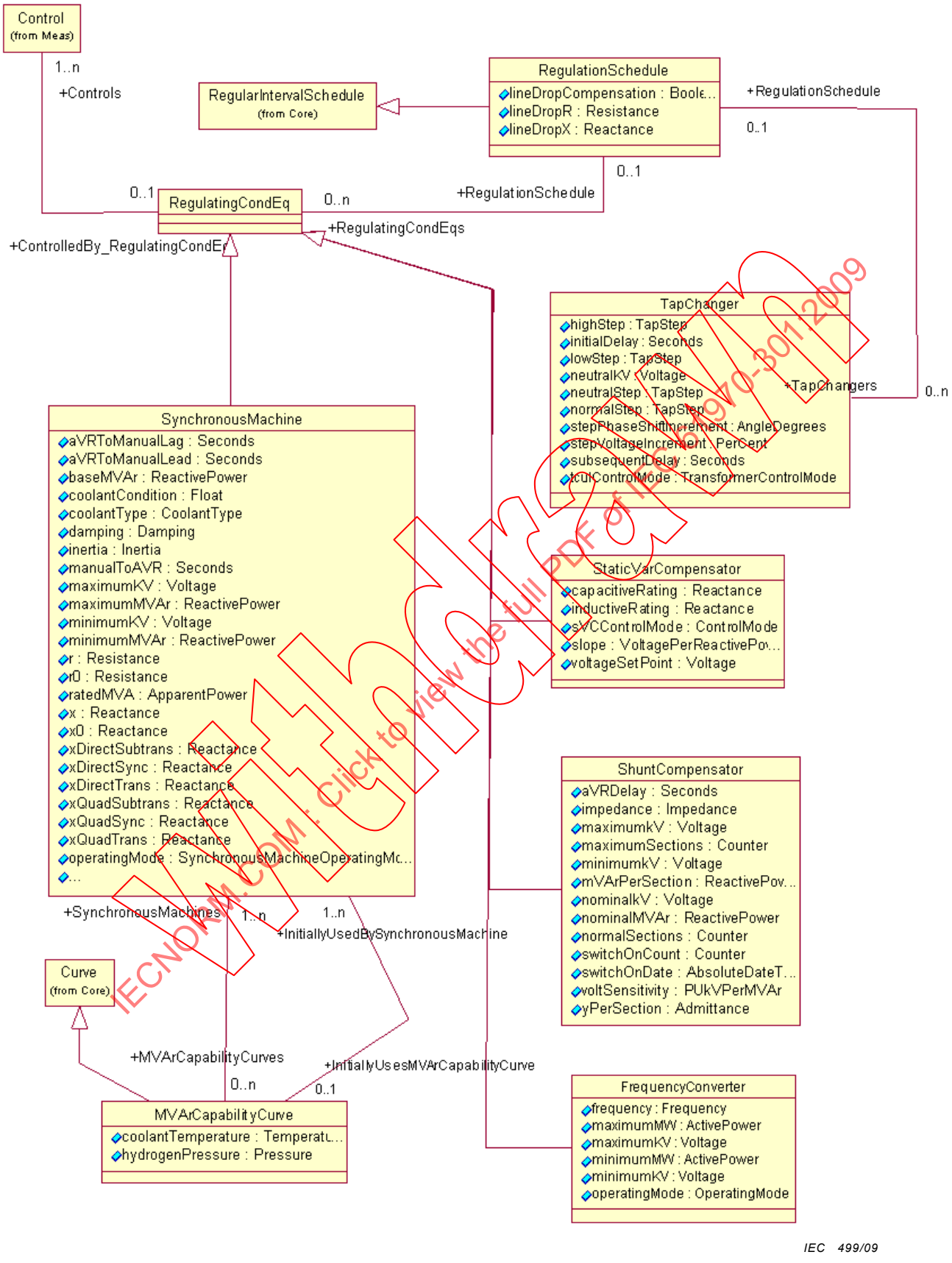


Figure 35 – RegulatingEquipment

Figure 35 shows all classes related to equipment regulation and reactive power compensation.

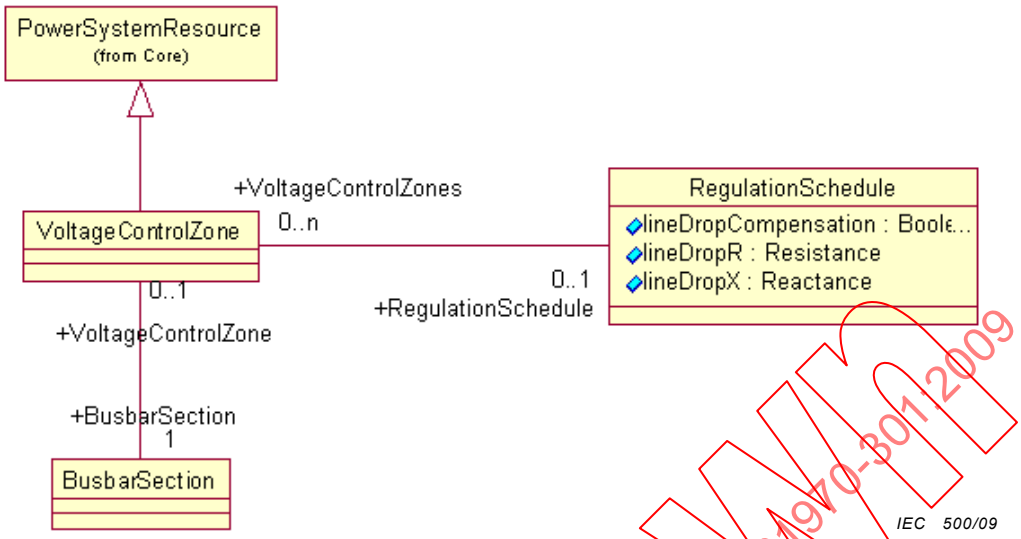


Figure 36 – VoltageControl

Figure 36 shows all classes related to area voltage control.

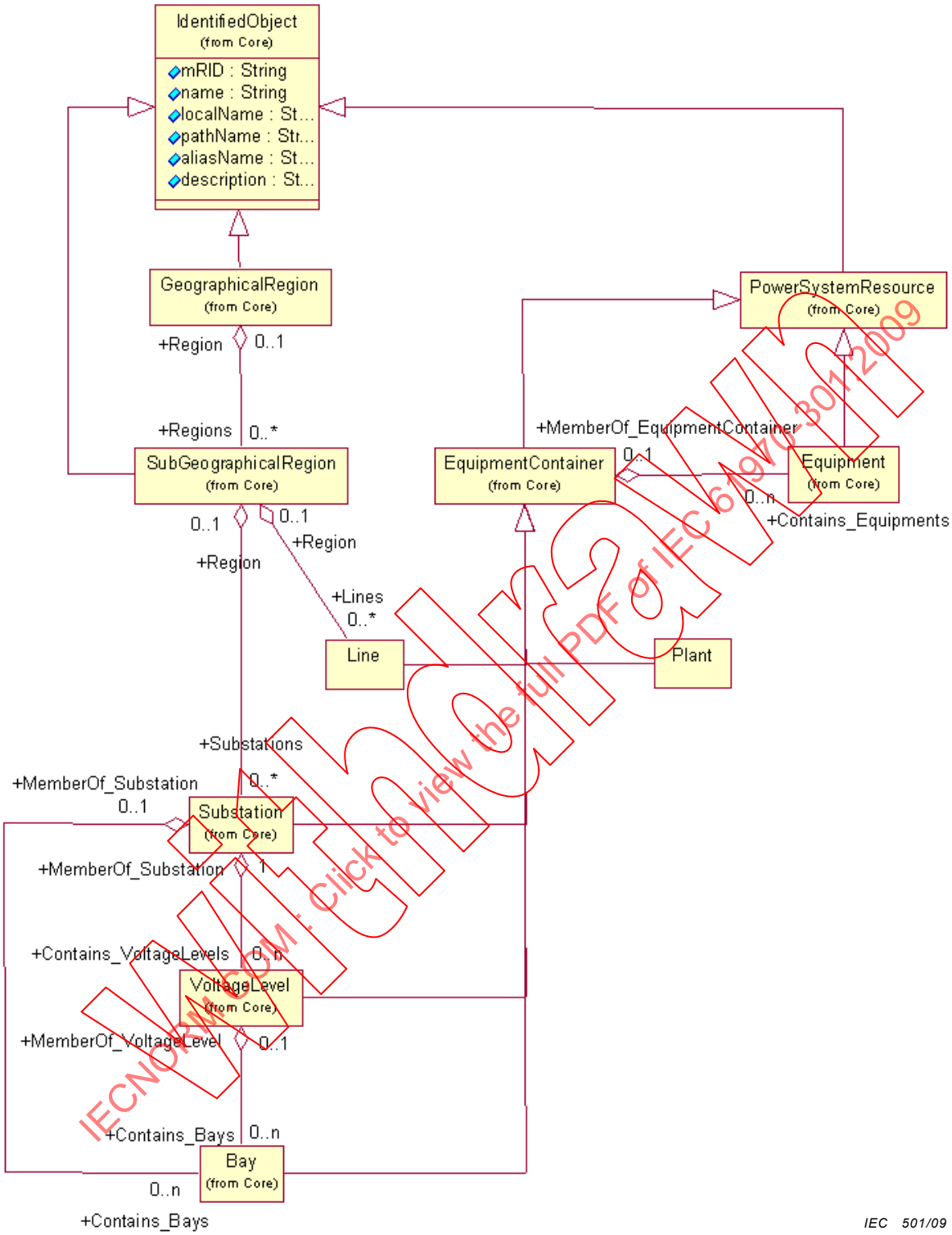


Figure 37 – NamingHierarchyPart1

Figure 37 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.

6.8.1 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.

Inherited Attributes

b0ch	Susceptance	Conductor
bch	Susceptance	Conductor
g0ch	Conductance	Conductor
gch	Conductance	Conductor
length	LongLength	Conductor
r	Resistance	Conductor
r0	Resistance	Conductor
x	Reactance	Conductor
x0	Reactance	Conductor
phases	PhaseCode	ConductingEquipment
mRID	String	IdentifiedObject
name	String	IdentifiedObject
localName	String	IdentifiedObject
pathName	String	IdentifiedObject
aliasName	String	IdentifiedObject
description	String	IdentifiedObject

Roles Inherited From Conductor

0..n	*ConductorType*	0..1	ConductorType	Conductor

Roles Inherited From ConductingEquipment

1	*Terminals*	0..n	Terminal	ConductingEquipment
0..n	*BaseVoltage*	0..1	BaseVoltage	ConductingEquipment
1	*ClearanceTags*	0..n	ClearanceTag	ConductingEquipment
0..n	*ProtectionEquipments*	0..n	ProtectionEquipment	ConductingEquipment

Roles Inherited From Equipment

0..n	*MemberOf_EquipmentContainer*	0..1	EquipmentContainer	Equipment

Roles Inherited From PowerSystemResource

0..n	*OperatedBy_Companies*	0..n	Company	PowerSystemResource
0..n	*PSRType*	0..1	PSRType	PowerSystemResource
1	*Contains_Measurements*	0..n	Measurement	PowerSystemResource
1	*OutageSchedule*	0..1	OutageSchedule	PowerSystemResource

Roles Inherited From IdentifiedObject

1..n	*ModelingAuthoritySet*	0..1	ModelingAuthoritySet	IdentifiedObject

6.8.2 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. The typeName is the type of breaker, e.g. oil, air blast, vacuum, SF6.

Native Attributes

ampRating	CurrentFlow	Fault interrupting rating in amperes
inTransitTime	Seconds	The transition time from open to close, in seconds.

Inherited Attributes

normalOpen	Boolean	Switch
switchOnCount	Counter	Switch
switchOnDate	AbsoluteDateTime	Switch
phases	PhaseCode	ConductingEquipment
mRID	String	IdentifiedObject
name	String	IdentifiedObject
localName	String	IdentifiedObject
pathName	String	IdentifiedObject
aliasName	String	IdentifiedObject
description	String	IdentifiedObject

Roles Inherited From ProtectedSwitch

0..n	*OperatedBy_ProtectionEquipments*	0..n	ProtectionEquipment	ProtectedSwitch
1	*RecloseSequences*	0..n	RecloseSequence	ProtectedSwitch

Roles Inherited From Switch

0..n	*CompositeSwitch*	0..1	CompositeSwitch	Switch
0..n	*SwitchingOperations*	0..n	SwitchingOperation	Switch

Roles Inherited From ConductingEquipment

1	*Terminals*	0..n	Terminal	ConductingEquipment
0..n	*BaseVoltage*	0..1	BaseVoltage	ConductingEquipment
1	*ClearanceTags*	0..n	ClearanceTag	ConductingEquipment
0..n	*ProtectionEquipments*	0..n	ProtectionEquipment	ConductingEquipment

Roles Inherited From Equipment

0..n	*MemberOf_EquipmentContainer*	0..1	EquipmentContainer	Equipment

Roles Inherited From PowerSystemResource

0..n	*OperatedBy_Companies*	0..n	Company	PowerSystemResource
0..n	*PSRType*	0..1	PSRType	PowerSystemResource
1	*Contains_Measurements*	0..n	Measurement	PowerSystemResource
1	*OutageSchedule*	0..1	OutageSchedule	PowerSystemResource

Roles Inherited From IdentifiedObject

1..n	*ModelingAuthoritySet*	0..1	ModelingAuthoritySet	IdentifiedObject

6.8.3 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 modelled with exactly one logical terminal. The typeName attribute indicates the type of bus bar section, e.g.: Main, Transfer.

Inherited Attributes

phases	PhaseCode	ConductingEquipment
mRID	String	IdentifiedObject
name	String	IdentifiedObject
localName	String	IdentifiedObject
pathName	String	IdentifiedObject
aliasName	String	IdentifiedObject
description	String	IdentifiedObject

Native Roles

1	*VoltageControlZone*	0..1	VoltageControlZone	A VoltageControlZone is controlled by a designated BusbarSection.

Roles Inherited From Connector

Roles Inherited From ConductingEquipment

1	*Terminals*	0..n	Terminal	ConductingEquipment
0..n	*BaseVoltage*	0..1	BaseVoltage	ConductingEquipment
1	*ClearanceTags*	0..n	ClearanceTag	ConductingEquipment
0..n	*ProtectionEquipments*	0..n	ProtectionEquipment	ConductingEquipment

Roles Inherited From Equipment

0..n	*MemberOf_EquipmentContainer*	0..1	EquipmentContainer	Equipment

Roles Inherited From PowerSystemResource

0..n	*OperatedBy_Companies*	0..n	Company	PowerSystemResource
0..n	*PSRType*	0..1	PSRType	PowerSystemResource
1	*Contains_Measurements*	0..n	Measurement	PowerSystemResource
1	*OutageSchedule*	0..1	OutageSchedule	PowerSystemResource

Roles Inherited From IdentifiedObject

1..n	*ModelingAuthoritySet*	0..1	ModelingAuthoritySet	IdentifiedObject

6.8.4 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.

Native Attributes

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

Inherited Attributes

mRID	String	IdentifiedObject
name	String	IdentifiedObject
localName	String	IdentifiedObject
pathName	String	IdentifiedObject
aliasName	String	IdentifiedObject
description	String	IdentifiedObject

Native Roles

0..1	*Switches*	0..n	Switch	
0..n	*MemberOf_Substation*	0..1	Substation	

Roles Inherited From EquipmentContainer

1	*ConnectivityNodes*	0..n	ConnectivityNode	EquipmentContainer
0..1	*Contains_Equipments*	0..n	Equipment	EquipmentContainer

Roles Inherited From PowerSystemResource

0..n	*OperatedBy_Companies*	0..n	Company	PowerSystemResource
0..n	*PSRType*	0..1	PSRType	PowerSystemResource
1	*Contains_Measurements*	0..n	Measurement	PowerSystemResource
1	*OutageSchedule*	0..1	OutageSchedule	PowerSystemResource

Roles Inherited From IdentifiedObject

1..n	*ModelingAuthoritySet*	0..1	ModelingAuthority Set	IdentifiedObject

6.8.5 Conductor

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

Native Attributes

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 (long length units)
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.

Inherited Attributes

phases	PhaseCode	ConductingEquipment
mRID	String	IdentifiedObject
name	String	IdentifiedObject
localName	String	IdentifiedObject
pathName	String	IdentifiedObject
aliasName	String	IdentifiedObject
description	String	IdentifiedObject

Native Roles

0..n	*ConductorType*	0..1	ConductorType	Sections of conductor are physically described by a conductor type.

Roles Inherited From ConductingEquipment

1	*Terminals*	0..n	Terminal	ConductingEquipment
0..n	*BaseVoltage*	0..1	BaseVoltage	ConductingEquipment
1	*ClearanceTags*	0..n	ClearanceTag	ConductingEquipment
0..n	*ProtectionEquipments*	0..n	ProtectionEquipment	ConductingEquipment

Roles Inherited From Equipment

0..n	*MemberOf_EquipmentContainer*	0..1	EquipmentContainer	Equipment

Roles Inherited From PowerSystemResource

0..n	*OperatedBy_Companies*	0..n	Company	PowerSystemResource
0..n	*PSRType*	0..1	PSRType	PowerSystemResource
1	*Contains_Measurements*	0..n	Measurement	PowerSystemResource
1	*OutageSchedule*	0..1	OutageSchedule	PowerSystemResource

Roles Inherited From IdentifiedObject

1..n	*ModelingAuthoritySet*	0..1	ModelingAuthoritySet	IdentifiedObject

6.8.6 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.

Native Attributes

sheathResistance	Resistance	Resistance of the sheath for cable conductors.
sheathReactance	Reactance	Reactance of the sheath for cable conductors.

Inherited Attributes

mRID	String	IdentifiedObject
name	String	IdentifiedObject
localName	String	IdentifiedObject
pathName	String	IdentifiedObject
aliasName	String	IdentifiedObject
description	String	IdentifiedObject

Native Roles

0..1	*Conductors*	0..n	Conductor	Sections of conductor are physically described by a conductor type.
0..1	*WireArrangements*	0..n	WireArrangement	A ConductorType is made up of wires that can be configured in several ways.

Roles Inherited From IdentifiedObject

1..n	*ModelingAuthoritySet*	0..1	ModelingAuthority Set	IdentifiedObject

6.8.7 Connector

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

Inherited Attributes

phases	PhaseCode	ConductingEquipment
mRID	String	IdentifiedObject
name	String	IdentifiedObject
localName	String	IdentifiedObject
pathName	String	IdentifiedObject
aliasName	String	IdentifiedObject
description	String	IdentifiedObject

Roles Inherited From ConductingEquipment

1	*Terminals*	0..n	Terminal	ConductingEquipment
0..n	*BaseVoltage*	0..1	BaseVoltage	ConductingEquipment
1	*ClearanceTags*	0..n	ClearanceTag	ConductingEquipment
0..n	*ProtectionEquipments*	0..n	ProtectionEquipment	ConductingEquipment

Roles Inherited From Equipment

0..n	*MemberOf_EquipmentContainer*	0..1	EquipmentContainer	Equipment

Roles Inherited From PowerSystemResource

0..n	*OperatedBy_Companies*	0..n	Company	PowerSystemResource
0..n	*PSRType*	0..1	PSRType	PowerSystemResource
1	*Contains_Measurements*	0..n	Measurement	PowerSystemResource
1	*OutageSchedule*	0..1	OutageSchedule	PowerSystemResource

Roles Inherited From IdentifiedObject

1..n	*ModelingAuthoritySet*	0..1	ModelingAuthority Set	IdentifiedObject

6.8.8 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.

Native Attributes

dcSegmentInductance	Inductance	Inductance of the DC line segment, in millihenries.
dcSegmentResistance	Resistance	Resistance of the DC line segment, in ohms.

Inherited Attributes

b0ch	Susceptance	Conductor
bch	Susceptance	Conductor
g0ch	Conductance	Conductor
gch	Conductance	Conductor
length	LongLength	Conductor
r	Resistance	Conductor
r0	Resistance	Conductor
x	Reactance	Conductor
x0	Reactance	Conductor
phases	PhaseCode	ConductingEquipment
mRID	String	IdentifiedObject
name	String	IdentifiedObject
localName	String	IdentifiedObject
pathName	String	IdentifiedObject
aliasName	String	IdentifiedObject
description	String	IdentifiedObject

Roles Inherited From Conductor

0..n	*ConductorType*	0..1	ConductorType	Conductor

Roles Inherited From ConductingEquipment

1	*Terminals*	0..n	Terminal	ConductingEquipment
0..n	*BaseVoltage*	0..1	BaseVoltage	ConductingEquipment
1	*ClearanceTags*	0..n	ClearanceTag	ConductingEquipment
0..n	*ProtectionEquipments*	0..n	ProtectionEquipment	ConductingEquipment

Roles Inherited From Equipment

0..n	*MemberOf_EquipmentContainer*	0..1	EquipmentContainer	Equipment

Roles Inherited From PowerSystemResource

0..n	*OperatedBy_Companies*	0..n	Company	PowerSystemResource
0..n	*PSRType*	0..1	PSRType	PowerSystemResource
1	*Contains_Measurements*	0..n	Measurement	PowerSystemResource
1	*OutageSchedule*	0..1	OutageSchedule	PowerSystemResource

Roles Inherited From IdentifiedObject

1..n	*ModelingAuthoritySet*	0..1	ModelingAuthority Set	IdentifiedObject

6.8.9 Disconnector

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

Inherited Attributes

normalOpen	Boolean	Switch
switchOnCount	Counter	Switch
switchOnDate	AbsoluteDateTime	Switch
phases	PhaseCode	ConductingEquipment
mRID	String	IdentifiedObject
name	String	IdentifiedObject
localName	String	IdentifiedObject
pathName	String	IdentifiedObject
aliasName	String	IdentifiedObject
description	String	IdentifiedObject

Roles Inherited From Switch

0..n	*CompositeSwitch*	0..1	CompositeSwitch	Switch
0..n	*SwitchingOperations*	0..n	SwitchingOperation	Switch

Roles Inherited From ConductingEquipment

1	*Terminals*	0..n	Terminal	ConductingEquipment
0..n	*BaseVoltage*	0..1	BaseVoltage	ConductingEquipment
1	*ClearanceTags*	0..n	ClearanceTag	ConductingEquipment
0..n	*ProtectionEquipments*	0..n	ProtectionEquipment	ConductingEquipment

Roles Inherited From Equipment

0..n	*MemberOf_EquipmentContainer*	0..1	EquipmentContainer	Equipment

Roles Inherited From PowerSystemResource

0..n	*OperatedBy_Companies*	0..n	Company	PowerSystemResource
0..n	*PSRType*	0..1	PSRType	PowerSystemResource
1	*Contains_Measurements*	0..n	Measurement	PowerSystemResource
1	*OutageSchedule*	0..1	OutageSchedule	PowerSystemResource

Roles Inherited From IdentifiedObject

1..n	*ModelingAuthoritySet*	0..1	ModelingAuthority Set	IdentifiedObject

6.8.10 EnergyConsumer

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

Native Attributes

conformingLoadFlag	Boolean	Flag is set to YES if the load is conforming, i.e. tracks the area load to which the energy consumer belongs.
customerCount	Counter	Number of individual customers represented by this Demand.
pFexp	Exponent	Exponent of per unit frequency effecting real power.
pfixed	ActivePower	Real component of the load that is a fixed quantity, MW.
pfixedPct	PerCent	Fixed MW as per cent of load group fixed MW.
pnom	ActivePower	Nominal value for real power, MW. Nominal real power is adjusted according to the load profile selected for the consumer. It equates to one per unit in the load profile.
pnomPct	PerCent	Nominal MW as per cent of load group nominal MW.
powerFactor	PowerFactor	Power factor for nominal portion of load. Defined as MW/MVA.
pVexp	Exponent	Exponent of per unit voltage effecting real power.
qFexp	Exponent	Exponent of per unit frequency effecting reactive power.
qfixed	ReactivePower	Reactive component of the load that is a fixed quantity, MVAr.
qfixedPct	PerCent	Fixed MVAr as per cent of load group fixed MVAr.
qnom	ReactivePower	Nominal value for reactive power, MVAr.
qnomPct	PerCent	Nominal MVAr as per cent of load group nominal MVAr.
qVexp	Exponent	Exponent of per unit voltage effecting reactive power.

Inherited Attributes

phases	PhaseCode	ConductingEquipment
mRID	String	IdentifiedObject
name	String	IdentifiedObject
localName	String	IdentifiedObject
pathName	String	IdentifiedObject
aliasName	String	IdentifiedObject
description	String	IdentifiedObject

Native Roles

1	*LoadDemandModels*	0..n	LoadDemandModel	An energy consumer may have one or more load demand models.
1	*NonConformLoadSchedules*	0..n	NonConformLoadSchedule	An energy consumer may have a non-conforming load schedule.
0..n	*LoadArea*	0..1	LoadArea	Consumers may be assigned to a load area.

1..n	*PowerCutZone*	0..1	PowerCutZone	An energy consumer is assigned to a power cut zone.

Roles Inherited From ConductingEquipment

1	*Terminals*	0..n	Terminal	ConductingEquipment
0..n	*BaseVoltage*	0..1	BaseVoltage	ConductingEquipment
1	*ClearanceTags*	0..n	ClearanceTag	ConductingEquipment
0..n	*ProtectionEquipments*	0..n	ProtectionEquipment	ConductingEquipment

Roles Inherited From Equipment

0..n	*MemberOf_EquipmentContainer*	0..1	EquipmentContainer	Equipment

Roles Inherited From PowerSystemResource

0..n	*OperatedBy_Companies*	0..n	Company	PowerSystemResource
0..n	*PSRType*	0..1	PSRType	PowerSystemResource
1	*Contains_Measurements*	0..n	Measurement	PowerSystemResource
1	*OutageSchedule*	0..1	OutageSchedule	PowerSystemResource

Roles Inherited From IdentifiedObject

1..n	*ModelingAuthoritySet*	0..1	ModelingAuthoritySet	IdentifiedObject

6.8.11 EquivalentSource

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

Native Attributes

xn	Reactance	Negative sequence Thevenin reactance in ohms.
rn	Resistance	Negative sequence Thevenin resistance in ohms.
nominalVoltage	Voltage	Phase-to-phase nominal voltage.
x	Reactance	Positive sequence Thevenin reactance in ohms.
r	Resistance	Positive sequence Thevenin resistance in ohms.
voltageAngle	AngleRadians	Phase angle of a-phase open circuit.
voltageMagnitude	Voltage	Phase-to-phase open circuit voltage magnitude.
x0	Reactance	Zero sequence Thevenin reactance in ohms.
r0	Resistance	Zero sequence Thevenin resistance in ohms.
activePower	ActivePower	High voltage source load.

Inherited Attributes

phases	PhaseCode	ConductingEquipment
mRID	String	IdentifiedObject
name	String	IdentifiedObject
localName	String	IdentifiedObject
pathName	String	IdentifiedObject
aliasName	String	IdentifiedObject
description	String	IdentifiedObject

Roles Inherited From ConductingEquipment

1	*Terminals*	0..n	Terminal	ConductingEquipment
0..n	*BaseVoltage*	0..1	BaseVoltage	ConductingEquipment
1	*ClearanceTags*	0..n	ClearanceTag	ConductingEquipment
0..n	*ProtectionEquipments*	0..n	ProtectionEquipment	ConductingEquipment

Roles Inherited From Equipment

0..n	*MemberOf_EquipmentContainer*	0..1	EquipmentContainer	Equipment

Roles Inherited From PowerSystemResource

0..n	*OperatedBy_Companies*	0..n	Company	PowerSystemResource
0..n	*PSRType*	0..1	PSRType	PowerSystemResource
1	*Contains_Measurements*	0..n	Measurement	PowerSystemResource
1	*OutageSchedule*	0..1	OutageSchedule	PowerSystemResource

Roles Inherited From IdentifiedObject

1..n	*ModelingAuthoritySet*	0..1	ModelingAuthoritySet	IdentifiedObject

6.8.12 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.

Native Attributes

frequency	Frequency	Frequency on the AC side.
maximumMW	ActivePower	The maximum power on the DC side at which the frequence converter should operate.
maximumKV	Voltage	The maximum voltage on the DC side at which the frequency converter should operate.
minimumMW	ActivePower	The minimum power on the DC side at which the frequence converter should operate.
minimumKV	Voltage	The minimum voltage on the DC side at which the frequency converter should operate.
operatingMode	OperatingMode	Operating mode for the frequency converter.

Inherited Attributes

phases	PhaseCode	ConductingEquipment
mRID	String	IdentifiedObject
name	String	IdentifiedObject
localName	String	IdentifiedObject
pathName	String	IdentifiedObject
aliasName	String	IdentifiedObject
description	String	IdentifiedObject

Roles Inherited From RegulatingCondEq

0..n	*Measurement*	0..1	Measurement	RegulatingCondEq
0..n	*RegulationSchedule*	0..1	RegulationSchedule	RegulatingCondEq
0..1	*Controls*	1..n	Control	RegulatingCondEq

Roles Inherited From ConductingEquipment

1	*Terminals*	0..n	Terminal	ConductingEquipment
0..n	*BaseVoltage*	0..1	BaseVoltage	ConductingEquipment
1	*ClearanceTags*	0..n	ClearanceTag	ConductingEquipment
0..n	*ProtectionEquipments*	0..n	ProtectionEquipment	ConductingEquipment

Roles Inherited From Equipment

0..n	*MemberOf_EquipmentContainer*	0..1	EquipmentContainer	Equipment

Roles Inherited From PowerSystemResource

0..n	*OperatedBy_Companies*	0..n	Company	PowerSystemResource
0..n	*PSRType*	0..1	PSRType	PowerSystemResource
1	*Contains_Measurements*	0..n	Measurement	PowerSystemResource
1	*OutageSchedule*	0..1	OutageSchedule	PowerSystemResource

Roles Inherited From IdentifiedObject

1..n	*ModelingAuthoritySet*	0..1	ModelingAuthoritySet	IdentifiedObject

6.8.13 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.

Native Attributes

ampRating	CurrentFlow	Fault interrupting rating in amperes

Inherited Attributes

normalOpen	Boolean	Switch
switchOnCount	Counter	Switch
switchOnDate	AbsoluteDateTime	Switch
phases	PhaseCode	ConductingEquipment
mRID	String	IdentifiedObject
name	String	IdentifiedObject
localName	String	IdentifiedObject

pathName	String	IdentifiedObject
aliasName	String	IdentifiedObject
description	String	IdentifiedObject

Roles Inherited From Switch

0..n	*CompositeSwitch*	0..1	CompositeSwitch	Switch
0..n	*SwitchingOperations*	0..n	SwitchingOperation	Switch

Roles Inherited From ConductingEquipment

1	*Terminals*	0..n	Terminal	ConductingEquipment
0..n	*BaseVoltage*	0..1	BaseVoltage	ConductingEquipment
1	*ClearanceTags*	0..n	ClearanceTag	ConductingEquipment
0..n	*ProtectionEquipments*	0..n	ProtectionEquipment	ConductingEquipment

Roles Inherited From Equipment

0..n	*MemberOf_EquipmentContainer*	0..1	EquipmentContainer	Equipment

Roles Inherited From PowerSystemResource

0..n	*OperatedBy_Companies*	0..n	Company	PowerSystemResource
0..n	*PSRType*	0..1	PSRType	PowerSystemResource
1	*Contains_Measurements*	0..n	Measurement	PowerSystemResource
1	*OutageSchedule*	0..1	OutageSchedule	PowerSystemResource

Roles Inherited From IdentifiedObject

1..n	*ModelingAuthoritySet*	0..1	ModelingAuthoritySet	IdentifiedObject

6.8.14 Ground

A common point for connecting grounded conducting equipment such as shunt capacitors. The power system model can have more than one ground. The typeName indicates the type of ground, e.g. mesh, earth rod. It is recommended to use GroundDisconnector instead of Ground class when applying CIM. In case of grounding a shunt compensator use Compensator of type SHUNT.

Inherited Attributes

phases	PhaseCode	ConductingEquipment
mRID	String	IdentifiedObject
name	String	IdentifiedObject
localName	String	IdentifiedObject
pathName	String	IdentifiedObject
aliasName	String	IdentifiedObject
description	String	IdentifiedObject

Roles Inherited From ConductingEquipment

1	*Terminals*	0..n	Terminal	ConductingEquipment
0..n	*BaseVoltage*	0..1	BaseVoltage	ConductingEquipment
1	*ClearanceTags*	0..n	ClearanceTag	ConductingEquipment
0..n	*ProtectionEquipments*	0..n	ProtectionEquipment	ConductingEquipment

Roles Inherited From Equipment

0..n	*MemberOf_EquipmentContainer*	0..1	EquipmentContainer	Equipment

Roles Inherited From PowerSystemResource

0..n	*OperatedBy_Companies*	0..n	Company	PowerSystemResource
0..n	*PSRType*	0..1	PSRType	PowerSystemResource
1	*Contains_Measurements*	0..n	Measurement	PowerSystemResource
1	*OutageSchedule*	0..1	OutageSchedule	PowerSystemResource

Roles Inherited From IdentifiedObject

1..n	*ModelingAuthoritySet*	0..1	ModelingAuthoritySet	IdentifiedObject

6.8.15 GroundDisconnector

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

Inherited Attributes

normalOpen	Boolean	Switch
switchOnCount	Counter	Switch
switchOnDate	AbsoluteDateTime	Switch
phases	PhaseCode	ConductingEquipment
mRID	String	IdentifiedObject
name	String	IdentifiedObject
localName	String	IdentifiedObject
pathName	String	IdentifiedObject
aliasName	String	IdentifiedObject
description	String	IdentifiedObject

Roles Inherited From Switch

0..n	*CompositeSwitch*	0..1	CompositeSwitch	Switch
0..n	*SwitchingOperations*	0..n	SwitchingOperation	Switch

Roles Inherited From ConductingEquipment

1	*Terminals*	0..n	Terminal	ConductingEquipment
0..n	*BaseVoltage*	0..1	BaseVoltage	ConductingEquipment
1	*ClearanceTags*	0..n	ClearanceTag	ConductingEquipment
0..n	*ProtectionEquipments*	0..n	ProtectionEquipment	ConductingEquipment

Roles Inherited From Equipment

0..n	*MemberOf_EquipmentContainer*	0..1	EquipmentContainer	Equipment

Roles Inherited From PowerSystemResource

0..n	*OperatedBy_Companies*	0..n	Company	PowerSystemResource
0..n	*PSRType*	0..1	PSRType	PowerSystemResource
1	*Contains_Measurements*	0..n	Measurement	PowerSystemResource
1	*OutageSchedule*	0..1	OutageSchedule	PowerSystemResource

Roles Inherited From IdentifiedObject

1..n	*ModelingAuthoritySet*	0..1	ModelingAuthority Set	IdentifiedObject

6.8.16 HeatExchanger

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

Inherited Attributes

mRID	String	IdentifiedObject
name	String	IdentifiedObject
localName	String	IdentifiedObject
pathName	String	IdentifiedObject
aliasName	String	IdentifiedObject
description	String	IdentifiedObject

Native Roles

0..1	*PowerTransformer*	1	PowerTransformer	A transformer may have a heat exchanger.

Roles Inherited From Equipment

0..n	*MemberOf_EquipmentContainer*	0..1	EquipmentContainer	Equipment

Roles Inherited From PowerSystemResource

0..n	*OperatedBy_Companies*	0..n	Company	PowerSystemResource
0..n	*PSRType*	0..1	PSRType	PowerSystemResource
1	*Contains_Measurements*	0..n	Measurement	PowerSystemResource
1	*OutageSchedule*	0..1	OutageSchedule	PowerSystemResource

Roles Inherited From IdentifiedObject

1..n	*ModelingAuthoritySet*	0..1	ModelingAuthority Set	IdentifiedObject

6.8.17 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 modelled by an ACLineSegment with a zero impedance ConductorType.

Inherited Attributes

normalOpen	Boolean	Switch
switchOnCount	Counter	Switch
switchOnDate	AbsoluteDateTime	Switch
phases	PhaseCode	ConductingEquipment
mRID	String	IdentifiedObject
name	String	IdentifiedObject
localName	String	IdentifiedObject
pathName	String	IdentifiedObject
aliasName	String	IdentifiedObject
description	String	IdentifiedObject

Roles Inherited From Switch

0..n	*CompositeSwitch*	0..1	CompositeSwitch	Switch
0..n	*SwitchingOperations*	0..n	SwitchingOperation	Switch

Roles Inherited From ConductingEquipment

1	*Terminals*	0..n	Terminal	ConductingEquipment
0..n	*BaseVoltage*	0..1	BaseVoltage	ConductingEquipment
1	*ClearanceTags*	0..n	ClearanceTag	ConductingEquipment
0..n	*ProtectionEquipments*	0..n	ProtectionEquipment	ConductingEquipment

Roles Inherited From Equipment

0..n	*MemberOf_EquipmentContainer*	0..1	EquipmentContainer	Equipment

Roles Inherited From PowerSystemResource

0..n	*OperatedBy_Companies*	0..n	Company	PowerSystemResource
0..n	*PSRType*	0..1	PSRType	PowerSystemResource
1	*Contains_Measurements*	0..n	Measurement	PowerSystemResource
1	*OutageSchedule*	0..1	OutageSchedule	PowerSystemResource

Roles Inherited From IdentifiedObject

1..n	*ModelingAuthoritySet*	0..1	ModelingAuthoritySet	IdentifiedObject

6.8.18 Junction

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

Inherited Attributes

phases	PhaseCode	ConductingEquipment
mRID	String	IdentifiedObject
name	String	IdentifiedObject
localName	String	IdentifiedObject
pathName	String	IdentifiedObject
aliasName	String	IdentifiedObject
description	String	IdentifiedObject

Roles Inherited From Connector

Roles Inherited From ConductingEquipment

1	*Terminals*	0..n	Terminal	ConductingEquipment
0..n	*BaseVoltage*	0..1	BaseVoltage	ConductingEquipment
1	*ClearanceTags*	0..n	ClearanceTag	ConductingEquipment
0..n	*ProtectionEquipments*	0..n	ProtectionEquipment	ConductingEquipment

Roles Inherited From Equipment

0..n	*MemberOf_EquipmentContainer*	0..1	EquipmentContainer	Equipment

Roles Inherited From PowerSystemResource

0..n	*OperatedBy_Companies*	0..n	Company	PowerSystemResource
0..n	*PSRType*	0..1	PSRType	PowerSystemResource
1	*Contains_Measurements*	0..n	Measurement	PowerSystemResource
1	*OutageSchedule*	0..1	OutageSchedule	PowerSystemResource

Roles Inherited From IdentifiedObject

1..n	*ModelingAuthoritySet*	0..1	ModelingAuthoritySet	IdentifiedObject

6.8.19 Line

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

Inherited Attributes

mRID	String	IdentifiedObject
name	String	IdentifiedObject
localName	String	IdentifiedObject
pathName	String	IdentifiedObject
aliasName	String	IdentifiedObject
description	String	IdentifiedObject

Native Roles

0..*	*Region*	0..1	SubGeographicalRegion	

Roles Inherited From EquipmentContainer

1	*ConnectivityNodes*	0..n	ConnectivityNode	EquipmentContainer
0..1	*Contains_Equipments*	0..n	Equipment	EquipmentContainer

Roles Inherited From PowerSystemResource

0..n	*OperatedBy_Companies*	0..n	Company	PowerSystemResource
0..n	*PSRType*	0..1	PSRType	PowerSystemResource
1	*Contains_Measurements*	0..n	Measurement	PowerSystemResource
1	*OutageSchedule*	0..1	OutageSchedule	PowerSystemResource

Roles Inherited From IdentifiedObject

1..n	*ModelingAuthoritySet*	0..1	ModelingAuthoritySet	IdentifiedObject

6.8.20 LoadBreakSwitch

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

Native Attributes

ampRating	CurrentFlow	Current carrying capacity, expressed in amperes, of a wire or cable under stated thermal conditions.

Inherited Attributes

normalOpen	Boolean	Switch
switchOnCount	Counter	Switch
switchOnDate	AbsoluteDateTime	Switch
phases	PhaseCode	ConductingEquipment
mRID	String	IdentifiedObject
name	String	IdentifiedObject
localName	String	IdentifiedObject
pathName	String	IdentifiedObject
aliasName	String	IdentifiedObject
description	String	IdentifiedObject

Roles Inherited From ProtectedSwitch

0..n	*OperatedBy_ProtectionEquipments*	0..n	ProtectionEquipment	ProtectedSwitch
1	*RecloseSequences*	0..n	RecloseSequence	ProtectedSwitch

Roles Inherited From Switch

0..n	*CompositeSwitch*	0..1	CompositeSwitch	Switch
0..n	*SwitchingOperations*	0..n	SwitchingOperation	Switch

Roles Inherited From ConductingEquipment

1	*Terminals*	0..n	Terminal	ConductingEquipment
0..n	*BaseVoltage*	0..1	BaseVoltage	ConductingEquipment
1	*ClearanceTags*	0..n	ClearanceTag	ConductingEquipment
0..n	*ProtectionEquipments*	0..n	ProtectionEquipment	ConductingEquipment

Roles Inherited From Equipment

0..n	*MemberOf_EquipmentContainer*	0..1	EquipmentContainer	Equipment

Roles Inherited From PowerSystemResource

0..n	*OperatedBy_Companies*	0..n	Company	PowerSystemResource
0..n	*PSRType*	0..1	PSRType	PowerSystemResource
1	*Contains_Measurements*	0..n	Measurement	PowerSystemResource
1	*OutageSchedule*	0..1	OutageSchedule	PowerSystemResource

Roles Inherited From IdentifiedObject

1..n	*ModelingAuthoritySet*	0..1	ModelingAuthority Set	IdentifiedObject

6.8.21 MVArCapabilityCurve

Reactive power rating envelope versus the synchronous machine's active power, in both the generating and motoring modes. For each MW value, there is a corresponding high and low MVAr 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.

Native Attributes

coolantTemperature	Temperature	The machine's coolant temperature in degrees Celsius (e.g. ambient air or stator circulating water).
hydrogenPressure	Pressure	The hydrogen coolant pressure.

Inherited Attributes

curveStyle	CurveStyle	Curve
xUnit	String	Curve
y1Unit	String	Curve
y2Unit	String	Curve
mRID	String	IdentifiedObject
name	String	IdentifiedObject
localName	String	IdentifiedObject
pathName	String	IdentifiedObject
aliasName	String	IdentifiedObject
description	String	IdentifiedObject

Native Roles

0..n	*SynchronousMachines*	1..n	SynchronousMachine	
0..1	*InitiallyUsedBySynchronousMachine*	1..n	SynchronousMachine	

Roles Inherited From Curve

1	*CurveScheduleDatas*	0..n	CurveData	Curve

Roles Inherited From IdentifiedObject

1..n	*ModelingAuthoritySet*	0..1	ModelingAuthority Set	IdentifiedObject

6.8.22 Plant

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

Inherited Attributes

mRID	String	IdentifiedObject
name	String	IdentifiedObject
localName	String	IdentifiedObject
pathName	String	IdentifiedObject
aliasName	String	IdentifiedObject
description	String	IdentifiedObject

Roles Inherited From EquipmentContainer

1	*ConnectivityNodes*	0..n	ConnectivityNode	EquipmentContainer
0..1	*Contains_Equipments*	0..n	Equipment	EquipmentContainer

Roles Inherited From PowerSystemResource

0..n	*OperatedBy_Companies*	0..n	Company	PowerSystemResource
0..n	*PSRType*	0..1	PSRType	PowerSystemResource
1	*Contains_Measurements*	0..n	Measurement	PowerSystemResource
1	*OutageSchedule*	0..1	OutageSchedule	PowerSystemResource

Roles Inherited From IdentifiedObject

1..n	*ModelingAuthoritySet*	0..1	ModelingAuthority Set	IdentifiedObject

6.8.23 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 (MW flow). The typeName attribute indicates type of transformer.

Native Attributes

bmagSat	PerCent	Core shunt magnetizing susceptance in the saturation region, in per cent.
magBaseKV	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. Possible values { ABCN , ABC, ABN, ACN, BCN, AB, AC, BC, AN, BN, CN, A, B, C, N }.
transfCoolingType	TransformerCoolingType	Type of transformer cooling.
transformerType	TransformerType	

Inherited Attributes

mRID	String	IdentifiedObject
name	String	IdentifiedObject
localName	String	IdentifiedObject
pathName	String	IdentifiedObject
aliasName	String	IdentifiedObject
description	String	IdentifiedObject

Native Roles

1	*HeatExchanger*	0..1	HeatExchanger	A transformer may have a heat exchanger.
1	*Contains_TransformerWindings*	1..n	TransformerWinding	A transformer has windings.

Roles Inherited From Equipment

0..n	*MemberOf_EquipmentContainer*	0..1	EquipmentContainer	Equipment

Roles Inherited From PowerSystemResource

0..n	*OperatedBy_Companies*	0..n	Company	PowerSystemResource
0..n	*PSRType*	0..1	PSRType	PowerSystemResource
1	*Contains_Measurements*	0..n	Measurement	PowerSystemResource
1	*OutageSchedule*	0..1	OutageSchedule	PowerSystemResource

Roles Inherited From IdentifiedObject

1..n	*ModelingAuthoritySet*	0..1	ModelingAuthority Set	IdentifiedObject

6.8.24 ProtectedSwitch

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

Inherited Attributes

normalOpen	Boolean	Switch
switchOnCount	Counter	Switch
switchOnDate	AbsoluteDateTime	Switch
phases	PhaseCode	ConductingEquipment
mRID	String	IdentifiedObject
name	String	IdentifiedObject
localName	String	IdentifiedObject
pathName	String	IdentifiedObject
aliasName	String	IdentifiedObject
description	String	IdentifiedObject

Native Roles

0..n	*OperatedBy_ProtectionEquipments*	0..n	ProtectionEquipment	Circuit breakers may be operated by protection relays.
1	*RecloseSequences*	0..n	RecloseSequence	A breaker may have zero or more automatic reclosures after a trip occurs.

Roles Inherited From Switch

0..n	*CompositeSwitch*	0..1	CompositeSwitch	Switch
0..n	*SwitchingOperations*	0..n	SwitchingOperation	Switch

Roles Inherited From ConductingEquipment

1	*Terminals*	0..n	Terminal	ConductingEquipment
0..n	*BaseVoltage*	0..1	BaseVoltage	ConductingEquipment
1	*ClearanceTags*	0..n	ClearanceTag	ConductingEquipment
0..n	*ProtectionEquipments*	0..n	ProtectionEquipment	ConductingEquipment

Roles Inherited From Equipment

0..n	*MemberOf_Equipment Container*	0..1	EquipmentContainer	Equipment

Roles Inherited From PowerSystemResource

0..n	*OperatedBy_Companies*	0..n	Company	PowerSystemResource
0..n	*PSRType*	0..1	PSRType	PowerSystemResource
1	*Contains_Measurements*	0..n	Measurement	PowerSystemResource
1	*OutageSchedule*	0..1	OutageSchedule	PowerSystemResource

Roles Inherited From IdentifiedObject

1..n	*ModelingAuthoritySet*	0..1	ModelingAuthoritySet	IdentifiedObject

6.8.25 RectifierInverter

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

Native Attributes

ratedKV	Voltage	Rectifier/inverter primary base voltage.
bridges	Counter	Number of bridges.
commutatingReactance	Reactance	Commutating reactance in ohms at AC bus frequency.
commutatingResistance	Resistance	Commutating resistance in ohms.
compoundResistance	Resistance	Compounding resistance in ohms.
minCompoundVoltage	Voltage	Minimum compounded DC voltage.
frequency	Frequency	Frequency on the AC side.
maximumMW	ActivePower	The maximum power on the DC side at which the frequence converter should operate.
minimumMW	ActivePower	The minimum power on the DC side at which the frequence converter should operate.
maximumKV	VoltageControlZone	The maximum voltage on the DC side at which the frequency converter should operate.
minimumKV	Voltage	The minimum voltage on the DC side at which the frequency converter should operate.
operatingMode	OperatingMode	Operating mode for the frequency converter.

Inherited Attributes

phases	PhaseCode	ConductingEquipment
mRID	String	IdentifiedObject
name	String	IdentifiedObject
localName	String	IdentifiedObject
pathName	String	IdentifiedObject
aliasName	String	IdentifiedObject
description	String	IdentifiedObject

Roles Inherited From ConductingEquipment

1	*Terminals*	0..n	Terminal	ConductingEquipment
0..n	*BaseVoltage*	0..1	BaseVoltage	ConductingEquipment
1	*ClearanceTags*	0..n	ClearanceTag	ConductingEquipment
0..n	*ProtectionEquipments*	0..n	ProtectionEquipment	ConductingEquipment

Roles Inherited From Equipment

0..n	*MemberOf_EquipmentContainer*	0..1	EquipmentContainer	Equipment

Roles Inherited From PowerSystemResource

0..n	*OperatedBy_Companies*	0..n	Company	PowerSystemResource
0..n	*PSRType*	0..1	PSRType	PowerSystemResource
1	*Contains_Measurements*	0..n	Measurement	PowerSystemResource
1	*OutageSchedule*	0..1	OutageSchedule	PowerSystemResource

Roles Inherited From IdentifiedObject

1..n	*ModelingAuthoritySet*	0..1	ModelingAuthoritySet	IdentifiedObject

6.8.26 RegulatingCondEq

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

Inherited Attributes

phases	PhaseCode	ConductingEquipment
mRID	String	IdentifiedObject
name	String	IdentifiedObject
localName	String	IdentifiedObject
pathName	String	IdentifiedObject
aliasName	String	IdentifiedObject
description	String	IdentifiedObject

Native Roles

0..n	*Measurement*	0..1	Measurement	A type of conducting equipment that may be used to regulate a network measurement, typically voltage.
0..n	*RegulationSchedule*	0..1	RegulationSchedule	A regulating class may have a voltage regulation schedule.
0..1	*Controls*	1..n	Control	

Roles Inherited From ConductingEquipment

1	*Terminals*	0..n	Terminal	ConductingEquipment
0..n	*BaseVoltage*	0..1	BaseVoltage	ConductingEquipment
1	*ClearanceTags*	0..n	ClearanceTag	ConductingEquipment
0..n	*ProtectionEquipments*	0..n	ProtectionEquipment	ConductingEquipment

Roles Inherited From Equipment

0..n	*MemberOf_EquipmentContainer*	0..1	EquipmentContainer	Equipment

Roles Inherited From PowerSystemResource

0..n	*OperatedBy_Companies*	0..n	Company	PowerSystemResource
0..n	*PSRType*	0..1	PSRType	PowerSystemResource
1	*Contains_Measurements*	0..n	Measurement	PowerSystemResource
1	*OutageSchedule*	0..1	OutageSchedule	PowerSystemResource

Roles Inherited From IdentifiedObject

1..n	*ModelingAuthoritySet*	0..1	ModelingAuthoritySet	IdentifiedObject

6.8.27 RegulationSchedule

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

Native Attributes

lineDropCompensation	Boolean	Flag to indicate that line drop compensation is to be applied.
lineDropR	Resistance	Line drop resistance
lineDropX	Reactance	Line drop reactance

Inherited Attributes

timeStep	Seconds	RegularIntervalSchedule
endTime	AbsoluteDateTime	RegularIntervalSchedule
startTime	AbsoluteDateTime	BasicIntervalSchedule
value1Unit	String	BasicIntervalSchedule
value2Unit	String	BasicIntervalSchedule
mRID	String	IdentifiedObject
name	String	IdentifiedObject
localName	String	IdentifiedObject
pathName	String	IdentifiedObject
aliasName	String	IdentifiedObject
description	String	IdentifiedObject

Native Roles

0..1	*VoltageControlZones*	0..n	VoltageControlZone	A VoltageControlZone may have a voltage regulation schedule.
0..1	*RegulatingCondEqs*	0..n	RegulatingCondEq	A regulating class may have a voltage regulation schedule.
0..1	*TapChangers*	0..n	TapChanger	An LTC may have a regulation schedule.

Roles Inherited From RegularIntervalSchedule

1	*TimePoints*	1..*	RegularTimePoint	RegularIntervalSchedule

Roles Inherited From BasicIntervalSchedule

Roles Inherited From IdentifiedObject

1..n	*ModelingAuthoritySet*	0..1	ModelingAuthoritySet	IdentifiedObject

6.8.28 SeriesCompensator

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

Native Attributes

r	Resistance	Positive sequence resistance of the capacitor bank
x	Reactance	Positive sequence reactance of the capacitor bank

Inherited Attributes

phases	PhaseCode	ConductingEquipment
mRID	String	IdentifiedObject
name	String	IdentifiedObject
localName	String	IdentifiedObject
pathName	String	IdentifiedObject
aliasName	String	IdentifiedObject
description	String	IdentifiedObject

Roles Inherited From ConductingEquipment

1	*Terminals*	0..n	Terminal	ConductingEquipment
0..n	*BaseVoltage*	0..1	BaseVoltage	ConductingEquipment
1	*ClearanceTags*	0..n	ClearanceTag	ConductingEquipment
0..n	*ProtectionEquipments*	0..n	ProtectionEquipment	ConductingEquipment

Roles Inherited From Equipment

0..n	*MemberOf_EquipmentContainer*	0..1	EquipmentContainer	Equipment

Roles Inherited From PowerSystemResource

0..n	*OperatedBy_Companies*	0..n	Company	PowerSystemResource
0..n	*PSRType*	0..1	PSRType	PowerSystemResource
1	*Contains_Measurements*	0..n	Measurement	PowerSystemResource
1	*OutageSchedule*	0..1	OutageSchedule	PowerSystemResource

Roles Inherited From IdentifiedObject

1..n	*ModelingAuthoritySet*	0..1	ModelingAuthoritySet	IdentifiedObject

6.8.29 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.

Native Attributes

aVRDelay	Seconds	Time delay in seconds required for the device to be connected or disconnected by automatic voltage regulation (AVR).
impedance	Impedance	The positive sequence impedance of the capacitor.
maximumkV	Voltage	The maximum voltage at which the capacitor bank should operate.
maximumSections	Counter	For a capacitor bank, the maximum number of sections that may be switched in.
minimumkV	Voltage	The minimum voltage at which the capacitor bank should operate.
mVArPerSection	ReactivePower	For a capacitor bank, the size in MVAr of each switchable section at the Nominal kV.
nominalkV	Voltage	The nominal voltage at which the nominal MVAr was measured. This should normally be within 10% of the voltage at which the capacitor is connected to the network.

nominalMVAr	ReactivePower	Nominal MVAr output of the capacitor bank at the nominal kV. This number should be positive.
normalSections	Counter	For a capacitor bank, the normal number of sections switched in. This number should correspond to the Nominal MVAr.
switchOnCount	Counter	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.
voltSensitivity	PUkVPerMVAr	Voltage sensitivity required for the device to regulate the bus voltage, in per unit voltage/MVAr.
yPerSection	Admittance	For a capacitor bank, the admittance of each switchable section. Calculated using the MVAr per section and corrected for network voltage.

Inherited Attributes

phases	PhaseCode	ConductingEquipment
mRID	String	IdentifiedObject
name	String	IdentifiedObject
localName	String	IdentifiedObject
pathName	String	IdentifiedObject
aliasName	String	IdentifiedObject
description	String	IdentifiedObject

Roles Inherited From RegulatingCondEq

0..n	*Measurement*	0..1	Measurement	RegulatingCondEq
0..n	*RegulationSchedule*	0..1	RegulationSchedule	RegulatingCondEq
0..1	*Controls*	1..n	Control	RegulatingCondEq

Roles Inherited From ConductingEquipment

1	*Terminals*	0..n	Terminal	ConductingEquipment
0..n	*BaseVoltage*	0..1	BaseVoltage	ConductingEquipment
1	*ClearanceTags*	0..n	ClearanceTag	ConductingEquipment
0..n	*ProtectionEquipments*	0..n	ProtectionEquipment	ConductingEquipment

Roles Inherited From Equipment

0..n	*MemberOf_EquipmentContainer*	0..1	EquipmentContainer	Equipment

Roles Inherited From PowerSystemResource

0..n	*OperatedBy_Companies*	0..n	Company	PowerSystemResource
0..n	*PSRType*	0..1	PSRType	PowerSystemResource
1	*Contains_Measurements*	0..n	Measurement	PowerSystemResource
1	*OutageSchedule*	0..1	OutageSchedule	PowerSystemResource

Roles Inherited From IdentifiedObject

1..n	*ModelingAuthoritySet*	0..1	ModelingAuthoritySet	IdentifiedObject

6.8.30 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.

Native Attributes

capacitiveRating	Reactance	Maximum available capacitive reactive power.
inductiveRating	Reactance	Maximum available inductive reactive power.
sVCControlMode	ControlMode	SVC control mode: MVAr, Voltage.
slope	VoltagePerReactivePower	The characteristics slope of an SVC defines how the reactive power output changes in proportion to the difference between the regulated bus voltage and the voltage setpoint.
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.

Inherited Attributes

phases	PhaseCode	ConductingEquipment
mRID	String	IdentifiedObject
name	String	IdentifiedObject
localName	String	IdentifiedObject
pathName	String	IdentifiedObject
aliasName	String	IdentifiedObject
description	String	IdentifiedObject

Roles Inherited From RegulatingCondEq

0..n	*Measurement*	0..1	Measurement	RegulatingCondEq
0..n	*RegulationSchedule*	0..1	RegulationSchedule	RegulatingCondEq
0..1	*Controls*	1..n	Control	RegulatingCondEq

Roles Inherited From ConductingEquipment

1	*Terminals*	0..n	Terminal	ConductingEquipment
0..n	*BaseVoltage*	0..1	BaseVoltage	ConductingEquipment
1	*ClearanceTags*	0..n	ClearanceTag	ConductingEquipment
0..n	*ProtectionEquipments*	0..n	ProtectionEquipment	ConductingEquipment

Roles Inherited From Equipment

0..n	*MemberOf_EquipmentContainer*	0..1	EquipmentContainer	Equipment

Roles Inherited From PowerSystemResource

0..n	*OperatedBy_Companies*	0..n	Company	PowerSystemResource
0..n	*PSRType*	0..1	PSRType	PowerSystemResource
1	*Contains_Measurements*	0..n	Measurement	PowerSystemResource
1	*OutageSchedule*	0..1	OutageSchedule	PowerSystemResource

Roles Inherited From IdentifiedObject

1..n	*ModelingAuthoritySet*	0..1	ModelingAuthority Set	IdentifiedObject

6.8.31 Switch

A generic device designed to close, or open, or both, one or more electric circuits. The typeName attribute may be used to indicate that the database switch does not represent a corresponding real device but has been introduced for modeling purposes only.

Native Attributes

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 Measurement.normalValue is expected to match with the Switch.normalOpen.
switchOnCount	Counter	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.

Inherited Attributes

phases	PhaseCode	ConductingEquipment
mRID	String	IdentifiedObject
name	String	IdentifiedObject
localName	String	IdentifiedObject
pathName	String	IdentifiedObject
aliasName	String	IdentifiedObject
description	String	IdentifiedObject

Native Roles

0..n	*CompositeSwitch*	0..1	CompositeSwitch	
0..n	*SwitchingOperations*	0..n	SwitchingOperation	A switch may be operated by many schedules.

Roles Inherited From ConductingEquipment

1	*Terminals*	0..n	Terminal	ConductingEquipment
0..n	*BaseVoltage*	0..1	BaseVoltage	ConductingEquipment
1	*ClearanceTags*	0..n	ClearanceTag	ConductingEquipment
0..n	*ProtectionEquipments*	0..n	ProtectionEquipment	ConductingEquipment

Roles Inherited From Equipment

0..n	*MemberOf_EquipmentContainer*	0..1	EquipmentContainer	Equipment

Roles Inherited From PowerSystemResource

0..n	*OperatedBy_Companies*	0..n	Company	PowerSystemResource
0..n	*PSRType*	0..1	PSRType	PowerSystemResource
1	*Contains_Measurements*	0..n	Measurement	PowerSystemResource
1	*OutageSchedule*	0..1	OutageSchedule	PowerSystemResource

Roles Inherited From IdentifiedObject

1..n	*ModelingAuthoritySet*	0..1	ModelingAuthoritySet	IdentifiedObject

6.8.32 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.

Native Attributes

aVRToManualLag	Seconds	Time delay, in seconds, required when switching from AVR to manual for a lagging MVAr violation.
aVRToManualLead	Seconds	Time delay, in seconds, required when switching from Automatic Voltage Regulation to Manual for a leading MVAr violation.
baseMVAr	ReactivePower	Default base MVAr value. This value represents the initial MVAr that can be used by any application function.
coolantCondition	Float	Temperature or pressure of coolant medium.
coolantType	CoolantType	Method of cooling the machine, e.g. air, hydrogen gas, water.
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	Inertia	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, in seconds, required when switching from Manual to Automatic Voltage Regulation. This value is used in the accelerating power reference frame for powerflow solutions.
maximumKV	Voltage	Maximum kV limit for the unit.
maximumMVAr	ReactivePower	Maximum MVAr limit. This is the maximum (nameplate) limit for the unit.
minimumKV	Voltage	Minimum kV limit for the unit.
minimumMVAr	ReactivePower	Minimum MVAr limit for the unit.
r	Resistance	Positive sequence resistance of the synchronous machine.
r0	Resistance	Zero sequence resistance of the synchronous machine.
ratedMVA	ApparentPower	Nameplate MVA rating for the unit.

x	Reactance	Positive sequence reactance of the synchronous machine.
x0	Reactance	Zero sequence reactance of the synchronous machine.
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 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.
operatingMode	SynchronousMachineOperatingMode	Current mode of operation, i.e. generator or condenser.
type	SynchronousMachineType	Modes that this synchronous machine can operate in, i.e. as a generator, condenser, or both.
condenserMW	ActivePower	

Inherited Attributes

phases	PhaseCode	ConductingEquipment
mRID	String	IdentifiedObject
name	String	IdentifiedObject
localName	String	IdentifiedObject
pathName	String	IdentifiedObject
aliasName	String	IdentifiedObject
description	String	IdentifiedObject

Native Roles

1..n	*MVArCapabilityCurves*	0..n	MVArCapabilityCurve	
1..n	*InitiallyUsesMVArCapability Curve*	0..1	MVArCapabilityCurve	
1	*Drives_HydroPump*	0..1	HydroPump	The synchronous machine drives the turbine which moves the water from a low elevation to a higher elevation. The direction of machine rotation for pumping may or may not be the same as for generating.
1..n	*MemberOf_GeneratingUnit*	0..1	GeneratingUnit	A synchronous machine may operate as a generator and as such becomes a member of a generating unit.
0..n	*DrivenBy_PrimeMover*	0..n	PrimeMover	

Roles Inherited From RegulatingCondEq

0..n	*Measurement*	0..1	Measurement	RegulatingCondEq
0..n	*RegulationSchedule*	0..1	RegulationSchedule	RegulatingCondEq
0..1	*Controls*	1..n	Control	RegulatingCondEq

Roles Inherited From ConductingEquipment

1	*Terminals*	0..n	Terminal	ConductingEquipment
0..n	*BaseVoltage*	0..1	BaseVoltage	ConductingEquipment
1	*ClearanceTags*	0..n	ClearanceTag	ConductingEquipment
0..n	*ProtectionEquipments*	0..n	ProtectionEquipment	ConductingEquipment

Roles Inherited From Equipment

0..n	*MemberOf_EquipmentContainer*	0..1	EquipmentContainer	Equipment

Roles Inherited From PowerSystemResource

0..n	*OperatedBy_Companies*	0..n	Company	PowerSystemResource
0..n	*PSRType*	0..1	PSRType	PowerSystemResource
1	*Contains_Measurements*	0..n	Measurement	PowerSystemResource
1	*OutageSchedule*	0..1	OutageSchedule	PowerSystemResource

Roles Inherited From IdentifiedObject

1..n	*ModelingAuthoritySet*	0..1	ModelingAuthoritySet	IdentifiedObject

6.8.33 TapChanger

Mechanism for changing transformer winding tap positions. The typeName attribute indicates type of changer, designated as "Fixed" or "LTC."

Native Attributes

highStep	TapStep	Highest possible tap step position, advance from neutral.
initialDelay	Seconds	For an LTC, the delay for initial tap changer operation (first step change).
lowStep	TapStep	Lowest possible tap step position, retard from neutral.
neutralKV	Voltage	Voltage at which the winding operates at the neutral tap setting.
neutralStep	TapStep	The neutral tap step position for this winding.
normalStep	TapStep	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, in degrees, 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).
tculControlMode	TransformerControlMode	For an LTC, the tap changer control mode, e.g.: Off, Local, Volt, MVAr.

Inherited Attributes

mRID	String	IdentifiedObject
name	String	IdentifiedObject
localName	String	IdentifiedObject
pathName	String	IdentifiedObject
aliasName	String	IdentifiedObject
description	String	IdentifiedObject

Native Roles

0..n	*TransformerWinding*	1	TransformerWinding	A transformer winding may have tap changers, separately for voltage and phase angle.
0..n	*Measurement*	0..1	Measurement	An LTC may regulate a specific measurement from the network, typically voltage. A phase shifter would typically be used to regulate a real power (MW) flow measurement. An LTC with significant phase shift characteristics could be used to regulate MW flow instead of voltage.
0..n	*RegulationSchedule*	0..1	RegulationSchedule	An LTC may have a regulation schedule.

Roles Inherited From PowerSystemResource

0..n	*OperatedBy_Companies*	0..n	Company	PowerSystemResource
0..n	*PSRType*	0..1	PSRType	PowerSystemResource
1	*Contains_Measurements*	0..n	Measurement	PowerSystemResource
1	*OutageSchedule*	0..1	OutageSchedule	PowerSystemResource

Roles Inherited From IdentifiedObject

1..n	*ModelingAuthoritySet*	0..1	ModelingAuthority Set	IdentifiedObject

6.8.34 TransformerWinding

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

Native Attributes

b	Susceptance	Magnetizing branch susceptance (B mag).
insulationKV	Voltage	Basic insulation level voltage rating.
connectionType	WindingConnection	The type of connection of the winding (e.g. Delta, Wye, zigzag).
emergencyMVA	ApparentPower	The MVA that the winding can carry under emergency conditions.
g	Conductance	Magnetizing branch conductance (G mag).
grounded	Boolean	Set if the winding is grounded.
r	Resistance	Positive sequence series resistance of the winding.

r0	Resistance	Zero sequence series resistance of the winding.
ratedKV	Voltage	The rated voltage (phase-to-phase) of the winding, usually the same as the neutral voltage.
ratedMVA	ApparentPower	The normal MVA rating for the winding.
rground	Resistance	Ground resistance path through connected grounding transformer.
shortTermMVA	ApparentPower	MVA that the winding can carry for a short period of time.
windingType	WindingType	The type of winding, i.e. Primary, Secondary, Tertiary, Quaternary.
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.

Inherited Attributes

phases	PhaseCode	ConductingEquipment
mRID	String	IdentifiedObject
name	String	IdentifiedObject
localName	String	IdentifiedObject
pathName	String	IdentifiedObject
aliasName	String	IdentifiedObject
description	String	IdentifiedObject

Native Roles

1..n	*MemberOf_PowerTransformer*	1	PowerTransformer	A transformer has windings.
1	*TapChangers*	0..n	TapChanger	A transformer winding may have tap changers, separately for voltage and phase angle.
1	*From_WindingTests*	0..n	WindingTest	The winding from which the test was conducted.
0..n	*To_WindingTest*	0..1	WindingTest	The winding to which the test was conducted.

Roles Inherited From ConductingEquipment

1	*Terminals*	0..n	Terminal	ConductingEquipment
0..n	*BaseVoltage*	0..1	BaseVoltage	ConductingEquipment
1	*ClearanceTags*	0..n	ClearanceTag	ConductingEquipment
0..n	*ProtectionEquipments*	0..n	ProtectionEquipment	ConductingEquipment

Roles Inherited From Equipment

0..n	*MemberOf_Equipment Container*	0..1	EquipmentContainer	Equipment

Roles Inherited From PowerSystemResource

0..n	*OperatedBy_Companies*	0..n	Company	PowerSystemResource
0..n	*PSRType*	0..1	PSRType	PowerSystemResource
1	*Contains_Measurements*	0..n	Measurement	PowerSystemResource
1	*OutageSchedule*	0..1	OutageSchedule	PowerSystemResource

Roles Inherited From IdentifiedObject

1..n	*ModelingAuthoritySet*	0..1	ModelingAuthority Set	IdentifiedObject

6.8.35 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.

Native Attributes

excitingCurrent	ExcitingCurrent	The exciting current % ("to" winding open-circuited) from the test report.
fromTapStep	TapStep	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 MVA and kV ratings of the "from" winding.
loadLoss	LoadLoss	The load loss kW ("to" winding short-circuited) from the test report.
noLoadLoss	NoLoadLoss	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	TapStep	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" winding's rated voltage and all other windings open-circuited.

Inherited Attributes

mRID	String	IdentifiedObject
name	String	IdentifiedObject
localName	String	IdentifiedObject
pathName	String	IdentifiedObject
aliasName	String	IdentifiedObject
description	String	IdentifiedObject

Native Roles

0..n	*From_TransformerWinding*	1	TransformerWinding	The winding from which the test was conducted.
0..1	*To_TransformeWindings*	0..n	TransformerWinding	The winding to which the test was conducted.

Roles Inherited From IdentifiedObject

1..n	*ModelingAuthoritySet*	0..1	ModelingAuthority Set	IdentifiedObject

6.8.36 WireArrangement

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

Native Attributes

mountingPointX	Integer	Mounting point where wire One is mounted.
mountingPointY	Integer	Mounting point where wire One is mounted.

Inherited Attributes

mRID	String	IdentifiedObject
name	String	IdentifiedObject
localName	String	IdentifiedObject
pathName	String	IdentifiedObject
aliasName	String	IdentifiedObject
description	String	IdentifiedObject

Native Roles

0..n	*ConductorType*	0..1	ConductorType	A ConductorType is made up of wires that can be configured in several ways.
0..n	*WireType*	0..1	WireType	A WireType is mounted at a specified place in a WireArrangement.

Roles Inherited From IdentifiedObject

1..n	*ModelingAuthoritySet*	0..1	ModelingAuthoritySet	IdentifiedObject

6.8.37 WiresVersion

Native Attributes

version
date

6.8.38 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.

Native Attributes

phaseConductorCount	Counter	Number of conductor strands in the (symmetrical) bundle (1-12).
phaseConductorSpacing	ShortLength	Distance between conductor strands in a (symmetrical) bundle (short length units).
ampRating	CurrentFlow	Current carrying capacity, expressed in amperes, 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.

Inherited Attributes

mRID	String	IdentifiedObject
name	String	IdentifiedObject
localName	String	IdentifiedObject
pathName	String	IdentifiedObject
aliasName	String	IdentifiedObject
description	String	IdentifiedObject

Native Roles

0..1	*WireArrangements*	0..n	WireArrangement	A WireType is mounted at a specified place in a WireArrangement.

Roles Inherited From IdentifiedObject

1..n	*ModelingAuthoritySet*	0..1	ModelingAuthority Set	IdentifiedObject

6.8.39 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.

Inherited Attributes

mRID	String	IdentifiedObject
name	String	IdentifiedObject
localName	String	IdentifiedObject
pathName	String	IdentifiedObject
aliasName	String	IdentifiedObject
description	String	IdentifiedObject

Native Roles

0..1	*BusbarSection*	1	BusbarSection	A VoltageControlZone is controlled by a designated BusbarSection.
0..n	*RegulationSchedule*	0..1	RegulationSchedule	A VoltageControlZone may have a voltage regulation schedule.

Roles Inherited From PowerSystemResource

0..n	*OperatedBy_Companies*	0..n	Company	PowerSystemResource
0..n	*PSRType*	0..1	PSRType	PowerSystemResource
1	*Contains_Measurements*	0..n	Measurement	PowerSystemResource
1	*OutageSchedule*	0..1	OutageSchedule	PowerSystemResource

Roles Inherited From IdentifiedObject

1..n	*ModelingAuthoritySet*	0..1	ModelingAuthority Set	IdentifiedObject

6.9 Generation

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.

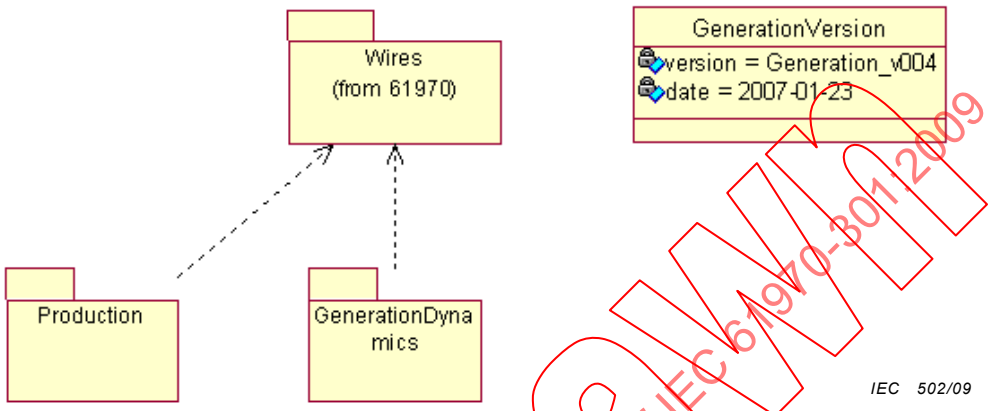


Figure 38 – Main

Figure 38 shows the two main packages comprising Generation and their dependency relationship with the Wires package.

6.9.1 GenerationVersion

Native Attributes

version

date

6.10 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.

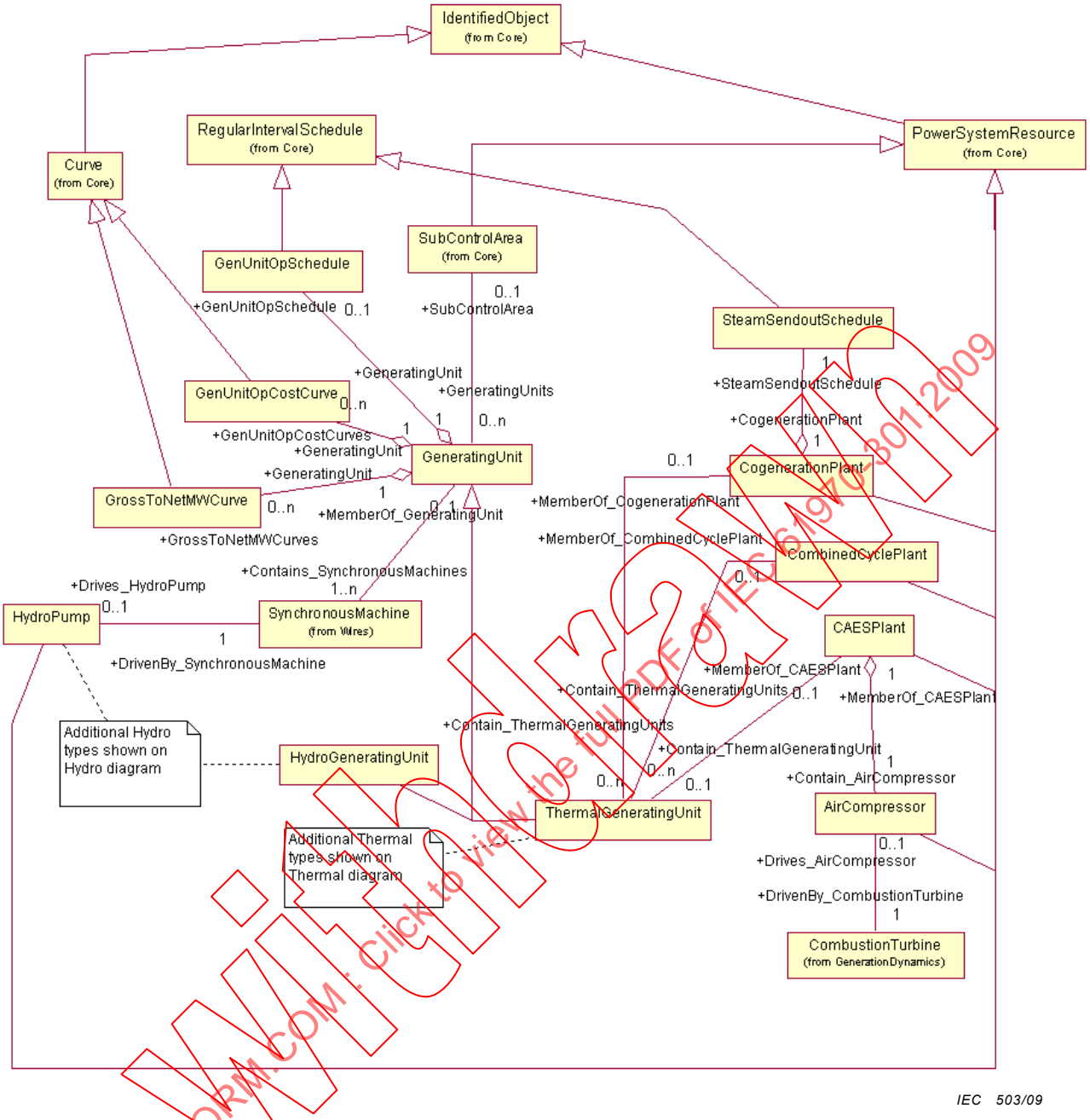


Figure 39 – Main

Figure 39 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.

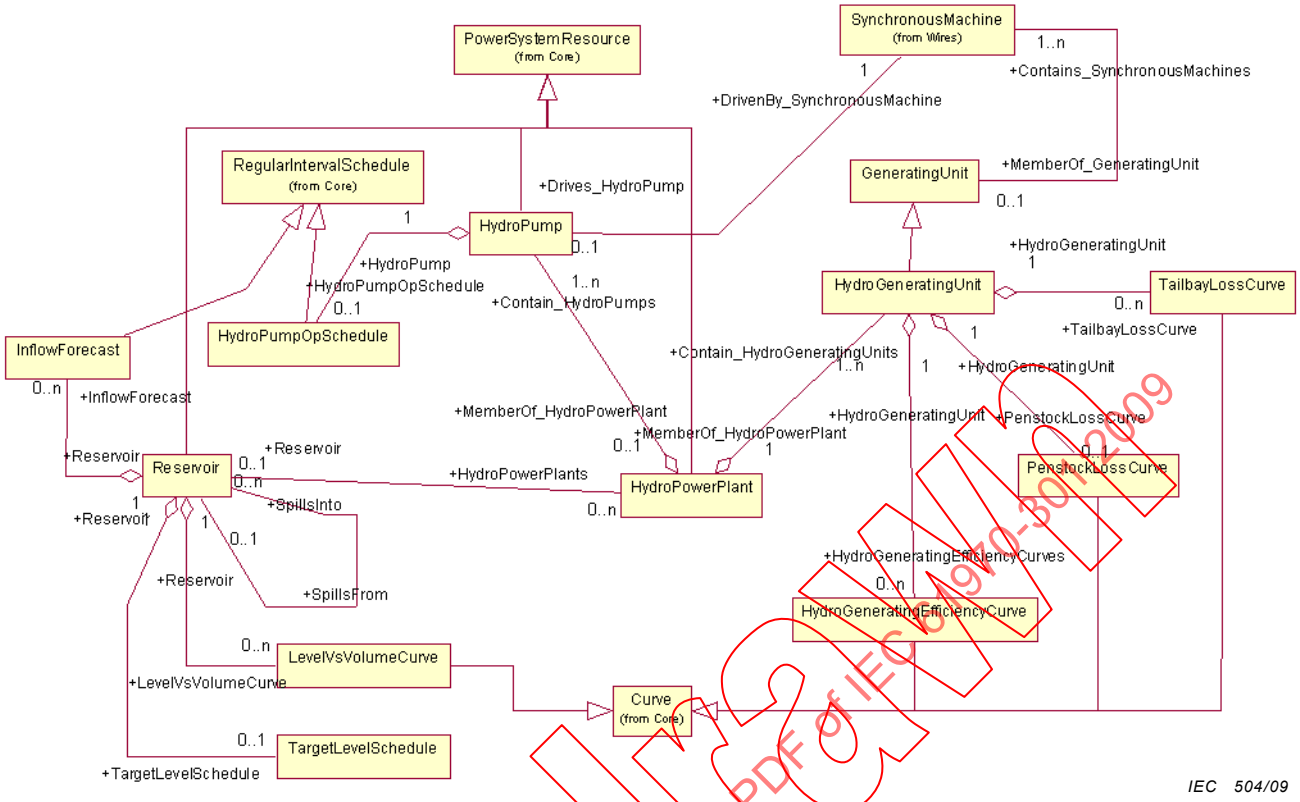


Figure 40 – Hydro

Figure 40 shows all classes included in the Hydro package as well as the key external classes that have associations with Hydro classes.

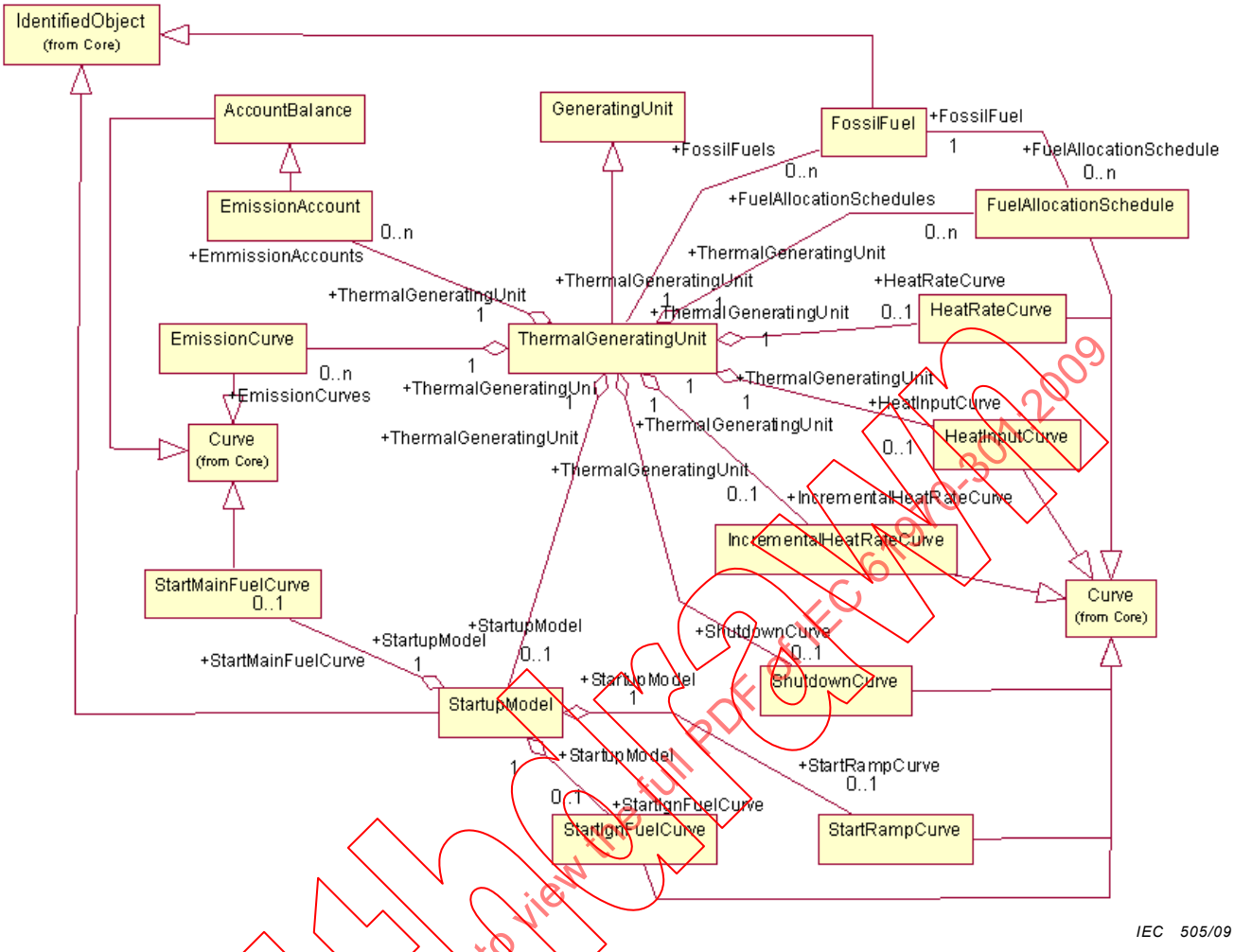


Figure 41 – Thermal

Figure 41 shows all classes included in the Thermal package as well as the key external classes that have associations with Thermal classes.

6.10.1 AccountBalance

Inherited Attributes

curveStyle	CurveStyle	Curve
xUnit	String	Curve
y1Unit	String	Curve
y2Unit	String	Curve
mRID	String	IdentifiedObject
name	String	IdentifiedObject
localName	String	IdentifiedObject
pathName	String	IdentifiedObject
aliasName	String	IdentifiedObject
description	String	IdentifiedObject

Roles Inherited From Curve

1	*CurveScheduleDatas*	0..n	CurveData	Curve

Roles Inherited From IdentifiedObject

1..n	*ModelingAuthoritySet*	0..1	ModelingAuthority Set	IdentifiedObject

6.10.2 AirCompressor

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

Native Attributes

airCompressorRating	Float	Rating of the CAES air compressor

Inherited Attributes

mRID	String	IdentifiedObject
name	String	IdentifiedObject
localName	String	IdentifiedObject
pathName	String	IdentifiedObject
aliasName	String	IdentifiedObject
description	String	IdentifiedObject

Native Roles

1	*MemberOf_CAESPlant*	1	CAESPlant	An air compressor may be a member of a compressed air energy storage plant.
0..1	*DrivenBy_CombustionTurbine*	1	CombustionTurbine	A CAES air compressor is driven by a combustion turbine.

Roles Inherited From PowerSystemResource

0..n	*OperatedBy_Companies*	0..n	Company	PowerSystemResource
0..n	*PSRType*	0..1	PSRType	PowerSystemResource
1	*Contains_Measurements*	0..n	Measurement	PowerSystemResource
1	*OutageSchedule*	0..1	OutageSchedule	PowerSystemResource

Roles Inherited From IdentifiedObject

1..n	*ModelingAuthoritySet*	0..1	ModelingAuthoritySet	IdentifiedObject

6.10.3 CAESPlant

Compressed air energy storage plant

Native Attributes

energyStorageCapacity	EnergyAsMWh	The rated energy storage capacity in megawatt-hours.
ratedCapacityMW	ActivePower	The CAES plant's gross rated generating capacity in MW.

Inherited Attributes

mRID	String	IdentifiedObject
name	String	IdentifiedObject
localName	String	IdentifiedObject
pathName	String	IdentifiedObject
aliasName	String	IdentifiedObject
description	String	IdentifiedObject

Native Roles

1	*Contain_AirCompressor*	1	AirCompressor	An air compressor may be a member of a compressed air energy storage plant.
0..1	*Contain_ThermalGeneratingUnit*	0..1	ThermalGeneratingUnit	A thermal generating unit may be a member of a compressed air energy storage plant.

Roles Inherited From PowerSystemResource

0..n	*OperatedBy_Companies*	0..n	Company	PowerSystemResource
0..n	*PSRType*	0..1	PSRType	PowerSystemResource
1	*Contains_Measurements*	0..n	Measurement	PowerSystemResource
1	*OutageSchedule*	0..1	OutageSchedule	PowerSystemResource

Roles Inherited From IdentifiedObject

1..n	*ModelingAuthoritySet*	0..1	ModelingAuthoritySet	IdentifiedObject

6.10.4 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.

Native Attributes

cogenHPSendoutRating	Float	The high pressure steam sendout, in klb/h.
cogenHPSteamRating	Float	The high pressure steam rating, in psi.
cogenLPSendoutRating	Float	The low pressure steam sendout, in klb/h.
cogenLPSteamRating	Float	The low pressure steam rating, in psi
cogenPlantMWRating	ActivePower	The rated output MW of the cogeneration plant.

Inherited Attributes

mRID	String	IdentifiedObject
name	String	IdentifiedObject
localName	String	IdentifiedObject
pathName	String	IdentifiedObject
aliasName	String	IdentifiedObject
description	String	IdentifiedObject

Native Roles

0..1	*Contain_ThermalGeneratingUnits*	0..n	ThermalGeneratingUnit	A thermal generating unit may be a member of a cogeneration plant.
1	*SteamSendoutSchedule*	1	SteamSendoutSchedule	A cogeneration plant has a steam sendout schedule.

Roles Inherited From PowerSystemResource

0..n	*OperatedBy_Companies*	0..n	Company	PowerSystemResource
0..n	*PSRType*	0..1	PSRType	PowerSystemResource
1	*Contains_Measurements*	0..n	Measurement	PowerSystemResource
1	*OutageSchedule*	0..1	OutageSchedule	PowerSystemResource

Roles Inherited From IdentifiedObject

1..n	*ModelingAuthoritySet*	0..1	ModelingAuthority Set	IdentifiedObject

6.10.5 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.

Native Attributes

combCyclePlantRating	ActivePower	The combined cycle plant's output rating, in MW.

Inherited Attributes

mRID	String	IdentifiedObject
name	String	IdentifiedObject
localName	String	IdentifiedObject
pathName	String	IdentifiedObject
aliasName	String	IdentifiedObject
description	String	IdentifiedObject

Native Roles

0..1	*Contain_ThermalGenerating Units*	0..n	ThermalGeneratingUnit	A thermal generating unit may be a member of a combined cycle plant.

Roles Inherited From PowerSystemResource

0..n	*OperatedBy_Companies*	0..n	Company	PowerSystemResource
0..n	*PSRType*	0..1	PSRType	PowerSystemResource
1	*Contains_Measurements*	0..n	Measurement	PowerSystemResource
1	*OutageSchedule*	0..1	OutageSchedule	PowerSystemResource

Roles Inherited From IdentifiedObject

1..n	*ModelingAuthoritySet*	0..1	ModelingAuthority Set	IdentifiedObject

6.10.6 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.

Native Attributes

emissionType	EmissionType	The type of emission, for example sulfur dioxide (SO2). The y1AxisUnits of the curve contains the unit of measure (e.g. kg) and the emissionType is the type of emission (e.g. sulfer dioxide).
emissionValueSource	EmissionValueSource	The source of the emission value: Measured or Calculated.

Inherited Attributes

curveStyle	CurveStyle	Curve
xUnit	String	Curve
y1Unit	String	Curve
y2Unit	String	Curve
mRID	String	IdentifiedObject
name	String	IdentifiedObject
localName	String	IdentifiedObject
pathName	String	IdentifiedObject
aliasName	String	IdentifiedObject
description	String	IdentifiedObject

Native Roles

0..n	*ThermalGeneratingUnit*	1	ThermalGeneratingUnit	A thermal generating unit may have one or more emission allowance accounts.

Roles Inherited From AccountBalance

Roles Inherited From Curve

1	*CurveScheduleDatas*	0..n	CurveData	Curve

Roles Inherited From IdentifiedObject

1..n	*ModelingAuthoritySet*	0..1	ModelingAuthoritySet	IdentifiedObject

6.10.7 EmissionCurve

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

Native Attributes

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. sulfer dioxide).
netGrossMWFlag	Boolean	Flag is set to YES when output is expressed in net MW.

Inherited Attributes

curveStyle	CurveStyle	Curve
xUnit	String	Curve
y1Unit	String	Curve
y2Unit	String	Curve
mRID	String	IdentifiedObject
name	String	IdentifiedObject
localName	String	IdentifiedObject
pathName	String	IdentifiedObject
aliasName	String	IdentifiedObject
description	String	IdentifiedObject

Native Roles

0..n	*ThermalGeneratingUnit*	1	ThermalGeneratingUnit	A thermal generating unit may have one or more emission curves.

Roles Inherited From Curve

1	*CurveScheduleDatas*	0..n	CurveData	Curve

Roles Inherited From IdentifiedObject

1..n	*ModelingAuthoritySet*	0..1	ModelingAuthoritySet	IdentifiedObject

6.10.8 FossilFuel

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

Native Attributes

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 MBtu absorbed.
fuelHandlingCost	CostPerHeatUnit	Handling and processing cost associated with this fuel.
fuelHeatContent	Float	The amount of heat (Btu) per weight (or volume) of the given type of fuel.
fuelMixture	PerCent	The amount in percent 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 (MBtu).
highMWBreakpoint	ActivePower	The MW 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 MW output levels.
lowMWBreakpoint	ActivePower	The MW 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 MW output levels.

Inherited Attributes

mRID	String	IdentifiedObject
name	String	IdentifiedObject
localName	String	IdentifiedObject
pathName	String	IdentifiedObject
aliasName	String	IdentifiedObject
description	String	IdentifiedObject

Native Roles

1	*FuelAllocationSchedule*	0..n	FuelAllocationSchedule	A fuel allocation schedule must have a fossil fuel.
0..n	*ThermalGeneratingUnit*	1	ThermalGeneratingUnit	A thermal generating unit may have one or more fossil fuels.

Roles Inherited From IdentifiedObject

1..n	*ModelingAuthoritySet*	0..1	ModelingAuthoritySet	IdentifiedObject

6.10.9 FuelAllocationSchedule

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

Native Attributes

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.

Inherited Attributes

curveStyle	CurveStyle	Curve
xUnit	String	Curve
y1Unit	String	Curve
y2Unit	String	Curve
mRID	String	IdentifiedObject
name	String	IdentifiedObject
localName	String	IdentifiedObject
pathName	String	IdentifiedObject
aliasName	String	IdentifiedObject
description	String	IdentifiedObject

Native Roles

0..n	*FossilFuel*	1	FossilFuel	A fuel allocation schedule must have a fossil fuel.
0..n	*ThermalGeneratingUnit*	1	ThermalGeneratingUnit	A thermal generating unit may have one or more fuel allocation schedules.

Roles Inherited From Curve

1	*CurveScheduleDatas*	0..n	CurveData	Curve

Roles Inherited From IdentifiedObject

1..n	*ModelingAuthoritySet*	0..1	ModelingAuthoritySet	IdentifiedObject

6.10.10 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.

Native Attributes

controlDeadband	ActivePower	Unit control error deadband. When a unit's desired MW 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	PowerROCPerSec	Unit response rate which specifies the MW change for a control pulse of one second in the most responsive loading level of the unit.
efficiency	PU	The efficiency of the unit in converting mechanical energy, from the prime mover, into electrical energy.
genControlMode	GeneratorControlMode	Select the unit control mode as Setpoint (S) or Pulse (P).
genControlSource	GeneratorControlSource	The source of controls for a generating unit, i.e. Unavailable, Off-AGC, On-AGC, Plant Control.
governorMPL	PU	Governor Motor Position Limit.
governorSCD	PerCent	Governor Speed Changer Droop.
highControlLimit	ActivePower	High limit for secondary (AGC) control.
initialMW	ActivePower	Default Initial MW which is used to store a powerflow result for the initial MW for this unit in this network configuration.
lowControlLimit	ActivePower	Low limit for secondary (AGC) control.
maximumAllowableSpinningReserve	ActivePower	Maximum allowable spinning reserve. Spinning reserve will never be considered greater than this value regardless of the current operating point.
maximumEconomicMW	ActivePower	Maximum high economic MW limit, that should not exceed the maximum operating MW limit.
maximumOperatingMW	ActivePower	This is the maximum operating MW limit the dispatcher can enter for this unit.
minimumEconomicMW	ActivePower	Low economic MW limit that must be greater than or equal to the minimum operating MW limit.
minimumOperatingMW	ActivePower	This is the minimum operating MW limit the dispatcher can enter for this unit.
modelDetail	Classification	Detail level of the generator model data.
ratedGrossMaxMW	ActivePower	The unit's gross rated maximum capacity (Book Value).
ratedGrossMinMW	ActivePower	The gross rated minimum generation level which the unit can safely operate at while delivering power to the transmission grid.

ratedNetMaxMW	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.
startupTime	Seconds	Time it takes to get the unit on-line, from the time that the prime mover mechanical power is applied.
autoCntrlMarginMW	ActivePower	The planned unused capacity which can be used to support automatic control overruns, in MW.
allocSpinResMW	ActivePower	The planned unused capacity (spinning reserve) which can be used to support emergency load.
baseMW	ActivePower	For dispatchable units, this value represents the economic MW 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.
dispReserveFlag	Boolean	
energyMinMW	HeatPerHour	
fastStartFlag	Boolean	
fuelPriority	Priority	
genOperatingMode	GeneratorOperatingMode	Operating mode for secondary control, e.g.: Off, Manual, Fixed, LFC, AGC, EDC, RPN, MRN, or REG.
longPF	ParticipationFactor	
lowerRampRate	PowerROCPerMin	
normalPF	ParticipationFactor	
penaltyFactor	PenaltyFactor	
raiseRampRate	PowerROCPerMin	
shortPF	ParticipationFactor	
spinReserveRamp	PowerROCPerMin	
stepChange	ActivePower	
tieLinePF	ParticipationFactor	
minimumOffTime	Seconds	Minimum time interval between unit shutdown and startup.

Inherited Attributes

mRID	String	IdentifiedObject
name	String	IdentifiedObject
localName	String	IdentifiedObject
pathName	String	IdentifiedObject
aliasName	String	IdentifiedObject
description	String	IdentifiedObject

Native Roles

1	*GenUnitOpCostCurves*	0..n	GenUnitOpCostCurve	A generating unit may have one or more cost curves, depending upon fuel mixture and fuel cost.
1	*GenUnitOpSchedule*	0..1	GenUnitOpSchedule	A generating unit may have an operating schedule, indicating the planned operation of the unit.
1	*GrossToNetMWCurves*	0..n	GrossToNetMWCurve	A generating unit may have a gross MW to net MW curve, describing the losses and auxiliary power requirements of the unit.

0..n	*SubControlArea*	0..1	SubControlArea	A GeneratingUnit injects energy into a SubControlArea.
0..1	*Contains_SynchronousMachines*	1..n	SynchronousMachine	A synchronous machine may operate as a generator and as such becomes a member of a generating unit.

Roles Inherited From Equipment

0..n	*MemberOf_EquipmentContainer*	0..1	EquipmentContainer	Equipment

Roles Inherited From PowerSystemResource

0..n	*OperatedBy_Companies*	0..n	Company	PowerSystemResource
0..n	*PSRType*	0..1	PSRType	PowerSystemResource
1	*Contains_Measurements*	0..n	Measurement	PowerSystemResource
1	*OutageSchedule*	0..1	OutageSchedule	PowerSystemResource

Roles Inherited From IdentifiedObject

1..n	*ModelingAuthoritySet*	0..1	ModelingAuthoritySet	IdentifiedObject

6.10.11 GenUnitOpCostCurve

Relationship between unit operating cost in dollars/h (Y-axis) and unit output in MW (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.

Native Attributes

netGrossMWFlag	Boolean	Flag is set to YES when output is expressed in net MW.

Inherited Attributes

curveStyle	CurveStyle	Curve
xUnit	String	Curve
y1Unit	String	Curve
y2Unit	String	Curve
mRID	String	IdentifiedObject
name	String	IdentifiedObject
localName	String	IdentifiedObject
pathName	String	IdentifiedObject
aliasName	String	IdentifiedObject
description	String	IdentifiedObject

Native Roles

0..n	*GeneratingUnit*	1	GeneratingUnit	A generating unit may have one or more cost curves, depending upon fuel mixture and fuel cost.

Roles Inherited From Curve

1	*CurveScheduleDatas*	0..n	CurveData	Curve

Roles Inherited From IdentifiedObject

1..n	*ModelingAuthoritySet*	0..1	ModelingAuthority Set	IdentifiedObject

6.10.12 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 MW value: etc.). The Y2-axis represents the must run fixed MW value where required.

Inherited Attributes

timeStep	Seconds	RegularIntervalSchedule
endTime	AbsoluteDateTime	RegularIntervalSchedule
startTime	AbsoluteDateTime	BasicIntervalSchedule
value1Unit	String	BasicIntervalSchedule
value2Unit	String	BasicIntervalSchedule
mRID	String	IdentifiedObject
name	String	IdentifiedObject
localName	String	IdentifiedObject
pathName	String	IdentifiedObject
aliasName	String	IdentifiedObject
description	String	IdentifiedObject

Native Roles

0..1	*GeneratingUnit*	1	GeneratingUnit	A generating unit may have an operating schedule, indicating the planned operation of the unit.

Roles Inherited From RegularIntervalSchedule

1	*TimePoints*	1..*	RegularTimePoint	RegularIntervalSchedule

Roles Inherited From BasicIntervalSchedule

Roles Inherited From IdentifiedObject

1..n	*ModelingAuthoritySet*	0..1	ModelingAuthority Set	IdentifiedObject

6.10.13 GrossToNetMWCurve

Relationship between the generating unit's gross MW output on the X-axis (measured at the terminals of the machine(s)) and the generating unit's net MW 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.

Inherited Attributes

curveStyle	CurveStyle	Curve
xUnit	String	Curve
y1Unit	String	Curve
y2Unit	String	Curve
mRID	String	IdentifiedObject
name	String	IdentifiedObject
localName	String	IdentifiedObject
pathName	String	IdentifiedObject

aliasName	String		IdentifiedObject
description	String		IdentifiedObject

Native Roles

0..n	*GeneratingUnit*	1	GeneratingUnit	A generating unit may have a gross MW to net MW curve, describing the losses and auxiliary power requirements of the unit.

Roles Inherited From Curve

1	*CurveScheduleDatas*	0..n	CurveData	Curve

Roles Inherited From IdentifiedObject

1..n	*ModelingAuthoritySet*	0..1	ModelingAuthoritySet	IdentifiedObject

6.10.14 HeatInputCurve

Relationship between unit heat input in MBtu per hour for main fuel (Y1-axis) and supplemental fuel (Y2-axis) versus unit output in MW (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.

Native Attributes

auxPowerOffset	ActivePower	Power output - auxiliary power offset adjustment factor in MW.
auxPowerMult	PU	Power output - auxiliary power multiplier adjustment factor in per unit.
heatInputEff	PU	Heat input - efficiency multiplier adjustment factor in per unit.
heatInputOffset	HeatPerHour	Heat input - offset adjustment factor in MBtu/h.
netGrossMWFlag	Boolean	Flag is set to YES when output is expressed in net MW.

Inherited Attributes

curveStyle	CurveStyle	Curve
xUnit	String	Curve
y1Unit	String	Curve
y2Unit	String	Curve
mRID	String	IdentifiedObject
name	String	IdentifiedObject
localName	String	IdentifiedObject
pathName	String	IdentifiedObject
aliasName	String	IdentifiedObject
description	String	IdentifiedObject

Native Roles

0..1	*ThermalGeneratingUnit*	1	ThermalGeneratingUnit	A thermal generating unit may have a heat input curve.

Roles Inherited From Curve

1	*CurveScheduleDatas*	0..n	CurveData	Curve

Roles Inherited From IdentifiedObject

1..n	*ModelingAuthoritySet*	0..1	ModelingAuthoritySet	IdentifiedObject

6.10.15 HeatRateCurve

Relationship between unit heat rate in MBtu/h per MW (Y-axis) and unit output in MW (X-axis). The heat input is from all fuels.

Native Attributes

netGrossMWFlag	Boolean	Flag is set to YES when output is expressed in net MW.

Inherited Attributes

curveStyle	CurveStyle	Curve
xUnit	String	Curve
y1Unit	String	Curve
y2Unit	String	Curve
mRID	String	IdentifiedObject
name	String	IdentifiedObject
localName	String	IdentifiedObject
pathName	String	IdentifiedObject
aliasName	String	IdentifiedObject
description	String	IdentifiedObject

Native Roles

0..1	*ThermalGeneratingUnit*	1	ThermalGeneratingUnit	A thermal generating unit may have a heat rate curve.

Roles Inherited From Curve

1	*CurveScheduleDatas*	0..n	CurveData	Curve

Roles Inherited From IdentifiedObject

1..n	*ModelingAuthoritySet*	0..1	ModelingAuthoritySet	IdentifiedObject

6.10.16 HydroGeneratingEfficiencyCurve

Relationship between unit efficiency in percent and unit output in MW 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=%) (P=MW) (H=m) (Q=m^3/s) (K=constant)

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

Inherited Attributes

curveStyle	CurveStyle	Curve
xUnit	String	Curve
y1Unit	String	Curve
y2Unit	String	Curve
mRID	String	IdentifiedObject
name	String	IdentifiedObject
localName	String	IdentifiedObject
pathName	String	IdentifiedObject
aliasName	String	IdentifiedObject
description	String	IdentifiedObject

Native Roles

0..n	*HydroGeneratingUnit*	1	HydroGeneratingUnit	A hydro generating unit has an efficiency curve.

Roles Inherited From Curve

1	*CurveScheduleDatas*	0..n	CurveData	Curve

Roles Inherited From IdentifiedObject

1..n	*ModelingAuthoritySet*	0..1	ModelingAuthoritySet	IdentifiedObject

6.10.17 HydroGeneratingUnit

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

Native Attributes

hydroUnitWaterCost	Float	The equivalent cost of water that drives the hydro turbine, expressed as (dollars/h) per (m^3/s).

Inherited Attributes

controlDeadband	ActivePower	GeneratingUnit
controlPulseHigh	Seconds	GeneratingUnit
controlPulseLow	Seconds	GeneratingUnit
controlResponseRate	PowerROCPerSec	GeneratingUnit
efficiency	PU	GeneratingUnit
genControlMode	GeneratorControlMode	GeneratingUnit
genControlSource	GeneratorControlSource	GeneratingUnit
governorMPL	PU	GeneratingUnit
governorSCD	PerCent	GeneratingUnit
highControlLimit	ActivePower	GeneratingUnit
initialMW	ActivePower	GeneratingUnit
lowControlLimit	ActivePower	GeneratingUnit
maximumAllowableSpinningReserve	ActivePower	GeneratingUnit
maximumEconomicMW	ActivePower	GeneratingUnit
maximumOperatingMW	ActivePower	GeneratingUnit
minimumEconomicMW	ActivePower	GeneratingUnit
minimumOperatingMW	ActivePower	GeneratingUnit
modelDetail	Classification	GeneratingUnit
ratedGrossMaxMW	ActivePower	GeneratingUnit
ratedGrossMinMW	ActivePower	GeneratingUnit
ratedNetMaxMW	ActivePower	GeneratingUnit
startupTime	Seconds	GeneratingUnit
autoCntrlMarginMW	ActivePower	GeneratingUnit
allocSpinResMW	ActivePower	GeneratingUnit
baseMW	ActivePower	GeneratingUnit
dispReserveFlag	Boolean	GeneratingUnit
energyMinMW	HeatPerHour	GeneratingUnit
fastStartFlag	Boolean	GeneratingUnit
fuelPriority	Priority	GeneratingUnit
genOperatingMode	GeneratorOperatingMode	GeneratingUnit
longPF	ParticipationFactor	GeneratingUnit
lowerRampRate	PowerROCPerMin	GeneratingUnit
normalPF	ParticipationFactor	GeneratingUnit
penaltyFactor	PenaltyFactor	GeneratingUnit
raiseRampRate	PowerROCPerMin	GeneratingUnit
shortPF	ParticipationFactor	GeneratingUnit
spinReserveRamp	PowerROCPerMin	GeneratingUnit