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Entwurf

Schnittstelle für Anwendungsprogramme für Netzführungssysteme (EMS-API) – Teil 457: Dynamik-Profil (IEC 57/2229/CDV:2020); Englische Fassung prEN IEC 61970-457:2020

Energy Management System Application Program Interface (EMS-API) – Part 457: Dynamics profile (IEC 57/2229/CDV:2020); English version prEN IEC 61970-457:2020

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Gesamtumfang 443 Seiten

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Nationales Vorwort

Die Deutsche Fassung des europäischen Dokuments prEN IEC 61970-457:2020 "Schnittstelle für Anwendungsprogramme für Netzführungssysteme (EMS-API) – Teil 457: Dynamik-Profil" (Entwurf in der Umfrage) ist unverändert in diesen Norm-Entwurf übernommen worden.

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1 Scope

This international standard specifies a standard interface for exchanging dynamic model information needed to support the analysis of the steady state stability (small-signal stability) and/or transient stability of a power system or parts of it. The schema(s) for expressing the dynamic model information shall be derived directly from the CIM, more specifically from IEC 61970-302.

The scope of this standard includes only the dynamic model information that needs to be exchanged as part of a dynamic study, namely the type, description and parameters of each control equipment associated with a piece of power system equipment included in the steady state solution of a complete power system network model. Therefore, this profile is dependent upon other standard profiles for the equipment as specified in IEC 61970-452: CIM static transmission network model profiles, the topology, the steady state hypothesis and the steady-state solution (as specified in IEC 61970-456: Solved power system state profiles) of the power system, which bounds the scope of the exchange. The profile information described by this standard must be exchanged in conjunction with the IEC 61970-452 and the IEC 61970-456 profiles' information to support the data requirements of transient analysis tools. IEC 61970-456 provides a detailed description of how different profile standards can be combined to form various types of power system network model exchanges.

This standard supports the exchange of the following types of dynamic models:

- standard models: a simplified approach to exchange, where models are contained in predefined libraries of classes interconnected in a standard manner that represent dynamic behaviour of elements of the power system. The exchange only indicates the name of the model along with the attributes needed to describe its behaviour.
- proprietary user-defined models: an exchange that would provide users the ability to exchange the parameters of a model representing a vendor or user proprietary device where an explicit description of the model is not described in this standard. The connections between the proprietary models and standard models are the same as described for the standard models exchange. Recipient of the data exchange will need to contact the sender for the behavioural details of the model.

This standard builds on the IEC 61970-302, CIM for dynamics which defines the descriptions of the standard dynamic models, their function block diagrams, and how they are interconnected and associated with the static network model. This type of model information is assumed to be pre-stored by all software applications hence it is not necessary to be exchanged in real-time or as part of a dynamics model exchange.

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 61970-301:Ed7, *Energy management system application program interface (EMS-API) – Part 301: Common information model (CIM) base*

IEC 61970-302:2018, *Energy management system application program interface (EMS-API) – Part 302: Common information model (CIM) dynamics*

IEC 61970-452:Ed4, *Energy management system application program interface (EMS-API) – Part 452: CIM static transmission network model profiles*

IEC 61970-456:Ed3, *Energy management system application program interface (EMS-API) – Part 456: Solved power system state profiles*

3 Terms and definitions

No terms and definitions are listed in this document.

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ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at http://www.electropedia.org/
- ISO Online browsing platform: available at http://www.iso.org/obp

4 Profile specification

4.1 General

This document is applicable for both CIM16 and CIM17 base models, however if exchanged with CIM16 related standards some types of wind models cannot be exchanged due to lack of power electronics related classes in IEC 61970-452:2017 and IEC 61970-456:2018.

The profiles defined in this standard have the following URIs:

- http://iec.ch/TC57/CIM/Dynamics/1/0

The detailed version specification can be found in respective version clases under Clause 8.

4.2 Requirements and constraints

This clause defines requirements and constraints that shall be fulfiled by applications that conform to this document. The naming of the rules shall not be used for the machine processing and for the moment it is just a string. The naming convention of the constraints is as follows.

“{rule.Type}:{rule.Standard}:{rule.Profile}:{rule.Property}:{rule.Name}”

where

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

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

rule.Profile: the abbreviation of the profile, e.g. TP for Topology profile. It is left blank if the rule is cross profile. If set to “ALL” the constraint is applicable to all profiles.

rule.Property: the name of the class and attribute or association end, e.g. IdentifiedObject.name

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

Example: C:452:EQ:IdentifiedObject.name:StringLength.

- C:457:DY:GovSteamSGO.pmin:datatype

There is a mistake in the IEC 61970-302. The datatype of the attribute GovSteamSGO.pmin is Seconds. The value exchanged with this attribute shall be PU as it is for GovSteamSGO.pmax.

- C:457:DY:mwbase:equation

The vast majority of turbine-governor models have mwbase as a parameter. The parameter is specified explicitly in the turbine-governor models to support use of a different value by transient analysis tools, if needed. If this parameter is present it shall correspond to RotatingMachine.ratedPowerFactor * RotatingMachine.ratedS. In case mwbase is not provided or the value is set to 0 then the tools shall use RotatingMachine.ratedPowerFactor * RotatingMachine.ratedS.

- C:457:DY:IdentifiedObject.name:StringLength

The string is maximum 128 characters.

- C:457:DY:IdentifiedObject.description:StringLength

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The string is maximum 256 characters.

- C:457:DY:ExcitationSystemDynamics.SynchronousMachineDynamics:reference

ExcitationSystemDynamics.SynchronousMachineDynamics cannot point to an object of type SynchronousMachineSimplified.

- C:457:DY:TurbineGovernorDynamics:deltaomega

Some turbine governors diagrams have deltaomega as an input others just omega. In cases where deltaomega is an input the following relation with the speed is defined: deltaomega = (speed – 1) in pu.

- C:457:DY:Float:ValueType

Value type is IEEE 754 simple precision floating point.

- C:457:DY:RotatingMachineDynamics:ModelType

Anhang A specifies the usage of different attributes related to the model type.

5 Overview

This document describes an interface standard in which payloads are used to exchange dynamic model information of prime mover response, controls and other data needed to support the analysis of the steady state stability (small-signal stability) and/or transient stability of a power system.

The primary objective is to enable interoperability among different software vendors used by utilities and regional or national reliability entities to help ensure bulk power system reliability and security of supply through the exchange of the dynamic models needed to conduct small signal stability and transient stability analysis studies. These studies are also utilized in system development processes where new interconnections or other grid reinforcements are studied.

The IEC 61970-302 extends the CIM standard information model by adding new standard power system dynamic models to the static power system network model described by IEC 61970-301, IEC 61970-452 and IEC 61970-456. The scope of the standard models is defined to include the vast majority of models commonly implemented by vendors or commonly used by utilities today.

This standard defines a standard model exchange format (a profile) based on the extended CIM information model to accommodate the data requirements that shall be exchanged to completely specify a particular dynamic case, including association of these dynamic models to static load flow model elements for some specific point in time. The current practice is to use vendor proprietary formats and a converter to transform from one proprietary format to another depending on the software products sending and receiving the dynamic case files.

The modelling approach sought to minimize the amount of information that had to be actually exchanged by leveraging commonly understood information about the individual dynamic model subsystems, such as the specific model behaviour, equations, interconnection patterns, input/output signals, and initialization procedures that can be pre-stored and thus do not need to be exchanged. The only information required in the exchange is the identity of the specific standard or user-defined (proprietary) models, an association to a specific equipment instance in the static network model, the parameter values that are dependent on the behavior of the physical equipment, the electromechanical and electronic controls, and the small signal behavioural aspects of the equipment.

In some cases the purpose of the exchange is to include all data necessary to perform a small signal stability analysis of a specific scenario. In this case, the entire electrical model as defined in IEC 61970-452 and the data describing the solved state as defined in IEC-61970-456 will be required. The solved state will be based on the study conditions such as equipment outages and generator output levels.

How to read this document:

- The ‘Use cases’ clause gives examples of business problems that this standard is intended to address.

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- The ‘Architecture’ clause summarizes how the models described in this document work with parts described in other IEC 61970 series standards.
- The ‘Detailed profile specification’ clause defines the kinds of datasets controlled by this standard.
- Anhang A provides implementation clarifications related to the models inherited from RotatingMachineDynamics class.
- Anhang B provides some examples when using IEC 61970-552 serialisation.

6 Use cases

6.1 General

The Use case clause presents some of the business problems that were considered in the design of this standard and discusses how the standard is expected to provide value to the industry.

Dynamics models exchange supplies data for one of the most complex analyses of a power system. The requirements of the data exchanges are directly related to the level of detail of the power system modelling applied in a given area. This standard (dynamics profile) supports the exchange of dynamic behaviour models used by software applications which perform analysis of the steady state stability (small-signal stability) and/or transient stability of a power system as defined by IEEE / CIGRE Standard Terms and Definitions for Power System Stability Analysis.

Dynamics models are typically described using both graphics and text. Therefore, there is a high level of complexity and room for interpretation, which this standard is designed to minimize.

6.2 Dynamic assessment studies

Small signal stability and transient stability analysis studies are used by utilities and regional or national reliability entities to help ensure bulk power system reliability and security of supply. These studies are utilized in the scope of system development processes where new interconnections or other grid reinforcements are studied. Sharing of dynamics behaviour information is not just useful, but crucial, for grid operations entities (utilities, regional reliability organizations, transmission system operators) that need to do system-wide studies utilizing different applications. These studies are generally over very large portions of the network, if not the entire interconnection, and each entity studying the dynamic stability of its system needs to acquire dynamics data from each of its neighboring systems.

The standard models library (see IEC 61970-302) is based on numerous common models (some IEEE standard, some IEC standard and some models widely used by the utilities or organizations), which have been defined for various components of the power system. Since dynamic stability studies performed at both utilities and reliability entities require model definitions of each component, exchange of dynamic models in a standardized format benefits overall grid reliability and grid planning by eliminating manual entry errors and facilitating timely data sharing.

Dynamic assessment studies require a full steady state electrical equipment model including topology and a solved state. The source of this data may vary.

- In the case of long term studies, planning models are typically used. These models reflect the equipment in place at the time of the study. The steady state hypothesis, topology, and solution state reflect normal or adverse conditions based on the purpose of the study.
- Current conditions are usually studied by using an electrical model from a state estimator along with a topology based on current switch positions and a solved state reflecting current generation and load.
- For historic events which warrant small signal analysis or reproduction of the behaviour of generators during the event, previous state estimator models and solutions are typically used in providing equipment, topology and state of the study period.
- New generation or area-to-area interconnections are mostly studied using small signal stability studies. In these cases planning models are often used.

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7 Architecture

7.1 General

The main architectural feature of this standard is the reduction in complexity of how the different models connect to one another and to the electrical equipment they are related to. In order to study the dynamic behaviour of a generator, a model describing the transient behaviour of the generator, prime mover, governor, exciter, power system stabilizer, voltage regulator, and any other equipment must be defined. In addition, similar detail of all generators in the region shall be modelled in the same detail.

All of the models covered in the IEC 61970-302 document are included in this profile. The document lists all concrete and abstract classes used by the dynamics profile. However only concrete classes are present in the exchange of dynamics model data as they include all of the data inherited from the abstract classes. This document augments the IEC 61970-302 document with examples of how the dynamics data is organized and dependant on other profiles. Some examples of payload are included in this standard.

Details of the descriptions of the individual models found in the IEC 61970-302 document are further amended in this document in order to describe the usage of the models. The IEC 61970-302 lists typical values to assist understanding of the magnitude of the quantities used for each of the attributes. These values do not replace or reflect any real data, hence shall not be interpreted as default values and shall not be used in real data exchange as a substitute of unknown values for the parameters. The untended use of typical values is to indicate a potential set of parameters that can be used during development and testing of applications supporting the standard models defined in the standard. The attributes used in the payload of any CIM transfer shall normally reflect commissioning data or results from subsequent testing of the machines being studied in order to provide reliable results. This standard specifies the required attributes for each class in the profile as well as the directions of the associations. Therefore the profile is designed to augment the equipment model with additional transient model data. The associations between the classes in the equipment model and the classes covered under this profile shall be defined within the instances of the classes included in this profile. Persistence in identifiers shall be maintained for these types of exchanges.

Figure 1 gives an example of linkage between dynamics profile and a SynchronousMachine defined in equipment profile (IEC 61970-452)

```
<cim:SynchronousMachineTimeConstantReactance rdf:ID="_99d08548-89cf-11e3-8aa9-2c44fd6790f2">
 <cim:IdentifiedObject.name>GENROU</cim:IdentifiedObject.name>
 <cim:DynamicsFunctionBlock.enabled>true</cim:DynamicsFunctionBlock.enabled>
...
<cim:SynchronousMachineDynamics.SynchronousMachine rdf:resource="#_caca0471-89ce-11e3-8aa9-
2c44fd6790f2" />
...
</cim:SynchronousMachineTimeConstantReactance>
```

Figure 1 – SynchronousMachineDynamics association

7.2 Profile architecture

Every generator in the equipment model shall have all of its dynamic components modelled. Some of the dynamic components feed signals to other components. Some generators share controls, which shall be modelled. Many of the component models are standardized throughout the industry. The standard component models are generally connected together in a standard way based on the type of generator. Several types of these standard model interconnections are outlined in IEC 61970-302. The diagram shown in Figure 2 below is one of those and specifies how to trace signals through the different standard component models of a synchronous generator.

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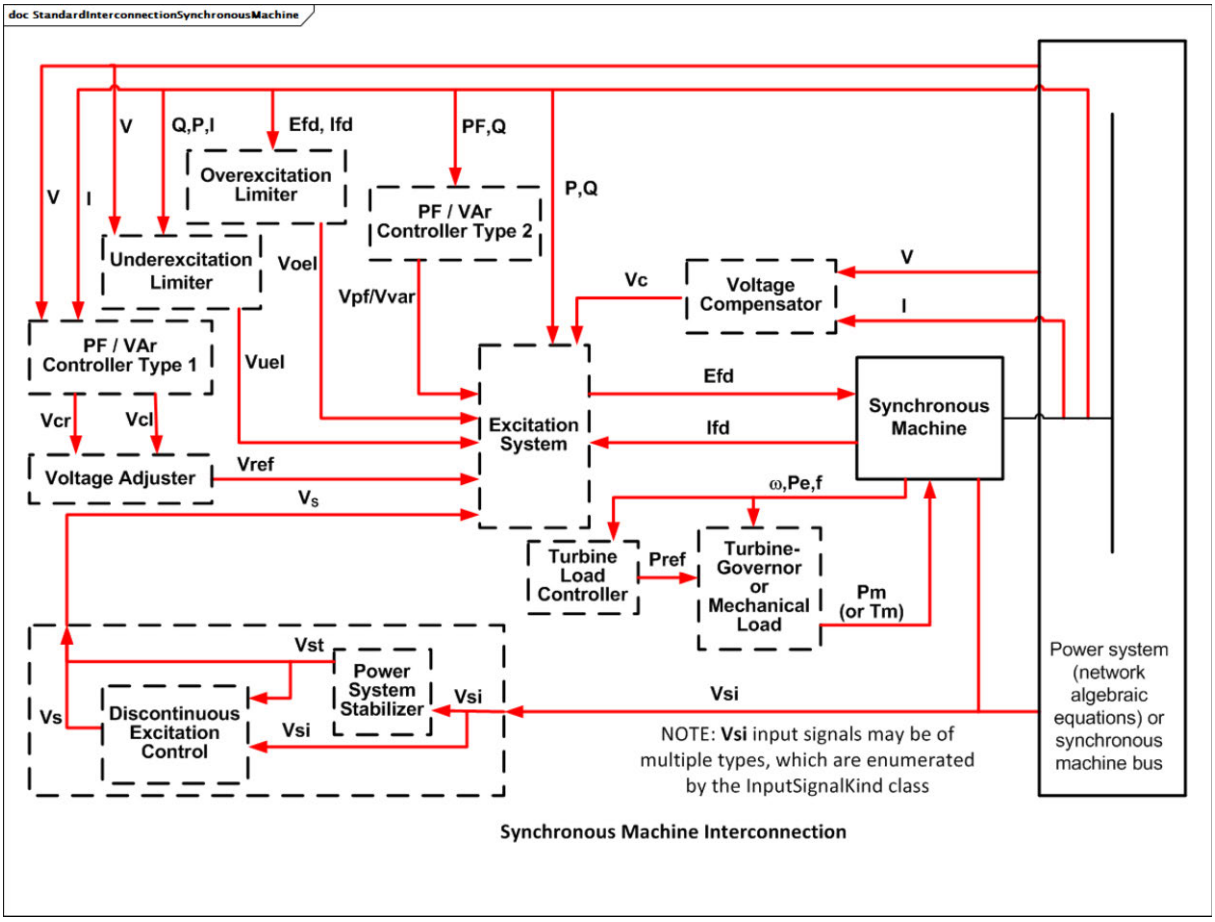


Figure 2 – Interconnection diagram for a synchronous machine

There are CIM classes representing each type of component and the associations between them reflect the possible combinations of components that can be used to represent a specific type of interconnection. For example, the synchronous machine, whose interconnection diagram is shown in Figure 3, is represented by the CIM classes and associations shown in Figure 2. The cardinality of the associations reflects how many of which components can be used in describing a given synchronous machine.

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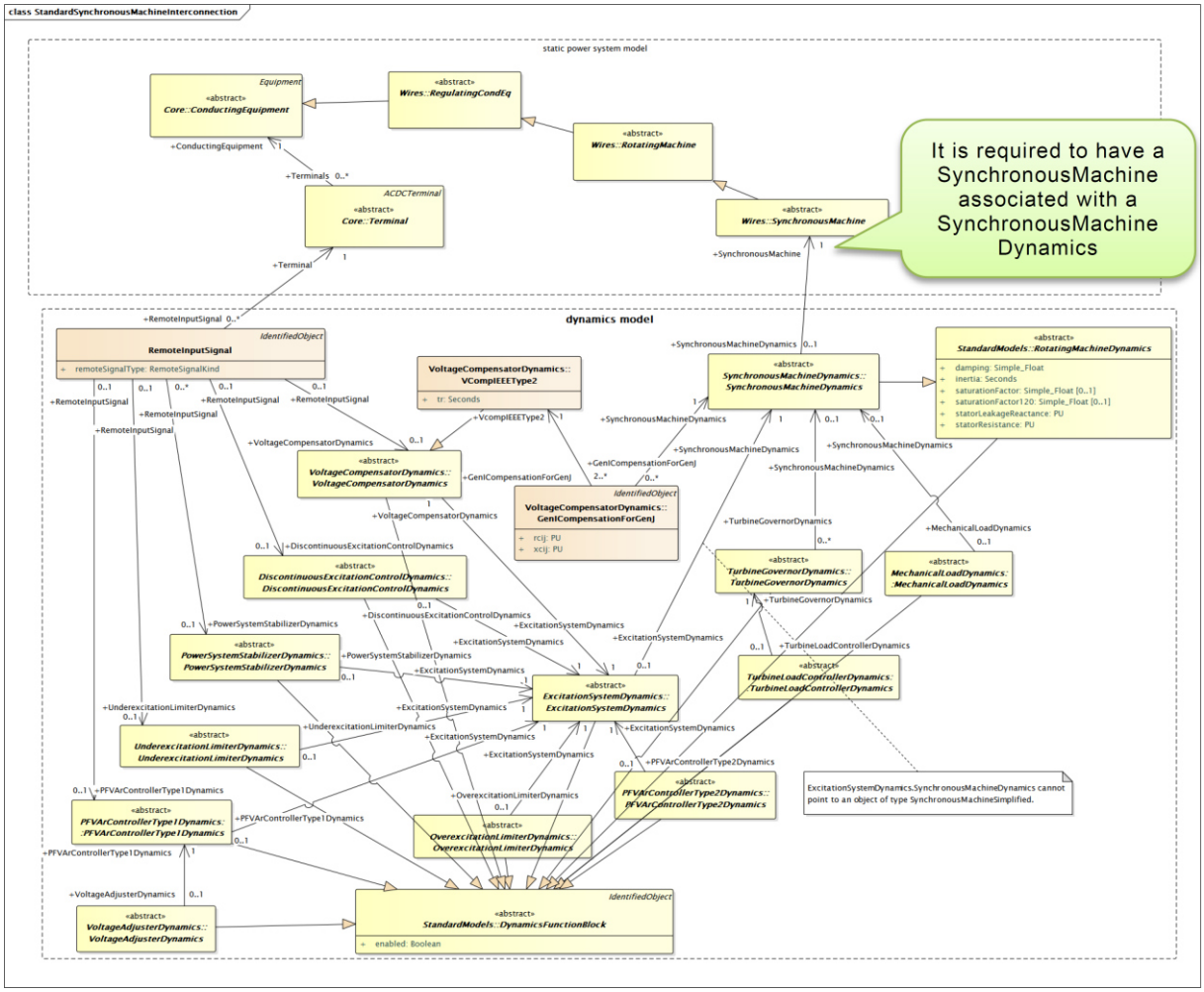


Figure 3 – Standard connections for a synchronous machine

Specifying the signal connectivity between models is not necessary for the standard models. A dynamic model for a specific generator shall include all of the components necessary to simulate its response to the electrical system. For example, if a generator does not have specific components installed such as limiters on the excitation controllers then the UnderexcitationLimiterDynamics and OverexcitationLimiterDynamics instances shall be excluded from the payload. The output signals from these components are not passed to the exciter component. In some cases such as with a voltage adjuster, the input signal shall be passed through to the excitation system.

The exchange of dynamics data for use in simulations depends on data from other exchanges as defined in other IEC documentation and shown in Figure 4 profile relationships below.

- Static network model profiles defined in the IEC 61970-452 include the Equipment Model profile, which contains static modelling information describing power system physical elements and their electrical connections. Associations from Dynamics Models profile classes to equipment profile classes allow dynamic models to be associated with the specific equipment they represent. For example, there is an association from SynchronousMachineDynamics to SynchronousMachine which ties SynchronousMachineDynamics, along with all of its associated components, to the equipment model. This is illustrated in Figure 3.
- The steady-state solution profiles (Topology and State Variables) defined in the IEC 61970-456 provide the topological connectivity of the model and the solved state of the model, which is used as a starting condition of the dynamics simulation. The steady-state solution information is accessible to the dynamics simulation because the classes of those profiles also refer to Equipment Model profile classes.

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- The Schematic Layout profile defined in the IEC 61970-453 describes the elements of schematic or geographic displays. Exchange of graphics data is not required to support dynamic simulation studies, but may be helpful in diagnosing or analyzing problem in the study.

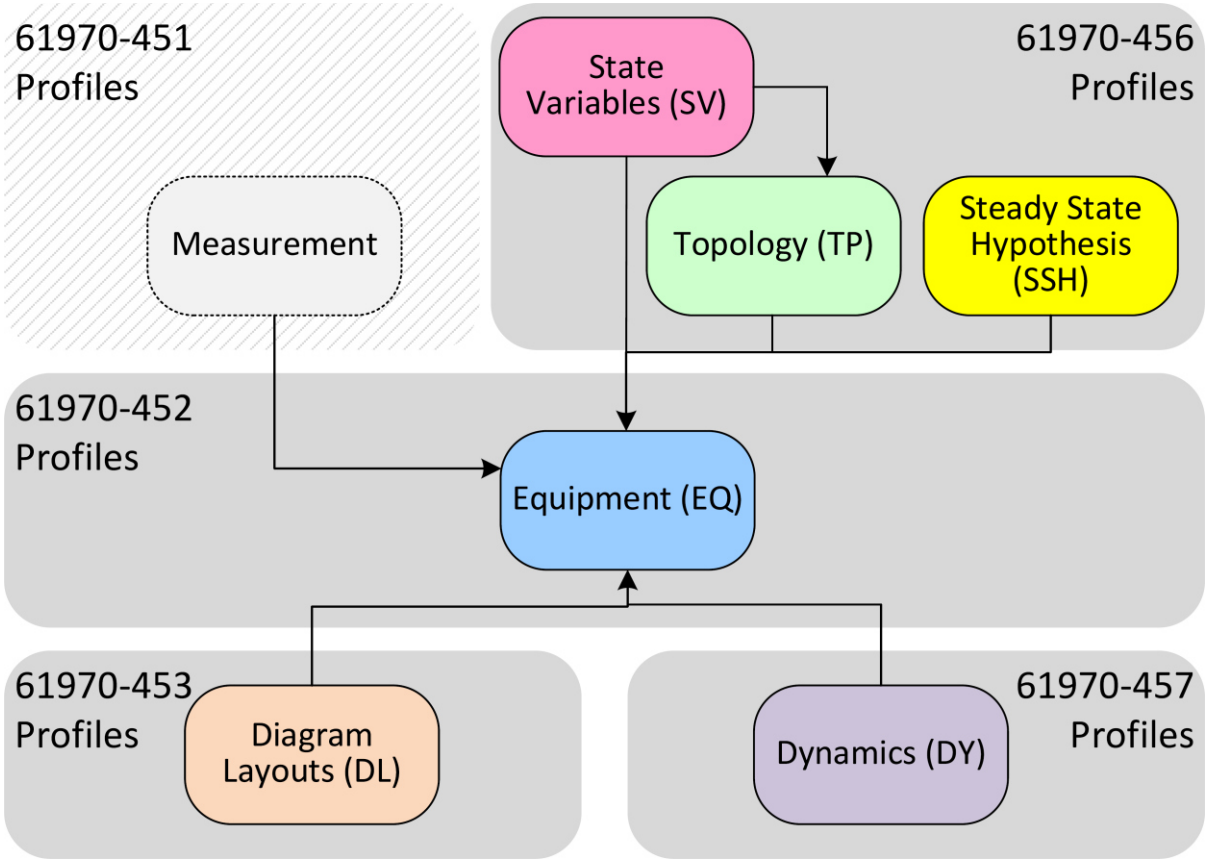


Figure 4 – Profile relationships

8 Detailed profile specification

8.1 General

This chapter contains the detailed specification for the dynamics profile.

8.2 Package DynamicsProfile

8.2.1 General

This is the IEC 61970-457 profile.

8.2.2 (abstract) DynamicsProfileVersion root class

Version details.

Table 1 shows all attributes of DynamicsProfileVersion.

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Table 1 – Attributes of DynamicsProfile::DynamicsProfileVersion

name	mult	type	description
baseUML	1..1	String	(const=iec61970cim17v38_iec61968cim13v12_iec62325cim03v17a) Base UML provided by CIM model manager.
baseURI	1..1	String	(const=http://iec.ch/TC57/CIM/Dynamics/1/0) Profile URI used in the Model Exchange header and defined in IEC standards. It uniquely identifies the Profile and its version. The last two elements in the URI (e.g. http://iec.ch/TC57/61970-452/CoreEquipment/yy/zzz) indicate major and minor versions where: - yy - indicates a major version; - zzz - indicates a minor version.
date	1..1	Date	(const=2020-05-14) Profile creation date. The form is YYYY-MM-DD. For example, for 5 January 2009 it is 2009-01-05.
differenceModelURI	1..1	String	(const=http://iec.ch/TC57/61970-552/DifferenceModel/1#) Difference model URI defined by IEC 61970-552.
profileUML	1..1	String	(const=FDIS09-iec61970-600-CGMES-v3_0_0) UML which contains the profile.
modelDescriptionURI	1..1	String	(const=http://iec.ch/TC57/61970-552/ModelDescription/1#) Model Description URI defined by IEC 61970-552.
namespaceRDF	1..1	String	(const=http://www.w3.org/1999/02/22-rdf-syntax-ns#) RDF namespace.
namespaceUML	1..1	String	(const=http://iec.ch/TC57/CIM100#) CIM UML namespace.
shortName	1..1	String	(const=DY) The short name of the profile used in profile documentation.

8.2.3 Package Base

8.2.3.1 General

Content of the base CIM published as IEC 61970-301.

8.2.3.2 Package Domain

8.2.3.2.1 General

The domain package defines primitive datatypes that are used by classes in other packages. Stereotypes are used to describe the datatypes. The following stereotypes are defined:

<<enumeration>> A list of permissible constant values.

<<Primitive>> The most basic data types used to compose all other data types.

<<CIMDatatype>> A datatype that contains a value attribute, an optional unit of measure and a unit multiplier. The unit and multiplier may be specified as a static variable initialized to the allowed value.

<<Compound>> A composite of Primitive, enumeration, CIMDatatype or other Compound classes, as long as the Compound classes do not recurse.

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

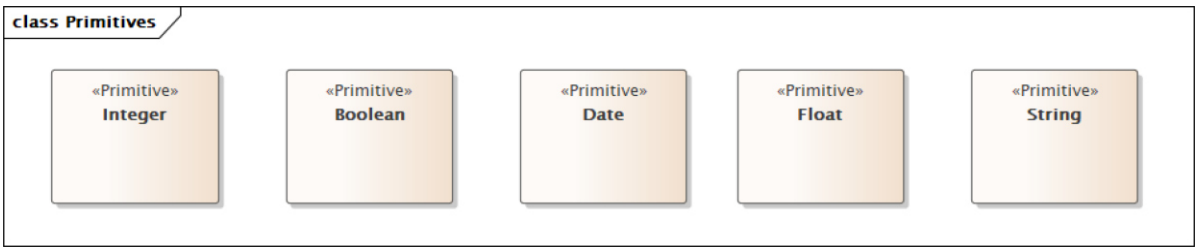


Figure 5 – Class diagram Domain::Primitives

Figure 5: This diagram lists the primitives defined in the CIM and used in this standard.

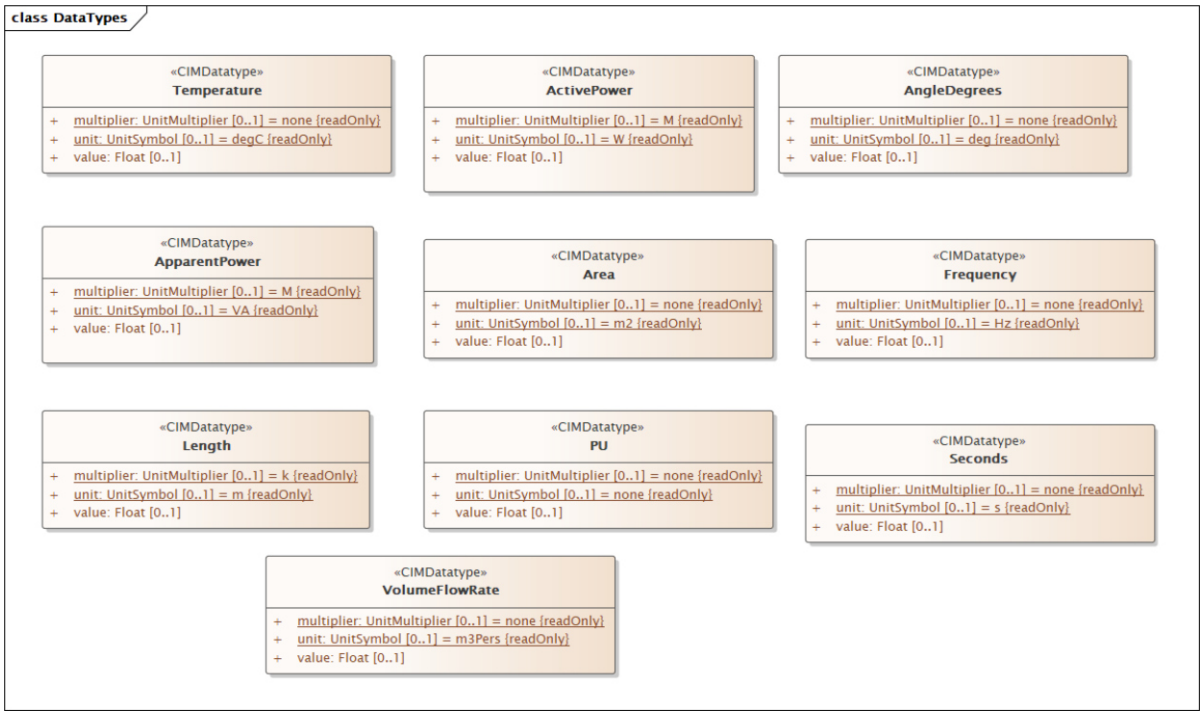


Figure 6 – Class diagram Domain::DataTypes

Figure 6: This diagram illustrates the data types supported by the CIM and used in this standard.

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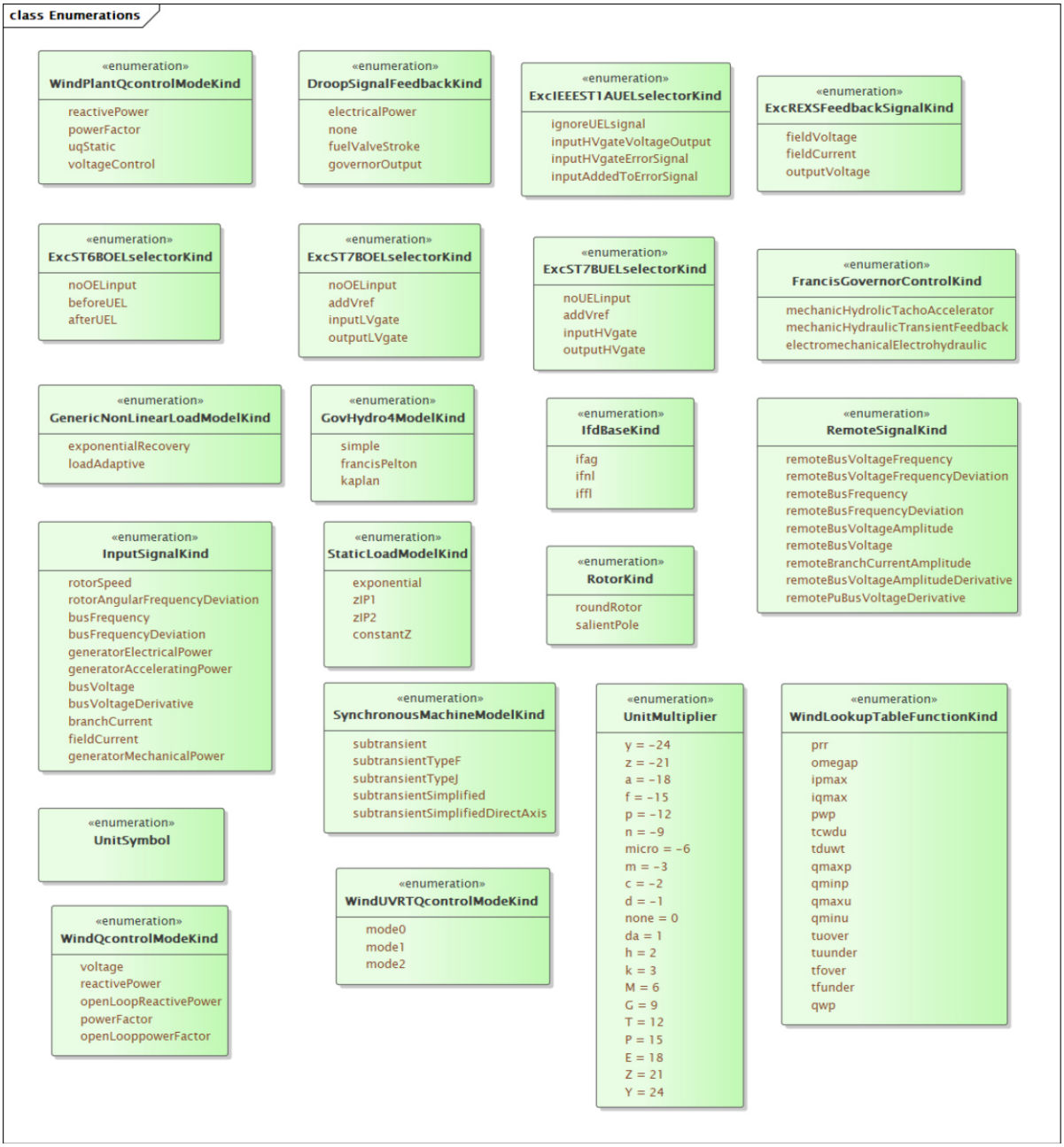


Figure 7 – Class diagram Domain::Enumerations

Figure 7: This diagram provides information on the enumerations defined in the CIM and used in this standard.

8.2.3.2.2 ActivePower datatype

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

Table 2 shows all attributes of ActivePower.

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Table 2 – Attributes of Domain::ActivePower

name	mult	type	description
value	0..1	Float	
multiplier	0..1	UnitMultiplier	(const=M)
unit	0..1	UnitSymbol	(const=W)

8.2.3.2.3 AngleDegrees datatype

Measurement of angle in degrees.

Table 3 shows all attributes of AngleDegrees.

Table 3 – Attributes of Domain::AngleDegrees

name	mult	type	description
value	0..1	Float	
unit	0..1	UnitSymbol	(const=deg)
multiplier	0..1	UnitMultiplier	(const=none)

8.2.3.2.4 ApparentPower datatype

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

Table 4 shows all attributes of ApparentPower.

Table 4 – Attributes of Domain::ApparentPower

name	mult	type	description
value	0..1	Float	
multiplier	0..1	UnitMultiplier	(const=M)
unit	0..1	UnitSymbol	(const=VA)

8.2.3.2.5 Area datatype

Area.

Table 5 shows all attributes of Area.

Table 5 – Attributes of Domain::Area

name	mult	type	description
value	0..1	Float	
unit	0..1	UnitSymbol	(const=m2)
multiplier	0..1	UnitMultiplier	(const=none)

8.2.3.2.6 Frequency datatype

Cycles per second.

Table 6 shows all attributes of Frequency.

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Table 6 – Attributes of Domain::Frequency

name	mult	type	description
value	0..1	Float	
unit	0..1	UnitSymbol	(const=Hz)
multiplier	0..1	UnitMultiplier	(const=none)

8.2.3.2.7 Length datatype

Unit of length. It shall be a positive value or zero.

Table 7 shows all attributes of Length.

Table 7 – Attributes of Domain::Length

name	mult	type	description
value	0..1	Float	
unit	0..1	UnitSymbol	(const=m)
multiplier	0..1	UnitMultiplier	(const=k)

8.2.3.2.8 PU datatype

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

Table 8 shows all attributes of PU.

Table 8 – Attributes of Domain::PU

name	mult	type	description
value	0..1	Float	
unit	0..1	UnitSymbol	(const=none)
multiplier	0..1	UnitMultiplier	(const=none)

8.2.3.2.9 Seconds datatype

Time, in seconds.

Table 9 shows all attributes of Seconds.

Table 9 – Attributes of Domain::Seconds

name	mult	type	description
value	0..1	Float	Time, in seconds
unit	0..1	UnitSymbol	(const=s)
multiplier	0..1	UnitMultiplier	(const=none)

8.2.3.2.10 Temperature datatype

Value of temperature in degrees Celsius.

Table 10 shows all attributes of Temperature.

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Table 10 – Attributes of Domain::Temperature

name	mult	type	description
multiplier	0..1	UnitMultiplier	(const=none)
unit	0..1	UnitSymbol	(const=degC)
value	0..1	Float	

8.2.3.2.11 VolumeFlowRate datatype

Volume per time.

Table 11 shows all attributes of VolumeFlowRate.

Table 11 – Attributes of Domain::VolumeFlowRate

name	mult	type	description
multiplier	0..1	UnitMultiplier	(const=none)
unit	0..1	UnitSymbol	(const=m3Pers)
value	0..1	Float	

8.2.3.2.12 Boolean primitive

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

8.2.3.2.13 Float primitive

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

8.2.3.2.14 Date primitive

Date as "yyyy-mm-dd", which conforms with ISO 8601. UTC time zone is specified as "yyyy-mm-ddZ". A local timezone relative UTC is specified as "yyyy-mm-dd(+/-)hh:mm".

8.2.3.2.15 Integer primitive

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

8.2.3.2.16 String primitive

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

8.2.3.2.17 DroopSignalFeedbackKind enumeration

Governor droop signal feedback source.

Table 12 shows all literals of DroopSignalFeedbackKind.

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Table 12 – Literals of Domain::DroopSignalFeedbackKind

literal	value	description
electricalPower		Electrical power feedback (connection indicated as 1 in the block diagrams of models, e.g. GovCT1, GovCT2).
none		No droop signal feedback, is isochronous governor.
fuelValveStroke		Fuel valve stroke feedback (true stroke) (connection indicated as 2 in the block diagrams of model, e.g. GovCT1, GovCT2).
governorOutput		Governor output feedback (requested stroke) (connection indicated as 3 in the block diagrams of models, e.g. GovCT1, GovCT2).

8.2.3.2.18 ExcIEEEST1AUELselectorKind enumeration

Types of connections for the UEL input used in ExcIEEEST1A.

Table 13 shows all literals of ExcIEEEST1AUELselectorKind.

Table 13 – Literals of Domain::ExcIEEEST1AUELselectorKind

literal	value	description
ignoreUELsignal		Ignore UEL signal.
inputHVgateVoltageOutput		UEL input HV gate with voltage regulator output.
inputHVgateErrorSignal		UEL input HV gate with error signal.
inputAddedToErrorSignal		UEL input added to error signal.

8.2.3.2.19 ExcREXSFeedbackSignalKind enumeration

Types of rate feedback signals.

Table 14 shows all literals of ExcREXSFeedbackSignalKind.

Table 14 – Literals of Domain::ExcREXSFeedbackSignalKind

literal	value	description
fieldVoltage		The voltage regulator output voltage is used. It is the same as exciter field voltage.
fieldCurrent		The exciter field current is used.
outputVoltage		The output voltage of the exciter is used.

8.2.3.2.20 ExcST6BOELselectorKind enumeration

Types of connections for the OEL input used for static excitation systems type 6B.

Table 15 shows all literals of ExcST6BOELselectorKind.

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Table 15 – Literals of Domain::ExcST6BOELselectorKind

literal	value	description
noOELinput		No OEL input is used. Corresponds to OELin not = 1 and not = 2 on the ExcST6B diagram. Original ExcST6B model would have called this OELin = 0.
beforeUEL		The connection is before UEL. Corresponds to OELin = 1 on the ExcST6B diagram.
afterUEL		The connection is after UEL. Corresponds to OELin = 2 on the ExcST6B diagram.

8.2.3.2.21 ExcST7BOELselectorKind enumeration

Types of connections for the OEL input used for static excitation systems type 7B.

Table 16 shows all literals of ExcST7BOELselectorKind.

Table 16 – Literals of Domain::ExcST7BOELselectorKind

literal	value	description
noOELinput		No OEL input is used. Corresponds to OELin not = 1 and not = 2 and not = 3 on the ExcST7B diagram. Original ExcST7B model would have called this OELin = 0.
addVref		The signal is added to Vref. Corresponds to OELin = 1 on the ExcST7B diagram.
inputLVgate		The signal is connected into the input LVGate. Corresponds to OELin = 2 on the ExcST7B diagram.
outputLVgate		The signal is connected into the output LVGate. Corresponds to OELin = 3 on the ExcST7B diagram.

8.2.3.2.22 ExcST7BUELselectorKind enumeration

Types of connections for the UEL input used for static excitation systems type 7B.

Table 17 shows all literals of ExcST7BUELselectorKind.

Table 17 – Literals of Domain::ExcST7BUELselectorKind

literal	value	description
noUELinput		No UEL input is used. Corresponds to UELin not = 1 and not = 2 and not = 3 on the ExcST7B diagram. Original ExcST7B model would have called this UELin = 0.
addVref		The signal is added to Vref. Corresponds to UELin = 1 on the ExcST7B diagram.
inputHVgate		The signal is connected into the input HVGate. Corresponds to UELin = 2 on the ExcST7B diagram.
outputHVgate		The signal is connected into the output HVGate. Corresponds to UELin = 3 on the ExcST7B diagram.

8.2.3.2.23 FrancisGovernorControlKind enumeration

Governor control flag for Francis hydro model.

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Table 18 shows all literals of FrancisGovernorControlKind.

Table 18 – Literals of Domain::FrancisGovernorControlKind

literal	value	description
mechanicHydrolicTachoAccelerator		Mechanic-hydraulic regulator with tacho-accelerometer (Cflag = 1).
mechanicHydraulicTransientFeedback		Mechanic-hydraulic regulator with transient feedback (Cflag=2).
electromechanicalElectrohydraulic		Electromechanical and electrohydraulic regulator (Cflag=3).

8.2.3.2.24 GenericNonLinearLoadModelKind enumeration

Type of generic non-linear load model.

Table 19 shows all literals of GenericNonLinearLoadModelKind.

Table 19 – Literals of Domain::GenericNonLinearLoadModelKind

literal	value	description
exponentialRecovery		Exponential recovery model.
loadAdaptive		Load adaptive model.

8.2.3.2.25 GovHydro4ModelKind enumeration

Possible types of GovHydro4 models.

Table 20 shows all literals of GovHydro4ModelKind.

Table 20 – Literals of Domain::GovHydro4ModelKind

literal	value	description
simple		Simple model.
francisPelton		Francis or Pelton model.
kaplan		Kaplan model.

8.2.3.2.26 IfdBaseKind enumeration

Excitation base system mode.

Table 21 shows all literals of IfdBaseKind.

Table 21 – Literals of Domain::IfdBaseKind

literal	value	description
ifag		Air gap line mode.
ifnl		No load system with saturation mode.
iffl		Full load system mode.

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8.2.3.2.27 InputSignalKind enumeration

Types of input signals. In dynamics modelling, commonly represented by the j parameter.

Table 22 shows all literals of InputSignalKind.

Table 22 – Literals of Domain::InputSignalKind

literal	value	description
rotorSpeed		Input signal is rotor or shaft speed (angular frequency).
rotorAngularFrequencyDeviation		Input signal is rotor or shaft angular frequency deviation.
busFrequency		Input signal is bus voltage frequency. This could be a terminal frequency or remote frequency.
busFrequencyDeviation		Input signal is deviation of bus voltage frequency. This could be a terminal frequency deviation or remote frequency deviation.
generatorElectricalPower		Input signal is generator electrical power on rated S.
generatorAcceleratingPower		Input signal is generator accelerating power.
busVoltage		Input signal is bus voltage. This could be a terminal voltage or remote voltage.
busVoltageDerivative		Input signal is derivative of bus voltage. This could be a terminal voltage derivative or remote voltage derivative.
branchCurrent		Input signal is amplitude of remote branch current.
fieldCurrent		Input signal is generator field current.
generatorMechanicalPower		Input signal is generator mechanical power.

8.2.3.2.28 RemoteSignalKind enumeration

Type of input signal coming from remote bus.

Table 23 shows all literals of RemoteSignalKind.

Table 23 – Literals of Domain::RemoteSignalKind

literal	value	description
remoteBusVoltageFrequency		Input is voltage frequency from remote terminal bus.
remoteBusVoltageFrequencyDeviation		Input is voltage frequency deviation from remote terminal bus.
remoteBusFrequency		Input is frequency from remote terminal bus.
remoteBusFrequencyDeviation		Input is frequency deviation from remote terminal bus.
remoteBusVoltageAmplitude		Input is voltage amplitude from remote terminal bus.
remoteBusVoltage		Input is voltage from remote terminal bus.
remoteBranchCurrentAmplitude		Input is branch current amplitude from remote terminal bus.
remoteBusVoltageAmplitudeDerivative		Input is branch current amplitude derivative from remote terminal bus.
remotePuBusVoltageDerivative		Input is PU voltage derivative from remote terminal bus.

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8.2.3.2.29 RotorKind enumeration

Type of rotor on physical machine.

Table 24 shows all literals of RotorKind.

Table 24 – Literals of Domain::RotorKind

literal	value	description
roundRotor		Round rotor type of synchronous machine.
salientPole		Salient pole type of synchronous machine.

8.2.3.2.30 StaticLoadModelKind enumeration

Type of static load model.

Table 25 shows all literals of StaticLoadModelKind.

Table 25 – Literals of Domain::StaticLoadModelKind

literal	value	description
exponential		This model is an exponential representation of the load. Exponential equations for active and reactive power are used and the following attributes are required: kp1, kp2, kp3, kpf, ep1, ep2, ep3 kq1, kq2, kq3, kqf, eq1, eq2, eq3.
zIP1		This model integrates the frequency-dependent load (primarily motors). ZIP1 equations for active and reactive power are used and the following attributes are required: kp1, kp2, kp3, kpf kq1, kq2, kq3, kqf.
zIP2		This model separates the frequency-dependent load (primarily motors) from other load. ZIP2 equations for active and reactive power are used and the following attributes are required: kp1, kp2, kp3, kq4, kpf kq1, kq2, kq3, kq4, kqf.
constantZ		The load is represented as a constant impedance. ConstantZ equations are used for active and reactive power and no attributes are required.

8.2.3.2.31 SynchronousMachineModelKind enumeration

Type of synchronous machine model used in dynamic simulation applications.

Table 26 shows all literals of SynchronousMachineModelKind.

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Table 26 – Literals of Domain::SynchronousMachineModelKind

literal	value	description
subtransient		Subtransient synchronous machine model.
subtransientTypeF		WECC type F variant of subtransient synchronous machine model.
subtransientTypeJ		WECC type J variant of subtransient synchronous machine model.
subtransientSimplified		Simplified version of subtransient synchronous machine model where magnetic coupling between the direct- and quadrature- axes is ignored.
subtransientSimplifiedDirectAxis		Simplified version of a subtransient synchronous machine model with no damper circuit on the direct-axis.

8.2.3.2.32 UnitMultiplier enumeration

The unit multipliers defined for the CIM. When applied to unit symbols, the unit symbol is treated as a derived unit. Regardless of the contents of the unit symbol text, the unit symbol shall be treated as if it were a single-character unit symbol. Unit symbols should not contain multipliers, and it should be left to the multiplier to define the multiple for an entire data type.

For example, if a unit symbol is "m2Pers" and the multiplier is "k", then the value is k(m**2/s), and the multiplier applies to the entire final value, not to any individual part of the value. This can be conceptualized by substituting a derived unit symbol for the unit type. If one imagines that the symbol "Þ" represents the derived unit "m2Pers", then applying the multiplier "k" can be conceptualized simply as "kÞ".

For example, the SI unit for mass is "kg" and not "g". If the unit symbol is defined as "kg", then the multiplier is applied to "kg" as a whole and does not replace the "k" in front of the "g". In this case, the multiplier of "m" would be used with the unit symbol of "kg" to represent one gram. As a text string, this violates the instructions in IEC 80000-1. However, because the unit symbol in CIM is treated as a derived unit instead of as an SI unit, it makes more sense to conceptualize the "kg" as if it were replaced by one of the proposed replacements for the SI mass symbol. If one imagines that the "kg" were replaced by a symbol "Þ", then it is easier to conceptualize the multiplier "m" as creating the proper unit "mÞ", and not the forbidden unit "mkg".

Table 27 shows all literals of UnitMultiplier.

Table 27 – Literals of Domain::UnitMultiplier

literal	value	description
y	-24	Yocto 10**-24.
z	-21	Zepto 10**-21.
a	-18	Atto 10**-18.
f	-15	Femto 10**-15.
p	-12	Pico 10**-12.
n	-9	Nano 10**-9.
micro	-6	Micro 10**-6.
m	-3	Milli 10**-3.
c	-2	Centi 10**-2.
d	-1	Deci 10**-1.
none	0	No multiplier or equivalently multiply by 1.

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literal	value	description
da	1	Deca 10**1.
h	2	Hecto 10**2.
k	3	Kilo 10**3.
M	6	Mega 10**6.
G	9	Giga 10**9.
T	12	Tera 10**12.
P	15	Peta 10**15.
E	18	Exa 10**18.
Z	21	Zetta 10**21.
Y	24	Yotta 10**24.

8.2.3.2.33 UnitSymbol enumeration

The derived units defined for usage in the CIM. In some cases, the derived unit is equal to an SI unit. Whenever possible, the standard derived symbol is used instead of the formula for the derived unit. For example, the unit symbol Farad is defined as "F" instead of "CPerV". In cases where a standard symbol does not exist for a derived unit, the formula for the unit is used as the unit symbol. For example, density does not have a standard symbol and so it is represented as "kgPerm3". With the exception of the "kg", which is an SI unit, the unit symbols do not contain multipliers and therefore represent the base derived unit to which a multiplier can be applied as a whole.

Every unit symbol is treated as an unparseable text as if it were a single-letter symbol. The meaning of each unit symbol is defined by the accompanying descriptive text and not by the text contents of the unit symbol.

To allow the widest possible range of serializations without requiring special character handling, several substitutions are made which deviate from the format described in IEC 80000-1. The division symbol "/" is replaced by the letters "Per". Exponents are written in plain text after the unit as "m3" instead of being formatted as "m" with a superscript of 3 or introducing a symbol as in "m^3". The degree symbol "°" is replaced with the letters "deg". Any clarification of the meaning for a substitution is included in the description for the unit symbol.

Non-SI units are included in list of unit symbols to allow sources of data to be correctly labelled with their non-SI units (for example, a GPS sensor that is reporting numbers that represent feet instead of meters). This allows software to use the unit symbol information correctly convert and scale the raw data of those sources into SI-based units.

The integer values are used for harmonization with IEC 61850.

Table 28 shows all literals of UnitSymbol.

Table 28 – Literals of Domain::UnitSymbol

literal	value	description
none	0	Dimension less quantity, e.g. count, per unit, etc.
m	2	Length in metres.
kg	3	Mass in kilograms. Note: multiplier “k” is included in this unit symbol for compatibility with IEC 61850-7-3.
s	4	Time in seconds.
A	5	Current in amperes.

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literal	value	description
K	6	Temperature in kelvins.
mol	7	Amount of substance in moles.
cd	8	Luminous intensity in candelas.
deg	9	Plane angle in degrees.
rad	10	Plane angle in radians (m/m).
sr	11	Solid angle in steradians (m2/m2).
Gy	21	Absorbed dose in grays (J/kg).
Bq	22	Radioactivity in becquerels (1/s).
degC	23	Relative temperature in degrees Celsius. In the SI unit system the symbol is °C. Electric charge is measured in coulomb that has the unit symbol C. To distinguish degree Celsius from coulomb the symbol used in the UML is degC. The reason for not using °C is that the special character ° is difficult to manage in software.
Sv	24	Dose equivalent in sieverts (J/kg).
F	25	Electric capacitance in farads (C/V).
C	26	Electric charge in coulombs (A·s).
S	27	Conductance in siemens.
H	28	Electric inductance in henrys (Wb/A).
V	29	Electric potential in volts (W/A).
ohm	30	Electric resistance in ohms (V/A).
J	31	Energy in joules (N·m = C·V = W·s).
N	32	Force in newtons (kg·m/s²).
Hz	33	Frequency in hertz (1/s).
lx	34	Illuminance in lux (lm/m²).
lm	35	Luminous flux in lumens (cd·sr).
Wb	36	Magnetic flux in webers (V·s).
T	37	Magnetic flux density in teslas (Wb/m2).
W	38	Real power in watts (J/s). Electrical power may have real and reactive components. The real portion of electrical power (I²R or VIcos(phi)), is expressed in Watts. See also apparent power and reactive power.
Pa	39	Pressure in pascals (N/m²). Note: the absolute or relative measurement of pressure is implied with this entry. See below for more explicit forms.
m2	41	Area in square metres (m²).
m3	42	Volume in cubic metres (m³).
mPers	43	Velocity in metres per second (m/s).
mPers2	44	Acceleration in metres per second squared (m/s²).
m3Pers	45	Volumetric flow rate in cubic metres per second (m³/s).

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literal	value	description
mPerm3	46	Fuel efficiency in metres per cubic metres (m/m³).
kgm	47	Moment of mass in kilogram metres (kg·m) (first moment of mass). Note: multiplier “k” is included in this unit symbol for compat bility with IEC 61850-7-3.
kgPerm3	48	Density in kilogram/cubic metres (kg/m³). Note: multiplier “k” is included in this unit symbol for compatibility with IEC 61850-7-3.
m2Pers	49	Viscosity in square metres / second (m²/s).
WPermK	50	Thermal conductivity in watt/metres kelvin.
JPerK	51	Heat capacity in joules/kelvin.
ppm	52	Concentration in parts per million.
rotPers	53	Rotations per second (1/s). See also Hz (1/s).
radPers	54	Angular velocity in radians per second (rad/s).
WPerm2	55	Heat flux density, irradiance, watts per square metre.
JPerm2	56	Insulation energy density, joules per square metre or watt second per square metre.
SPerm	57	Conductance per length (F/m).
KPers	58	Temperature change rate in kelvins per second.
PaPers	59	Pressure change rate in pascals per second.
JPerkgK	60	Specific heat capacity, specific entropy, joules per kilogram Kelvin.
VA	61	Apparent power in volt amperes. See also real power and reactive power.
VAr	63	Reactive power in volt amperes reactive. The “reactive” or “imaginary” component of electrical power (VIsin(phi)). (See also real power and apparent power). Note: Different meter designs use different methods to arrive at their results. Some meters may compute reactive power as an arithmetic value, while others compute the value vectorially. The data consumer should determine the method in use and the suitability of the measurement for the intended purpose.
cosPhi	65	Power factor, dimensionless. Note 1: This definition of power factor only holds for balanced systems. See the alternative definition under code 153. Note 2 : Beware of differing sign conventions in use between the IEC and EEI. It is assumed that the data consumer understands the type of meter in use and the sign convention in use by the utility.
Vs	66	Volt seconds (Ws/A).
V2	67	Volt squared (W²/A²).
As	68	Ampere seconds (A·s).
A2	69	Amperes squared (A²).

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literal	value	description
A2s	70	Ampere squared time in square amperes (A^2s).
VAh	71	Apparent energy in volt ampere hours.
Wh	72	Real energy in watt hours.
VArh	73	Reactive energy in volt ampere reactive hours.
VPerHz	74	Magnetic flux in volt per hertz.
HzPers	75	Rate of change of frequency in hertz per second.
character	76	Number of characters.
charPers	77	Data rate (baud) in characters per second.
kgm2	78	Moment of mass in kilogram square metres ($kg \cdot m^2$) (Second moment of mass, commonly called the moment of inertia). Note: multiplier “k” is included in this unit symbol for compatibility with IEC 61850-7-3.
dB	79	Sound pressure level in decibels. Note: multiplier “d” is included in this unit symbol for compat bility with IEC 61850-7-3.
WPers	81	Ramp rate in watts per second.
lPers	82	Volumetric flow rate in litres per second.
dBm	83	Power level (logarithmic ratio of signal strength , Bel-mW), normalized to 1mW. Note: multiplier “d” is included in this unit symbol for compat bility with IEC 61850-7-3.
h	84	Time in hours, hour = 60 min = 3600 s.
min	85	Time in minutes, minute = 60 s.
Q	100	Quantity power, Q.
Qh	101	Quantity energy, Qh.
ohmm	102	Resistivity, ohm metres, (rho).
APerm	103	A/m, magnetic field strength, amperes per metre.
V2h	104	Volt-squared hour, volt-squared-hours.
A2h	105	Ampere-squared hour, ampere-squared hour.
Ah	106	Ampere-hours, ampere-hours.
count	111	Amount of substance, Counter value.
ft3	119	Volume, cubic feet.
m3Perh	125	Volumetric flow rate, cubic metres per hour.
gal	128	Volume in gallons, US gallon (1 gal = 231 in3 = 128 fl ounce).
Btu	132	Energy, British Thermal Units.
l	134	Volume in litres, litre = dm3 = m3/1000.
lPerh	137	Volumetric flow rate, litres per hour.
lPerl	143	Concentration, The ratio of the volume of a solute divided by the volume of the solution. Note: Users may need use a prefix such a ‘µ’ to express a quantity such as ‘µL/L’.

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literal	value	description
gPerg	144	Concentration, The ratio of the mass of a solute divided by the mass of the solution. Note: Users may need use a prefix such a 'µ' to express a quantity such as 'µg/g'.
molPerm3	145	Concentration, The amount of substance concentration, (c), the amount of solvent in moles divided by the volume of solution in m³.
molPermol	146	Concentration, Molar fraction, the ratio of the molar amount of a solute divided by the molar amount of the solution.
molPerkg	147	Concentration, Molality, the amount of solute in moles and the amount of solvent in kilograms.
sPers	149	Time, Ratio of time. Note: Users may need to supply a prefix such as 'µ' to show rates such as 'µs/s'.
HzPerHz	150	Frequency, rate of frequency change. Note: Users may need to supply a prefix such as 'm' to show rates such as 'mHz/Hz'.
VPerV	151	Voltage, ratio of voltages. Note: Users may need to supply a prefix such as 'm' to show rates such as 'mV/V'.
APerA	152	Current, ratio of amperages. Note: Users may need to supply a prefix such as 'm' to show rates such as 'mA/A'.
VPerVA	153	Power factor, PF, the ratio of the active power to the apparent power. Note: The sign convention used for power factor will differ between IEC meters and EEI (ANSI) meters. It is assumed that the data consumers understand the type of meter being used and agree on the sign convention in use at any given utility.
rev	154	Amount of rotation, revolutions.
kat	158	Catalytic activity, katal = mol / s.
JPerkg	165	Specific energy, Joules / kg.
m3Uncompensated	166	Volume, cubic metres, with the value uncompensated for weather effects.
m3Compensated	167	Volume, cubic metres, with the value compensated for weather effects.
WPerW	168	Signal Strength, ratio of power. Note: Users may need to supply a prefix such as 'm' to show rates such as 'mW/W'.
therm	169	Energy, therms.
onePerm	173	Wavenumber, reciprocal metres, (1/m).
m3Perkg	174	Specific volume, cubic metres per kilogram, v.
Pas	175	Dynamic viscosity, pascal seconds.
Nm	176	Moment of force, newton metres.
NPerm	177	Surface tension, newton per metre.
radPers2	178	Angular acceleration, radians per second squared.
JPerm3	181	Energy density, joules per cubic metre.
VPerm	182	Electric field strength, volts per metre.

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literal	value	description
CPerm3	183	Electric charge density, coulombs per cubic metre.
CPerm2	184	Surface charge density, coulombs per square metre.
FPerm	185	Permittivity, farads per metre.
HPerm	186	Permeability, henrys per metre.
JPermol	187	Molar energy, joules per mole.
JPermolK	188	Molar entropy, molar heat capacity, joules per mole kelvin.
CPerkg	189	Exposure (x rays), coulombs per kilogram.
GyPers	190	Absorbed dose rate, grays per second.
WPersr	191	Radiant intensity, watts per steradian.
WPerm2sr	192	Radiance, watts per square metre steradian.
katPerm3	193	Catalytic activity concentration, katals per cubic metre.
d	195	Time in days, day = 24 h = 86400 s.
anglemin	196	Plane angle, minutes.
anglesec	197	Plane angle, seconds.
ha	198	Area, hectares.
tonne	199	Mass in tons, “tonne” or “metric ton” (1000 kg = 1 Mg).
bar	214	Pressure in bars, (1 bar = 100 kPa).
mmHg	215	Pressure, millimetres of mercury (1 mmHg is approximately 133.3 Pa).
M	217	Length, nautical miles (1 M = 1852 m).
kn	219	Speed, knots (1 kn = 1852/3600) m/s.
Mx	276	Magnetic flux, maxwells (1 Mx = 10-8 Wb).
G	277	Magnetic flux density, gausses (1 G = 10-4 T).
Oe	278	Magnetic field in oersteds, (1 Oe = (103/4p) A/m).
Vh	280	Volt-hour, Volt hours.
WPerA		Active power per current flow, watts per Ampere.
onePerHz		Reciprocal of frequency (1/Hz).
VPerVAr		Power factor, PF, the ratio of the active power to the apparent power. Note: The sign convention used for power factor will differ between IEC meters and EEI (ANSI) meters. It is assumed that the data consumers understand the type of meter being used and agree on the sign convention in use at any given utility.
ohmPerm	86	Electric resistance per length in ohms per metre ((V/A)/m).
kgPerJ		Weight per energy in kilograms per joule (kg/J). Note: multiplier “k” is included in this unit symbol for compatibility with IEC 61850-7-3.
JPers		Energy rate in joules per second (J/s).

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8.2.3.2.34 WindLookupTableFunctionKind enumeration

Function of the lookup table.

Table 29 shows all literals of WindLookupTableFunctionKind.

Table 29 – Literals of Domain::WindLookupTableFunctionKind

literal	value	description
prr		Power versus speed change (negative slip) lookup table (prr(deltaomega)). It is used for the rotor resistance control model, IEC 61400-27-1:2015, 5.6.5.3.
omegap		Power vs. speed lookup table (omega(p)). It is used for the P control model type 3, IEC 61400-27-1:2015, 5.6.5.4.
ipmax		Lookup table for voltage dependency of active current limits (ipmax(uWT)). It is used for the current limitation model, IEC 61400-27-1:2015, 5.6.5.8.
iqmax		Lookup table for voltage dependency of reactive current limits (iqmax(uWT)). It is used for the current limitation model, IEC 61400-27-1:2015, 5.6.5.8.
pwp		Power vs. frequency lookup table (pWPbias(f)). It is used for the wind power plant frequency and active power control model, IEC 61400-27-1:2015, Annex D.
tcwdu		Crowbar duration versus voltage variation look-up table (TCW(du)). It is a case-dependent parameter. It is used for the type 3B generator set model, IEC 61400-27-1:2015, 5.6.3.3.
tduwt		Lookup table to determine the duration of the power reduction after a voltage dip, depending on the size of the voltage dip (Td(uWT)). It is a type-dependent parameter. It is used for the pitch control power model, IEC 61400-27-1:2015, 5.6.5.1.
qmaxp		Lookup table for active power dependency of reactive power maximum limit (qmaxp(p)). It is used for the QP and QU limitation model, IEC 61400-27-1:2015, 5.6.5.10.
qminp		Lookup table for active power dependency of reactive power minimum limit (qminp(p)). It is used for the QP and QU limitation model, IEC 61400-27-1:2015, 5.6.5.10.
qmaxu		Lookup table for voltage dependency of reactive power maximum limit (qmaxu(p)). It is used for the QP and QU limitation model, IEC 61400-27-1:2015, 5.6.5.10.
qminu		Lookup table for voltage dependency of reactive power minimum limit (qminu(p)). It is used for the QP and QU limitation model, IEC 61400-27-1:2015, 5.6.5.10.
tuover		Disconnection time versus over-voltage lookup table (Tuover(uWT)). It is used for the grid protection model, IEC 61400-27-1:2015, 5.6.6.
tuunder		Disconnection time versus under-voltage lookup table (Tuunder(uWT)). It is used for the grid protection model, IEC 61400-27-1:2015, 5.6.6.

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literal	value	description
tfover		Disconnection time versus over-frequency lookup table (Tfover(fWT)). It is used for the grid protection model, IEC 61400-27-1:2015, 5.6.6.
tfunder		Disconnection time versus under-frequency lookup table (Tfunder(fWT)). It is used for the grid protection model, IEC 61400-27-1:2015, 5.6.6.
qwp		Look up table for the UQ static mode (qWP(uerr)). It is used for the voltage and reactive power control model, IEC 61400-27-1:2015, Annex D.

8.2.3.2.35 WindPlantQcontrolModeKind enumeration

Reactive power/voltage controller mode.

Table 30 shows all literals of WindPlantQcontrolModeKind.

Table 30 – Literals of Domain::WindPlantQcontrolModeKind

literal	value	description
reactivePower		Reactive power reference.
powerFactor		Power factor reference.
uqStatic		UQ static.
voltageControl		Voltage control.

8.2.3.2.36 WindQcontrolModeKind enumeration

General wind turbine Q control modes MqG.

Table 31 shows all literals of WindQcontrolModeKind.

Table 31 – Literals of Domain::WindQcontrolModeKind

literal	value	description
voltage		Voltage control (MqG equals 0).
reactivePower		Reactive power control (MqG equals 1).
openLoopReactivePower		Open loop reactive power control (only used with closed loop at plant level) (MqG equals 2).
powerFactor		Power factor control (MqG equals 3).
openLooppowerFactor		Open loop power factor control (MqG equals 4).

8.2.3.2.37 WindUVRTQcontrolModeKind enumeration

UVRT Q control modes MqUVRT.

Table 32 shows all literals of WindUVRTQcontrolModeKind.

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Table 32 – Literals of Domain::WindUVRTQcontrolModeKind

literal	value	description
mode0		Voltage-dependent reactive current injection (MqUVRT equals 0).
mode1		Reactive current injection controlled as the pre-fault value plus an additional voltage dependent reactive current injection (MqUVRT equals 1).
mode2		Reactive current injection controlled as the pre-fault value plus an additional voltage-dependent reactive current injection during fault, and as the pre-fault value plus an additional constant reactive current injection post fault (MqUVRT equals 2).

8.2.3.3 Package Core

8.2.3.3.1 General

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

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