

DIN EN 61968-13



ICS 35.240.50; 35.240.99

Einsprüche bis 2018-09-27
Vorgesehen als Ersatz für
DIN EN 61968-13:2009-02**Entwurf**

**Integration von Anwendungen in Anlagen der Elektrizitätsversorgung –
Systemschnittstellen für Netzführung –
Teil 13: Allgemeine Profile zur Modellierung von Verteilnetzen
(IEC 57/1714/CD:2016);
Text Englisch**

Application integration at electric utilities –
System interfaces for distribution management –
Part 13: Common distribution power system model profiles
(IEC 57/1714/CD:2016);
Text in English

Intégration d'applications pour les services électriques –
Système d'interfaces pour la gestion de la distribution –
Partie 13: Profils généraux des modèles de réseaux de distribution
(IEC 57/1714/CD:2016);
Texte en anglaise

Anwendungswarnvermerk

Dieser Norm-Entwurf mit Erscheinungsdatum 2018-07-27 wird der Öffentlichkeit zur Prüfung und Stellungnahme vorgelegt.

Weil die beabsichtigte Norm von der vorliegenden Fassung abweichen kann, ist die Anwendung dieses Entwurfs besonders zu vereinbaren.

Stellungnahmen werden erbeten

- vorzugsweise online im Norm-Entwurfs-Portal von DIN unter www.din.de/go/entwuerfe bzw. für Norm-Entwürfe der DKE auch im Norm-Entwurfs-Portal der DKE unter www.entwuerfe.normenbibliothek.de, sofern dort wiedergegeben;
- oder als Datei per E-Mail an dke@vde.com möglichst in Form einer Tabelle. Die Vorlage dieser Tabelle kann im Internet unter www.din.de/go/stellungnahmen-norm-entwuerfe oder für Stellungnahmen zu Norm-Entwürfen der DKE unter www.dke.de/stellungnahme abgerufen werden;
- oder in Papierform an die DKE Deutsche Kommission Elektrotechnik Elektronik Informationstechnik in DIN und VDE, Stresemannallee 15, 60596 Frankfurt am Main.

Die Empfänger dieses Norm-Entwurfs werden gebeten, mit ihren Kommentaren jegliche relevanten Patentrechte, die sie kennen, mitzuteilen und unterstützende Dokumentationen zur Verfügung zu stellen.

Gesamtumfang 241 Seiten

DKE Deutsche Kommission Elektrotechnik Elektronik Informationstechnik in DIN und VDE

Nationales Vorwort

Die englische Originalfassung des internationalen Dokuments IEC 57/1714/CD:2016 „Application integration at electric utilities – System interfaces for distribution management – Part 13: Common distribution power system model profiles“ (CD, en: Committee Draft) ist unverändert in diesen Norm-Entwurf übernommen worden.

Das internationale Dokument wurde vom TC 57 „Power systems management and associated information exchange“ der Internationalen Elektrotechnischen Kommission (IEC) erarbeitet und den nationalen Komitees zur Stellungnahme vorgelegt.

Die IEC und das Europäische Komitee für Elektrotechnische Normung (CENELEC) haben vereinbart, dass ein auf IEC-Ebene erarbeiteter Entwurf für eine Internationale Norm zeitgleich (parallel) bei IEC und CENELEC zur Umfrage (CDV-Stadium) und Abstimmung als FDIS (en: Final Draft International Standard) bzw. Schluss-Entwurf für eine Europäische Norm gestellt wird, um eine Beschleunigung und Straffung der Normungsarbeit zu erreichen. Dokumente, die bei CENELEC als Europäische Norm angenommen und ratifiziert werden, sind unverändert als Deutsche Normen zu übernehmen.

Da der Abstimmungszeitraum für einen FDIS bzw. Schluss-Entwurf prEN nur 6 Wochen beträgt, und dann keine sachlichen Stellungnahmen mehr abgegeben werden können, sondern nur noch eine „JA/NEIN“-Entscheidung möglich ist, wobei eine „NEIN“-Entscheidung fundiert begründet werden muss, wird bereits der CD als DIN-Norm-Entwurf veröffentlicht, um die Stellungnahmen aus der Öffentlichkeit frühzeitig berücksichtigen zu können.

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

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

Da sich die Benutzer des vorliegenden Normentwurfs der englischen Sprache als Fachsprache bedienen, wird die Englische Fassung der FprEN 61968-13 veröffentlicht. Zu deren Abschnitt 1, der den Anwendungsbereich festlegt, und Abschnitt 2, der die Begriffe festlegt, wurde eine Übersetzung angefertigt und als Nationaler Anhang NA des vorliegenden Normentwurfs Norm hinzugefügt. Für einige der verwendeten Begriffe existieren keine gebräuchlichen deutschen Benennungen, da sich die deutschen Anwender in der Regel ebenfalls der englischen Benennungen bedienen. Dieser Normentwurf steht nicht in unmittelbarem Zusammenhang mit Rechtsvorschriften und ist nicht als Sicherheitsnorm anzusehen.

Es ist vorgesehen, auch bei der entsprechenden zukünftigen Deutschen Norm auf die deutsche Sprachfassung zu verzichten und diese in der englischsprachigen Fassung zu veröffentlichen.

Für den Fall einer undatierten Verweisung im normativen Text (Verweisung auf ein Dokument ohne Angabe des Ausgabedatums und ohne Hinweis auf eine Abschnitsnummer, eine Tabelle, ein Bild usw.) bezieht sich die Verweisung auf die jeweils aktuellste Ausgabe des in Bezug genommenen Dokuments.

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

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

Es wird auf die Möglichkeit hingewiesen, dass einige Elemente dieses Dokuments Patentrechte berühren können. IEC ist nicht dafür verantwortlich, einige oder alle diesbezüglichen Patentrechte zu identifizieren.

Änderungen

Gegenüber DIN EN 61968-13:2009-02 wurden folgende Änderungen vorgenommen:

- a) Sammlung der relevanten Anwendungsfälle;
- b) gelöste spezifische Verteilnetz Modellierung und CIM bezogene Themen;
- c) Modell Profile für CIM Verteilnetz Modell Profile.

Nationaler Anhang NA (informativ)

Auszugsweise Übersetzung^{N1}

1 Anwendungsbereich

Dieser Teil von IEC 61968 legt das Format und die Regeln für den Austausch von Modellierungsinformationen fest, die auf dem CIM beruhen und mit Daten von Verteilnetzen zusammenhängen. Er definiert allgemeine Profile zur Modellierung von Verteilnetzen (en: common distribution power system model; CDPSM).

Ziel dieses Teils von IEC 61968 ist es, den Massenaustausch von Instanzdaten zu ermöglichen. Die importierten Netzmodelldaten sollten also ausreichen, um Analysen der Netzkonnektivität einschließlich Netzverfolgung, Ausfallanalyse, Lastflussberechnungen usw. durchzuführen. Dieser Teil könnte für die Synchronisierung von Datenbanken geografischer Informationssysteme mit Datenbanken von Fernsteuerungssystemen genutzt werden.

Diese Norm stützt sich auf und vervollständigt die Komponentenschnittstellen-Normenreihe IEC 61970-4x, welche die funktionalen Anforderungen an Schnittstellen festlegt, die von einer Komponente (oder Anwendung) für den Informationsaustausch mit anderen Komponenten (oder Anwendungen) und/oder den normgerechten Zugriff auf öffentlich zugängliche Daten umgesetzt werden müssen.

Diese Norm legt die speziellen Profile (bzw. Teilmengen) des CIM für den Austausch von statischen Verteilnetzdaten fest, um

- Datenkonsistenz innerhalb eines Versorgungsbetriebs sicherzustellen,
- Datenkonsistenz zwischen den an einem verbundenen Versorgungsnetzmodell beteiligten Entitäten sicherzustellen und
- verschiedene Berechnungen wie Zustandsschätzungen oder Lastflussanwendungen auszuführen.

Es verwendet das in IEC 61970-501 vorgestellte Resource Description Framework(RDF)-Schema des CIM als Metamodell-Framework zur Erstellung von XML1-Dokumenten, die Informationen der Versorgungsnetzmodellierung enthalten. Die Syntax dieser Dokumente wird als „CIM-XML-Format“ bezeichnet. Der Modellaustausch mittels Dateiübertragung ist in vielerlei Hinsicht nützlich, insbesondere bei Anwendungen, für die das gesamte Netzmodell definiert sein muss. Wenngleich das Format für den allgemeinen Informationsaustausch auf Grundlage des CIM verwendet werden kann, werden in diesem Teil von IEC 61968 spezielle Profile (bzw. Teilmengen) des CIM für besondere Anforderungen an den Austausch definiert.

2.3 Begriffe und Abkürzungen

LV: Niederspannung (en: low voltage)

^{N1} Nationale Fußnote: Die Nummerierung aus IEC 57/1714/CD:2016 wurde beibehalten.

MV: Mittelspannung (en: medium voltage)

HV: Hochspannung (en: high voltage)

EHV: Höchstspannung (en: extra high voltage)

DMS: Verteilnetzmanagementsystem (en: distribution management system)

Nach IEC 61968 besteht ein DMS aus diversen dezentralen Anwendungskomponenten, mit denen Energieversorgungsunternehmen Stromverteilnetze verwalten können. Diese Komponenten umfassen Funktionen wie die Überwachung und Steuerung von Betriebsmitteln zur Strombereitstellung, Verwaltungsprozesse zur Sicherstellung der Zuverlässigkeit des Systems, die Spannungsregelung, die Verwaltung auf Verbraucherseite, die Verwaltung von Ausfällen, die Arbeitsplanung, die automatische Zuordnung und die Verwaltung von Anlagen. Für jede in dem in Teil 1: Interface Architecture and General Requirements beschriebenen Schnittstellen-Referenzmodell (en: interface reference model; IRM) bestimmte Anwendungsklasse werden Normschnittstellen definiert.

DNO: Verteilnetzbetreiber (en: distribution network operator)

DSO: Verteilnetzbetreiber (en: distribution system operator). Ein DSO verwaltet in der Regel ein MV/LV-Netz.

EMS-API: Anwendungsprogramm-Schnittstelle für Energiemanagementsysteme (en: energy management system application program interface)

RDF: Ressourcen-Beschreibungssystem (en: resource description framework)

Rolle

Typ von Akteur, der bestimmte Zuständigkeiten hat und das extern beabsichtigte Verhalten einer Partei repräsentiert.

In der Reihe IEC/TS 62913 werden zwei verschiedene Arten von Rollen verwendet: Geschäftsrollen und Systemrollen.

BEISPIELE Ein gesetzlich definierter Marktteilnehmer (z. B. Netzbetreiber, Kunde), eine generische Rolle, die eine Sammlung möglicher Rollen repräsentiert (z. B. Flexibilitätsbetreiber), oder eine künstlich definierte Körperschaft, die für generische Prozesse und Anwendungsfallbeschreibungen benötigt wird.

[QUELLE: SG-CG/M490/C:2012-12]

ANMERKUNG – Gesetzliche oder generisch definierte externe Akteure dürfen anhand deren Rollen benannt oder identifiziert werden.

TSO: Transportnetzbetreiber (en: transport system operator). Ein TSO verwaltet in der Regel ein EHV/HV-Netz.

UML: einheitliche Modellierungssprache (en: unified modelling language)

Anwendungsfall

Spezifikation einer Menge von Aktionen, die von einem System durchgeführt werden und ein beobachtbares Ergebnis erbringen, das typischerweise für einen oder mehrere Akteure oder Interessenvertreter des Systems von Wert ist

[QUELLE: SG-CG/M490/E:2012-12]

ANMERKUNG – Es gibt zwei Typen von Anwendungsfällen:

- Geschäftsanwendungsfälle beschreiben, wie Geschäftsrollen miteinander interagieren, um einen Geschäftsprozess auszuführen. Diese Prozesse werden von Diensten, also Geschäftstransaktionen, abgeleitet, die zuvor definiert wurden.
- Systemanwendungsfälle beschreiben, wie System- und/oder Geschäftsrollen eines gegebenen Systems miteinander interagieren, um eine Smart-Grid-Funktion auszuführen, die zum Ermöglichen/Unterstützen der in Geschäftsanwendungsfällen beschriebenen Geschäftsprozesse erforderlich ist. Sie dienen dazu, die Ausführung dieser Prozesse aus Sicht eines Informationssystems zu beschreiben.

ANMERKUNG 2 – Da mit einer Smart-Grid-Funktion mehrere Geschäftsprozesse ermöglicht/unterstützt werden können, kann ein Systemanwendungsfall mit mehreren Geschäftsanwendungsfällen verknüpft werden.

XML: erweiterbare Auszeichnungssprache (en: eXtensible markup language)

BUC: Geschäftsanwendungsfall (en: business use case) (siehe Anwendungsfall)

SUC: Systemanwendungsfall (en: system use case) (siehe Anwendungsfall)

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INTRODUCTION

The IEC 61968 series is intended to facilitate inter-application integration, as opposed to intra-application integration of the various distributed software application systems supporting the management of utility electrical networks. Intra-application integration is aimed at programs in the same application system, usually communicating with each other using middleware that is embedded in their underlying runtime environment. Additionally the intra-application integration tends to be optimized for close, real-time, synchronous connections and interactive request/reply or conversation communication models. IEC 61968 series by contrast, is intended to support the inter-application integration of a utility enterprise that needs to connect disparate applications that are already built or new (legacy or purchased applications) each supported by dissimilar runtime environments. Therefore, IEC 61968 series is relevant to loosely coupled applications with more heterogeneity in languages, operating systems, protocols, and management tools. IEC 61968 series is intended to support applications that need to exchange data on an event driven basis. IEC 61968 series is also intended to be implemented with middleware services that broker messages among applications and complementing, but not replacing, utility data warehouses, database gateways, and operational stores.

IEC 61968 is a series of standards:

Table 1 - IEC 61968 series

IEC 61968 part	Title
1	Interface architecture and general recommendations
2	Glossary
3	Interface for network operation
4	Interface for records and asset management
5	Interface standard for operational planning and optimisation ¹
6	Interface for maintenance and construction ²
7	Interface standard for network extension planning ³
8	Interface standard for customer support ⁴
9	Interface for meter reading and control
11	Common information model (CIM) extensions for distribution
13	Common Distribution Power System Model Profiles
14-1	IEC Standards to Map IEC61968 and MultiSpeak Standards
14-2	IEC Standards to Create a CIM Profile to Implement MultiSpeak Functionality
100	Implementation profiles ⁵

This standard is based on, and completes IEC 61970-4x series of Component Interface Standards that specify the functional requirements for interfaces that a component (or application) shall implement to exchange information with other components (or applications) and/or to access publicly available data in a standard way.

This standard specifies the specific profiles (or subsets) of the CIM for exchange of Distribution static power system data in order to:

- insure data consistency at the intra-utility level,
- insure data consistency between entities participating in a interconnected power system model.

¹ Under consideration.

² Under consideration.

³ Under consideration.

⁴ Under consideration.

⁵ Under consideration.

- execute some calculations like state estimation or power flow applications.

The organization of IEC 61968-13 is described in Table 2.

Table 2 - Document overview for IEC 61968-13

Clause	Title	Purpose
1.	Scope	Scope of IEC 61968-13.
2.	General	Normative references Future standards documents related to this part Documents that contain provisions which, through reference in this text, constitute provisions of this International Standard. Distribution networks specificities
3.	Use Case list	Use cases related to CDPSM Use case overview table
4.	Distribution network modelling and CIM related issues resolved	Feeder modelling Partial-phase devices modeling
5.	CIM Distribution Network Static Model Profiles	
Informative Annex A	Data Types	
Informative Annex B	Use Cases	
Informative Annex C	Example of a North American distribution network	
Informative Annex D	Example of a European CDPSM MV/LV urban & rural network	CDPSM usage and associated satellite image
Informative Annex E	Example of a European CDPSM MV/LV urban network	CDPSM usage and associated satellite image
Informative Annex F	Example of a European CDPSM MV Urban and Rural Network	CDPSM usage and associated satellite image
Informative Annex G	Example of a Microgrid network	
Informative Annex H	Example of a Nuclear Distribution Network	

Document history

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Any important message to IEC editors should also be included in the table below.

Name of intervening person	Document received		Brief description of the changes introduced	Document sent	
	From	Date		To	Date
M. Noeth	Eric Lambert	2016-04-15	CD document	CO	2016-04-15

This table will be removed by IEC editors before FDIS circulation (in case of IS) or before final publication (in case of TS or TR).

APPLICATION INTEGRATION AT ELECTRIC UTILITIES SYSTEM INTERFACES FOR DISTRIBUTION MANAGEMENT

Part 13: Common Distribution Power System Model Profiles

1 Scope

This Part of IEC 61968 specifies the format and rules for exchanging modeling information based upon the CIM and related to Distribution Network Data. It defines Common Distribution Power System Model Profiles (CDPSM).

The intention of this Part of IEC 61968 is to allow the exchange of instance data in bulk. Thus, the imported network model data should be sufficient to allow performing network connectivity analysis, including network tracing, outage analysis, load flow calculations etc. This part could be used for synchronizing geographical information system databases with remote control system databases.

This standard is based on, and completes IEC 61970-4x series of Component Interface Standards that specify the functional requirements for interfaces that a component (or application) shall implement to exchange information with other components (or applications) and/or to access publicly available data in a standard way.

This standard specifies the specific profiles (or subsets) of the CIM for exchange of Distribution static power system data in order to:

- insure data consistency at the intra-utility level,
- insure data consistency between entities participating in a interconnected power system model.
- execute some calculations like state estimation or power flow applications.

It uses the CIM Resource Description Framework (RDF) Schema presented in IEC 61970-501 as the meta-model framework for constructing XML¹ documents containing power system modeling information. The syntax of these documents is called CIM XML format. Model exchange by file transfer serves many useful purposes, specifically when some applications need to have the complete network model defined. Though the format can be used for general CIM-based information exchange, in this Part of IEC 61968 specific profiles (or subsets) of the CIM are identified in order to address particular exchange requirements.

2 General

Given the CIM RDF Schema described in IEC 61970-501, a DMS power system model can be converted for export as an XML document, see Figure 1. This document is referred to as a CIM XML document. All of the tags (resource descriptions) used in the CIM XML document are supplied by the CIM RDF schema. The resulting CIM XML model exchange document can be parsed and the information imported into a foreign system.

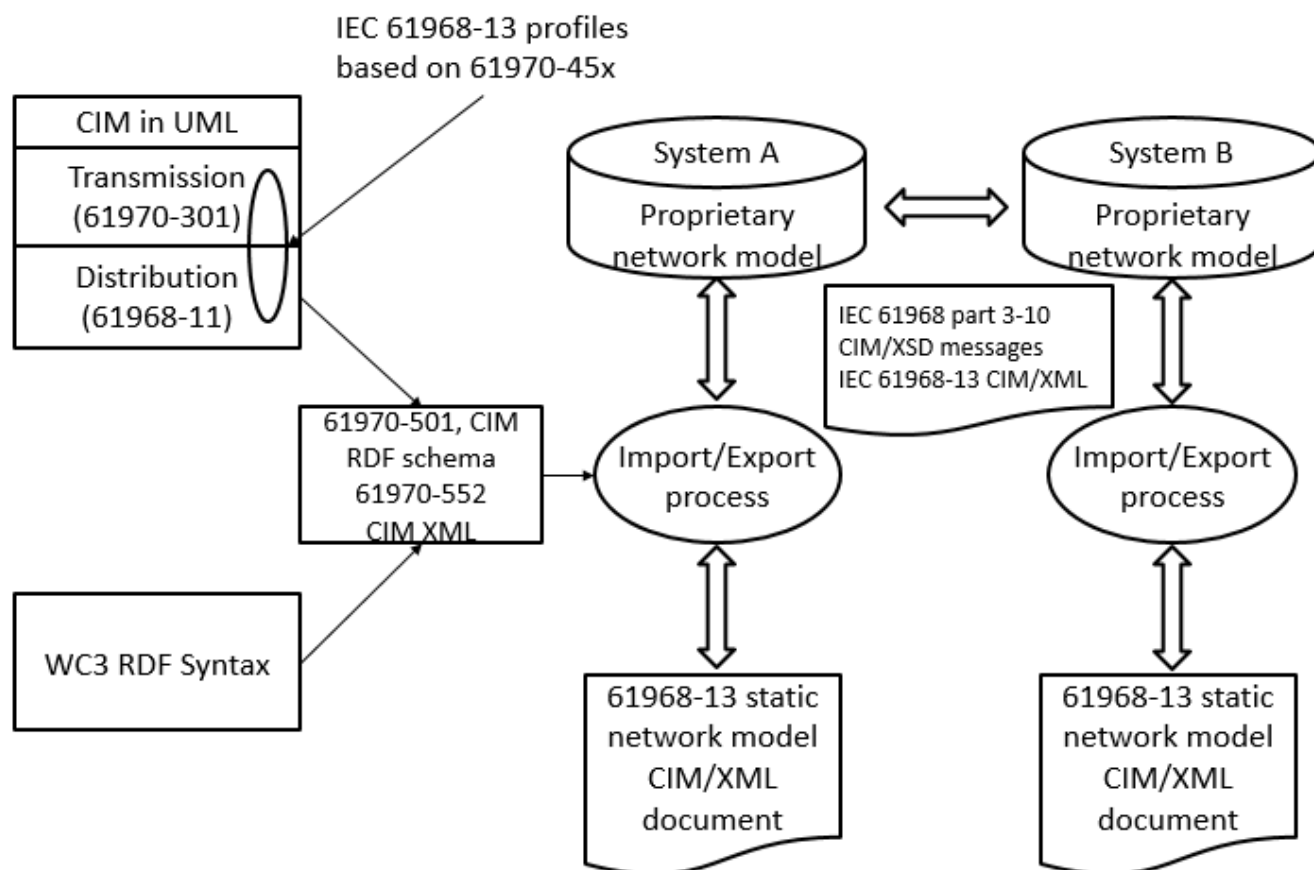


Figure 1 - XML-Based DMS Network Data Configuration

Similar to using any programming language, implementers have many choices when creating a CIM XML document. The RDF syntax itself can be used in several ways to achieve the same basic result. The way one approaches the CIM RDF schema can yield various forms when producing a CIM XML document. The following Clauses discuss the style guidelines for producing a CIM XML document. Such guideline rules are important to communicate and follow when producing these documents because they simplify and facilitate the software written to unambiguously interpret the model information.

Some comparisons have been made between CIM RDF and CIM XSD. A Network Management System can use a CIM XSD message types architecture, and/or CIM RDF which has three advantages:

- A UML model is a graph model and RDF helps to describe the graph model. XSD describes a hierarchical model which suits the message type approach.
- RDF is more readable and understandable by people working in the electrotechnical field.
- It is a basic requirement to build ontologies.

If required, tools would ensure the compatibility between CIM-RDF and CIM-XSD.

2.1 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 61968-1, Application integration at electric utilities - System interfaces for distribution management - Part 1: Interface architecture and general requirements
- IEC 61968-3, Application integration at electric utilities - System interfaces for distribution management - Part 3: Interface for network operations
- IEC 61968-4, Application integration at electric utilities - System interfaces for distribution management - Part 4: Interfaces for records and asset management

- IEC 61970-301, Energy management system application program interface (EMS-API) - Part 301: Common Information Model (CIM) base
- IEC 61968-11 Ed.2 Common information model (CIM) extensions for distribution
- IEC 61970-452, Energy management system application program interface (EMS-API) – Part 452 CIM Static Transmission Network Model Profiles
- IEC 61970-453, Energy management system application program interface (EMS-API) – Part 453 Diagram Layout Profile
- IEC 61970-456, Energy management system application program interface (EMS-API) – Part 456 Solved power system state profiles
- IEC 61970-501, Energy management system application program interface (EMS-API) - Part 501: Common Information Model Resource Description Framework (CIM RDF) schema
- IEC 61970-552, Energy Management System Application Program Interface (EMS-API) – Part 552: CIM XML Model Exchange Format
- IEC 62559-2 Use case methodology - Part 2: Definition of the templates for use cases, actor list and requirements list

2.2 Future standards documents related to this part

The following documents are taken into account even if they have not been published yet.

- IEC 62357-1 Ed.2 Power systems management and associated information exchange – Part 1: Reference architecture
- IEC 62913-1 Specific Application of the UC methodology for defining Generic SG Requirements
- IEC 62913-2-1 Generic Smart Grid Requirements - Grid related Domains
- IEC 62361-103 Standard Profiling
- IEC 61970-451, EMS-API – Part 451: SCADA Data Exchange profiles

2.3 Terms and Abbreviations

LV: Low Voltage

MV: Medium Voltage

HV: High Voltage

EHV: Extra High Voltage

DMS : Distribution Management System

As used in IEC 61968, a DMS consists of various distributed application components for the utility to manage electrical distribution networks. These capabilities include monitoring and control of equipment for power delivery, management processes to ensure system reliability, voltage management, demand-side management, outage management, work management, automated mapping and facilities management. Standards interfaces are defined for each class of applications identified in the Interface Reference Model (IRM), which is described in Part 1: Interface Architecture and General Requirements.

DNO: Distribution Network Operator

DSO: Distribution System Operator. Generally a DSO manage a MV/LV network

EMS-API : Energy Management System Application Program Interface

RDF : Resource Description Framework

Role

type of actor which has responsibilities and represents the external intended behaviour of a party.

IEC/TS 62913 series use two kinds of roles: Business Roles and System Roles



181 **EXAMPLES** A legally defined market participant (e.g. grid operator, customer), a generic role which represents a
182 bundle of possible roles (e.g. flexibility operator) or an artificially defined body needed for generic process and use
183 case descriptions.

184 [SOURCE: SG-CG/M490/C: 2012-12]

185 Note – Legally or generically defined external actors may be named and identified by their roles.

186 **TSO** : Transportation System Operator. Generally a TSO manage a EHV/HV network

187 **UML** : Unified Modelling Language

188 **Use case**

189 specification of a set of actions performed by a system, which yields an observable result that is,
190 typically, of value for one or more actors or other stakeholders of the system

191 [SOURCE: SG-CG/M490/E:2012-12]

192 Note – There are two types of Use Cases:

- 193 - Business Use Cases describe how Business Roles interact to execute a business process. These processes are
194 derived from services, i.e. business transactions, which have previously been identified.
- 195 - System Use Cases describe how System and/or Business Roles of a given system interact to perform a Smart Grid
196 Function required to enable / facilitate the business processes described in Business Use Cases. Their purpose is to
197 detail the execution of those processes from an Information System perspective.

198 Note 2 – Since a Smart Grid Function can be used to enable / facilitate more than one business process, a System Use Case
199 can be linked to more than one Business Use Case.

200 **XML**: eXtended Markup Language

201 **BUC**: Business Use Case (See Use Case)

202 **SUC**: System Use Case (see Use Case)

203

3 Use Cases list

3.1 Use cases related to the Common Distribution Power System Model Profiles

Business Processes and the associated interaction between business roles (inside and outside a given domain) can be described as Business Use Cases, Smart Grid Functions and the associated interactions between roles (Business and/or System roles) can be described in System Use Cases according to IEC/TS 62913 series

The definition of the Common Distribution Power System Model Profiles (CDPSM) standard is mainly based on the identification of the related Business and System Use Cases and their description in IEC 62559-2 template.

In order to identify the Business Use Cases of interest for CDPSM objectives, it was firstly analysed the BUC (Business Use Cases) collection specified in the IEC 62913-2-1 Ed. 1 (Table 3 – Identified Generic Business Use Cases of the Domain).

Table 3 - Identified Business Use Cases

Identified Business Use Cases	Brief description
Elaborate the distribution network multiannual masterplan	The Business Use Case describes how the HV and MV/LV System Operator elaborates the network multiannual masterplan by simulating constraints likely to appear on the network and prioritise network investments. <i>This Business Use Case is Generic and applied to European region</i>
Optimise network operations in operational planning based on a schedule	The Business Use Case describes how the HV and MV/LV System Operator anticipates / optimises network operations in medium-term (month and week ahead) and short-term (day ahead and intraday) operational planning. It consists in: - Anticipating the operating points based on local load and generation forecasts, identify and qualify risks of constraints on the network (primary substation, MV network, and HV network if managed by the HV and MV/LV System Operator), - Defining the network configuration in order to satisfy the contractual commitments, with the use of several optimisation levers which aim at solving detected constraints at the lowest cost, - Taking into consideration for all timeframes the work programmes, - Taking into consideration real-time network constraints (faults, transmission limitation or transmission outage, load transfers) and evaluating the impact on the operating points. <i>This Business Use Case is Generic and applied to European region</i>
Optimise work programmes (EHV and HV System Operator, Producers, and HV and MV/LV System Operator works)	The Business Use Case describes how the HV and MV/LV System Operator optimises work programmes on the HV and MV networks, i.e. schedules for operations related to the creation, maintenance, and repair of network assets – including works determined by the EHV and HV System Operator, HV and/or MV Producers, and the HV and MV/LV System Operator – in order to minimise their impact on the system and maximise renewable energy. <i>This Business Use Case is Generic and applied to European region</i>
Decide asset renewal priorities and optimise maintenance programmes	The Business Use Case describes how the System Operator decides asset renewal priorities and optimises maintenance programmes in the planning phase, based on the network assets analysis and the development of failure predictive and condition-based maintenance models.

Identified Business Use Cases	Brief description
	<i>This Business Use Case is Generic and applied to European region</i>
Decide to carry out urgent maintenance operations	The Business Use Case describes how the HV and MV/LV System Operator analyses network assets health indexes using archived data (assets use, maintenance operations, faults, voltage excursions...) and real-time data monitoring. Based on this information, the HV and MV/LV System Operator evaluates the risk of default and decides to carry out urgent maintenance operations to prevent faults. <i>This Business Use Case is Generic and applied to European region</i>
Operate the MV network in real-time in an optimised way using new automations and advanced functions	The Business Use Case describes how the MV/LV System Operator manages the MV network in real-time by optimising the configuration of the network, while ensuring coordination with the EHV-HV System Operator, maintaining voltage profile within acceptable limits, preventing critical situations using emergency levers, and restoring supply in case of faults. <i>This Business Use Case is Generic and applied to European region</i>
Monitor and manage the LV network	The Business Use Case describes how the MV/LV System Operator manages the LV network in real-time in normal conditions and in case of faults to maintain quality and continuity of supply, using for instance data from smart meters and other equipments installed on the network. <i>This Business Use Case is Generic and applied to European region</i>
Optimise grid operating conditions using available levers (LV phase balance optimisation and off-line MV/LV tap changers)	The Business Use Case describes how the HV and MV/LV System Operator performs load flow calculations based on archived metered, network and weather data and optimises: - The set point of the off line MV/LV tap changers, - The grid connection requirements, - The grid connection phase of single-phase meters which are already connected or to be connected to the LV network. This allows the HV and MV/LV System Operator to prevent network constraints and increase grid capacity. <i>This Business Use Case is Generic and applied to European region</i>
Deliver services based on data provision	The Generic Business Use Case describes how the Metering Data Manager transmits consumption data to Consumers or Metered Data User while respecting relevant data privacy issues. The Business Use Case includes the following steps: 1- Collection and revocation of the Consumer's consent 2-Collection and publication of personal consumption data to Consumers which have smart metering systems. 3- Collection, processing and transmission of consumption data to Metered Data User
Electrical Data Management in Nuclear Power Plants	Electrical data in nuclear power plants have to be managed, from the engineering studies to operation and maintenance. The electrical distribution grid of a nuclear power plant is substantial, and has to be managed carefully for safety reasons. Nuclear power plants have to be stopped regularly for refueling and maintenance (unit outage). The goal of nuclear utilities is to keep these unit outages as short as possible, in order to optimize the energy availability factor. The unit outages have then to be planned very precisely. Indeed, a lot of work has to be done in parallel, while some cooling circuits need to be preserved for nuclear safety. In this context, it is very important to be able to know (and simulate) which equipments are impacted by the unavailability of a distribution

Identified Business Use Cases	Brief description
	switch board: during planning, in order to optimize the maintenance work and during the unit outage itself, in order to face unexpected events. In addition, engineering teams also have to run simulations for power balance calculations and other network analyses.

From that list the BUC mainly considered for the definition of CDPSM are:

- Optimise network operations in operational planning based on a schedule
- Optimise network operations in real-time in an optimised way using new automations and advanced functions

CDPSM must support the following requirements extracted from the Business Use Case listed in Table 4

Table 4 - Identified Requirements

Requirement brief description
The MV/LV system operator in coordination with the EHV/HV System Operator, Producer and Customer, must have optimised the configuration of the network before real-time by using operational planning tools and load and generation forecasts at the primary substation level
The MV/LV system operator in coordination with the EHV/HV System Operator, Producer and Customer, must have taken into account the works planned on the MV/LV network and production schedules of Distributed Generators connected to the MV network if available
The Advanced FLISR System exchanges with MV System Operator : ○ Topological data and real-time operating conditions, ○ Load on Network assets and power flows, ○ Contextual information. ○ Protection plan and Network constraints in real time
The State estimation function shall integrate in its calculations the real-time network topology (position of switches) and impedances.
In case of a restoration plan requiring a load transfer, from one Primary Substation to another one, greater than a certain threshold, the MV System Operator exchanges information with the EHV/HV System Operator, in compliance with the Network operation contract in force between the two parties
Several voltage level mixing AC, DC network have to be managed (case of a Nuclear distribution network)

3.2 Use case overview table

In Table 5 are reported some more detailed BUC related to CDPSM scope.

Table 5- Business Use Case related to CDPSM

Name of Use Case	Short description	Actors	General remarks
DSO provides its power system models to TSO	In order to calculate the TSO grid power flow, the DSO provides to TSO an aggregate view of its power system model, including the related states and measurements.	TSO DSO	
A customer provides its DER plant power system models to DSO	A DER connection to Distribution grid request is supported by the description of an aggregate view of the DER plant power	DSO DER	

	system model		
DSO1 and DSO2 mutual exchange their power system models	DSO1 and DSO2 mutual exchange their power system models in order to manage the grid in case of outages on a boundary feeder	DSO1 DSO2	
TSO and DSO provides their power system models to a third party	TSO and DSO provides their power system models to a third party in order to perform an ex-post analysis of a power quality issue (i.e Voltage Dips)	TSO DSO Authority	
DSO/DNO internal information exchange	A DSO/DNO exchanges various information or data between different systems within the company	DSO or DNO	
DNOs provide their power system models to DSO	In order to perform network planning, various analyses, outage management, etc., of the whole distribution grid, the DSO needs power system models of the subordinate DNOs grids.	DSO DNO	DNOs own and operate a part of the whole distribution grid for which the DSO is responsible of

In order to support the definition of the CDPSM data requirement related to a concrete scenario, the section B.1 define a System Use Case (SUC) related to TSO-DSO information exchange supporting the first BUC listed in Table 5 .

This support also the same Use Case for an EMS: loadflow simulations (SV, SSH), transfer from detailed topology to bus branch model (TP Profile)

It is to be highlighted that the System Use Case supporting the BUC involving DSO and TSO roles defined in section B.1, could also be applied for BUC involving other roles (DSO/DSO, DSO/MicroGridSystemOperator, ...), since the profile requirements are equivalent.

4 Distribution network modelling specificities and CIM related issues resolved

4.1 Feeder modelling

In order to cover Use Cases such as outage management in a feeder (determine from which feeder we can transfer load) it is necessary to model the feeder with the CIM.

To do this with the current version of the CIM, there is a need to process the network connectivity, starting from the breaker in the primary substation, and following the connectivity chain (conducting equipments, terminals, and connectivity nodes) until the next breaker. Different set of rules, depending on utilities are applied to define the spreading part of network concerned by the connectivity processing.

This is typical to Distribution networks, where networks are managed as radial.

- Usually one Switch feeds a network part.
- Open Switches serve as borderline with other network parts (used to rescue when a feeder-switch is down).
- To satisfy different detailed level applications, expressing the composition of the feeder should be possible at 2 detail-levels: Containers and elementary equipments.
 - Containers: Substation, Line, VoltageLevel for undetailed definition.
 - ConductingEquipments or ConnectivityNodes for detailed definition.
- Feeders might be hierarchically subdivided (for Example a MV-Feeder feeds/includes several LV subnetworks).

A feeder modeled with CIM is illustrated in Figure 2:

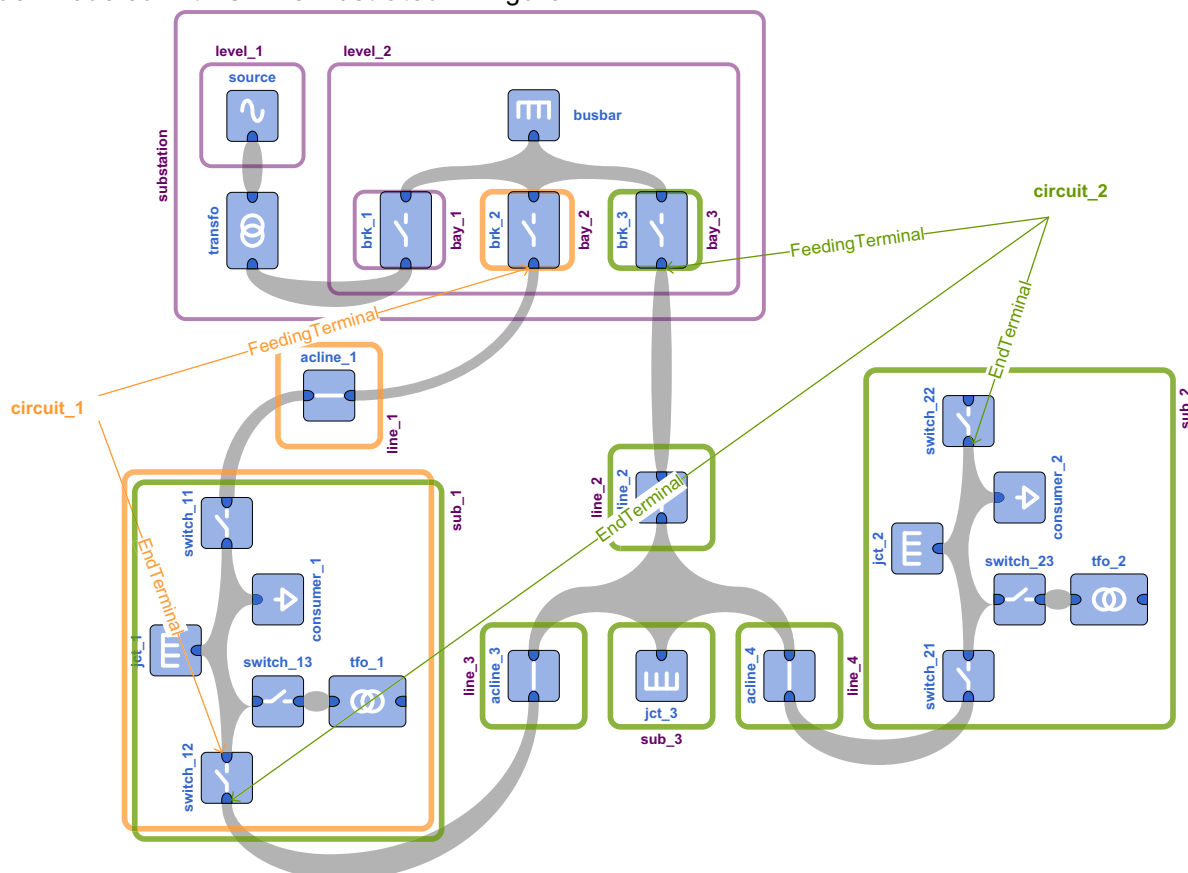


Figure 2 - CIM modelling of a substation network using circuit/feeder containers

To address distribution network with the CIM, without processing the connectivity it has been proposed to use the Circuit class (or name it as Feeder) because it existed in the previous version of the CIM and the needed associations have been added:

- Define associations to its contents:
 - EquipmentContainer<=>Circuit
 - ConductingEquipment<=>Circuit
- Define associations to its limits:
 - FeedingNodes: Circuit <=> Terminal. Identify the Terminal(s) of the ConductingEquipment considered as Incoming point of the feeder. (Might the feeder-switch, or first ACLineSegment connected to it).
 - CircuitEnds: Circuit <=> Terminal. Identify the Terminal(s) of open switches that are shared by 2 Circuits.
- Define association to its subdivisions:
 - Circuit(Including) <=> ("Included in") Circuit

Figure 3 describes the corresponding UML model of a feeder:

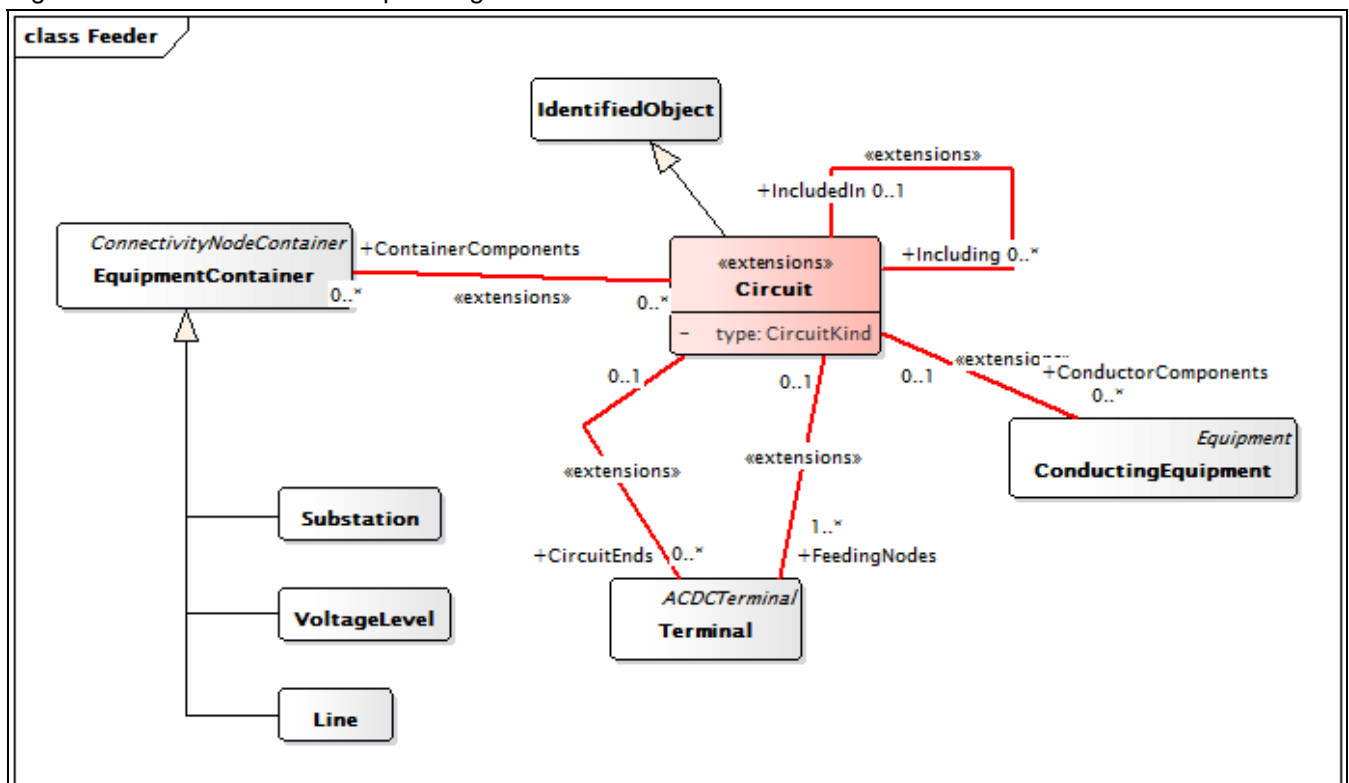


Figure 3 - Feeder UML model

The class Circuit, which inherits from IdentifiedObject, is not an equipment container. It is a different concept which aims at grouping equipment together. A Circuit can be associated with one Bay (optional). The Bay contains the Breaker that is the starting point of the feeder in the connectivity.

A Bay can be associated with one Circuit (optional). The Breaker of the Bay cannot be the starting point of more than one feeder. A Circuit can be associated with multiple Substation, Line and Plant (optional). These are the containers which contains the equipment that are connected to the same feeder. The grouping Circuit->containers should be consistent with the normal status of the switches supplied by the feeder: it should be consistent with Switch.normalOpen.

A Line or a Plant can be associated with one Circuit (optional). These containers are supposed to be supplied by only one feeder.

A substation can be associated with multiple Circuit (optional). A substation can be part of two distinct feeders, when this substation is at the boundary between two feeders. These two feeders overlap, and this "boundary" substation is an element of their two groups.

With this model, it is possible to know the Circuit from which a load transfer can be done, without processing the connectivity: these "transferable" feeders are the Circuits which have a common Substation with the current Circuit.

315

316 4.2 Partial-phase devices modelling

317

318 The IEC 61970-301 standard already has support for partial phase conducting devices through the
319 phase-code attribute which may be a combination of any or all of the letters A, B, C, and N. In general
320 one can think of a partial phase conducting device as being the same as a full 3-phase device with
321 some of the phases missing.

322

323 Impedances of unbalanced and partial phase devices:

324 61970-301 specifies impedance of conducting devices in terms of the real and reactive positive and
325 zero sequence impedance. Unfortunately, this is only valid for perfectly symmetric three-phase networks
326 where all 3 phases have the same value of self-impedance and the same mutual impedance value.

327

328 The impedance of unbalanced 3-phase conducting devices such as AC line segments must be specified
329 as a three by three complex matrix where the diagonal terms specify the self impedance of each phase
330 and the off-diagonal terms specify the mutual impedance between each phase pair. These values can
331 be computed using Carson's equations based on the geometric mean radius, the linear resistance and
332 the geometric arrangement of the three phases on the pole. 61970-301 provides all the parameters
333 necessary in the Conductor and WireArrangement classes. For 2-phase devices the impedance matrix
334 is two by two and for single-phase devices it is a complex scalar specifying the self impedance of the
335 single phase
336 conductor.

337

338 4.3 Manage LV cables in catalog

339

340 LV cables are commonly compound in a single asset of conductors with different characteristics: three
341 identical conductors for phases, a different conductor to the neutral.

342 To manage them in catalog, associated with AssetModel, it needs to set a assetinfo subtype that allows
343 to describe these assemblies:

344

- 345 • Characteristics (WireInfo) of each of the different type of conductors,
- 346 • Their respective quantities or assignment to phases / neutral
- 347 • Impedances.

348 (quantities or phase / neutral assignment are needed to identify clearly which phasing usage can be
349 done, and which WireInfo affects which column if PhaseImpedance by only using the level objects
350 "catalog" without resorting to a ACLineSegmentPhase link)

351

352 This applies to underground cables or twisted-assembled overhead use, but it would also be helpful for
353 overhead with single conductors. Good practices mounting rules in several utilities allow a limited amount
354 of opportunities for wires and positions assemblies. So it is more simple and concise to manage a
355 catalog of predefined assemblies, associating them with ACLineSegments, without the need to
356 repeatedly declare ACLineSegmentPhase to distinguish the 2 different WireInfos needed.

357

358 This issue can be addressed through two proposed resolution described in Figure 4 and Figure 5:

359

- 359 • New WireAssemblyInfo with two links to WireInfo and one link to PerLengthLineParameter
- One attribute phaseUsage (phase/neutral) on WireInfo and one link to PerLengthLineParameter

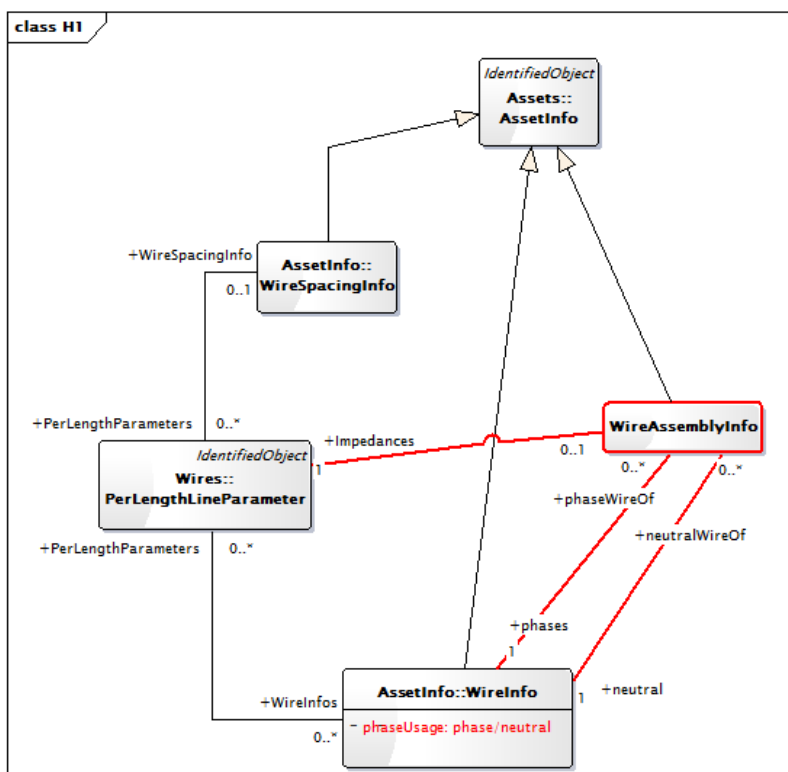


Figure 2 - Proposed WireAssemblyInfo UML Model 1

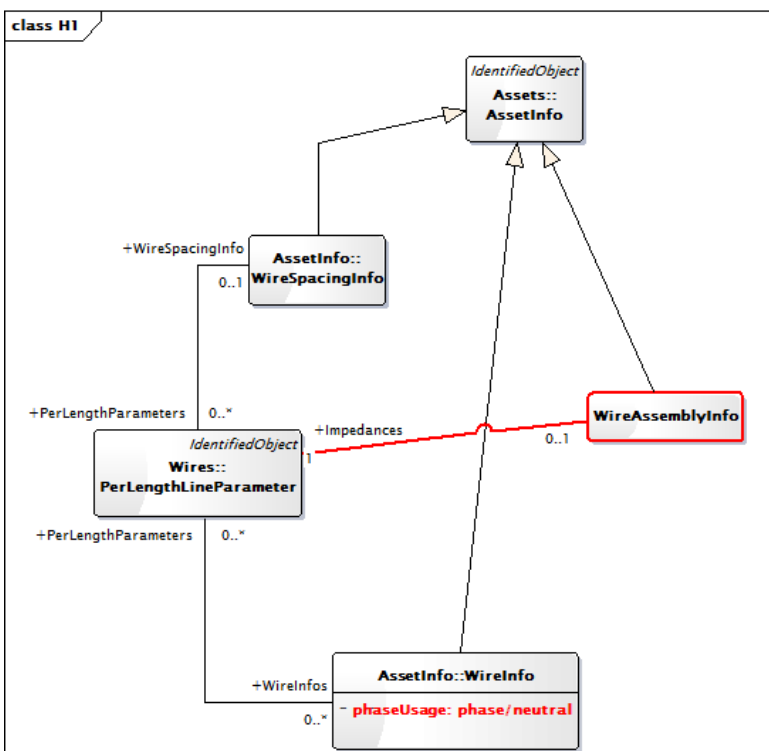


Figure 3 - Proposed WireAssemblyInfo UML Model 2

5 CIM Distribution Power System Model Profiles

5.1 General

This chapter lists the profiles that will be used for data exchange and the classes, attributes, and associations that are a part of each profile. Included are all the classes that a data consumer would be expected to recognize in the data being consumed. Additional classes are referenced in this chapter, when the classes to be exchanged inherit attributes or associations. For instance, many classes inherit attributes from the class IdentifiedObject. However, no instances of the class IdentifiedObject would exist in the data exchanged, so IdentifiedObject has not been included in the set of CIM classes for exchange.

CIM version used is IEC61970CIM17v09.

CDPSM version is cdpsm2015 v0.2.c from 2016-04-05.

Content generated from UML model file CDPSM2015-TC57CIM+CDPSMglobal+CDPSMProfile.eap.

The profiles and associated URIs are listed in Table 6.

Table 6 – CDPSM Profiles

Name	Version	URI	Revision date
Functional	1	http://iec.ch/TC57/61968-13/Functional/1	2016/04/05
ElectricalProperties	1	http://iec.ch/TC57/61968-13/ElectricalProperties/1	2016/04/05
Topology	1	http://iec.ch/TC57/61968-13/Topology/1	2016/04/05
Steady State Hypothesis	1	http://iec.ch/TC57/61968-13/SteadyStateHypothesis/1	2016/04/05
StatesVariable	1	http://iec.ch/TC57/61968-13/StateVariable/1	2016/04/05
Geographical	1	http://iec.ch/TC57/61968-13/Geographical/1	2016/04/05
Diagram Layouts	1	http://iec.ch/TC57/61968-13/DiagramLayouts/1	2016/04/05
Asset	1	http://iec.ch/TC57/61968-13/Asset/1	2016/04/05
Catalog	1	http://iec.ch/TC57/61968-13/Catalog/1	2016/04/05

The main steps for profiling CDPSM with CIM is presented in Figure 4:

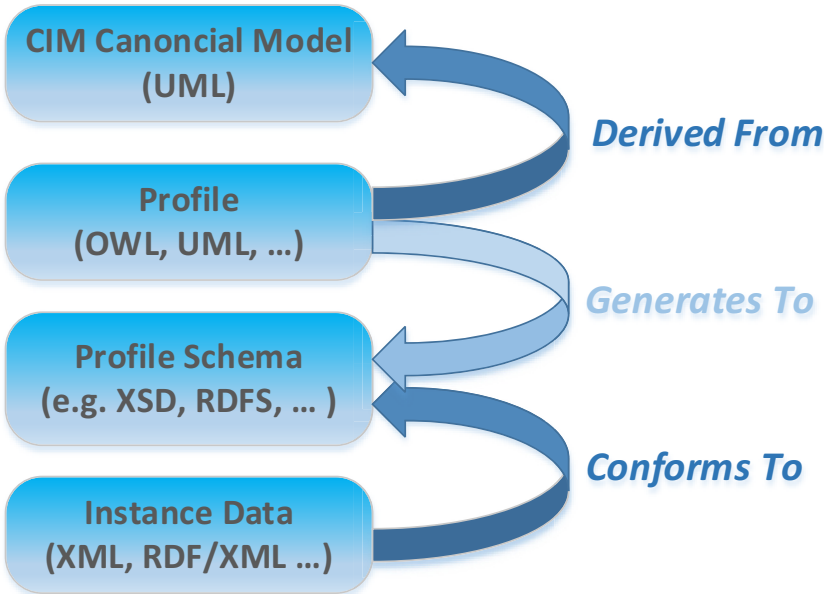


Figure 4 - Main steps for profiling CIM

The CDPSM Profiles named in Table 5 and described in the following sections, are derived from CIM Model (IEC 61970-301, IEC 61968-11) as described in the figure 5:

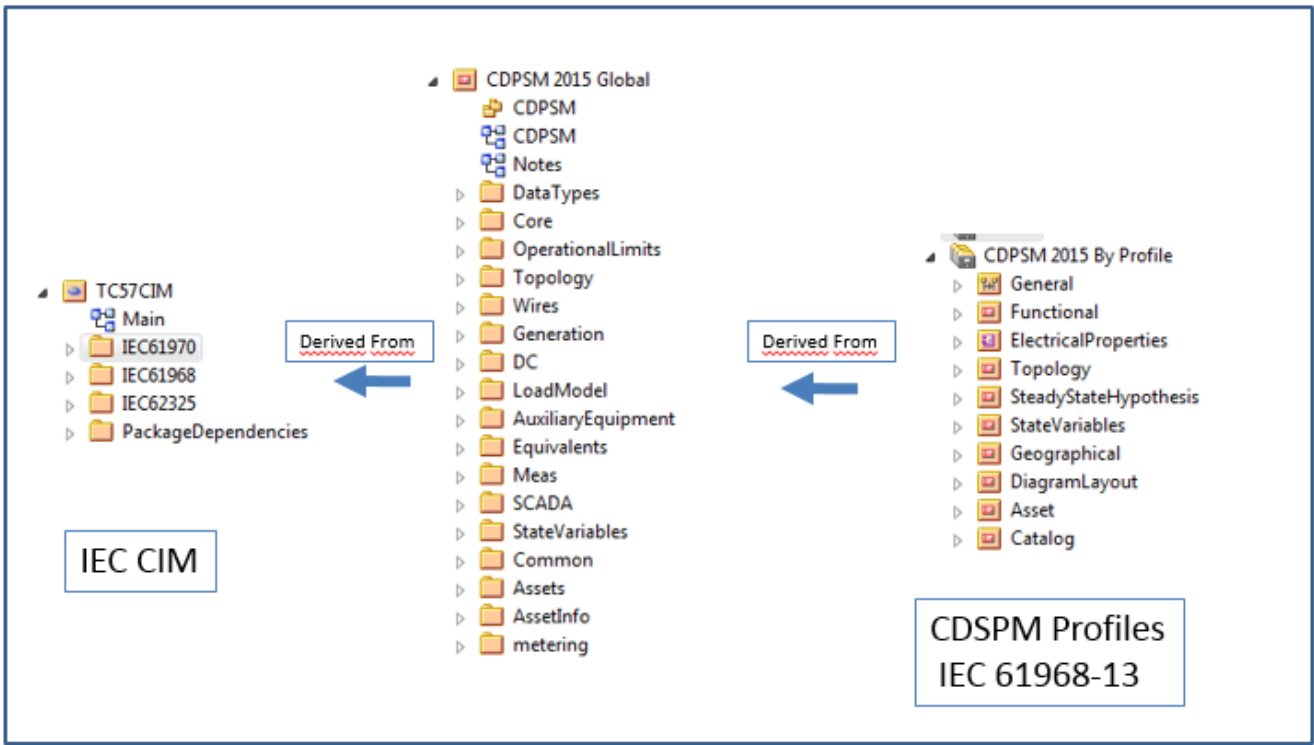


Figure 5 - UML CDPSM profiles

Figure 6 illustrates how CDPSM related profiles can be used in a utility environment. The Network Model Management will manage Power System Resources and Asset related classes. Some electrical properties can be found on a Power System Resources or could be taken from Catalog, or use a default value.

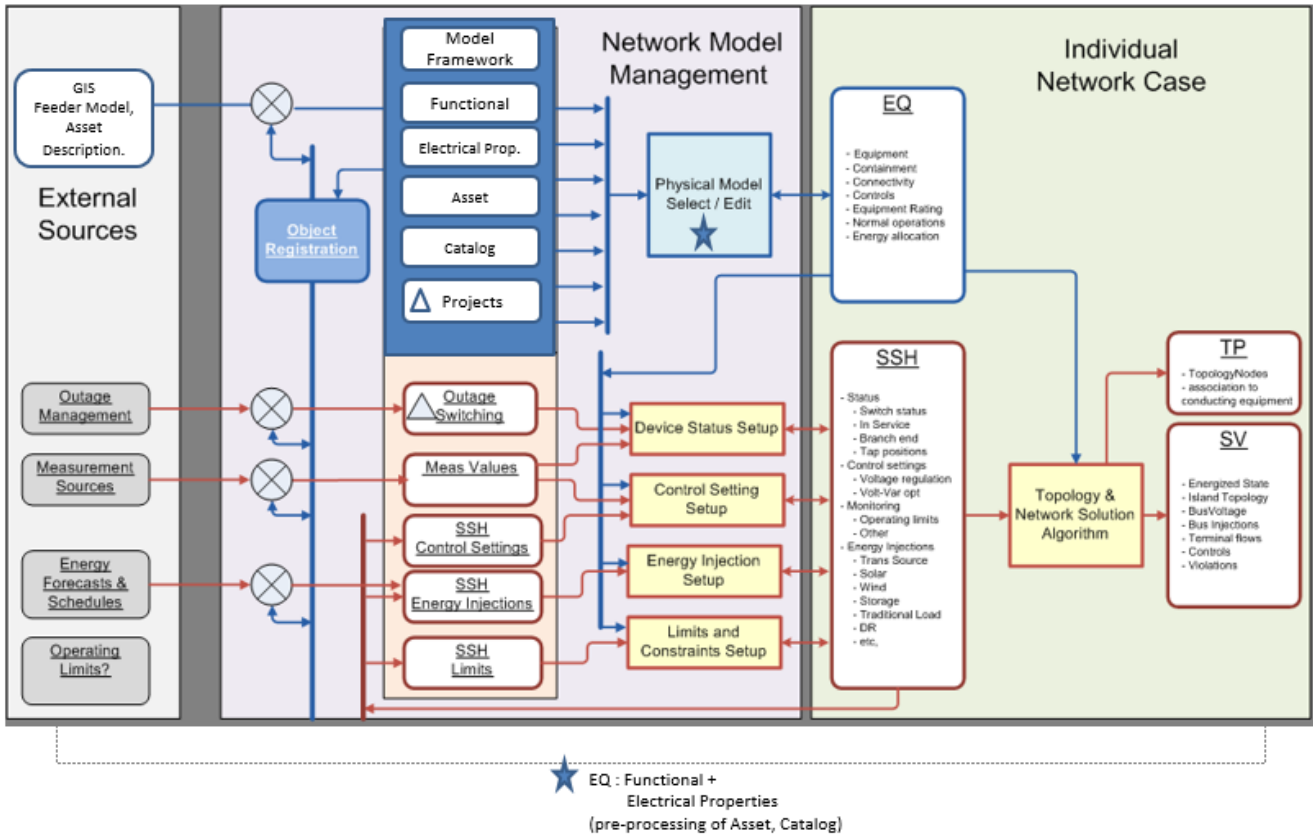


Figure 6 - CDPSM and 61970-45x profiles usage

If a topology or **Network solution algorithm** requires electrical properties being on each Equipment related classes, then the individual Network Case will be exported from Network Model Management with a processing on the Data Sets, in order to be in the requested format.

In Europe, ENTSO-E has defined Common Grid Model Exchange Standard (CGMES) which defines the interface between ENTSO-E members' software in order to exchange power system modelling information as required by the ENTSO-E and TSO business processes. Some profiles defined by ENTSO-E for now, are not used by DSO at the present time. This does not prevent a DSO network Distribution data set compliant with CDPSM profiles to leverage CGMES profiles implemented by a Vendor product. Figure 9 illustrates the process:

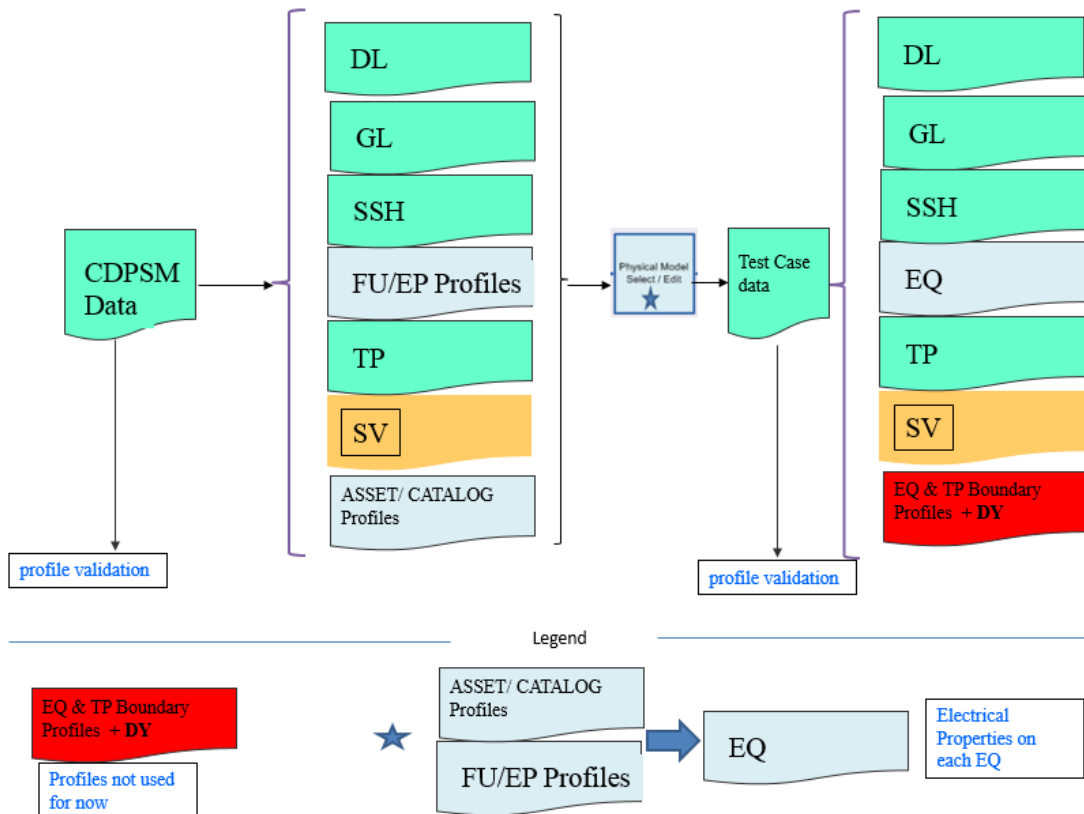


Figure 7 - Data Set Transformation

Some Network examples are given in Annex C, D, E, F, G, H.
 Annex C describes a North American Distribution Network.
 Annex D describes an Example of a European CDPSM MV/LV urban & rural network
 Annex E describes an Example of a European CDPSM MV/LV urban network
 Annex F describes an Example of a European CDPSM MV Urban and Rural Network
 Annex G describes an example of a Microgrid network
 Annex H describes an Example of a Nuclear Distribution Network.

5.2 Top package General

5.2.1 General

CDPSM 2015 profiles are build with the MODSARUS tool (Copyright © 2012, EDF R&D contact: modsarus@edf.fr) that provides profiling definition and editing in UML.

This tool 's scope is for Modelling Interoperable Electronic Data Interchanges for the Use Cases of the Electric Power System. This is complete modelling solution to provide in UML a methodology to support

IEC standards from Use Cases (IEC62913 and IEC62559) down to data flow modelling in particular regarding IEC CIM standards.

444

445

This tool is implemented as an add-in to Enterprise Architect (Copyright © 1998-2015, Sparx Systems <http://www.sparxsystems.com>) the UML modelling tool with which the CIM model is managed.

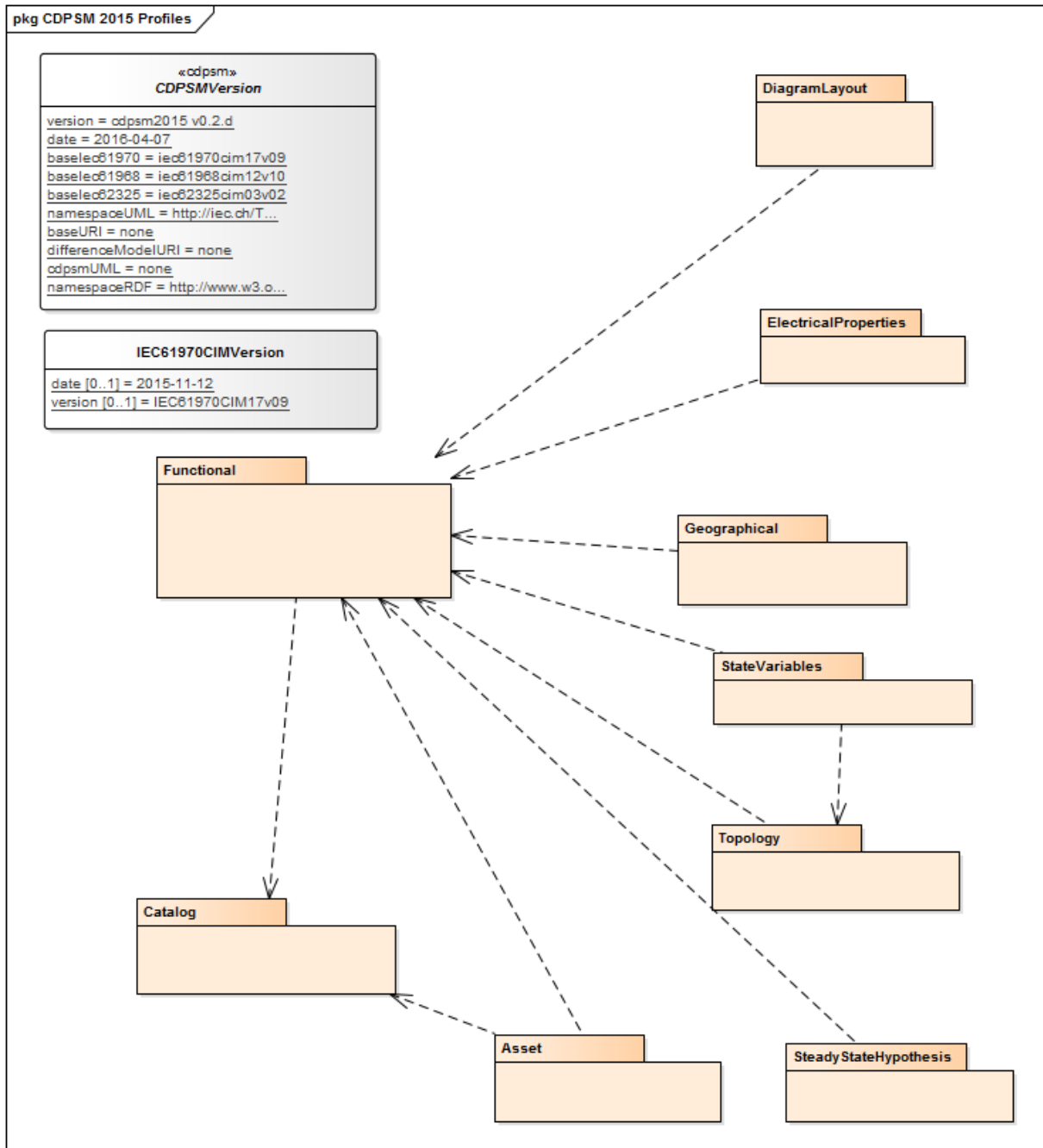


Figure 8 – Package diagram General::CDPSM 2015 Profiles

448

449

450

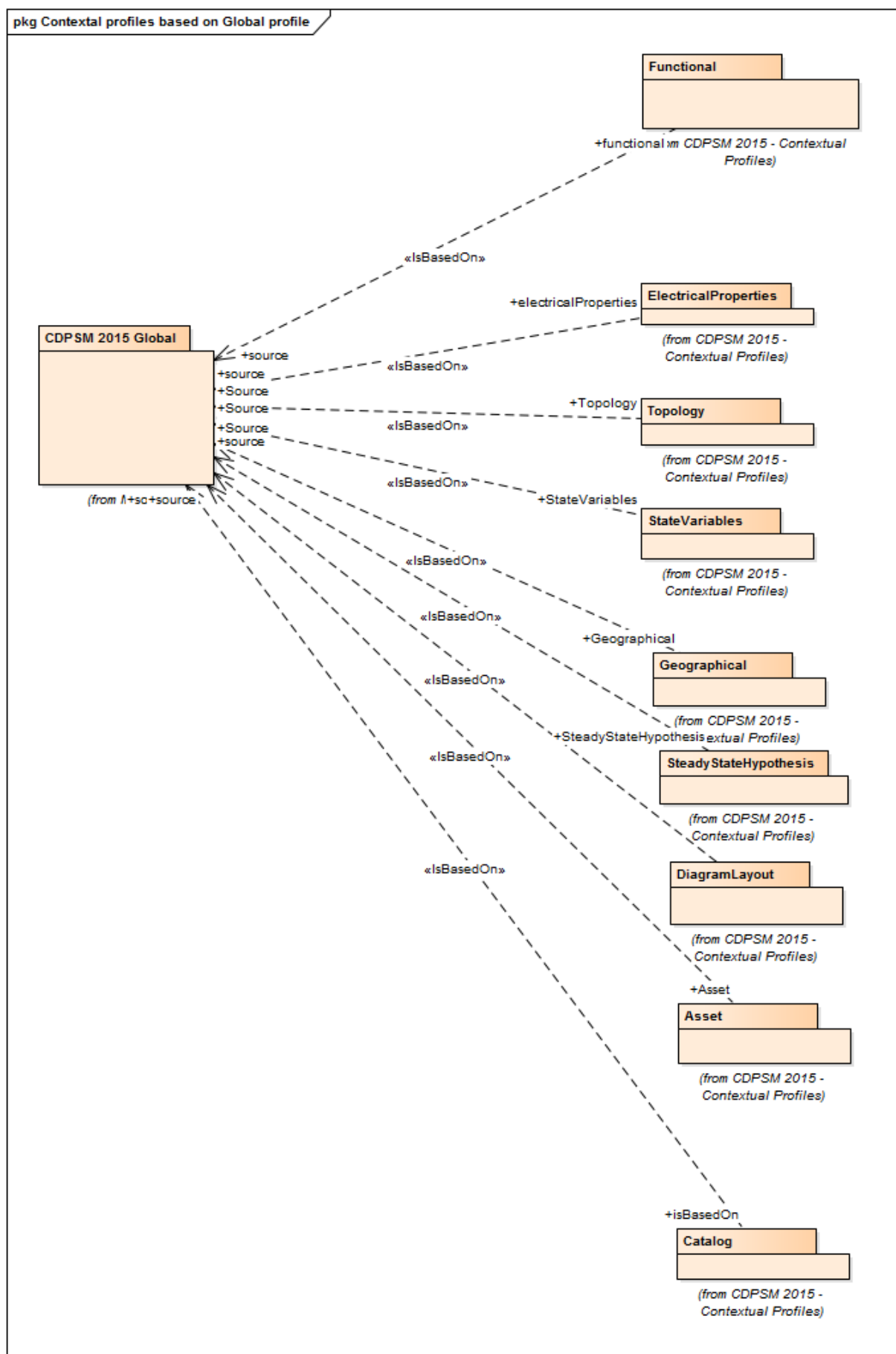


Figure 9 – Package diagram General::Contextual profiles based on Global profile

454 **5.2.2 (abstract) CDPSMVersion root class**

455 CDPSM profiles set version details.

456 This is a draft version, profiles are still in construction

457 Table 4 shows all attributes of CDPSMVersion.

458 **Table 4 – Attributes of General::CDPSMVersion**

name	mult	type	description
version	1..1	String	(const=cdpsm2015 v0.2.d) working in progress to construct profiles.
date	1..1	NullCIM	(const=2016-04-07) Profile creation date Form is YYYY-MM-DD for example for January 5, 2009 it is 2009-01-05.
baselec61970	1..1	NullCIM	(const=iec61970cim17v09) Base UML provided by CIM model manager, submodel 61970.
baselec61968	1..1	NullCIM	(const=iec61968cim12v10) Base UML provided by CIM model manager, submodel 61968.
baselec62325	1..1	NullCIM	(const=iec62325cim03v02) Base UML provided by CIM model manager, submodel 62325.
namespaceUML	1..1	NullCIM	(const=http://iec.ch/TC57/2016/CIM-schema-cim17#) CIM UML namespace.

459

460

5.3 Top package Functional

5.3.1 General

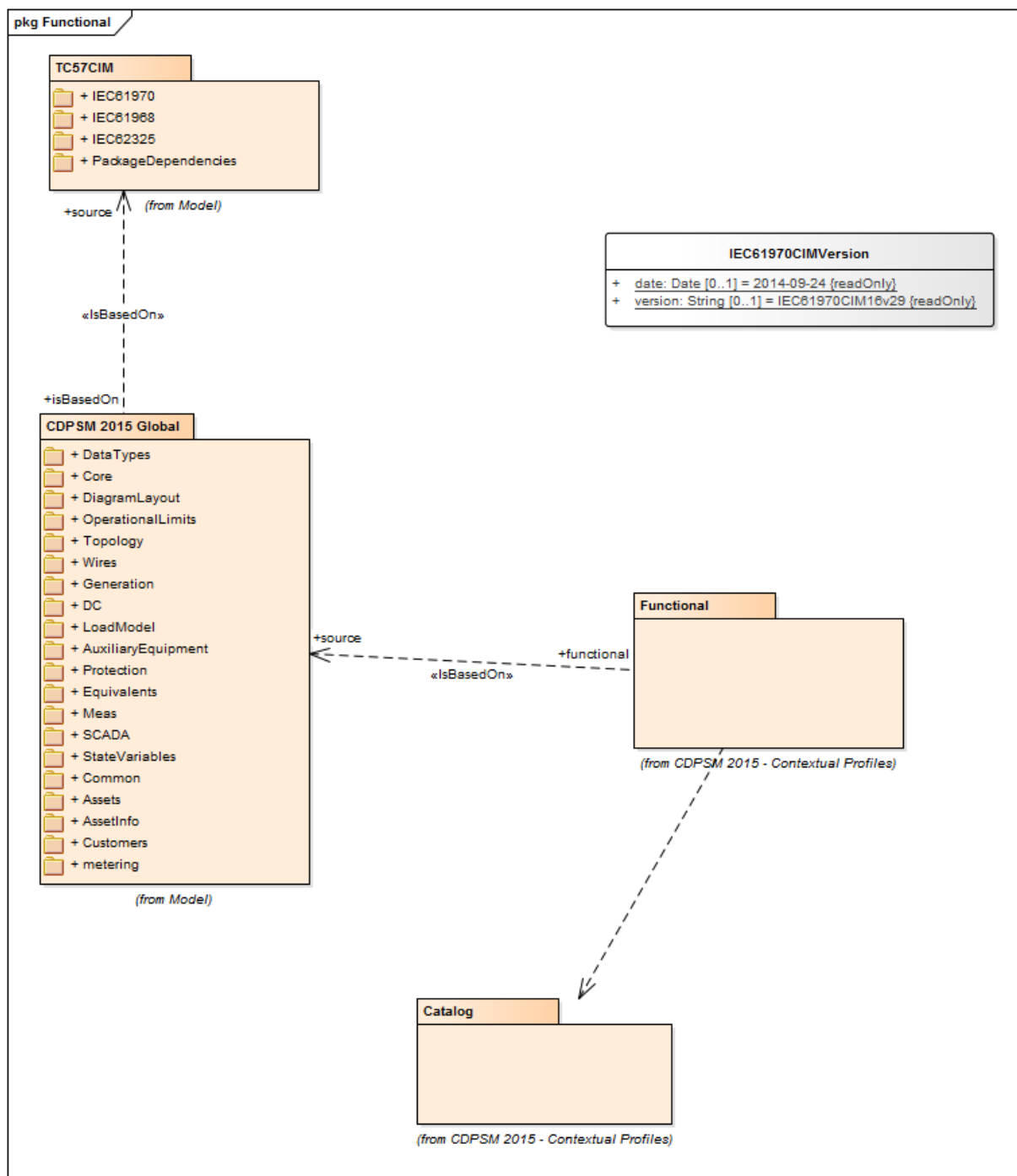


Figure 10 – Package diagram Functional::Functional

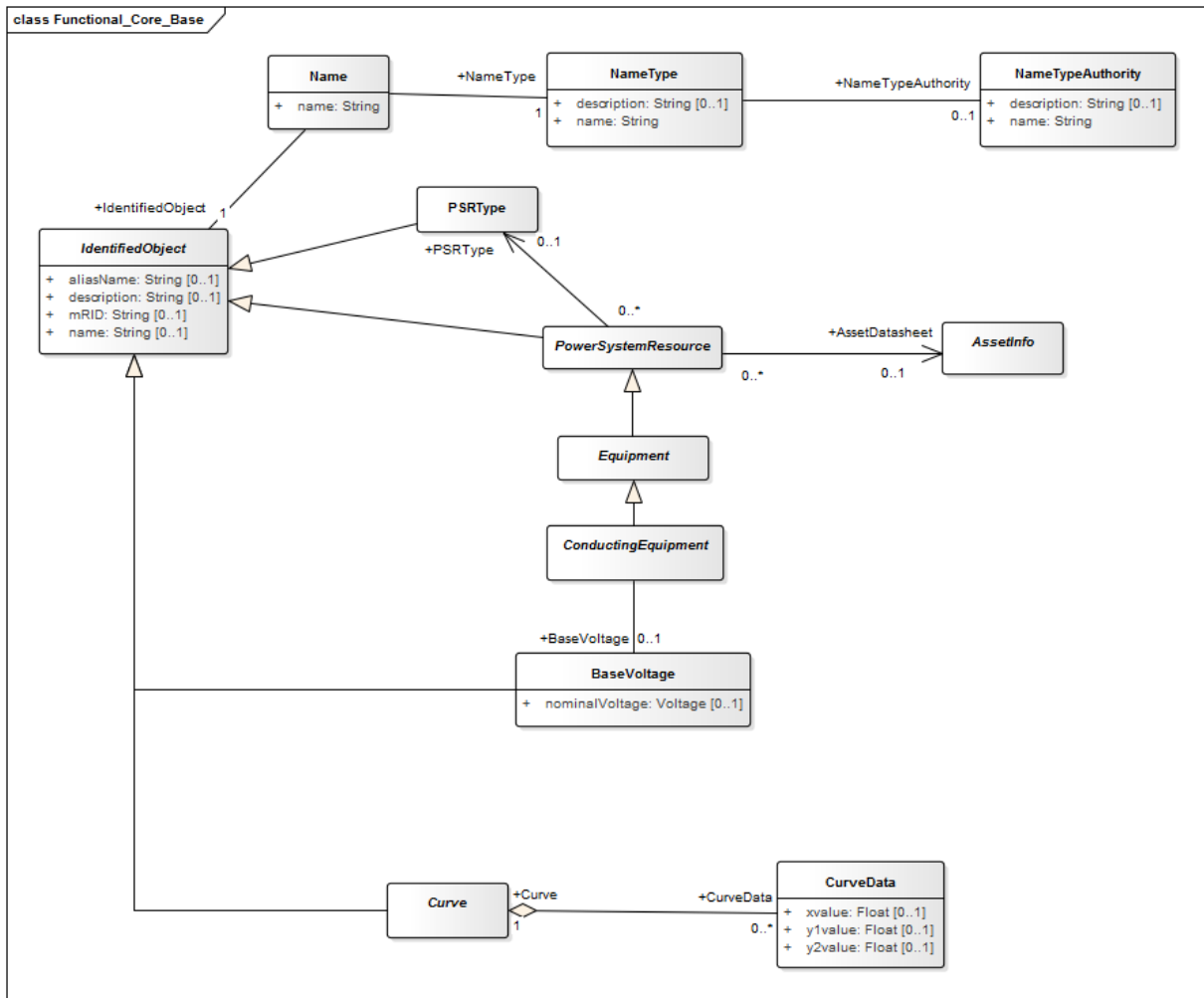


Figure 11 – Class diagram Functional::Functional_Core_Base

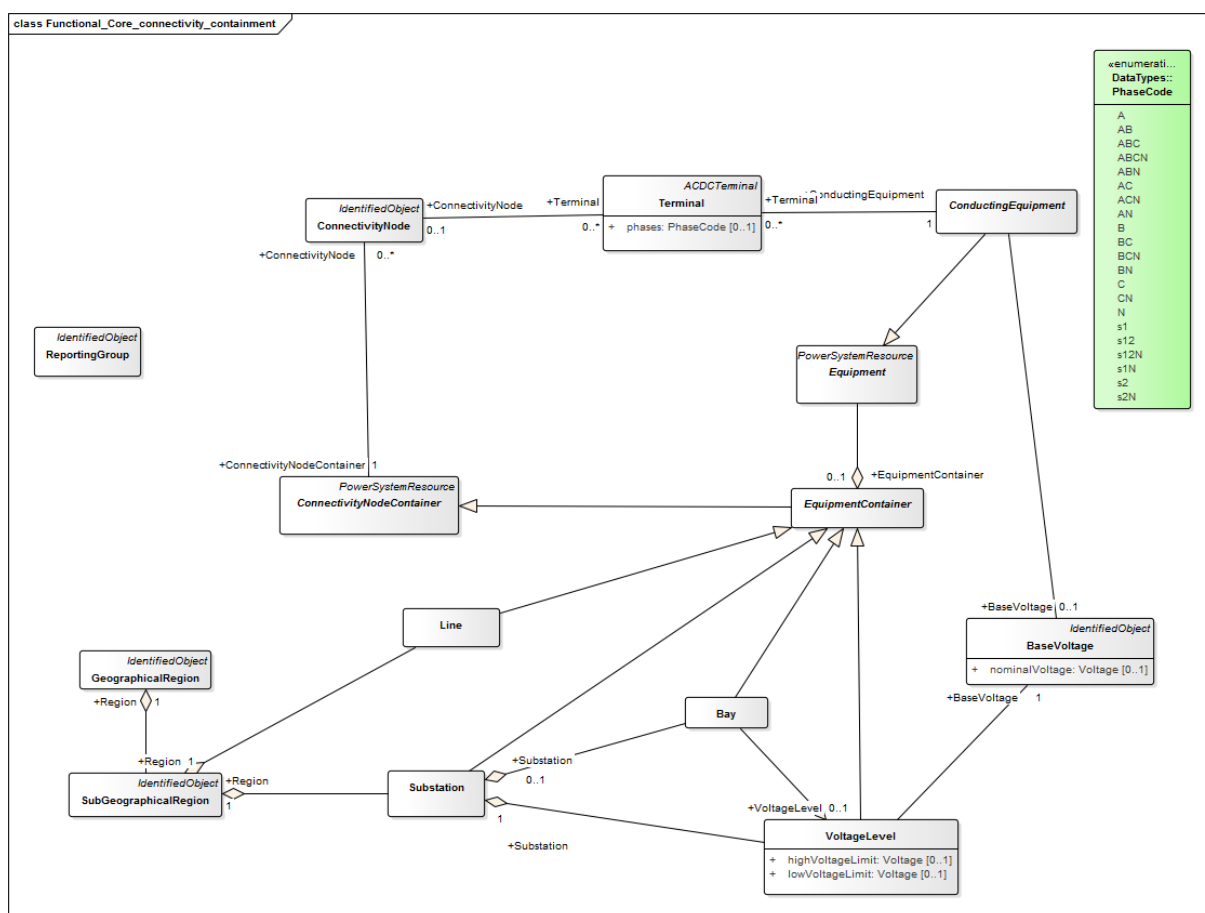


Figure 12 – Class diagram Functional::Functional_Core_connectivity_containment

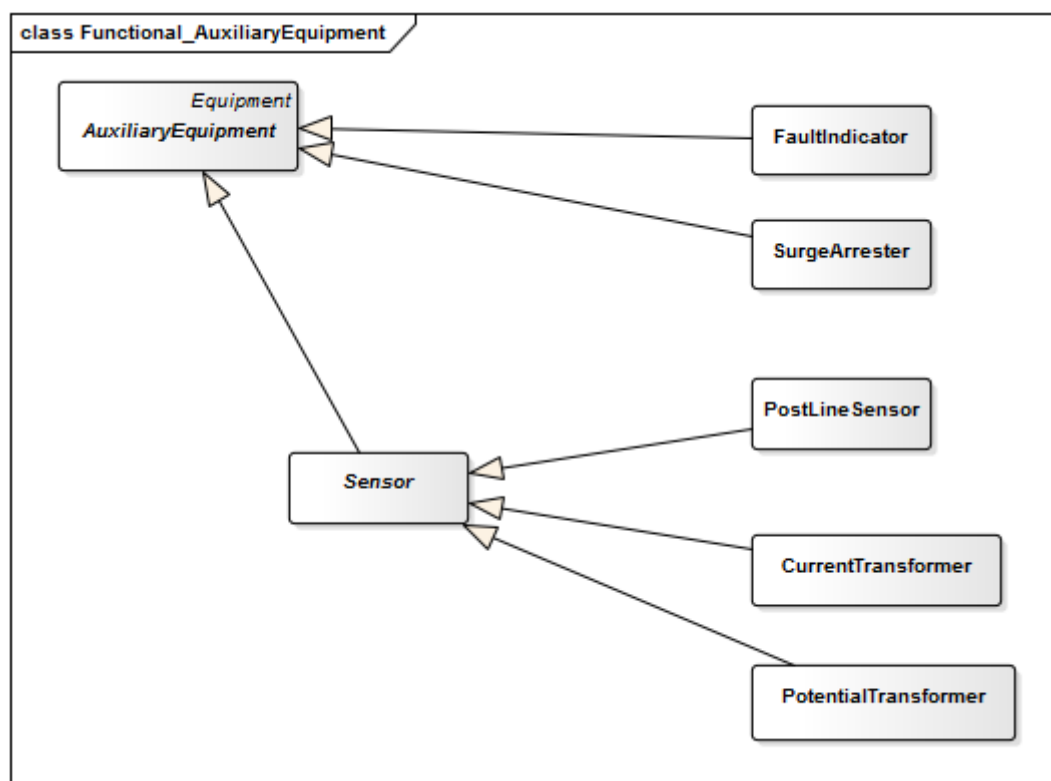


Figure 13 – Class diagram Functional::Functional_AuxiliaryEquipment

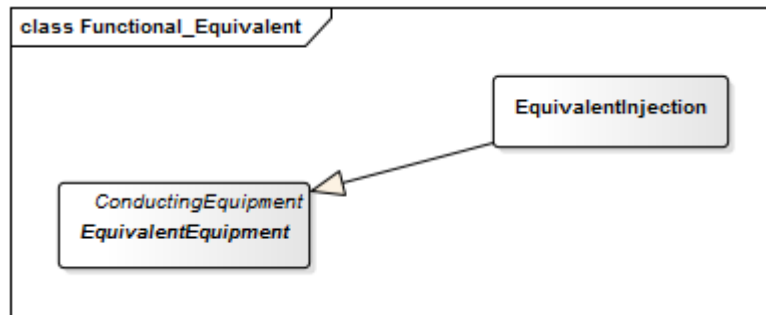


Figure 14 – Class diagram Functional::Functional_Equivalent

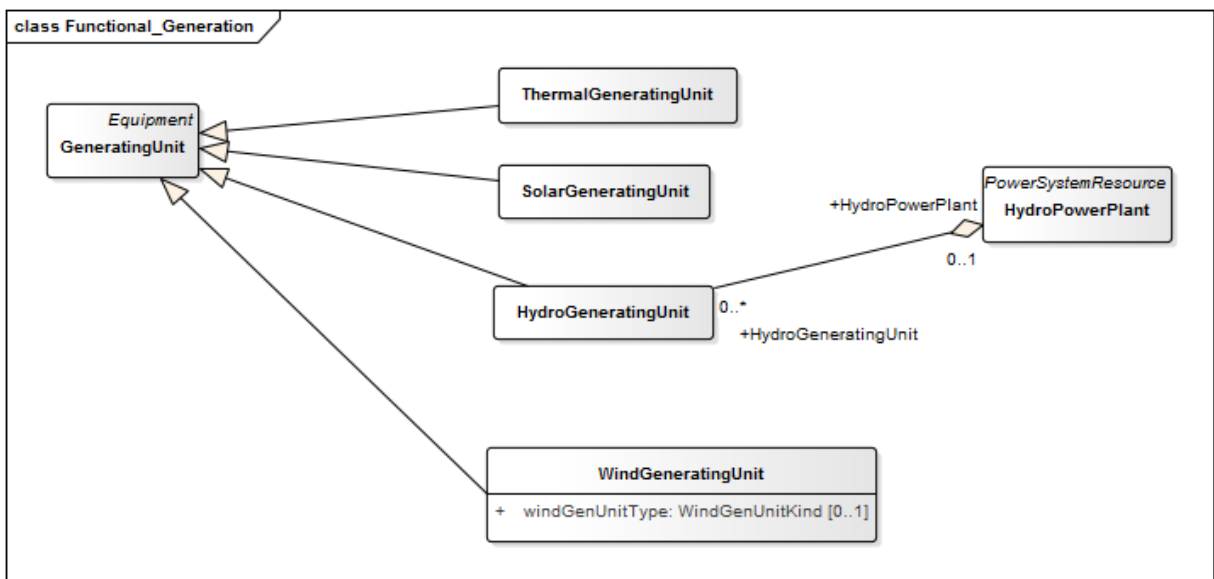


Figure 15 – Class diagram Functional::Functional_Generation

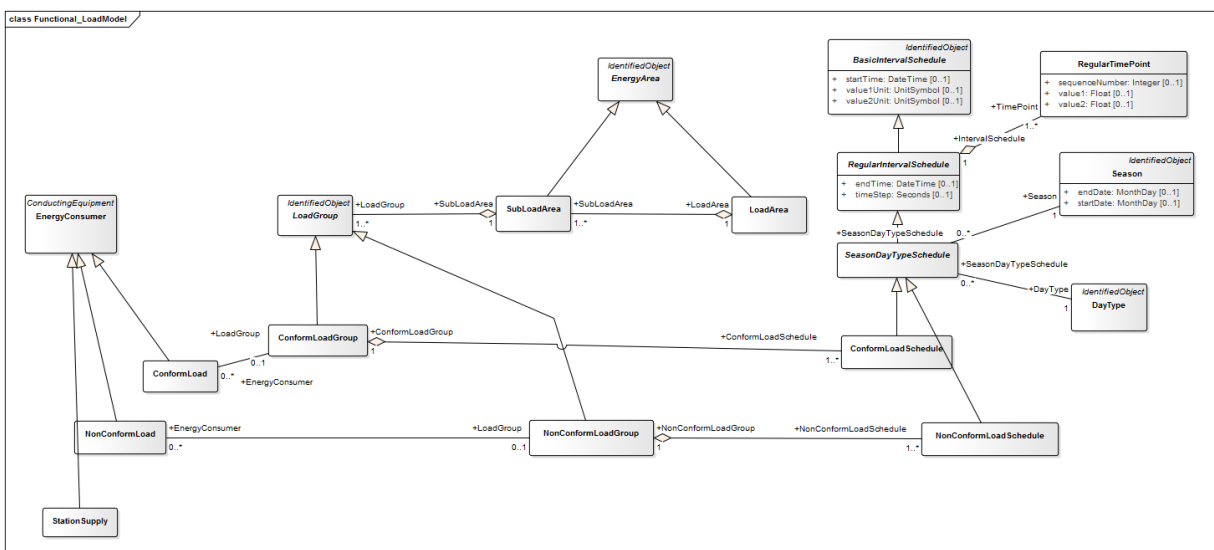


Figure 16 – Class diagram Functional::Functional_LoadModel

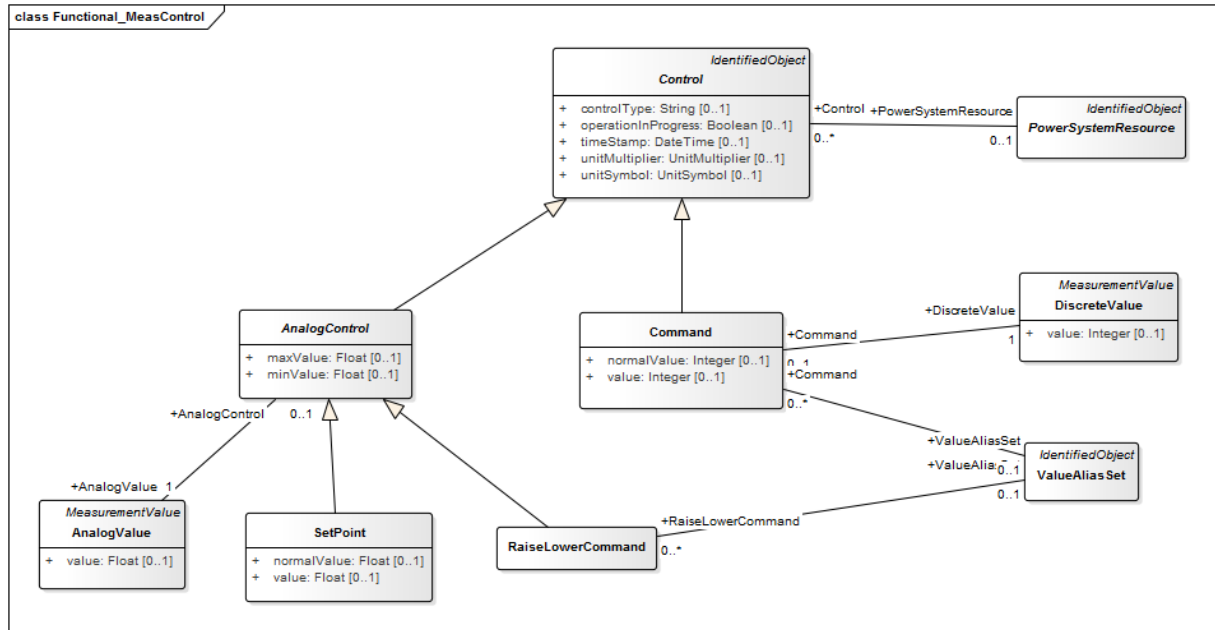


Figure 17 – Class diagram Functional::Functional_MeasControl

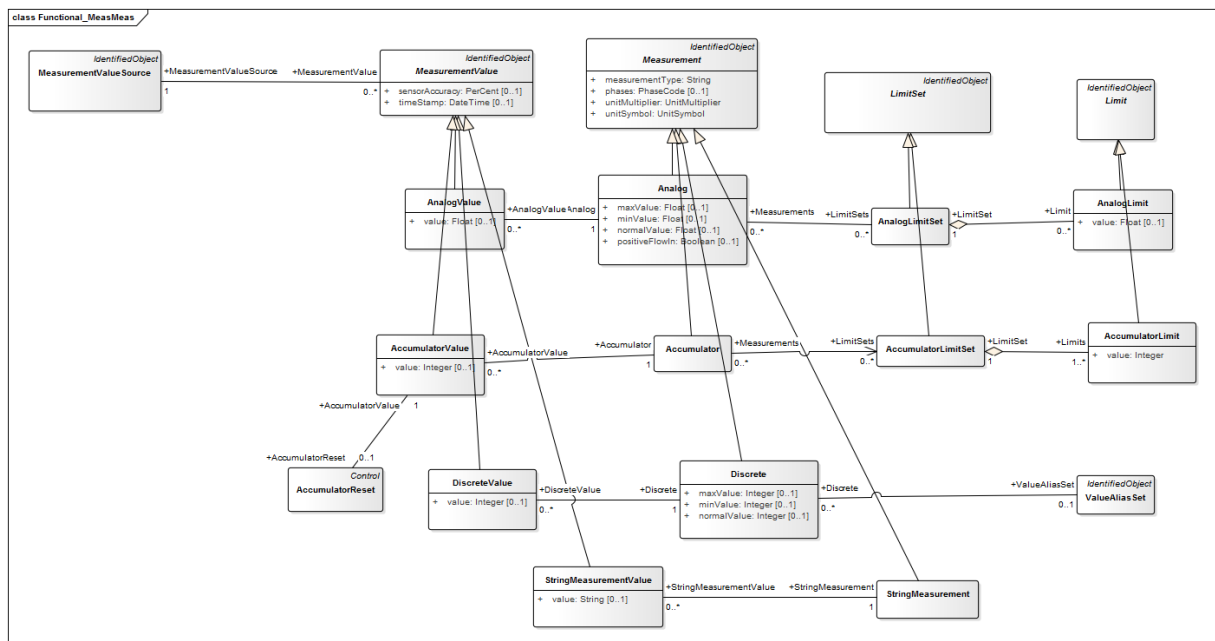


Figure 18 – Class diagram Functional::Functional_MeasMeas

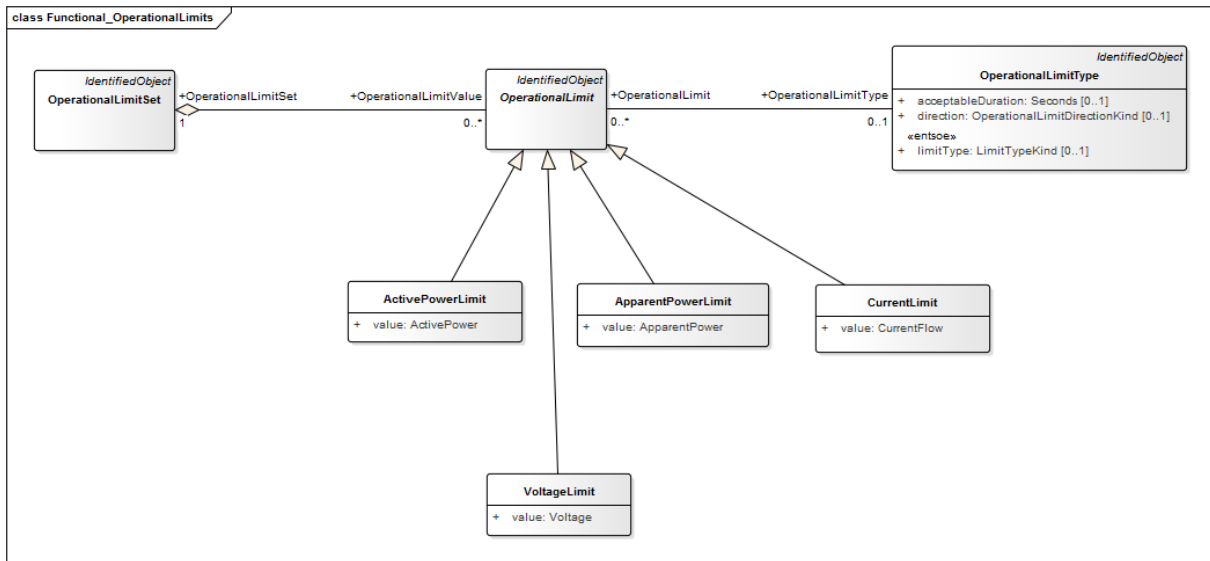


Figure 19 – Class diagram Functional::Functional_OperationalLimits

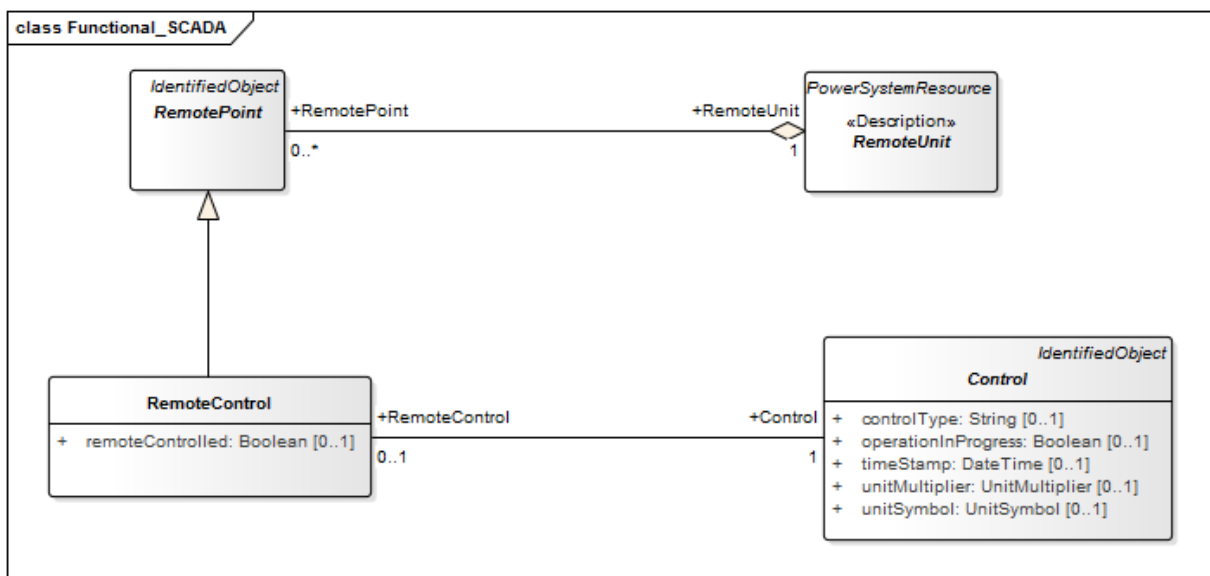


Figure 20 – Class diagram Functional::Functional_SCADA

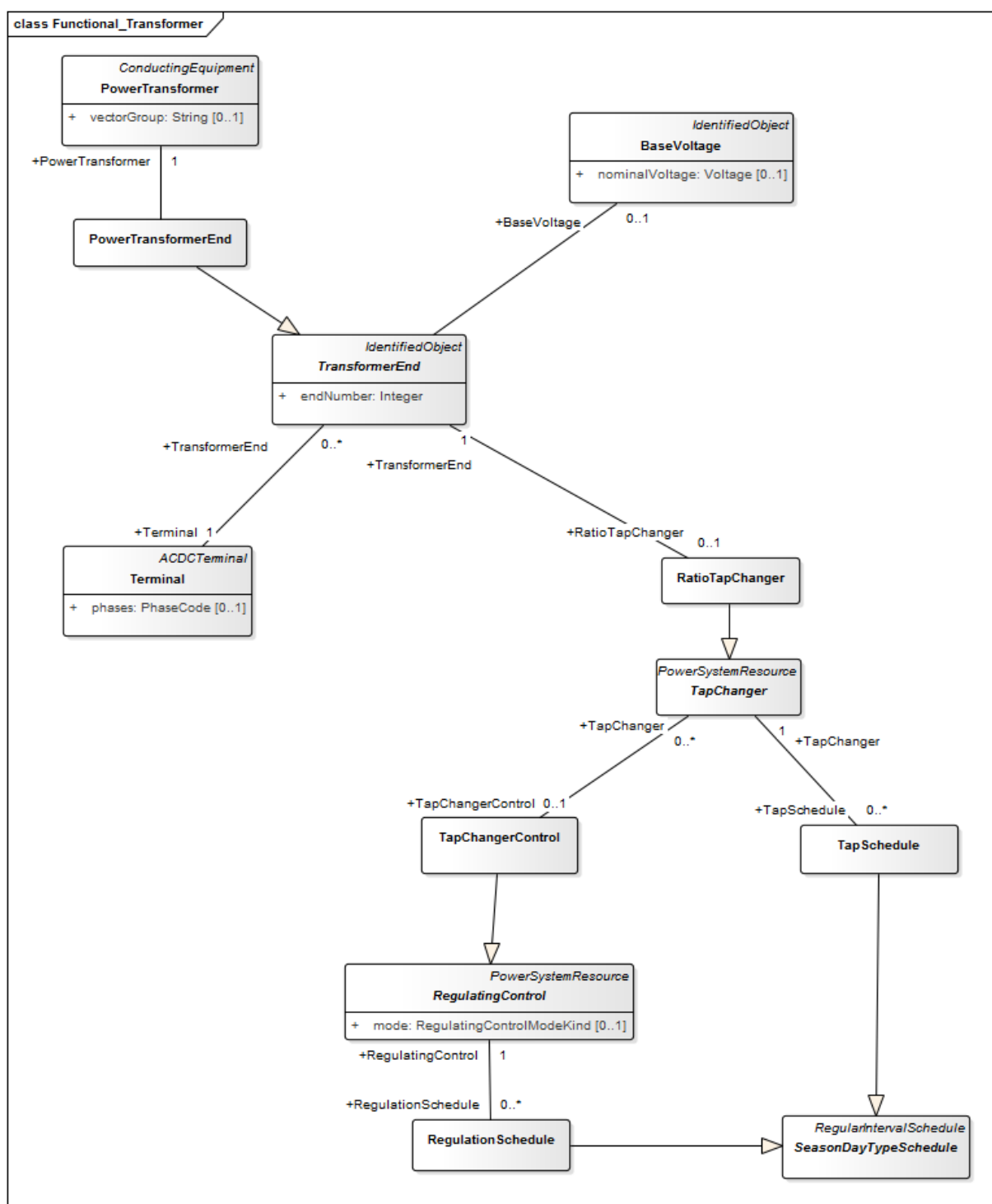


Figure 21 – Class diagram Functional::Functional_Transformer

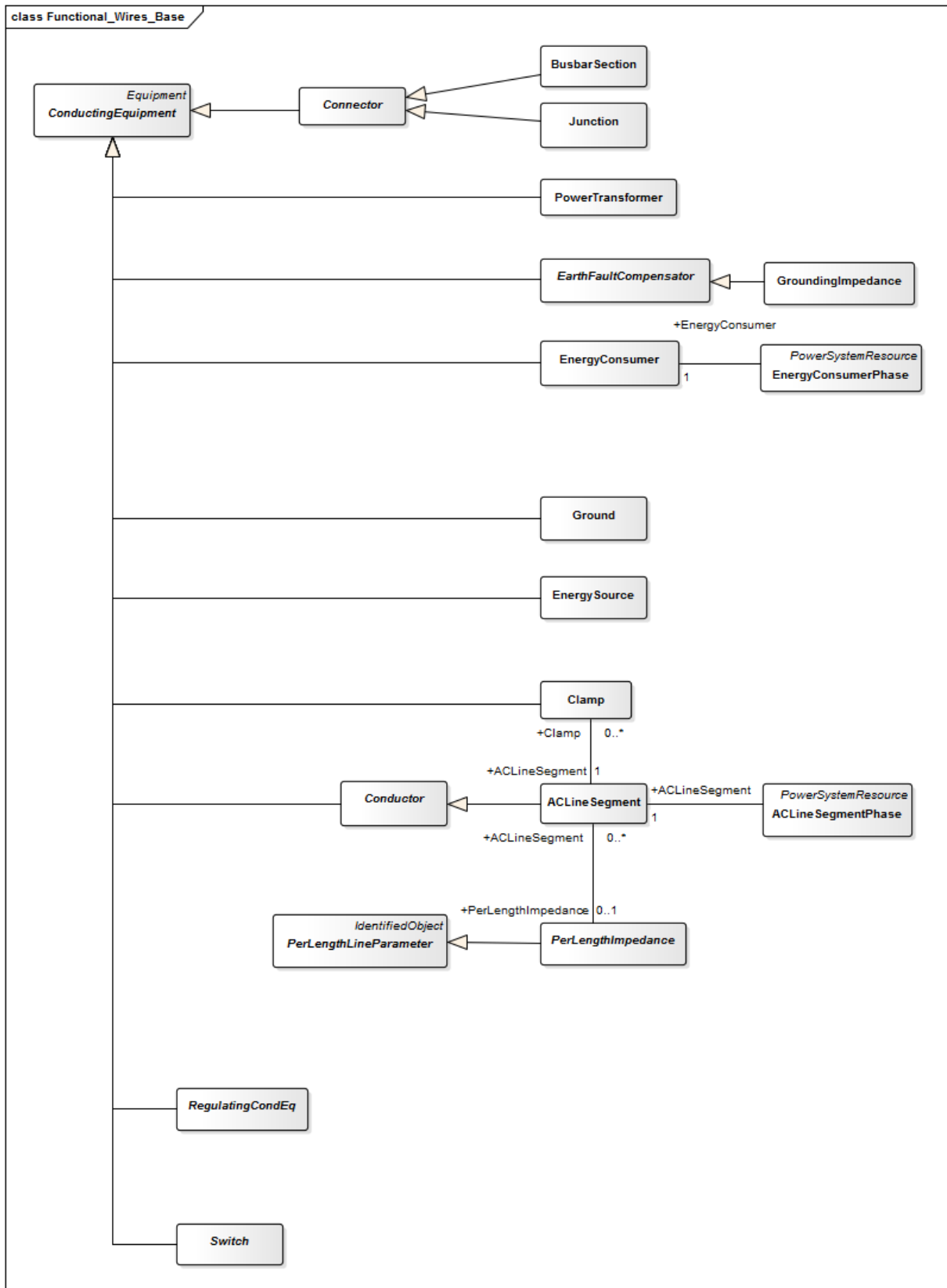


Figure 22 – Class diagram Functional::Functional_Wires_Base

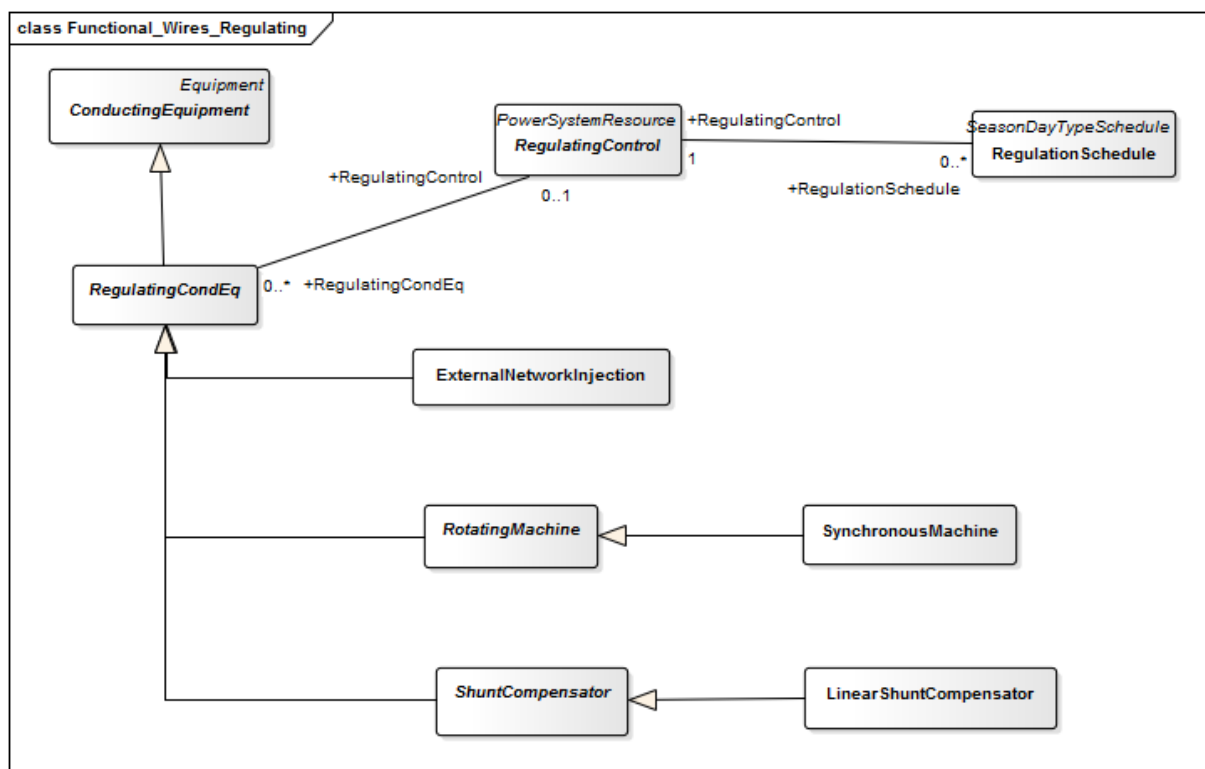


Figure 23 – Class diagram Functional::Functional_Wires_Regulating

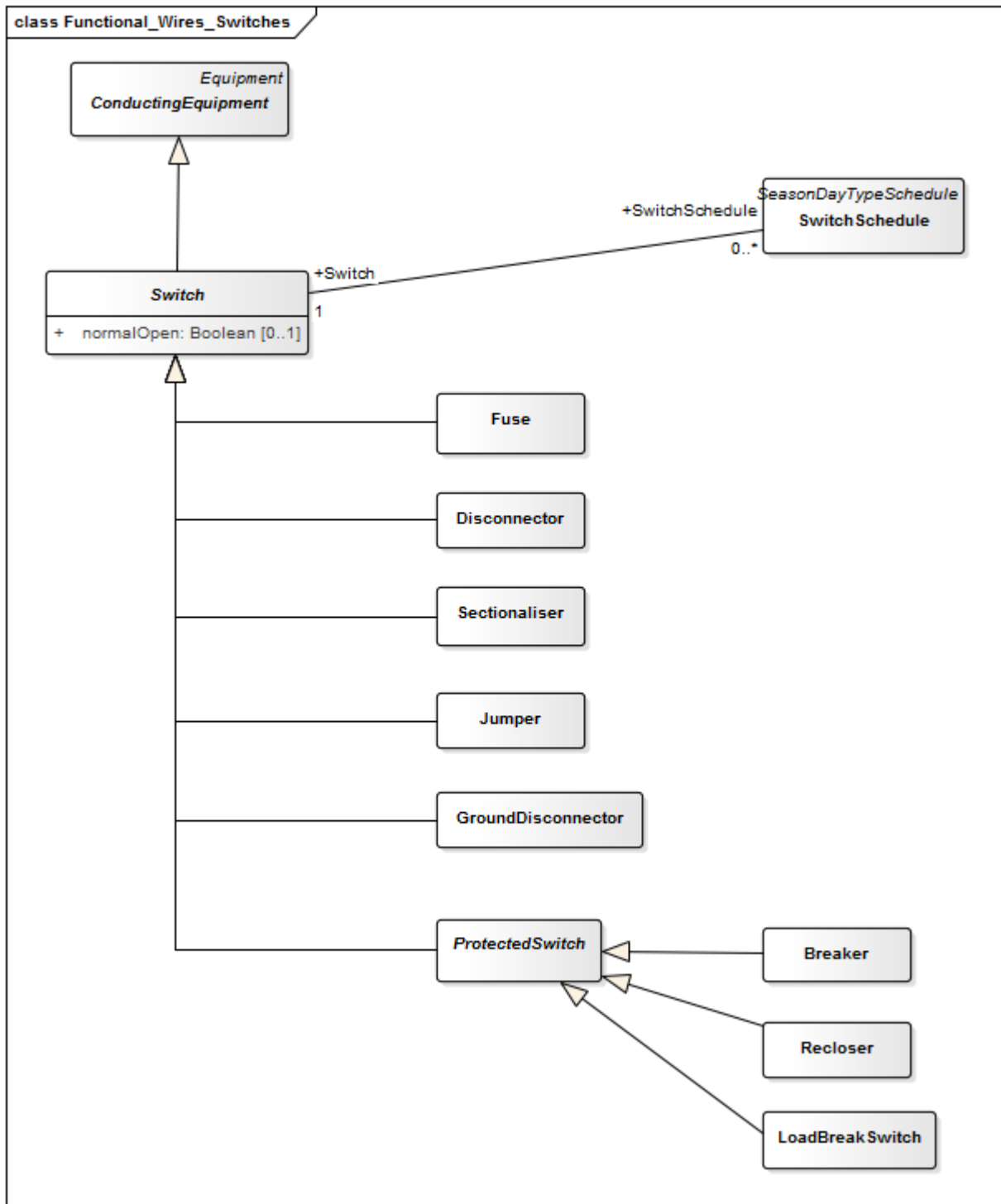


Figure 24 – Class diagram Functional::Functional_Wires_Switches

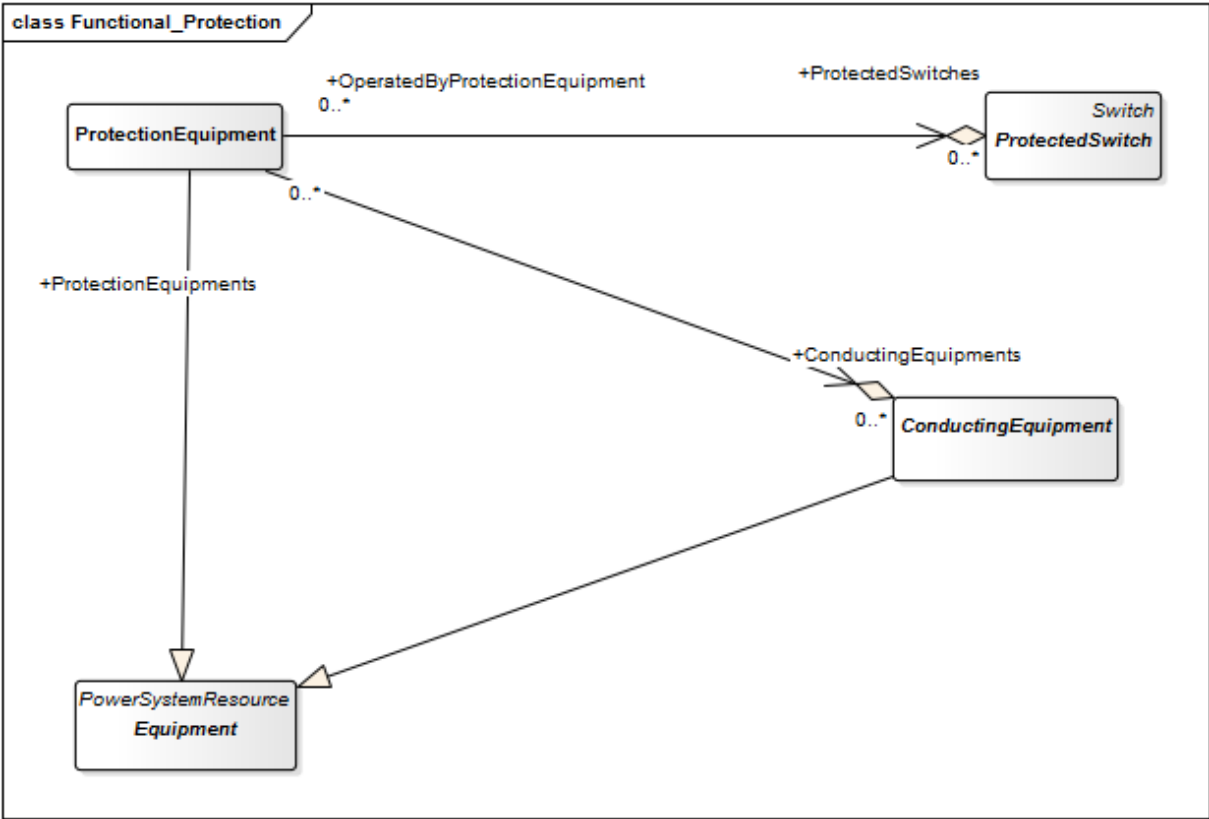


Figure 25 – Class diagram Functional::Functional_Protection

5.3.2 Accumulator

Accumulator represents an accumulated (counted) Measurement, e.g. an energy value.
Table 5 shows all attributes of Accumulator.

Table 5 – Attributes of Functional::Accumulator

name	mult	type	description
unitSymbol	1..1	UnitSymbol	inherited from: Measurement
measurementType	1..1	String	inherited from: Measurement
phases	0..1	PhaseCode	inherited from: Measurement
unitMultiplier	1..1	UnitMultiplier	inherited from: Measurement
name	0..1	String	inherited from: IdentifiedObject
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject

Table 6 shows all association ends of Accumulator with other classes.

Table 6 – Association ends of Functional::Accumulator with other classes

mult from	name	mult to	type	description
1..1	AccumulatorValue	0..*	AccumulatorValue	The values connected to this measurement.
0..*	LimitSets	0..*	AccumulatorLimitSet	A measurement may have zero or more limit ranges defined for it.
0..*	Terminal	0..1	ACDCTerminal	inherited from: Measurement

mult from	name	mult to	type	description
0..*	PowerSystemResource	0..1	PowerSystemResource	inherited from: Measurement

519

520 **5.3.3 AccumulatorLimit**

521 Limit values for Accumulator measurements.

522 Table 7 shows all attributes of AccumulatorLimit.

523 **Table 7 – Attributes of Functional::AccumulatorLimit**

name	mult	type	description
value	1..1	Integer	The value to supervise against. The value is positive.
name	0..1	String	inherited from: IdentifiedObject
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject

524

525 Table 8 shows all association ends of AccumulatorLimit with other classes.

526 **Table 8 – Association ends of Functional::AccumulatorLimit with other classes**

mult from	name	mult to	type	description
1..*	LimitSet	1..1	AccumulatorLimitSet	The set of limits.

527

528 **5.3.4 AccumulatorLimitSet**

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

530 Table 9 shows all attributes of AccumulatorLimitSet.

531 **Table 9 – Attributes of Functional::AccumulatorLimitSet**

name	mult	type	description
name	0..1	String	inherited from: IdentifiedObject
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject

532

533 Table 10 shows all association ends of AccumulatorLimitSet with other classes.

534 **Table 10 – Association ends of Functional::AccumulatorLimitSet with other classes**

mult from	name	mult to	type	description
1..1	Limits	1..*	AccumulatorLimit	The limit values used for supervision of Measurements.
0..*	Measurements	0..*	Accumulator	The Measurements using the LimitSet.

535

536 **5.3.5 AccumulatorReset**

537 This command reset the counter value to zero.

538 Table 11 shows all attributes of AccumulatorReset.

539 **Table 11 – Attributes of Functional::AccumulatorReset**

name	mult	type	description
unitSymbol	0..1	UnitSymbol	inherited from: Control
controlType	0..1	String	inherited from: Control
operationInProgress	0..1	Boolean	inherited from: Control
timeStamp	0..1	DateTime	inherited from: Control
unitMultiplier	0..1	UnitMultiplier	inherited from: Control
name	0..1	String	inherited from: IdentifiedObject
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject

540

541 Table 12 shows all association ends of AccumulatorReset with other classes.

542 **Table 12 – Association ends of Functional::AccumulatorReset with other classes**

mult from	name	mult to	type	description
0..1	AccumulatorValue	1..1	AccumulatorValue	The accumulator value that is reset by the command.
1..1	RemoteControl	0..1	RemoteControl	inherited from: Control
0..*	PowerSystemResource	0..1	PowerSystemResource	inherited from: Control

543

544 5.3.6 AccumulatorValue

545 AccumulatorValue represents an accumulated (counted) MeasurementValue.

546 Table 13 shows all attributes of AccumulatorValue.

547 **Table 13 – Attributes of Functional::AccumulatorValue**

name	mult	type	description
value	0..1	Integer	The value to supervise. The value is positive.
timeStamp	0..1	DateTime	inherited from: MeasurementValue
sensorAccuracy	0..1	PerCent	inherited from: MeasurementValue
name	0..1	String	inherited from: IdentifiedObject
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject

548

549 Table 14 shows all association ends of AccumulatorValue with other classes.

550 **Table 14 – Association ends of Functional::AccumulatorValue with other classes**

mult from	name	mult to	type	description
1..1	AccumulatorReset	0..1	AccumulatorReset	The command that reset the accumulator value.
0..*	Accumulator	1..1	Accumulator	Measurement to which this value is connected.

mult from	name	mult to	type	description
0..*	MeasurementValueSource	1..1	MeasurementValueSource	inherited from: MeasurementValue

551

552 **5.3.7 ACDCCConverter**

553 A unit with valves for three phases, together with unit control equipment, essential protective and
 554 switching devices, DC storage capacitors, phase reactors and auxiliaries, if any, used for conversion.

555 Table 15 shows all attributes of ACDCCConverter.

556 **Table 15 – Attributes of Functional::ACDCCConverter**

name	mult	type	description
name	0..1	String	inherited from: IdentifiedObject
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject

557

558 Table 16 shows all association ends of ACDCCConverter with other classes.

559 **Table 16 – Association ends of Functional::ACDCCConverter with other classes**

mult from	name	mult to	type	description
0..*	ProtectionEquipments	0..*	ProtectionEquipment	inherited from: ConductingEquipment
1..1	Terminal	0..*	Terminal	inherited from: ConductingEquipment
?..?	BaseVoltage	0..1	BaseVoltage	inherited from: ConductingEquipment
0..1	OperationalLimitSet	0..*	OperationalLimitSet	inherited from: Equipment
?..?	EquipmentContainer	0..1	EquipmentContainer	inherited from: Equipment
0..1	Control	0..*	Control	inherited from: PowerSystemResource
0..1	Measurement	0..*	Measurement	inherited from: PowerSystemResource
0..*	AssetDatasheet	0..1	AssetInfo	inherited from: PowerSystemResource
0..*	PSRType	0..1	PSRType	inherited from: PowerSystemResource

560

561 **5.3.8 (abstract) ACDCTerminal**

562 An electrical connection point (AC or DC) to a piece of conducting equipment. Terminals are connected
 563 at physical connection points called connectivity nodes.

564 Table 17 shows all attributes of ACDCTerminal.

565 **Table 17 – Attributes of Functional::ACDCTerminal**

name	mult	type	description
sequenceNumber	0..1	Integer	The orientation of the terminal connections for a multiple terminal conducting equipment. The sequence numbering starts with 1 and additional terminals should follow in increasing order. The first terminal is the "starting point" for a two terminal branch.
name	0..1	String	inherited from: IdentifiedObject
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject

566

567 Table 18 shows all association ends of ACDCTerminal with other classes.

568 **Table 18 – Association ends of Functional::ACDCTerminal with other classes**

mult from	name	mult to	type	description
0..1	OperationalLimitSet	0..*	OperationalLimitSet	
0..1	Measurement	0..*	Measurement	Measurements associated with this terminal defining where the measurement is placed in the network topology. It may be used, for instance, to capture the sensor position, such as a voltage transformer (PT) at a busbar or a current transformer (CT) at the bar between a breaker and an isolator.

569

570 **5.3.9 ACLineSegment**571 A wire or combination of wires, with consistent electrical characteristics, building a single electrical
572 system, used to carry alternating current between points in the power system.573 For symmetrical, transposed 3ph lines, it is sufficient to use ACLineSegment attributes, which describe
574 sequence impedances and admittances for the entire length of the segment.575 If per length impedance data is available from a library of standard types, impedances and admittances
576 can be calculated in one of the following ways:577 - calculate electrical parameters from asset data, using associated ConductorInfo, with values then
578 multiplied by Conductor.length to produce a matrix model.579 - calculate unbalanced electrical parameters from associated PerLengthPhaseImpedance, then
580 multiplied by Conductor.length to produce a matrix model.581 - calculate transposed electrical parameters from associated PerLengthSequenceImpedance, then
582 multiplied by Conductor.length to produce a sequence model.

583 Table 19 shows all attributes of ACLineSegment.

584 **Table 19 – Attributes of Functional::ACLineSegment**

name	mult	type	description
length	0..1	Length	inherited from: Conductor
name	0..1	String	inherited from: IdentifiedObject
aliasName	0..1	String	inherited from: IdentifiedObject
description	0..1	String	inherited from: IdentifiedObject
mRID	0..1	String	inherited from: IdentifiedObject

585

586 Table 20 shows all association ends of ACLineSegment with other classes.

587 **Table 20 – Association ends of Functional::ACLineSegment with other classes**

mult from	name	mult to	type	description
1..1	Clamp	0..*	Clamp	The clamps connected to the line segment.
0..*	PerLengthImpedance	0..1	PerLengthImpedance	Per-length impedance of this line segment.
0..*	ProtectionEquipments	0..*	ProtectionEquipment	inherited from: ConductingEquipment
1..1	Terminal	0..*	Terminal	inherited from: ConductingEquipment
???	BaseVoltage	0..1	BaseVoltage	inherited from: ConductingEquipment