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DIN EN IEC 61970-302:2019-12

Entwurf

Schnittstelle für Anwendungsprogramme für Energiemanagementsysteme (EMS-API) – Teil 302: Allgemeines Informationsmodell (CIM) Dynamik (IEC 57/2429/CDV:2021); Englische Fassung prEN IEC 61970-302:2021

Energy management system application program interface (EMS-API) –
Part 302: Common information model (CIM) dynamics
(IEC 57/2429/CDV:2021);
English version prEN IEC 61970-302:2021

Interface de programmation d'application pour système de gestion d'énergie (EMS-API) –
Partie 302: Régimes dynamiques de modèle d'information commun
(IEC 57/2429/CDV:2021);
Version anglaise prEN IEC 61970-302:2021

Anwendungswarnvermerk

Dieser Norm-Entwurf mit Erscheinungsdatum 2023-05-12 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, Merianstraße 28, 63069 Offenbach 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 681 Seiten

DKE Deutsche Kommission Elektrotechnik Elektronik Informationstechnik in DIN und VDE

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Nationales Vorwort

Die Englische Fassung des europäischen Dokuments prEN IEC 61970-302:2021-11 „Schnittstelle für Anwendungsprogramme für Energiemanagementsysteme (EMS-API) – Teil 302: Allgemeines Informationsmodell (CIM) Dynamik“ (Entwurf in der Umfrage) ist unverändert in diesen Norm-Entwurf übernommen worden.

Die Internationale Elektrotechnische Kommission (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. Dem entsprechend ist das internationale Dokument IEC 57/2429/CDV:2021-11 „Energy management system application program interface (EMS-API) – Part 302: Common information model (CIM) dynamics“ unverändert in den Entwurf prEN IEC 61970-302:2021-11 übernommen worden.

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

Bei der Abstimmung zu dem Europäischen Schluss-Entwurf bei CENELEC und dem Internationalen Schluss-Entwurf bei IEC [Final Draft International Standard (FDIS)] sind jeweils nur „JA/NEIN“-Entscheidungen möglich, wobei „NEIN“-Entscheidungen fundiert begründet werden müssen. Dokumente, die bei CENELEC als Europäische Norm angenommen und ratifiziert werden, sind unverändert als Deutsche Normen zu übernehmen.

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

Aktuelle Informationen zu diesem Dokument können über die Internetseiten von DKE (www.dke.de) und DIN (www.din.de) durch eine Suche nach der Dokumentennummer aufgerufen werden.

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 des IEC 57/2429/CDV veröffentlicht. Zu deren Einleitung, Abschnitt 1, der den Anwendungsbereich festlegt, und deren Abschnitt 3, der die Begriffe festlegt, wurde eine Übersetzung angefertigt und als informativer Nationaler Anhang NA des vorliegenden Normentwurfs hinzugefügt. Für die meisten 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 Abschnittsnummer, 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.

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Das Original-Dokument enthält Bilder in Farbe, die in der Papierversion in einer Graustufen-Darstellung wiedergegeben werden. Elektronische Versionen dieses Dokuments enthalten die Bilder in der originalen Farbdarstellung.

Änderungen

Gegenüber DIN EN IEC 61970-302:2019-12 wurden folgende Änderungen vorgenommen:

a) die meisten an IEC 61970-302:2018 festgestellten Problempunkte wurden überarbeitet;

b) die Norm IEEE 421.5-2016 zu Erregersystemen wurde vollumfänglich berücksichtigt;

c) der Turbinenbericht der IEEE aus dem Jahr 2013 wurde berücksichtigt und in diesem Zusammenhang wurden eine Reihe von Gas-, Dampf- und Wasserturbinen/-reglern hinzugefügt;

d) die Norm IEC 61400-27-1:2020 zu Windturbinen wurde vollumfänglich aufgenommen;

e) es wurden Wind- und-Speichermodelle des WECC hinzugefügt;

f) die anwenderdefinierten Modelle wurden um ein Modell ergänzt, das die Modellierung eines detaillierten dynamischen Modells ermöglicht;

g) es wurde ein Modell zum Austauschen von Simulationsergebnissen hinzugefügt;

h) die Arbeiten an den HGÜ-Modellen sind noch nicht abgeschlossen. Die HGÜ-Dynamikmodelle sind ein komplexer Bereich, in dem es keine Modelle gibt, die auf internationaler Ebene genehmigt oder allgemein anerkannt sind, d. h. es gibt nur projektbezogene Modelle. In diesem Stadium spezifiziert die IEC 61970-302 nur einige allgemeine Klassen. Es wird jedoch anerkannt, dass eine bessere Abdeckung von HGÜ in der nächsten Ausgabe dieses Dokuments erforderlich sein wird;

i) Modelle aus IEEE 1547-2018 „IEEE Standard for Interconnection and Interoperability of Distributed Energy Resources with Associated Electric Power Systems Interfaces“ werden hinzugefügt.

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Nationaler Anhang NA
(informativ)

Auszugsweise Übersetzung

Reihenfolge und Inhalt der folgenden Abschnitte sind identisch mit denen in den jeweiligen Abschnitten der Englischen Fassung

EINLEITUNG

Diese Internationale Norm gehört zur Normenreihe IEC 61970, die eine Anwendungsprogrammschnittstelle (API) für ein Energiemanagementsystem (EMS) definiert.

Der Hauptzweck der Normenreihe IEC 61970 ist die Entwicklung von Normen, die die Integration von EMS-Anwendungen, welche von unterschiedlichen Anbietern entwickelt wurden, zwischen kompletten unabhängig voneinander entwickelten EMS oder zwischen einem EMS und anderen Systemen für die verschiedenen Aspekte des Energieversorgungsbetriebs wie Erzeugungs- oder Verteilungsmanagementsysteme (DMS) ermöglichen. Dies wird erreicht, indem Anwendungsprogrammschnittstellen definiert werden, über die diese Anwendungen oder Systeme Zugang zu öffentlichen Daten erlangen und Informationen unabhängig davon, wie diese intern dargestellt werden, austauschen können.

Das allgemeine Informationsmodell (CIM) legt die Semantik für diese API fest. Die Schnittstellenspezifikationen von Komponenten (CIS), die in anderen Teilen der Normenreihe IEC 61970 enthalten sind, legen den Inhalt der ausgetauschten Nachrichten fest.

Das CIM ist ein abstraktes Modell, das alle wichtigen Objekte in einem Elektrizitätsversorgungsunternehmen darstellt, die typischerweise für die Modellierung der den Betrieb einer Versorgungseinrichtung betreffenden Aspekte erforderlich sind. Dieses Modell umfasst öffentliche Klassen und Attribute für diese Objekte sowie die Beziehung zwischen diesen.

IEC 61970-301 definiert die Basismenge der CIM-Pakete, die eine logische Betrachtungsweise der funktionalen Aspekte eines Energiemanagementsystems bereitstellen.

Dieser Teil der Norm, IEC 61970-302, baut auf IEC 61970-301 auf und enthält die Spezifikationen für den Austausch von Modellen, die das dynamische Verhalten der meisten gegenwärtig allgemein verwendeten Komponenten eines Energieversorgungssystems wiedergeben, damit Systemsimulationsstudien zur Bewertung der Systemdynamik und für Planungszwecke durchgeführt werden können.

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1 Anwendungsbereich

Das gemeinsame Informationsmodell (CIM) ist ein abstraktes Modell, das alle wichtigen Objekte in einem Elektrizitätsversorgungsunternehmen darstellt, die typischerweise am Versorgungsbetrieb beteiligt sind. Durch die Bereitstellung einer Standardmethode zur Darstellung von Stromversorgungsressourcen als Objektklassen und Attribute sowie und deren Beziehungen, erleichtert das CIM die Integration von Energiemanagementsystemen (EMS)-Anwendungen, die unabhängig voneinander von verschiedenen Anbietern entwickelt wurden, zwischen ganzen EMS oder zwischen einem EMS und anderen Systemen, die sich mit verschiedenen Aspekten des Aspekten des Stromnetzbetriebs befassen, wie z. B. dem Erzeugungs- oder Verteilungsmanagement. SCADA wird in dem Maße modelliert, wie es für die Simulation des Stromnetzes und die Kommunikation zwischen Leitstellen zu unterstützen. Das CIM erleichtert die Integration durch die Definition einer gemeinsamen Sprache (d. h. Semantik) auf der Grundlage von CIM, um diesen Anwendungen oder Systemen den Zugriff auf öffentliche Daten und Informationen auszutauschen, unabhängig davon, wie diese Informationen intern dargestellt werden.

Aufgrund des Umfangs der vollständigen CIM sind die in der CIM enthaltenen Objektklassen in logischen Paketen zusammengefasst, von denen jedes einen bestimmten Teil des gesamten modellierten Gesamtsystems darstellt. Sammlungen dieser Pakete werden als separate Internationale Normen entwickelt.

Dieses spezielle Dokument spezifiziert ein Dynamics-Paket, das einen Teil der CIM enthält, um den Austausch von Modellen zwischen Softwareanwendungen zu unterstützen, die eine Analyse der Stabilität im stationären Zustand (Kleinsignalstabilität) oder der transienten Stabilität eines Stromversorgungssystems gemäß der Definition IEEE / CIGRE *Definition und Klassifizierung der Netzstabilität IEEE/CIGRE Joint Task Force on Task Force on Stability Terms and Definitions*.

Die Modellbeschreibungen in dieser Norm enthalten Spezifikationen für jede Art von dynamischem Modell sowie die Informationen, die in den Austausch von dynamischen Fällen zwischen Planungs-/Studienanwendungen enthalten sein müssen.

Der Umfang des in dieser Norm spezifizierten CIM-Dynamik-Pakets umfasst:

- Standardmodelle: ein vereinfachter Ansatz zur Beschreibung von dynamischen Modellen, wobei Modelle, die das dynamische Verhalten von Elementen des Stromnetzes darstellen, sind in vordefinierten Klassenbibliotheken enthalten sind, die auf standardisierte Weise miteinander verbunden sind. Nur die Namen der ausgewählten Elemente der Modelle zusammen mit ihren Attributen benötigt werden, um dynamisches Verhalten zu beschreiben.
- proprietäre benutzerdefinierte Modelle: ein Ansatz, der den Benutzern die Möglichkeit gibt, die Parameter eines Modells des dynamischen Verhaltens zu definieren, das ein hersteller- oder benutzereigenes Gerät darstellt, für das die Norm keine explizite Beschreibung des Modells vorsieht. Die gleichen Bibliotheken und Standardverbindungen werden sowohl für proprietäre benutzerdefinierte Modelle als auch für Standardmodelle verwendet. Die Einzelheiten des Verhaltens des Modells sind in der Norm nicht dokumentiert, sondern nur die Modellparameter.
- Ein Modell, das den Austausch von Modellbeschreibungen ermöglicht. Dieser Ansatz kann verwendet werden, um benutzerdefinierte Modelle und Standardmodelle zu beschreiben.
- Ein Modell, das den Austausch von Simulationsergebnissen ermöglicht.

3 Begriffe

Für die Anwendung dieses Dokuments gelten die Begriffe nach IEC 60050 (für das allgemeine Glossar), nach IEC 61970-2 (für Glossarbegriffe zu EMS-API) und die folgenden Begriffe.

ISO und IEC stellen terminologische Datenbanken für die Verwendung in der Normung unter den folgenden Adressen bereit:

- IEC Electropedia: verfügbar unter http://www.electropedia.org/
- ISO Online Browsing Platform: verfügbar unter http://www.iso.org/obp

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3.1
Anwendungsprogramm-Schnittstelle
API, en: application program interface
Menge von öffentlichen Funktionen, die von einer ausführbaren Anwendungskomponente zum Aufruf durch andere ausführbare Anwendungskomponenten zur Verfügung gestellt wird

3.2
allgemeines Informationsmodell
CIM, en: common information model
bezieht sich auf die Arbeiten und Normen des IEC TC 57 im Zusammenhang mit den Normenreihen 61970, 61968 und 62325 zur Erstellung und gemeinsamen Nutzung eines allgemeinen kanonischen Datenmodells, das das Elektrizitätsnetz und die relevanten Vorgänge des Versorgungsbetriebs beschreibt

Anmerkung 1 zum Begriff: Begriff in Ausgabe 1: „abstraktes Modell, das alle wichtigen Objekte eines Elektrizitätsversorgungsunternehmens darstellt, die typischerweise in einem EMS-Informationsmodell enthalten sind“.

3.3
CIMXML
Serialisierungsformat für den Austausch von XML-Daten wie in diesem Dokument definiert

3.4
Energiemanagementsystem
EMS, en: energy management system)
Computersystem, das eine Softwareplattform für die grundlegenden Supportdienstleistungen und eine Reihe von Anwendungen zur Sicherstellung des effektiven Betriebs der elektrischen Energieerzeugungs- und -übertragungseinrichtungen beinhaltet, um eine angemessene Sicherheit der Energieversorgung bei minimalen Kosten sicherzustellen

3.5
Modell
Sammlung von Daten zur Beschreibung realer oder berechneter Objekte oder Einheiten, deren Semantik durch Profile (3.9) im Kontext des CIM definiert ist

Anmerkung 1 zum Begriff: Bei der Analyse von Energieversorgungssystemen ist ein Modell eine Menge von statischen Daten, die das Energieversorgungssystem beschreiben. Beispiele für Modelle sind das statische Netzwerkmodell, die Topologielösung und die Netzwerklösung, die von einer Lastfluss- oder Zustandsschätzungsanwendung erzeugt wird.

3.6
Anwendungsprofil
definierte strukturierte Sammlung von Datenelement-Beschreibungen zur Erfüllung der bestimmten Bedürfnisse einer oder mehrerer Anwendergemeinschaften

Anmerkung 1 zum Begriff: Diese Definition schließt das Konzept mit ein, das auch als „Profil“, „Metadaten-Anwendungsprofil“ oder „Metadatenprofil“ bezeichnet wird.

Anmerkung 2 zum Begriff: In IEC 61970-301:2020 wird ein Profil wie folgt definiert: „Teilmenge von CIM-Klassen, -Beziehungen und -Attributen, die benötigt wird, um einen speziellen Schnittstellentyp zu definieren“.

Anmerkung 3 zum Begriff: In DX-PROF wird ein Profil wie folgt definiert: „Spezifikation, die die Nutzung anderer Spezifikationen einschränkt, erweitert, kombiniert oder erläutert oder Hinweise zur Nutzung anderer Spezifikationen enthält“.

[QUELLE: ISO/IEC 19788-1:2011, 3.1]

3.7
Ressourcen-Beschreibungssystem
RDF, en: Resource Description Framework
genormtes Modell für den Austausch von Daten über das Web. Das RDF verfügt über Eigenschaften, die das Zusammenführen von Daten auch bei unterschiedlichen zugrunde liegenden Schemata ermöglichen, und unterstützt insbesondere die Weiterentwicklung von Schemata im Laufe der Zeit, ohne dass Änderungen an allen Datenconsumern vorgenommen werden müssen.

Das RDF erweitert die Verbindungsstruktur des Web dahingehend, dass URIs für die Bezeichnung der Beziehung zwischen Dingen sowie zwischen den beiden Enden einer Verbindung (en: link) verwendet werden (dies wird üblicherweise als „Triple“ bezeichnet).

[QUELLE: www.w3.org/RDF/]

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3.8
RDF-Schema
Universalsprache für die Darstellung einfacher RDF-Vokabulare im Web. Andere Vokabulardefinitionstechnologien wie OWL oder SKOS bauen auf RDFS auf und stellen eine Sprache für die Definition strukturierter, webbasierter Ontologien bereit, die eine umfassendere Integration und Interoperabilität von Daten zwischen den Beschreibergemeinschaften ermöglichen

[QUELLE: https://www.w3.org/2001/sw/wiki/RDFS]

3.9
Objekte der realen Welt
Objekte, die zur Problemdomäne der realen Welt gehören, im Unterschied zu Schnittstellenobjekten und Controller-Objekten in der Implementierung

Anmerkung 1 zum Begriff: Die Objekte der realen Welt für die EMS-Domäne werden in IEC 61970-301 als Klassen definiert.

Anmerkung 2 zum Begriff: Durch Klassen und Objekte werden diejenigen Komponenten eines Energieversorgungssystems modelliert, die für EMS-Anwendungen auf einheitliche Weise dargestellt werden müssen. Eine Klasse ist eine Beschreibung eines in der realen Welt vorkommenden Objektes, z. B. ein Transformator, ein Generator oder eine Last, das in einem EMS als Teil des Modells des gesamten Energieversorgungssystems abgebildet werden muss. Andere Objekttypen bilden u. a. Pläne und Messungen ab, die von EMS-Anwendungen ebenfalls verarbeitet, analysiert und gespeichert werden müssen. Derartige Objekte erfordern eine einheitliche Darstellung, damit die Ziele der EMS-API-Norm hinsichtlich der Steckerkompatibilität und Interoperabilität erreicht werden. Ein bestimmtes Objekt in einem Energieversorgungssystem, das eine eindeutige Identität aufweist, wird als Instanz der Klasse, zu der es gehört, modelliert.

3.10
genormte verallgemeinerte Auszeichnungssprache
SGML, en: Standard Generalized Markup Language
internationale Norm zur Definition geräte- und systemunabhängiger Methoden zur Darstellung von Texten in elektronischer Form

Anmerkung 1 zum Begriff: HTML und XML sind von SGML abgeleitet.

3.11
einheitliche Modellierungssprache
UML, en: Unified Modeling Language
objektorientierte Modellierungssprache und Methode zum Festlegen, Sichtbarmachen, Erstellen und Dokumentieren von Artefakten eines systemintensiven Prozesses

3.12
einheitlicher Identifikator für Ressourcen
URI, en: Uniform Resource Identifier
genormte Websyntax und -semantik zum Identifizieren (Referenzieren) von Ressourcen wie beispielsweise Dateien, Dokumenten und Bildern

3.13
erweiterbare Auszeichnungssprache
XML, en: eXtensible Markup Language
Teilmenge der genormten verallgemeinerten Auszeichnungssprache (SGML), ISO 8879, zum Einsetzen strukturierter Daten in eine Textdatei

Anmerkung 1 zum Begriff: Dies ist eine unterstützte Empfehlung des W3C. Sie ist lizenzfrei, plattformunabhängig und wird von vielen leicht erhältlichen Software-Tools unterstützt.

3.14
erweiterbare Stylesheet-Sprache
XSL, en: eXtensible Stylesheet Language
Sprache zum Ausdrücken von Stylesheets für XML-Dokumente

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Full document details: E DIN EN IEC 61970-302:2023-06

CONTENTS

Page

INTRODUCTION 40
1 Scope 41
2 Normative references 41
3 Terms and definitions 42
4 CIM Dynamics specification 44
4.1 General 44
4.2 Document structure 44
5 Common Information Model Dynamics package 44
5.1 General 44
5.2 Package StandardInterconnections 45
5.2.1 General 45
5.2.2 RemoteInputSignal 53
5.2.3 RemoteSignalKind enumeration 54
5.2.4 Package WindModels 55
5.3 Package StandardModels 62
5.3.1 General 62
5.3.2 DynamicsFunctionBlock 62
5.3.3 RotatingMachineDynamics 63
5.3.4 Package SynchronousMachineDynamics 64
5.3.5 Package AsynchronousMachineDynamics 94
5.3.6 Package TurbineGovernorDynamics 102
5.3.7 Package TurbineLoadControllerDynamics 213
5.3.8 Package MechanicalLoadDynamics 217
5.3.9 Package ExcitationSystemDynamics 221
5.3.10 Package OverexcitationLimiterDynamics 367
5.3.11 Package UnderexcitationLimiterDynamics 381
5.3.12 Package PowerSystemStabilizerDynamics 392
5.3.13 Package DiscontinuousExcitationControlDynamics 434
5.3.14 Package PFVArControllerType1Dynamics 440
5.3.15 Package PFVArControllerType2Dynamics 445
5.3.16 Package VoltageAdjusterDynamics 452
5.3.17 Package VoltageCompensatorDynamics 456
5.3.18 Package WindDynamics 460
5.3.19 Package WindDynamicsEd2 498
5.3.20 Package LoadDynamics 543
5.3.21 Package HVDCDynamics 562
5.3.22 Package RelayDynamics 566
5.3.23 Package StatorCurrentLimiterDynamics 569

Documents
Document Sharing Hub

Full document details: E DIN EN IEC 61970-302:2023-06

5.3.24 Package StaticVarCompensatorDynamics 574
5.3.25 Package StatcomDynamics 585
5.3.26 Package WECCDynamics 588
5.3.27 Package IEEE1547Dynamics 610
5.4 Package UserDefinedModels 625
5.4.1 General 625
5.4.2 SynchronousMachineUserDefined 626
5.4.3 AsynchronousMachineUserDefined 628
5.4.4 TurbineGovernorUserDefined 629
5.4.5 TurbineLoadControllerUserDefined 629
5.4.6 MechanicalLoadUserDefined 630
5.4.7 ExcitationSystemUserDefined 631
5.4.8 OverexcitationLimiterUserDefined 632
5.4.9 UnderexcitationLimiterUserDefined 633
5.4.10 PowerSystemStabilizerUserDefined 633
5.4.11 DiscontinuousExcitationControlUserDefined 634
5.4.12 PFVArControllerType1UserDefined 635
5.4.13 VoltageAdjusterUserDefined 636
5.4.14 PFVArControllerType2UserDefined 637
5.4.15 VoltageCompensatorUserDefined 637
5.4.16 LoadUserDefined 638
5.4.17 WindType1or2UserDefined 639
5.4.18 WindType3or4UserDefined 640
5.4.19 WindPlantUserDefined 641
5.4.20 CSCUserDefined 641
5.4.21 VSCUserDefined 642
5.4.22 SVCUserDefined 643
5.4.23 StatorCurrentLimiterUserDefined 644
5.4.24 ProprietaryParameterDynamics root class 644
5.4.25 StatcomUserDefined 646
5.4.26 HVDCInterconnectionUserDefined 647
5.4.27 RelayUserDefined 647
5.5 Package DetailedModelDescription 648
5.5.1 General 648
5.5.2 DetailedModelTypeDynamics 649
5.5.3 DetailedModelDescriptorArtifact 650
5.5.4 DetailedModelDocumentationArtifact 650
5.5.5 FunctionDescriptor 651
5.5.6 InputOutputDescriptor 652

AVA Documents
Document Sharing Hub

Full document details: E DIN EN IEC 61970-302:2023-06

5.5.7 LimiterDescriptor 653
5.5.8 OperatorDescriptor 653
5.5.9 ParameterDesctiptor 654
5.5.10 ParameterValue root class 655
5.5.11 SignalDescriptor 655
5.5.12 DetailedModelDescriptor 656
5.5.13 DetailedModelDynamics 656
5.5.14 ConstraintKind enumeration 657
5.5.15 LogicalKind enumeration 657
5.5.16 EquationLanguageKind enumeration 658
5.5.17 OperatorDescriptorKind enumeration 658
5.5.18 ParameterKind enumeration 658
5.5.19 XSDDatatypeKind enumeration 659
5.5.20 IRI primitive 659
5.6 Package SimulationResult 660
5.6.1 General 660
5.6.2 SimulationResult 660
5.6.3 SimulationResultCharacteristic 661
5.6.4 PowerFlowSettings 662
5.6.5 PowerFlowAlgorithmKind enumeration 664
5.6.6 SlackDistributionKind enumeration 664
5.6.7 PowerShiftKind enumeration 664
5.6.8 SimulationSettings 664
5.6.9 SignalRecorder 665
5.6.10 SignalKind enumeration 666
5.6.11 ParameterEvent 666
5.6.12 ParameterChangeKind enumeration 667
5.6.13 ClearSimulationEvent 667
5.6.14 SimulationEvents 668
5.6.15 SignalConfiguration 669
5.7 Package Examples 670
Annex A (informative) Dynamics package symbol representation conventions 673
Annex B (informative) Use of per unit 675
Annex C (informative) Updates to CIM dynamics standard models 676
Bibliography 681

Documents
Document Sharing Hub

Full document details: E DIN EN IEC 61970-302:2023-06

Figures

Figure 1 – StandardInterconnectionSynchronousMachine 45
Figure 2 – StandardInterconnectionSynchronousGeneratorCrossCompound 46
Figure 3 – StandardInterconnectionAsynchronousMachine 47
Figure 4 – StandardInterconnectionSingleLoad 48
Figure 5 – Class diagram StandardInterconnections::StandardSynchronousMachineInterconnection 49
Figure 6 – Class diagram StandardInterconnections::StandardAsynchronousMachineInterconnection 50
Figure 7 – Class diagram StandardInterconnections::StandardLoadInterconnection 51
Figure 8 – Class diagram StandardInterconnections::StandardHVDCInterconnection 52
Figure 9 – Class diagram StandardInterconnections::StandardStaticVarCompensatorInterconnection 53
Figure 10 – StandardInterconnectionWindTurbineType1Aand1B 55
Figure 11 – StandardInterconnectionWindTurbineType2 56
Figure 12 – StandardInterconnectionWindTurbineType3 57
Figure 13 – StandardInterconnectionWindTurbineType4Aand4B 58
Figure 14 – Class diagram WindModels::StandardWindType1and2Interconnection 60
Figure 15 – Class diagram WindModels::StandardWindType3and4Interconnection 61
Figure 16 – SynchronousGeneratorInterconnectionAndVariables 65
Figure 17 – SynchronousMotorInterconnectionAndVariables 66
Figure 18 – Class diagram SynchronousMachineDynamics::SynchronousMachineDynamics 67
Figure 19 – SynchronousMachineSaturationParameters 68
Figure 20 – SynchronousGeneratorMechanicalEquation 69
Figure 21 – SynchronousMotorMechanicalEquation 69
Figure 22 – SynchronousGeneratorPhasor 70
Figure 23 – SynchronousMotorPhasor 71
Figure 24 – Simplified 73
Figure 25 – SubtransientRoundRotor 77
Figure 26 – SubtransientSalientPole 78
Figure 27 – SubtransientTypeF 79
Figure 28 – SubtransientTypeJ 80
Figure 29 – SubtransientRoundRotorSimplified 81
Figure 30 – SubtransientSalientPoleSimplified 83
Figure 31 – SubtransientRoundRotorSimplifiedDirectAxis 85
Figure 32 – SubtransientSalientPoleSimplifiedDirectAxis 87
Figure 33 – SynchronousEquivalentCircuit 91
Figure 34 – AsynchronousGeneratorInterconnectionAndVariables 94
Figure 35 – AsynchronousMotorInterconnectionAndVariables 95
Figure 36 – Class diagram AsynchronousMachineDynamics::AsynchronousMachineDynamics 96
Figure 37 – AsynchronousGeneratorMechanicalEquation 97

Documents
Document Sharing Hub

Full document details: E DIN EN IEC 61970-302:2023-06

Figure 38 – AsynchronousMotorMechanicalEquation 97
Figure 39 – AsynchronousEquivalentCircuit 101
Figure 40 – TurbineGovernorInterconnectionAndVariables 103
Figure 41 – Class diagram TurbineGovernorDynamics::GasTurbineGovernorDynamics 104
Figure 42 – Class diagram TurbineGovernorDynamics::HydroTurbineGovernorDynamics 104
Figure 43 – Class diagram TurbineGovernorDynamics::SteamTurbineGovernorDynamics 105
Figure 44 – GovHydroIEEE0 129
Figure 45 – GovHydroIEEE2 131
Figure 46 – GovSteamIEEE1 133
Figure 47 – GovCT1 135
Figure 48 – GovCT2 138
Figure 49 – GovGAST 142
Figure 50 – GovGAST1 143
Figure 51 – GovGAST2 146
Figure 52 – GovGAST3 148
Figure 53 – GovGAST3ExhaustTemperature 149
Figure 54 – GovGAST4 151
Figure 55 – GovGASTWD 153
Figure 56 – GovHydro1 155
Figure 57 – GovHydro2 157
Figure 58 – GovHydro3 159
Figure 59 – GovHydro4 162
Figure 60 – GovHydro4SimpleHydroTurbine 163
Figure 61 – GovHydro4FrancisPeltonTurbine 164
Figure 62 – GovHydro4KaplanTurbine 165
Figure 63 – GovHydroDD 168
Figure 64 – GovHydroFrancis 170
Figure 65 – GovHydroFrancisNonLinearGainAndEfficiency 171
Figure 66 – DetailedHydroModelHydraulicSystem 172
Figure 67 – GovHydroPelton 174
Figure 68 – GovHydroPeltonNonLinearGainAndEfficiency 175
Figure 69 – GovHydroPID 177
Figure 70 – GovHydroPID2 180
Figure 71 – GovHydroR 182
Figure 72 – GovHydroWEH 185
Figure 73 – GovHydroWPID 189
Figure 74 – GovSteam0 191
Figure 75 – GovSteam1 192
Figure 76 – GovSteam1BacklashHysteresis 193

Documents
Document Sharing Hub

Full document details: E DIN EN IEC 61970-302:2023-06

Figure 77 – GovSteam1InputSpeedDeadband 194
Figure 78 – GovSteam2 196
Figure 79 – GovSteamBB 198
Figure 80 – GovSteamCC 199
Figure 81 – GovSteamEU 202
Figure 82 – GovSteamFV2 204
Figure 83 – GovSteamFV3 206
Figure 84 – GovSteamFV4 208
Figure 85 – GovSteamSGO 211
Figure 86 – Class diagram TurbineLoadControllerDynamics::TurbineLoadControllerDynamics 213
Figure 87 – TurbLCFB1 215
Figure 88 – MechanicalLoadInterconnectionAndVariables 217
Figure 89 – MechanicalLoadEquations 218
Figure 90 – Class diagram MechanicalLoadDynamics::MechanicalLoadDynamics 219
Figure 91 – ExcitationSystemInterconnectionAndVariables 222
Figure 92 – Class diagram ExcitationSystemDynamics::ExcitationSystemDynamics 223
Figure 93 – ExcAC1A 225
Figure 94 – ExcAC2A 227
Figure 95 – ExcAC3A 229
Figure 96 – ExcAC4A 231
Figure 97 – ExcAC5A 233
Figure 98 – ExcAC6A 235
Figure 99 – ExcAC8B 237
Figure 100 – ExcANS 239
Figure 101 – ExcAVR1 241
Figure 102 – ExcAVR2 243
Figure 103 – ExcAVR3 244
Figure 104 – ExcAVR4 246
Figure 105 – ExcAVR5 248
Figure 106 – ExcAVR7 249
Figure 107 – ExcBBC 251
Figure 108 – ExcCZ 253
Figure 109 – ExcDC1A 255
Figure 110 – ExcDC2A 257
Figure 111 – ExcDC3A 259
Figure 112 – ExcDC3A1 261
Figure 113 – ExcELIN1 263
Figure 114 – ExcELIN2 265
Figure 115 – ExcHU 267

Documents
Document Sharing Hub

Figure 116 – ExcNI ... 268
Figure 117 – ExcOEX3T ... 270
Figure 118 – ExcPIC ... 272
Figure 119 – ExcREXS ... 274
Figure 120 – ExcRQB ... 277
Figure 121 – ExcSCRX ... 279
Figure 122 – ExcSEXS ... 281
Figure 123 – ExcSK ... 283
Figure 124 – ExcST1A ... 285
Figure 125 – ExcST2A ... 287
Figure 126 – ExcST3A ... 289
Figure 127 – ExcST4B ... 291
Figure 128 – ExcST6B ... 293
Figure 129 – ExcST7B ... 295
Figure 130 – Class diagram IEEE4215from2005::IEEE4215from2005 ... 298
Figure 131 – Class diagram IEEE4215from2016::IEEE4215from2016 ... 326
Figure 132 – Class diagram OverexcitationLimiterDynamics::OverexcitationLimiterDynamics ... 367
Figure 133 – OverexcLim2 ... 370
Figure 134 – OverexcLimX1 ... 371
Figure 135 – OverexcLimX1TimeCharacteristic ... 372
Figure 136 – OverexcLimX2 ... 374
Figure 137 – OverexcLimX2TimeCharacteristic ... 375
Figure 138 – Class diagram UnderexcitationLimiterDynamics::UnderexcitationLimiterDynamics ... 382
Figure 139 – UnderexcLim2Simplified ... 388
Figure 140 – UnderexcLimX1 ... 390
Figure 141 – UnderexcLimX2 ... 391
Figure 142 – PowerSystemStabilizerInterconnectionAndVariables ... 393
Figure 143 – Class diagram PowerSystemStabilizerDynamics::PowerSystemStabilizerDynamics ... 394
Figure 144 – Pss1 ... 412
Figure 145 – Pss1A ... 414
Figure 146 – Pss2B ... 415
Figure 147 – Pss2ST ... 417
Figure 148 – Pss5 ... 419
Figure 149 – PssELIN2 ... 421
Figure 150 – PssPTIST1 ... 422
Figure 151 – PssPTIST3 ... 423
Figure 152 – PssRQB ... 426
Figure 153 – PssSB4 ... 427
Figure 154 – PssSH ... 428

Documents
Document Sharing Hub

Full document details: E DIN EN IEC 61970-302:2023-06

Figure 155 – PssSK 430
Figure 156 – PssSTAB2A 431
Figure 157 – PssWECC 432
Figure 158 – DiscontinuousExcitationControlInterconnectionAndVariables 435
Figure 159 – Class diagram DiscontinuousExcitationControlDynamics::DiscontinuousExcitationControlDynamics 436
Figure 160 – Class diagram PFVArControllerType1Dynamics::PFVArControllerType1Dynamics 440
Figure 161 – Class diagram PFVArControllerType2Dynamics::PFVArControllerType2Dynamics 446
Figure 162 – PFVArType2Common1 449
Figure 163 – Class diagram VoltageAdjusterDynamics::VoltageAdjusterDynamics 453
Figure 164 – VoltageCompensatorInterconnectionAndVariables 456
Figure 165 – Class diagram VoltageCompensatorDynamics::VoltageCompensatorDynamics 457
Figure 166 – Class diagram WindDynamics::WindDynamicsType1or2 461
Figure 167 – Class diagram WindDynamics::WindDynamicsType3 462
Figure 168 – Class diagram WindDynamics::WindDynamicsType4 463
Figure 169 – Class diagram WindDynamics::WindDynamicsPlant 464
Figure 170 – Class diagram WindDynamicsEd2::WindDynamicsType1or2 499
Figure 171 – Class diagram WindDynamicsEd2::WindDynamicsType3 500
Figure 172 – Class diagram WindDynamicsEd2::WindDynamicsType4 501
Figure 173 – Class diagram WindDynamicsEd2::WindDynamicsPlant 502
Figure 174 – LoadInterconnectionAndVariables 543
Figure 175 – Class diagram LoadDynamics::LoadDynamics 544
Figure 176 – LoadCompositeEquations 545
Figure 177 – LoadGenericNonLinearTypeEquations 547
Figure 178 – LoadStaticTypeEquations 551
Figure 179 – LoadMotor 554
Figure 180 – Class diagram LoadCompositeWECC::LoadCompositeWECC 557
Figure 181 – Class diagram HVDCDynamics::HVDCDynamics 563
Figure 182 – Class diagram RelayDynamics::RelayDynamics 566
Figure 183 – Class diagram StatorCurrentLimiterDynamics::StatorCurrentLimiterDynamics 570
Figure 184 – Class diagram StaticVarCompensatorDynamics::StaticVarCompensatorDynamics 575
Figure 185 – Class diagram StatcomDynamics::StatcomDynamics 585
Figure 186 – Class diagram StatcomDynamics::StatcomIEC 586
Figure 187 – Class diagram WECCDynamics::WeccDynamics 588
Figure 188 – Class diagram WECCDynamics::WeccBESS 589
Figure 189 – Class diagram IEEE1547Dynamics::IEEE1547Dynamics 611
Figure 190 – Class diagram UserDefinedModels::ProprietaryUserDefinedModels 626
Figure 191 – Class diagram DetailedModelDescription::DetailedModelDescription 649
Figure 192 – Class diagram SimulationResult::SimulationResult 660
Figure 193 – Object diagram Examples::ExampleStandardModel 670

Documents
Document Sharing Hub

Full document details: E DIN EN IEC 61970-302:2023-06

Figure 194 – Object diagram Examples::ExampleFunctionBlockProprietaryModel 671
Figure 195 – Object diagram Examples::ExampleCompleteProprietaryModel 672

Tables

Table 1 – Attributes of StandardInterconnections::RemoteInputSignal 53
Table 2 – Association ends of StandardInterconnections::RemoteInputSignal with other classes 54
Table 3 – Literals of StandardInterconnections::RemoteSignalKind 54
Table 4 – Attributes of StandardModels::DynamicsFunctionBlock 63
Table 5 – Association ends of StandardModels::DynamicsFunctionBlock with other classes 63
Table 6 – Attributes of StandardModels::RotatingMachineDynamics 63
Table 7 – Association ends of StandardModels::RotatingMachineDynamics with other classes 64
Table 8 – Attributes of SynchronousMachineDynamics::SynchronousMachineDynamics 72
Table 9 – Association ends of SynchronousMachineDynamics::SynchronousMachineDynamics with other classes 72
Table 10 – Attributes of SynchronousMachineDynamics::SynchronousMachineSimplified 74
Table 11 – Association ends of SynchronousMachineDynamics::SynchronousMachineSimplified with other classes 74
Table 12 – Attributes of SynchronousMachineDynamics::SynchronousMachineDetailed 75
Table 13 – Association ends of SynchronousMachineDynamics::SynchronousMachineDetailed with other classes 75
Table 14 – Attributes of SynchronousMachineDynamics::SynchronousMachineTimeConstantReactance 88
Table 15 – Association ends of SynchronousMachineDynamics::SynchronousMachineTimeConstantReactance with other classes 89
Table 16 – Attributes of SynchronousMachineDynamics::SynchronousMachineEquivalentCircuit 91
Table 17 – Association ends of SynchronousMachineDynamics::SynchronousMachineEquivalentCircuit with other classes 92
Table 18 – Literals of SynchronousMachineDynamics::IfdBaseKind 93
Table 19 – Literals of SynchronousMachineDynamics::SynchronousMachineModelKind 93
Table 20 – Literals of SynchronousMachineDynamics::RotorKind 94
Table 21 – Attributes of AsynchronousMachineDynamics::AsynchronousMachineDynamics 98
Table 22 – Association ends of AsynchronousMachineDynamics::AsynchronousMachineDynamics with other classes 98
Table 23 – Attributes of AsynchronousMachineDynamics::AsynchronousMachineTimeConstantReactance 99
Table 24 – Association ends of AsynchronousMachineDynamics::AsynchronousMachineTimeConstantReactance with other classes 100
Table 25 – Attributes of AsynchronousMachineDynamics::AsynchronousMachineEquivalentCircuit 101
Table 26 – Association ends of AsynchronousMachineDynamics::AsynchronousMachineEquivalentCircuit with other classes 102
Table 27 – Attributes of TurbineGovernorDynamics::TurbineGovernorDynamics 105

Documents
Document Sharing Hub

Full document details: E DIN EN IEC 61970-302:2023-06

Table 28 – Association ends of TurbineGovernorDynamics::TurbineGovernorDynamics with other classes 106
Table 29 – Attributes of TurbineGovernorDynamics::CombinedCycleGasTurbineDynamics 106
Table 30 – Association ends of TurbineGovernorDynamics::CombinedCycleGasTurbineDynamics with other classes 106
Table 31 – Attributes of TurbineGovernorDynamics::HydroGovernorDynamics 107
Table 32 – Association ends of TurbineGovernorDynamics::HydroGovernorDynamics with other classes 107
Table 33 – Attributes of TurbineGovernorDynamics::HydroWaterColumnDynamics 108
Table 34 – Association ends of TurbineGovernorDynamics::HydroWaterColumnDynamics with other classes 108
Table 35 – Attributes of TurbineGovernorDynamics::SteamTurbineGeneratorDynamics 108
Table 36 – Association ends of TurbineGovernorDynamics::SteamTurbineGeneratorDynamics with other classes 109
Table 37 – Attributes of TurbineGovernorDynamics::CrossCompoundTurbineGovernorDynamics 109
Table 38 – Association ends of TurbineGovernorDynamics::CrossCompoundTurbineGovernorDynamics with other classes 109
Table 39 – Attributes of TurbineGovernorDynamics::GovCIGREGT 110
Table 40 – Association ends of TurbineGovernorDynamics::GovCIGREGT with other classes 111
Table 41 – Attributes of TurbineGovernorDynamics::GovIEEEGT1 112
Table 42 – Association ends of TurbineGovernorDynamics::GovIEEEGT1 with other classes 113
Table 43 – Attributes of TurbineGovernorDynamics::GovIEEEHydroDD 113
Table 44 – Association ends of TurbineGovernorDynamics::GovIEEEHydroDD with other classes 114
Table 45 – Attributes of TurbineGovernorDynamics::GovIEEEHydroLL 114
Table 46 – Association ends of TurbineGovernorDynamics::GovIEEEHydroLL with other classes 115
Table 47 – Attributes of TurbineGovernorDynamics::GovIEEEHydroMech 116
Table 48 – Association ends of TurbineGovernorDynamics::GovIEEEHydroMech with other classes 116
Table 49 – Attributes of TurbineGovernorDynamics::GovIEEEHydroPID 117
Table 50 – Association ends of TurbineGovernorDynamics::GovIEEEHydroPID with other classes 117
Table 51 – Attributes of TurbineGovernorDynamics::GovIEEEHydroPIDspt 118
Table 52 – Association ends of TurbineGovernorDynamics::GovIEEEHydroPIDspt with other classes 119
Table 53 – Attributes of TurbineGovernorDynamics::GovSteamIEEEG1Aug 119
Table 54 – Association ends of TurbineGovernorDynamics::GovSteamIEEEG1Aug with other classes 120
Table 55 – Attributes of TurbineGovernorDynamics::GovSteamIEEETGOV5 121
Table 56 – Association ends of TurbineGovernorDynamics::GovSteamIEEETGOV5 with other classes 122
Table 57 – Attributes of TurbineGovernorDynamics::TurbCIGREHRSGST 123
Table 58 – Association ends of TurbineGovernorDynamics::TurbCIGREHRSGST with other classes 123
Table 59 – Attributes of TurbineGovernorDynamics::TurbIEEEGenericHRSGST 124
Table 60 – Association ends of TurbineGovernorDynamics::TurbIEEEGenericHRSGST with other classes 124

Documents
Document Sharing Hub

Full document details: E DIN EN IEC 61970-302:2023-06

Table 61 – Attributes of TurbineGovernorDynamics::TurbIEEEHydroWCgen 125
Table 62 – Association ends of TurbineGovernorDynamics::TurbIEEEHydroWCgen with other classes 125
Table 63 – Attributes of TurbineGovernorDynamics::TurbIEEEHydroWClinear 126
Table 64 – Association ends of TurbineGovernorDynamics::TurbIEEEHydroWClinear with other classes 126
Table 65 – Attributes of TurbineGovernorDynamics::TurbIEEEHydroWCNonLinear 126
Table 66 – Association ends of TurbineGovernorDynamics::TurbIEEEHydroWCNonLinear with other classes 127
Table 67 – Attributes of TurbineGovernorDynamics::TurbIEEEHydroWCNonLinearA 127
Table 68 – Association ends of TurbineGovernorDynamics::TurbIEEEHydroWCNonLinearA with other classes 128
Table 69 – Attributes of TurbineGovernorDynamics::TurbIEEEHydroWCNonLinearB 128
Table 70 – Association ends of TurbineGovernorDynamics::TurbIEEEHydroWCNonLinearB with other classes 129
Table 71 – Attributes of TurbineGovernorDynamics::GovHydroIEEE0 130
Table 72 – Association ends of TurbineGovernorDynamics::GovHydroIEEE0 with other classes 130
Table 73 – Attributes of TurbineGovernorDynamics::GovHydroIEEE2 131
Table 74 – Association ends of TurbineGovernorDynamics::GovHydroIEEE2 with other classes 132
Table 75 – Attributes of TurbineGovernorDynamics::GovSteamIEEE1 133
Table 76 – Association ends of TurbineGovernorDynamics::GovSteamIEEE1 with other classes 134
Table 77 – Attributes of TurbineGovernorDynamics::GovCT1 136
Table 78 – Association ends of TurbineGovernorDynamics::GovCT1 with other classes 138
Table 79 – Attributes of TurbineGovernorDynamics::GovCT2 139
Table 80 – Association ends of TurbineGovernorDynamics::GovCT2 with other classes 141
Table 81 – Attributes of TurbineGovernorDynamics::GovGAST 142
Table 82 – Association ends of TurbineGovernorDynamics::GovGAST with other classes 143
Table 83 – Attributes of TurbineGovernorDynamics::GovGAST1 144
Table 84 – Association ends of TurbineGovernorDynamics::GovGAST1 with other classes 145
Table 85 – Attributes of TurbineGovernorDynamics::GovGAST2 146
Table 86 – Association ends of TurbineGovernorDynamics::GovGAST2 with other classes 147
Table 87 – Attributes of TurbineGovernorDynamics::GovGAST3 149
Table 88 – Association ends of TurbineGovernorDynamics::GovGAST3 with other classes 150
Table 89 – Attributes of TurbineGovernorDynamics::GovGAST4 151
Table 90 – Association ends of TurbineGovernorDynamics::GovGAST4 with other classes 152
Table 91 – Attributes of TurbineGovernorDynamics::GovGASTWD 153
Table 92 – Association ends of TurbineGovernorDynamics::GovGASTWD with other classes 154
Table 93 – Attributes of TurbineGovernorDynamics::GovHydro1 156
Table 94 – Association ends of TurbineGovernorDynamics::GovHydro1 with other classes 156
Table 95 – Attributes of TurbineGovernorDynamics::GovHydro2 157
Table 96 – Association ends of TurbineGovernorDynamics::GovHydro2 with other classes 158

Documents
Document Sharing Hub

Full document details: E DIN EN IEC 61970-302:2023-06

Table 97 – Attributes of TurbineGovernorDynamics::GovHydro3 160
Table 98 – Association ends of TurbineGovernorDynamics::GovHydro3 with other classes 161
Table 99 – Attributes of TurbineGovernorDynamics::GovHydro4 165
Table 100 – Association ends of TurbineGovernorDynamics::GovHydro4 with other classes 167
Table 101 – Attributes of TurbineGovernorDynamics::GovHydroDD 168
Table 102 – Association ends of TurbineGovernorDynamics::GovHydroDD with other classes 170
Table 103 – Attributes of TurbineGovernorDynamics::GovHydroFrancis 172
Table 104 – Association ends of TurbineGovernorDynamics::GovHydroFrancis with other classes 173
Table 105 – Attributes of TurbineGovernorDynamics::GovHydroPelton 175
Table 106 – Association ends of TurbineGovernorDynamics::GovHydroPelton with other classes 177
Table 107 – Attributes of TurbineGovernorDynamics::GovHydroPID 178
Table 108 – Association ends of TurbineGovernorDynamics::GovHydroPID with other classes 179
Table 109 – Attributes of TurbineGovernorDynamics::GovHydroPID2 180
Table 110 – Association ends of TurbineGovernorDynamics::GovHydroPID2 with other classes 181
Table 111 – Attributes of TurbineGovernorDynamics::GovHydroR 183
Table 112 – Association ends of TurbineGovernorDynamics::GovHydroR with other classes 184
Table 113 – Attributes of TurbineGovernorDynamics::GovHydroWEH 186
Table 114 – Association ends of TurbineGovernorDynamics::GovHydroWEH with other classes 188
Table 115 – Attributes of TurbineGovernorDynamics::GovHydroWPID 189
Table 116 – Association ends of TurbineGovernorDynamics::GovHydroWPID with other classes 190
Table 117 – Attributes of TurbineGovernorDynamics::GovSteam0 191
Table 118 – Association ends of TurbineGovernorDynamics::GovSteam0 with other classes 192
Table 119 – Attributes of TurbineGovernorDynamics::GovSteam1 194
Table 120 – Association ends of TurbineGovernorDynamics::GovSteam1 with other classes 196
Table 121 – Attributes of TurbineGovernorDynamics::GovSteam2 197
Table 122 – Association ends of TurbineGovernorDynamics::GovSteam2 with other classes 197
Table 123 – Attributes of TurbineGovernorDynamics::GovSteamBB 198
Table 124 – Association ends of TurbineGovernorDynamics::GovSteamBB with other classes 199
Table 125 – Attributes of TurbineGovernorDynamics::GovSteamCC 200
Table 126 – Association ends of TurbineGovernorDynamics::GovSteamCC with other classes 201
Table 127 – Attributes of TurbineGovernorDynamics::GovSteamEU 203
Table 128 – Association ends of TurbineGovernorDynamics::GovSteamEU with other classes 204
Table 129 – Attributes of TurbineGovernorDynamics::GovSteamFV2 205
Table 130 – Association ends of TurbineGovernorDynamics::GovSteamFV2 with other classes 205
Table 131 – Attributes of TurbineGovernorDynamics::GovSteamFV3 206
Table 132 – Association ends of TurbineGovernorDynamics::GovSteamFV3 with other classes 207
Table 133 – Attributes of TurbineGovernorDynamics::GovSteamFV4 209
Table 134 – Association ends of TurbineGovernorDynamics::GovSteamFV4 with other classes 210
Table 135 – Attributes of TurbineGovernorDynamics::GovSteamSGO 211

Documents
Document Sharing Hub

Full document details: E DIN EN IEC 61970-302:2023-06

Table 136 – Association ends of TurbineGovernorDynamics::GovSteamSGO with other classes 212
Table 137 – Literals of TurbineGovernorDynamics::DroopSignalFeedbackKind 212
Table 138 – Literals of TurbineGovernorDynamics::FrancisGovernorControlKind 212
Table 139 – Literals of TurbineGovernorDynamics::GovHydro4ModelKind 213
Table 140 – Attributes of TurbineLoadControllerDynamics::TurbineLoadControllerDynamics 214
Table 141 – Association ends of TurbineLoadControllerDynamics::TurbineLoadControllerDynamics with other classes 214
Table 142 – Attributes of TurbineLoadControllerDynamics::TurbLCFB1 216
Table 143 – Association ends of TurbineLoadControllerDynamics::TurbLCFB1 with other classes 216
Table 144 – Attributes of MechanicalLoadDynamics::MechanicalLoadDynamics 219
Table 145 – Association ends of MechanicalLoadDynamics::MechanicalLoadDynamics with other classes 220
Table 146 – Attributes of MechanicalLoadDynamics::MechLoad1 220
Table 147 – Association ends of MechanicalLoadDynamics::MechLoad1 with other classes 221
Table 148 – Attributes of ExcitationSystemDynamics::ExcitationSystemDynamics 223
Table 149 – Association ends of ExcitationSystemDynamics::ExcitationSystemDynamics with other classes 224
Table 150 – Attributes of ExcitationSystemDynamics::ExcAC1A 225
Table 151 – Association ends of ExcitationSystemDynamics::ExcAC1A with other classes 226
Table 152 – Attributes of ExcitationSystemDynamics::ExcAC2A 227
Table 153 – Association ends of ExcitationSystemDynamics::ExcAC2A with other classes 228
Table 154 – Attributes of ExcitationSystemDynamics::ExcAC3A 230
Table 155 – Association ends of ExcitationSystemDynamics::ExcAC3A with other classes 231
Table 156 – Attributes of ExcitationSystemDynamics::ExcAC4A 232
Table 157 – Association ends of ExcitationSystemDynamics::ExcAC4A with other classes 232
Table 158 – Attributes of ExcitationSystemDynamics::ExcAC5A 233
Table 159 – Association ends of ExcitationSystemDynamics::ExcAC5A with other classes 234
Table 160 – Attributes of ExcitationSystemDynamics::ExcAC6A 235
Table 161 – Association ends of ExcitationSystemDynamics::ExcAC6A with other classes 236
Table 162 – Attributes of ExcitationSystemDynamics::ExcAC8B 237
Table 163 – Association ends of ExcitationSystemDynamics::ExcAC8B with other classes 239
Table 164 – Attributes of ExcitationSystemDynamics::ExcANS 240
Table 165 – Association ends of ExcitationSystemDynamics::ExcANS with other classes 240
Table 166 – Attributes of ExcitationSystemDynamics::ExcAVR1 241
Table 167 – Association ends of ExcitationSystemDynamics::ExcAVR1 with other classes 242
Table 168 – Attributes of ExcitationSystemDynamics::ExcAVR2 243
Table 169 – Association ends of ExcitationSystemDynamics::ExcAVR2 with other classes 244
Table 170 – Attributes of ExcitationSystemDynamics::ExcAVR3 245
Table 171 – Association ends of ExcitationSystemDynamics::ExcAVR3 with other classes 245
Table 172 – Attributes of ExcitationSystemDynamics::ExcAVR4 246

Documents
Document Sharing Hub

Full document details: E DIN EN IEC 61970-302:2023-06

Table 173 – Association ends of ExcitationSystemDynamics::ExcAVR4 with other classes 247
Table 174 – Attributes of ExcitationSystemDynamics::ExcAVR5 248
Table 175 – Association ends of ExcitationSystemDynamics::ExcAVR5 with other classes 249
Table 176 – Attributes of ExcitationSystemDynamics::ExcAVR7 250
Table 177 – Association ends of ExcitationSystemDynamics::ExcAVR7 with other classes 250
Table 178 – Attributes of ExcitationSystemDynamics::ExcBBC 252
Table 179 – Association ends of ExcitationSystemDynamics::ExcBBC with other classes 252
Table 180 – Attributes of ExcitationSystemDynamics::ExcCZ 253
Table 181 – Association ends of ExcitationSystemDynamics::ExcCZ with other classes 254
Table 182 – Attributes of ExcitationSystemDynamics::ExcDC1A 255
Table 183 – Association ends of ExcitationSystemDynamics::ExcDC1A with other classes 256
Table 184 – Attributes of ExcitationSystemDynamics::ExcDC2A 257
Table 185 – Association ends of ExcitationSystemDynamics::ExcDC2A with other classes 258
Table 186 – Attributes of ExcitationSystemDynamics::ExcDC3A 259
Table 187 – Association ends of ExcitationSystemDynamics::ExcDC3A with other classes 260
Table 188 – Attributes of ExcitationSystemDynamics::ExcDC3A1 261
Table 189 – Association ends of ExcitationSystemDynamics::ExcDC3A1 with other classes 262
Table 190 – Attributes of ExcitationSystemDynamics::ExcELIN1 263
Table 191 – Association ends of ExcitationSystemDynamics::ExcELIN1 with other classes 264
Table 192 – Attributes of ExcitationSystemDynamics::ExcELIN2 265
Table 193 – Association ends of ExcitationSystemDynamics::ExcELIN2 with other classes 266
Table 194 – Attributes of ExcitationSystemDynamics::ExcHU 267
Table 195 – Association ends of ExcitationSystemDynamics::ExcHU with other classes 268
Table 196 – Attributes of ExcitationSystemDynamics::ExcNI 269
Table 197 – Association ends of ExcitationSystemDynamics::ExcNI with other classes 269
Table 198 – Attributes of ExcitationSystemDynamics::ExcOEX3T 271
Table 199 – Association ends of ExcitationSystemDynamics::ExcOEX3T with other classes 271
Table 200 – Attributes of ExcitationSystemDynamics::ExcPIC 272
Table 201 – Association ends of ExcitationSystemDynamics::ExcPIC with other classes 273
Table 202 – Attributes of ExcitationSystemDynamics::ExcREXS 275
Table 203 – Association ends of ExcitationSystemDynamics::ExcREXS with other classes 277
Table 204 – Attributes of ExcitationSystemDynamics::ExcRQB 278
Table 205 – Association ends of ExcitationSystemDynamics::ExcRQB with other classes 278
Table 206 – Attributes of ExcitationSystemDynamics::ExcSCRX 279
Table 207 – Association ends of ExcitationSystemDynamics::ExcSCRX with other classes 280
Table 208 – Attributes of ExcitationSystemDynamics::ExcSEXS 281
Table 209 – Association ends of ExcitationSystemDynamics::ExcSEXS with other classes 282
Table 210 – Attributes of ExcitationSystemDynamics::ExcSK 283
Table 211 – Association ends of ExcitationSystemDynamics::ExcSK with other classes 285

Documents
Document Sharing Hub

Full document details: E DIN EN IEC 61970-302:2023-06

Table 212 – Attributes of ExcitationSystemDynamics::ExcST1A 286
Table 213 – Association ends of ExcitationSystemDynamics::ExcST1A with other classes 286
Table 214 – Attributes of ExcitationSystemDynamics::ExcST2A 287
Table 215 – Association ends of ExcitationSystemDynamics::ExcST2A with other classes 288
Table 216 – Attributes of ExcitationSystemDynamics::ExcST3A 289
Table 217 – Association ends of ExcitationSystemDynamics::ExcST3A with other classes 290
Table 218 – Attributes of ExcitationSystemDynamics::ExcST4B 291
Table 219 – Association ends of ExcitationSystemDynamics::ExcST4B with other classes 292
Table 220 – Attributes of ExcitationSystemDynamics::ExcST6B 293
Table 221 – Association ends of ExcitationSystemDynamics::ExcST6B with other classes 294
Table 222 – Attributes of ExcitationSystemDynamics::ExcST7B 295
Table 223 – Association ends of ExcitationSystemDynamics::ExcST7B with other classes 296
Table 224 – Literals of ExcitationSystemDynamics::ExcREXSFeedbackSignalKind 296
Table 225 – Literals of ExcitationSystemDynamics::ExcST6BOELselectorKind 297
Table 226 – Literals of ExcitationSystemDynamics::ExcST7BOELselectorKind 297
Table 227 – Literals of ExcitationSystemDynamics::ExcST7BUELselectorKind 297
Table 228 – Attributes of IEEE4215from2005::ExcIEEEAC1A 298
Table 229 – Association ends of IEEE4215from2005::ExcIEEEAC1A with other classes 299
Table 230 – Attributes of IEEE4215from2005::ExcIEEEAC2A 300
Table 231 – Association ends of IEEE4215from2005::ExcIEEEAC2A with other classes 300
Table 232 – Attributes of IEEE4215from2005::ExcIEEEAC3A 301
Table 233 – Association ends of IEEE4215from2005::ExcIEEEAC3A with other classes 302
Table 234 – Attributes of IEEE4215from2005::ExcIEEEAC4A 303
Table 235 – Association ends of IEEE4215from2005::ExcIEEEAC4A with other classes 303
Table 236 – Attributes of IEEE4215from2005::ExcIEEEAC5A 304
Table 237 – Association ends of IEEE4215from2005::ExcIEEEAC5A with other classes 305
Table 238 – Attributes of IEEE4215from2005::ExcIEEEAC6A 305
Table 239 – Association ends of IEEE4215from2005::ExcIEEEAC6A with other classes 306
Table 240 – Attributes of IEEE4215from2005::ExcIEEEAC7B 307
Table 241 – Association ends of IEEE4215from2005::ExcIEEEAC7B with other classes 308
Table 242 – Attributes of IEEE4215from2005::ExcIEEEAC8B 309
Table 243 – Association ends of IEEE4215from2005::ExcIEEEAC8B with other classes 309
Table 244 – Attributes of IEEE4215from2005::ExcIEEEDC1A 310
Table 245 – Association ends of IEEE4215from2005::ExcIEEEDC1A with other classes 311
Table 246 – Attributes of IEEE4215from2005::ExcIEEEDC2A 312
Table 247 – Association ends of IEEE4215from2005::ExcIEEEDC2A with other classes 312
Table 248 – Attributes of IEEE4215from2005::ExcIEEEDC3A 313
Table 249 – Association ends of IEEE4215from2005::ExcIEEEDC3A with other classes 314
Table 250 – Attributes of IEEE4215from2005::ExcIEEEDC4B 314

Documents
Document Sharing Hub

Full document details: E DIN EN IEC 61970-302:2023-06

Table 251 – Association ends of IEEE4215from2005::ExcIEEEDC4B with other classes 315
Table 252 – Attributes of IEEE4215from2005::ExcIEEEST1A 316
Table 253 – Association ends of IEEE4215from2005::ExcIEEEST1A with other classes 317
Table 254 – Attributes of IEEE4215from2005::ExcIEEEST2A 318
Table 255 – Association ends of IEEE4215from2005::ExcIEEEST2A with other classes 318
Table 256 – Attributes of IEEE4215from2005::ExcIEEEST3A 319
Table 257 – Association ends of IEEE4215from2005::ExcIEEEST3A with other classes 320
Table 258 – Attributes of IEEE4215from2005::ExcIEEEST4B 320
Table 259 – Association ends of IEEE4215from2005::ExcIEEEST4B with other classes 321
Table 260 – Attributes of IEEE4215from2005::ExcIEEEST5B 322
Table 261 – Association ends of IEEE4215from2005::ExcIEEEST5B with other classes 322
Table 262 – Attributes of IEEE4215from2005::ExcIEEEST6B 323
Table 263 – Association ends of IEEE4215from2005::ExcIEEEST6B with other classes 324
Table 264 – Attributes of IEEE4215from2005::ExcIEEEST7B 325
Table 265 – Association ends of IEEE4215from2005::ExcIEEEST7B with other classes 325
Table 266 – Literals of IEEE4215from2005::ExcIEEEST1AUELselectorKind 326
Table 267 – Attributes of IEEE4215from2016::ExcIEEEDC1C 327
Table 268 – Association ends of IEEE4215from2016::ExcIEEEDC1C with other classes 327
Table 269 – Attributes of IEEE4215from2016::ExcIEEEDC2C 328
Table 270 – Association ends of IEEE4215from2016::ExcIEEEDC2C with other classes 329
Table 271 – Attributes of IEEE4215from2016::ExcIEEEDC4C 329
Table 272 – Association ends of IEEE4215from2016::ExcIEEEDC4C with other classes 330
Table 273 – Attributes of IEEE4215from2016::ExcIEEEAC1C 331
Table 274 – Association ends of IEEE4215from2016::ExcIEEEAC1C with other classes 332
Table 275 – Attributes of IEEE4215from2016::ExcIEEEAC2C 332
Table 276 – Association ends of IEEE4215from2016::ExcIEEEAC2C with other classes 333
Table 277 – Attributes of IEEE4215from2016::ExcIEEEAC3C 334
Table 278 – Association ends of IEEE4215from2016::ExcIEEEAC3C with other classes 335
Table 279 – Attributes of IEEE4215from2016::ExcIEEEAC4C 336
Table 280 – Association ends of IEEE4215from2016::ExcIEEEAC4C with other classes 336
Table 281 – Attributes of IEEE4215from2016::ExcIEEEAC5C 337
Table 282 – Association ends of IEEE4215from2016::ExcIEEEAC5C with other classes 338
Table 283 – Attributes of IEEE4215from2016::ExcIEEEAC6C 338
Table 284 – Association ends of IEEE4215from2016::ExcIEEEAC6C with other classes 339
Table 285 – Literals of IEEE4215from2016::VuelInputKind 340
Table 286 – Literals of IEEE4215from2016::VoelInputKind 340
Table 287 – Literals of IEEE4215from2016::VsclInputKind 340
Table 288 – Attributes of IEEE4215from2016::ExcIEEEAC7C 341
Table 289 – Association ends of IEEE4215from2016::ExcIEEEAC7C with other classes 342

Documents
Document Sharing Hub

Full document details: E DIN EN IEC 61970-302:2023-06

Table 290 – Attributes of IEEE4215from2016::ExcIEEEAC8C 343
Table 291 – Association ends of IEEE4215from2016::ExcIEEEAC8C with other classes 344
Table 292 – Attributes of IEEE4215from2016::ExcIEEEAC9C 344
Table 293 – Association ends of IEEE4215from2016::ExcIEEEAC9C with other classes 346
Table 294 – Literals of IEEE4215from2016::VsInputKind 346
Table 295 – Attributes of IEEE4215from2016::ExcIEEEAC10C 346
Table 296 – Association ends of IEEE4215from2016::ExcIEEEAC10C with other classes 348
Table 297 – Attributes of IEEE4215from2016::ExcIEEEAC11C 349
Table 298 – Association ends of IEEE4215from2016::ExcIEEEAC11C with other classes 350
Table 299 – Attributes of IEEE4215from2016::ExcIEEEST1C 351
Table 300 – Association ends of IEEE4215from2016::ExcIEEEST1C with other classes..... 352
Table 301 – Attributes of IEEE4215from2016::ExcIEEEST2C 352
Table 302 – Association ends of IEEE4215from2016::ExcIEEEST2C with other classes..... 353
Table 303 – Attributes of IEEE4215from2016::ExcIEEEST3C 354
Table 304 – Association ends of IEEE4215from2016::ExcIEEEST3C with other classes..... 355
Table 305 – Literals of IEEE4215from2016::InputsST4CKind 355
Table 306 – Attributes of IEEE4215from2016::ExcIEEEST4C 356
Table 307 – Association ends of IEEE4215from2016::ExcIEEEST4C with other classes..... 357
Table 308 – Attributes of IEEE4215from2016::ExcIEEEST5C 357
Table 309 – Association ends of IEEE4215from2016::ExcIEEEST5C with other classes..... 358
Table 310 – Literals of IEEE4215from2016::InputsST6CKind 359
Table 311 – Attributes of IEEE4215from2016::ExcIEEEST6C 359
Table 312 – Association ends of IEEE4215from2016::ExcIEEEST6C with other classes..... 360
Table 313 – Literals of IEEE4215from2016::InputsST7CKind 360
Table 314 – Attributes of IEEE4215from2016::ExcIEEEST7C 361
Table 315 – Association ends of IEEE4215from2016::ExcIEEEST7C with other classes..... 361
Table 316 – Attributes of IEEE4215from2016::ExcIEEEST8C 362
Table 317 – Association ends of IEEE4215from2016::ExcIEEEST8C with other classes..... 363
Table 318 – Attributes of IEEE4215from2016::ExcIEEEST9C 364
Table 319 – Association ends of IEEE4215from2016::ExcIEEEST9C with other classes..... 365
Table 320 – Attributes of IEEE4215from2016::ExcIEEEST10C 365
Table 321 – Association ends of IEEE4215from2016::ExcIEEEST10C with other classes..... 366
Table 322 – Attributes of OverexcitationLimiterDynamics::OverexcitationLimiterDynamics 368
Table 323 – Association ends of OverexcitationLimiterDynamics::OverexcitationLimiterDynamics with other classes 368
Table 324 – Attributes of OverexcitationLimiterDynamics::OverexcLimIEEE 368
Table 325 – Association ends of OverexcitationLimiterDynamics::OverexcLimIEEE with other classes..... 369
Table 326 – Attributes of OverexcitationLimiterDynamics::OverexcLim2 370
Table 327 – Association ends of OverexcitationLimiterDynamics::OverexcLim2 with other classes 371

Documents
Document Sharing Hub

Full document details: E DIN EN IEC 61970-302:2023-06

Table 328 – Attributes of OverexcitationLimiterDynamics::OverexcLimX1 372
Table 329 – Association ends of OverexcitationLimiterDynamics::OverexcLimX1 with other classes 373
Table 330 – Attributes of OverexcitationLimiterDynamics::OverexcLimX2 375
Table 331 – Association ends of OverexcitationLimiterDynamics::OverexcLimX2 with other classes 376
Table 332 – Attributes of OverexcitationLimiterDynamics::OverexcLimIEEEOEL2C 377
Table 333 – Association ends of OverexcitationLimiterDynamics::OverexcLimIEEEOEL2C with other classes 378
Table 334 – Attributes of OverexcitationLimiterDynamics::OverexcLimIEEEOEL3C 378
Table 335 – Association ends of OverexcitationLimiterDynamics::OverexcLimIEEEOEL3C with other classes 379
Table 336 – Attributes of OverexcitationLimiterDynamics::OverexcLimIEEEOEL4C 379
Table 337 – Association ends of OverexcitationLimiterDynamics::OverexcLimIEEEOEL4C with other classes 380
Table 338 – Attributes of OverexcitationLimiterDynamics::OverexcLimIEEEOEL5C 380
Table 339 – Association ends of OverexcitationLimiterDynamics::OverexcLimIEEEOEL5C with other classes 381
Table 340 – Attributes of UnderexcitationLimiterDynamics::UnderexcitationLimiterDynamics 382
Table 341 – Association ends of UnderexcitationLimiterDynamics::UnderexcitationLimiterDynamics with other classes 383
Table 342 – Attributes of UnderexcitationLimiterDynamics::UnderexcLimIEEE1 383
Table 343 – Association ends of UnderexcitationLimiterDynamics::UnderexcLimIEEE1 with other classes 384
Table 344 – Attributes of UnderexcitationLimiterDynamics::UnderexcLimIEEE2 384
Table 345 – Association ends of UnderexcitationLimiterDynamics::UnderexcLimIEEE2 with other classes 386
Table 346 – Attributes of UnderexcitationLimiterDynamics::UnderexcLimIEEEUEL2C 386
Table 347 – Association ends of UnderexcitationLimiterDynamics::UnderexcLimIEEEUEL2C with other classes 387
Table 348 – Attributes of UnderexcitationLimiterDynamics::UnderexcLim2Simplified 389
Table 349 – Association ends of UnderexcitationLimiterDynamics::UnderexcLim2Simplified with other classes 389
Table 350 – Attributes of UnderexcitationLimiterDynamics::UnderexcLimX1 390
Table 351 – Association ends of UnderexcitationLimiterDynamics::UnderexcLimX1 with other classes 391
Table 352 – Attributes of UnderexcitationLimiterDynamics::UnderexcLimX2 392
Table 353 – Association ends of UnderexcitationLimiterDynamics::UnderexcLimX2 with other classes 392
Table 354 – Attributes of PowerSystemStabilizerDynamics::PowerSystemStabilizerDynamics 394
Table 355 – Association ends of PowerSystemStabilizerDynamics::PowerSystemStabilizerDynamics with other classes 395
Table 356 – Attributes of PowerSystemStabilizerDynamics::PssIEEE2C 395
Table 357 – Association ends of PowerSystemStabilizerDynamics::PssIEEE2C with other classes 396
Table 358 – Attributes of PowerSystemStabilizerDynamics::PssIEEE3C 397

Documents
Document Sharing Hub

Full document details: E DIN EN IEC 61970-302:2023-06

Table 359 – Association ends of PowerSystemStabilizerDynamics::PssIEEE3C with other classes 397
Table 360 – Attributes of PowerSystemStabilizerDynamics::PssIEEE4C 398
Table 361 – Association ends of PowerSystemStabilizerDynamics::PssIEEE4C with other classes 401
Table 362 – Attributes of PowerSystemStabilizerDynamics::PssIEEE5C 401
Table 363 – Association ends of PowerSystemStabilizerDynamics::PssIEEE5C with other classes 402
Table 364 – Attributes of PowerSystemStabilizerDynamics::PssIEEE6C 403
Table 365 – Association ends of PowerSystemStabilizerDynamics::PssIEEE6C with other classes 404
Table 366 – Attributes of PowerSystemStabilizerDynamics::PssIEEE7C 404
Table 367 – Association ends of PowerSystemStabilizerDynamics::PssIEEE7C with other classes 405
Table 368 – Attributes of PowerSystemStabilizerDynamics::PssIEEE1A 406
Table 369 – Association ends of PowerSystemStabilizerDynamics::PssIEEE1A with other classes 406
Table 370 – Attributes of PowerSystemStabilizerDynamics::PssIEEE2B 407
Table 371 – Association ends of PowerSystemStabilizerDynamics::PssIEEE2B with other classes 408
Table 372 – Attributes of PowerSystemStabilizerDynamics::PssIEEE3B 408
Table 373 – Association ends of PowerSystemStabilizerDynamics::PssIEEE3B with other classes 409
Table 374 – Attributes of PowerSystemStabilizerDynamics::PssIEEE4B 410
Table 375 – Association ends of PowerSystemStabilizerDynamics::PssIEEE4B with other classes 412
Table 376 – Attributes of PowerSystemStabilizerDynamics::Pss1 413
Table 377 – Association ends of PowerSystemStabilizerDynamics::Pss1 with other classes 413
Table 378 – Attributes of PowerSystemStabilizerDynamics::Pss1A 414
Table 379 – Association ends of PowerSystemStabilizerDynamics::Pss1A with other classes 415
Table 380 – Attributes of PowerSystemStabilizerDynamics::Pss2B 416
Table 381 – Association ends of PowerSystemStabilizerDynamics::Pss2B with other classes 417
Table 382 – Attributes of PowerSystemStabilizerDynamics::Pss2ST 418
Table 383 – Association ends of PowerSystemStabilizerDynamics::Pss2ST with other classes 418
Table 384 – Attributes of PowerSystemStabilizerDynamics::Pss5 419
Table 385 – Association ends of PowerSystemStabilizerDynamics::Pss5 with other classes 420
Table 386 – Attributes of PowerSystemStabilizerDynamics::PssELIN2 421
Table 387 – Association ends of PowerSystemStabilizerDynamics::PssELIN2 with other classes 421
Table 388 – Attributes of PowerSystemStabilizerDynamics::PssPTIST1 422
Table 389 – Association ends of PowerSystemStabilizerDynamics::PssPTIST1 with other classes 423
Table 390 – Attributes of PowerSystemStabilizerDynamics::PssPTIST3 424
Table 391 – Association ends of PowerSystemStabilizerDynamics::PssPTIST3 with other classes 425
Table 392 – Attributes of PowerSystemStabilizerDynamics::PssRQB 426
Table 393 – Association ends of PowerSystemStabilizerDynamics::PssRQB with other classes 427
Table 394 – Attributes of PowerSystemStabilizerDynamics::PssSB4 427
Table 395 – Association ends of PowerSystemStabilizerDynamics::PssSB4 with other classes 428
Table 396 – Attributes of PowerSystemStabilizerDynamics::PssSH 429
Table 397 – Association ends of PowerSystemStabilizerDynamics::PssSH with other classes 429

Documents
Document Sharing Hub

Full document details: E DIN EN IEC 61970-302:2023-06

Table 398 – Attributes of PowerSystemStabilizerDynamics::PssSK 430
Table 399 – Association ends of PowerSystemStabilizerDynamics::PssSK with other classes 431
Table 400 – Attributes of PowerSystemStabilizerDynamics::PssSTAB2A 432
Table 401 – Association ends of PowerSystemStabilizerDynamics::PssSTAB2A with other classes 432
Table 402 – Attributes of PowerSystemStabilizerDynamics::PssWECC 433
Table 403 – Association ends of PowerSystemStabilizerDynamics::PssWECC with other classes 434
Table 404 – Literals of PowerSystemStabilizerDynamics::InputSignalKind 434
Table 405 – Attributes of DiscontinuousExcitationControlDynamics::DiscontinuousExcitationControlDynamics 436
Table 406 – Association ends of DiscontinuousExcitationControlDynamics::DiscontinuousExcitationControlDynamics with other classes 437
Table 407 – Attributes of DiscontinuousExcitationControlDynamics::DiscExcContIEEEDEC1A 437
Table 408 – Association ends of DiscontinuousExcitationControlDynamics::DiscExcContIEEEDEC1A with other classes 438
Table 409 – Attributes of DiscontinuousExcitationControlDynamics::DiscExcContIEEEDEC2A 438
Table 410 – Association ends of DiscontinuousExcitationControlDynamics::DiscExcContIEEEDEC2A with other classes 439
Table 411 – Attributes of DiscontinuousExcitationControlDynamics::DiscExcContIEEEDEC3A 439
Table 412 – Association ends of DiscontinuousExcitationControlDynamics::DiscExcContIEEEDEC3A with other classes 439
Table 413 – Attributes of PFVArControllerType1Dynamics::PFVArControllerType1Dynamics 441
Table 414 – Association ends of PFVArControllerType1Dynamics::PFVArControllerType1Dynamics with other classes 441
Table 415 – Attributes of PFVArControllerType1Dynamics::PFVArType1IEEEPFController 442
Table 416 – Association ends of PFVArControllerType1Dynamics::PFVArType1IEEEPFController with other classes 442
Table 417 – Attributes of PFVArControllerType1Dynamics::PFVArType1IEEEVArController 443
Table 418 – Association ends of PFVArControllerType1Dynamics::PFVArType1IEEEVArController with other classes 443
Table 419 – Attributes of PFVArControllerType1Dynamics::PFVArType1CIEEEPFController 444
Table 420 – Association ends of PFVArControllerType1Dynamics::PFVArType1CIEEEPFController with other classes 444
Table 421 – Attributes of PFVArControllerType1Dynamics::PFVArType1CIEEEVArController 445
Table 422 – Association ends of PFVArControllerType1Dynamics::PFVArType1CIEEEVArController with other classes 445
Table 423 – Attributes of PFVArControllerType2Dynamics::PFVArControllerType2Dynamics 446
Table 424 – Association ends of PFVArControllerType2Dynamics::PFVArControllerType2Dynamics with other classes 447
Table 425 – Attributes of PFVArControllerType2Dynamics::PFVArType2IEEEPFController 447
Table 426 – Association ends of PFVArControllerType2Dynamics::PFVArType2IEEEPFController with other classes 448
Table 427 – Attributes of PFVArControllerType2Dynamics::PFVArType2IEEEVArController 448

Documents
Document Sharing Hub

Full document details: E DIN EN IEC 61970-302:2023-06

Table 428 – Association ends of PFVArControllerType2Dynamics::PFVArType2IEEEVArController with other classes 449
Table 429 – Attributes of PFVArControllerType2Dynamics::PFVArType2Common1 450
Table 430 – Association ends of PFVArControllerType2Dynamics::PFVArType2Common1 with other classes 450
Table 431 – Attributes of PFVArControllerType2Dynamics::PFVArType2CIEEEPFController 451
Table 432 – Association ends of PFVArControllerType2Dynamics::PFVArType2CIEEEPFController with other classes 451
Table 433 – Attributes of PFVArControllerType2Dynamics::PFVArType2CIEEEVArController 452
Table 434 – Association ends of PFVArControllerType2Dynamics::PFVArType2CIEEEVArController with other classes 452
Table 435 – Attributes of VoltageAdjusterDynamics::VoltageAdjusterDynamics 453
Table 436 – Association ends of VoltageAdjusterDynamics::VoltageAdjusterDynamics with other classes 454
Table 437 – Attributes of VoltageAdjusterDynamics::VAdjIEEE 454
Table 438 – Association ends of VoltageAdjusterDynamics::VAdjIEEE with other classes 455
Table 439 – Attributes of VoltageAdjusterDynamics::VAdjIEEE2 455
Table 440 – Association ends of VoltageAdjusterDynamics::VAdjIEEE2 with other classes 455
Table 441 – Attributes of VoltageCompensatorDynamics::VoltageCompensatorDynamics 457
Table 442 – Association ends of VoltageCompensatorDynamics::VoltageCompensatorDynamics with other classes 457
Table 443 – Attributes of VoltageCompensatorDynamics::VCompIEEEType1 458
Table 444 – Association ends of VoltageCompensatorDynamics::VCompIEEEType1 with other classes 458
Table 445 – Attributes of VoltageCompensatorDynamics::VCompIEEEType2 459
Table 446 – Association ends of VoltageCompensatorDynamics::VCompIEEEType2 with other classes 459
Table 447 – Attributes of VoltageCompensatorDynamics::GenICompensationForGenJ 460
Table 448 – Association ends of VoltageCompensatorDynamics::GenICompensationForGenJ with other classes 460
Table 449 – Attributes of WindDynamics::WindPlantIEC 465
Table 450 – Association ends of WindDynamics::WindPlantIEC with other classes 465
Table 451 – Attributes of WindDynamics::WindPlantDynamics 466
Table 452 – Association ends of WindDynamics::WindPlantDynamics with other classes 466
Table 453 – Attributes of WindDynamics::WindTurbineType1or2Dynamics 466
Table 454 – Association ends of WindDynamics::WindTurbineType1or2Dynamics with other classes 467
Table 455 – Attributes of WindDynamics::WindTurbineType3or4Dynamics 467
Table 456 – Association ends of WindDynamics::WindTurbineType3or4Dynamics with other classes 467
Table 457 – Attributes of WindDynamics::WindTurbineType1or2IEC 468
Table 458 – Association ends of WindDynamics::WindTurbineType1or2IEC with other classes 468
Table 459 – Attributes of WindDynamics::WindTurbineType3or4IEC 469

Documents
Document Sharing Hub

Full document details: E DIN EN IEC 61970-302:2023-06

Table 460 – Association ends of WindDynamics::WindTurbineType3or4IEC with other classes 469
Table 461 – Attributes of WindDynamics::WindTurbineType3IEC 470
Table 462 – Association ends of WindDynamics::WindTurbineType3IEC with other classes 470
Table 463 – Attributes of WindDynamics::WindTurbineType4IEC 471
Table 464 – Association ends of WindDynamics::WindTurbineType4IEC with other classes 471
Table 465 – Attributes of WindDynamics::WindGenTurbineType1aIEC 472
Table 466 – Association ends of WindDynamics::WindGenTurbineType1aIEC with other classes 472
Table 467 – Attributes of WindDynamics::WindGenTurbineType1bIEC 472
Table 468 – Association ends of WindDynamics::WindGenTurbineType1bIEC with other classes 473
Table 469 – Attributes of WindDynamics::WindGenTurbineType2IEC 473
Table 470 – Association ends of WindDynamics::WindGenTurbineType2IEC with other classes 473
Table 471 – Attributes of WindDynamics::WindGenType3IEC 474
Table 472 – Association ends of WindDynamics::WindGenType3IEC with other classes 474
Table 473 – Attributes of WindDynamics::WindTurbineType4aIEC 475
Table 474 – Association ends of WindDynamics::WindTurbineType4aIEC with other classes 475
Table 475 – Attributes of WindDynamics::WindTurbineType4bIEC 476
Table 476 – Association ends of WindDynamics::WindTurbineType4bIEC with other classes 476
Table 477 – Attributes of WindDynamics::WindGenType3aIEC 477
Table 478 – Association ends of WindDynamics::WindGenType3aIEC with other classes 477
Table 479 – Attributes of WindDynamics::WindGenType3bIEC 477
Table 480 – Association ends of WindDynamics::WindGenType3bIEC with other classes 478
Table 481 – Attributes of WindDynamics::WindGenType4IEC 478
Table 482 – Association ends of WindDynamics::WindGenType4IEC with other classes 479
Table 483 – Attributes of WindDynamics::WindRefFrameRotIEC 479
Table 484 – Association ends of WindDynamics::WindRefFrameRotIEC with other classes 479
Table 485 – Attributes of WindDynamics::WindAeroConstIEC 480
Table 486 – Association ends of WindDynamics::WindAeroConstIEC with other classes 480
Table 487 – Attributes of WindDynamics::WindAeroOneDimIEC 480
Table 488 – Association ends of WindDynamics::WindAeroOneDimIEC with other classes 480
Table 489 – Attributes of WindDynamics::WindAeroTwoDimIEC 481
Table 490 – Association ends of WindDynamics::WindAeroTwoDimIEC with other classes 481
Table 491 – Attributes of WindDynamics::WindMechIEC 482
Table 492 – Association ends of WindDynamics::WindMechIEC with other classes 482
Table 493 – Attributes of WindDynamics::WindPitchContPowerIEC 482
Table 494 – Association ends of WindDynamics::WindPitchContPowerIEC with other classes 483
Table 495 – Attributes of WindDynamics::WindContRotorRIEC 483
Table 496 – Association ends of WindDynamics::WindContRotorRIEC with other classes 484
Table 497 – Attributes of WindDynamics::WindContPType3IEC 484
Table 498 – Association ends of WindDynamics::WindContPType3IEC with other classes 485

Documents
Document Sharing Hub

Full document details: E DIN EN IEC 61970-302:2023-06

Table 499 – Attributes of WindDynamics::WindContPType4aIEC 486
Table 500 – Association ends of WindDynamics::WindContPType4aIEC with other classes 486
Table 501 – Attributes of WindDynamics::WindContPType4bIEC 486
Table 502 – Association ends of WindDynamics::WindContPType4bIEC with other classes 487
Table 503 – Attributes of WindDynamics::WindContQIEC 487
Table 504 – Association ends of WindDynamics::WindContQIEC with other classes 488
Table 505 – Attributes of WindDynamics::WindContCurrLimIEC 488
Table 506 – Association ends of WindDynamics::WindContCurrLimIEC with other classes 489
Table 507 – Attributes of WindDynamics::WindContQLimIEC 489
Table 508 – Association ends of WindDynamics::WindContQLimIEC with other classes 490
Table 509 – Attributes of WindDynamics::WindContQPQULimIEC 490
Table 510 – Association ends of WindDynamics::WindContQPQULimIEC with other classes 490
Table 511 – Attributes of WindDynamics::WindContPitchAngleIEC 491
Table 512 – Association ends of WindDynamics::WindContPitchAngleIEC with other classes 491
Table 513 – Attributes of WindDynamics::WindProtectionIEC 492
Table 514 – Association ends of WindDynamics::WindProtectionIEC with other classes 492
Table 515 – Attributes of WindDynamics::WindPlantReactiveControlIEC 493
Table 516 – Association ends of WindDynamics::WindPlantReactiveControlIEC with other classes 494
Table 517 – Attributes of WindDynamics::WindPlantFreqPcontrolIEC 494
Table 518 – Association ends of WindDynamics::WindPlantFreqPcontrolIEC with other classes 495
Table 519 – Attributes of WindDynamics::WindDynamicsLookupTable 495
Table 520 – Association ends of WindDynamics::WindDynamicsLookupTable with other classes 496
Table 521 – Literals of WindDynamics::WindQcontrolModeKind 496
Table 522 – Literals of WindDynamics::WindUVRTQcontrolModeKind 497
Table 523 – Literals of WindDynamics::WindLookupTableFunctionKind 497
Table 524 – Literals of WindDynamics::WindPlantQcontrolModeKind 498
Table 525 – Attributes of WindDynamicsEd2::CommunicationDelayIEC 503
Table 526 – Association ends of WindDynamicsEd2::CommunicationDelayIEC with other classes 503
Table 527 – Attributes of WindDynamicsEd2::CommunicationIEC 503
Table 528 – Association ends of WindDynamicsEd2::CommunicationIEC with other classes 503
Table 529 – Attributes of WindDynamicsEd2::LinearCommunicationIEC 504
Table 530 – Association ends of WindDynamicsEd2::LinearCommunicationIEC with other classes 504
Table 531 – Attributes of WindDynamicsEd2::WindPlantControlCommIEC 504
Table 532 – Association ends of WindDynamicsEd2::WindPlantControlCommIEC with other classes 505
Table 533 – Attributes of WindDynamicsEd2::WindPlantQCompensationIEC 505
Table 534 – Association ends of WindDynamicsEd2::WindPlantQCompensationIEC with other classes 505
Table 535 – Attributes of WindDynamicsEd2::WindPlantBasicIEC 506
Table 536 – Association ends of WindDynamicsEd2::WindPlantBasicIEC with other classes 506
Table 537 – Attributes of WindDynamicsEd2::WindPlantDynamics2 507

Documents
Document Sharing Hub

Full document details: E DIN EN IEC 61970-302:2023-06

Table 538 – Association ends of WindDynamicsEd2::WindPlantDynamics2 with other classes 507
Table 539 – Attributes of WindDynamicsEd2::WindTurbineType1or2IEC2 507
Table 540 – Association ends of WindDynamicsEd2::WindTurbineType1or2IEC2 with other classes 508
Table 541 – Attributes of WindDynamicsEd2::WindTurbineType3or4IEC2 508
Table 542 – Association ends of WindDynamicsEd2::WindTurbineType3or4IEC2 with other classes 509
Table 543 – Attributes of WindDynamicsEd2::WindTurbineType3IEC2 509
Table 544 – Association ends of WindDynamicsEd2::WindTurbineType3IEC2 with other classes 510
Table 545 – Attributes of WindDynamicsEd2::WindTurbineType4IEC2 511
Table 546 – Association ends of WindDynamicsEd2::WindTurbineType4IEC2 with other classes 511
Table 547 – Attributes of WindDynamicsEd2::WindGenTurbineType1aIEC2 512
Table 548 – Association ends of WindDynamicsEd2::WindGenTurbineType1aIEC2 with other classes 512
Table 549 – Attributes of WindDynamicsEd2::WindGenTurbineType1bIEC2 513
Table 550 – Association ends of WindDynamicsEd2::WindGenTurbineType1bIEC2 with other classes 513
Table 551 – Attributes of WindDynamicsEd2::WindGenTurbineType2IEC2 514
Table 552 – Association ends of WindDynamicsEd2::WindGenTurbineType2IEC2 with other classes 514
Table 553 – Attributes of WindDynamicsEd2::WindGenType3IEC2 515
Table 554 – Association ends of WindDynamicsEd2::WindGenType3IEC2 with other classes 515
Table 555 – Attributes of WindDynamicsEd2::WindGridMeasForControl 515
Table 556 – Association ends of WindDynamicsEd2::WindGridMeasForControl with other classes 516
Table 557 – Attributes of WindDynamicsEd2::WindGridMeasForProtection 516
Table 558 – Association ends of WindDynamicsEd2::WindGridMeasForProtection with other classes 517
Table 559 – Attributes of WindDynamicsEd2::WindTurbineType4aIEC2 517
Table 560 – Association ends of WindDynamicsEd2::WindTurbineType4aIEC2 with other classes 517
Table 561 – Attributes of WindDynamicsEd2::WindTurbineType4bIEC2 518
Table 562 – Association ends of WindDynamicsEd2::WindTurbineType4bIEC2 with other classes 518
Table 563 – Attributes of WindDynamicsEd2::WindGenType3aIEC2 519
Table 564 – Association ends of WindDynamicsEd2::WindGenType3aIEC2 with other classes 520
Table 565 – Attributes of WindDynamicsEd2::WindGenType3bIEC2 520
Table 566 – Association ends of WindDynamicsEd2::WindGenType3bIEC2 with other classes 520
Table 567 – Attributes of WindDynamicsEd2::WindGenType4IEC2 521
Table 568 – Association ends of WindDynamicsEd2::WindGenType4IEC2 with other classes 521
Table 569 – Attributes of WindDynamicsEd2::WindRefFrameRotIEC2 522
Table 570 – Association ends of WindDynamicsEd2::WindRefFrameRotIEC2 with other classes 522
Table 571 – Attributes of WindDynamicsEd2::WindAeroConstIEC2 522
Table 572 – Association ends of WindDynamicsEd2::WindAeroConstIEC2 with other classes 523
Table 573 – Attributes of WindDynamicsEd2::WindAeroOneDimIEC2 523
Table 574 – Association ends of WindDynamicsEd2::WindAeroOneDimIEC2 with other classes 523

Documents
Document Sharing Hub

Full document details: E DIN EN IEC 61970-302:2023-06

Table 575 – Attributes of WindDynamicsEd2::WindAeroTwoDimIEC2 524
Table 576 – Association ends of WindDynamicsEd2::WindAeroTwoDimIEC2 with other classes 524
Table 577 – Attributes of WindDynamicsEd2::WindElectricalSystemGamma 524
Table 578 – Association ends of WindDynamicsEd2::WindElectricalSystemGamma with other classes 525
Table 579 – Attributes of WindDynamicsEd2::WindMechIEC2 525
Table 580 – Association ends of WindDynamicsEd2::WindMechIEC2 with other classes 525
Table 581 – Attributes of WindDynamicsEd2::WindPitchContPowerIEC2 526
Table 582 – Association ends of WindDynamicsEd2::WindPitchContPowerIEC2 with other classes 526
Table 583 – Attributes of WindDynamicsEd2::WindContRotorRIEC2 527
Table 584 – Association ends of WindDynamicsEd2::WindContRotorRIEC2 with other classes 527
Table 585 – Attributes of WindDynamicsEd2::WindContPType3IEC2 528
Table 586 – Association ends of WindDynamicsEd2::WindContPType3IEC2 with other classes 529
Table 587 – Attributes of WindDynamicsEd2::WindContPType4aIEC2 529
Table 588 – Association ends of WindDynamicsEd2::WindContPType4aIEC2 with other classes 530
Table 589 – Attributes of WindDynamicsEd2::WindContPType4bIEC2 530
Table 590 – Association ends of WindDynamicsEd2::WindContPType4bIEC2 with other classes 531
Table 591 – Attributes of WindDynamicsEd2::WindContQIEC2 531
Table 592 – Association ends of WindDynamicsEd2::WindContQIEC2 with other classes 532
Table 593 – Attributes of WindDynamicsEd2::WindContCurrLimIEC2 533
Table 594 – Association ends of WindDynamicsEd2::WindContCurrLimIEC2 with other classes 533
Table 595 – Attributes of WindDynamicsEd2::WindContQLimIEC2 534
Table 596 – Association ends of WindDynamicsEd2::WindContQLimIEC2 with other classes 534
Table 597 – Attributes of WindDynamicsEd2::WindContQPQULimIEC2 534
Table 598 – Association ends of WindDynamicsEd2::WindContQPQULimIEC2 with other classes 535
Table 599 – Attributes of WindDynamicsEd2::WindContPitchAngleIEC2 535
Table 600 – Association ends of WindDynamicsEd2::WindContPitchAngleIEC2 with other classes 536
Table 601 – Attributes of WindDynamicsEd2::WindProtectionIEC2 536
Table 602 – Association ends of WindDynamicsEd2::WindProtectionIEC2 with other classes 537
Table 603 – Attributes of WindDynamicsEd2::WindPlantQControlIEC 537
Table 604 – Association ends of WindDynamicsEd2::WindPlantQControlIEC with other classes 538
Table 605 – Attributes of WindDynamicsEd2::WindPlantPControlIEC 539
Table 606 – Association ends of WindDynamicsEd2::WindPlantPControlIEC with other classes 539
Table 607 – Attributes of WindDynamicsEd2::WindDynamicsLookupTable2 540
Table 608 – Association ends of WindDynamicsEd2::WindDynamicsLookupTable2 with other classes 540
Table 609 – Literals of WindDynamicsEd2::CommunicationModuleKind 541
Table 610 – Literals of WindDynamicsEd2::WindQcontrolModeKind2 541
Table 611 – Literals of WindDynamicsEd2::WindFRTQcontrolModeKind 541
Table 612 – Literals of WindDynamicsEd2::WindLookupTableFunctionKind2 542

Documents
Document Sharing Hub

Full document details: E DIN EN IEC 61970-302:2023-06

Table 613 – Literals of WindDynamicsEd2::WindPlantQcontrolModeKind2 542
Table 614 – Attributes of LoadDynamics::LoadComposite 545
Table 615 – Association ends of LoadDynamics::LoadComposite with other classes 546
Table 616 – Attributes of LoadDynamics::LoadGenericNonLinear 548
Table 617 – Association ends of LoadDynamics::LoadGenericNonLinear with other classes 548
Table 618 – Attributes of LoadDynamics::LoadDynamics 548
Table 619 – Association ends of LoadDynamics::LoadDynamics with other classes 549
Table 620 – Attributes of LoadDynamics::LoadAggregate 549
Table 621 – Association ends of LoadDynamics::LoadAggregate with other classes 550
Table 622 – Attributes of LoadDynamics::LoadStatic 552
Table 623 – Association ends of LoadDynamics::LoadStatic with other classes 553
Table 624 – Attributes of LoadDynamics::LoadMotor 555
Table 625 – Association ends of LoadDynamics::LoadMotor with other classes 555
Table 626 – Literals of LoadDynamics::GenericNonLinearLoadModelKind 556
Table 627 – Literals of LoadDynamics::StaticLoadModelKind 556
Table 628 – Attributes of LoadCompositeWECC::LoadAirCoWECC 557
Table 629 – Association ends of LoadCompositeWECC::LoadAirCoWECC with other classes 558
Table 630 – Attributes of LoadCompositeWECC::LoadCompositeWECC 558
Table 631 – Association ends of LoadCompositeWECC::LoadCompositeWECC with other classes 559
Table 632 – Attributes of LoadCompositeWECC::LoadElectronicWECC 560
Table 633 – Association ends of LoadCompositeWECC::LoadElectronicWECC with other classes 560
Table 634 – Attributes of LoadCompositeWECC::LoadMotorWECC 561
Table 635 – Association ends of LoadCompositeWECC::LoadMotorWECC with other classes 561
Table 636 – Attributes of LoadCompositeWECC::LoadStaticWECC 562
Table 637 – Association ends of LoadCompositeWECC::LoadStaticWECC with other classes 562
Table 638 – Attributes of HVDCDynamics::HVDCInterconnectionDynamics 563
Table 639 – Association ends of HVDCDynamics::HVDCInterconnectionDynamics with other classes 564
Table 640 – Attributes of HVDCDynamics::HVDCDynamics 564
Table 641 – Association ends of HVDCDynamics::HVDCDynamics with other classes 564
Table 642 – Attributes of HVDCDynamics::CSCDynamics 565
Table 643 – Association ends of HVDCDynamics::CSCDynamics with other classes 565
Table 644 – Attributes of HVDCDynamics::VSCDynamics 565
Table 645 – Association ends of HVDCDynamics::VSCDynamics with other classes 566
Table 646 – Attributes of RelayDynamics::RelayDynamics 567
Table 647 – Association ends of RelayDynamics::RelayDynamics with other classes 567
Table 648 – Attributes of RelayDynamics::WeccTIOCRS 568
Table 649 – Association ends of RelayDynamics::WeccTIOCRS with other classes 568
Table 650 – Attributes of RelayDynamics::RateOfChangeOfPowerRelay 569
Table 651 – Association ends of RelayDynamics::RateOfChangeOfPowerRelay with other classes 569

Documents
Document Sharing Hub

Full document details: E DIN EN IEC 61970-302:2023-06

Table 652 – Attributes of StatorCurrentLimiterDynamics::StatorCurrentLimiterDynamics 570
Table 653 – Association ends of StatorCurrentLimiterDynamics::StatorCurrentLimiterDynamics with other classes 571
Table 654 – Attributes of StatorCurrentLimiterDynamics::StatorCurrentLimIEEESCL1C 571
Table 655 – Association ends of StatorCurrentLimiterDynamics::StatorCurrentLimIEEESCL1C with other classes 572
Table 656 – Attributes of StatorCurrentLimiterDynamics::StatorCurrentLimIEEESCL2C 572
Table 657 – Association ends of StatorCurrentLimiterDynamics::StatorCurrentLimIEEESCL2C with other classes 574
Table 658 – Attributes of StaticVarCompensatorDynamics::StaticVarCompensatorDynamics 575
Table 659 – Association ends of StaticVarCompensatorDynamics::StaticVarCompensatorDynamics with other classes 576
Table 660 – Attributes of StaticVarCompensatorDynamics::SVSMO1 576
Table 661 – Association ends of StaticVarCompensatorDynamics::SVSMO1 with other classes 578
Table 662 – Attributes of StaticVarCompensatorDynamics::SVSMO2 578
Table 663 – Association ends of StaticVarCompensatorDynamics::SVSMO2 with other classes 580
Table 664 – Attributes of StaticVarCompensatorDynamics::SVSMO3 581
Table 665 – Association ends of StaticVarCompensatorDynamics::SVSMO3 with other classes 582
Table 666 – Attributes of StaticVarCompensatorDynamics::SVSMO4 583
Table 667 – Association ends of StaticVarCompensatorDynamics::SVSMO4 with other classes 584
Table 668 – Attributes of StaticVarCompensatorDynamics::StaticVarCompensatorSystemDynamics 584
Table 669 – Association ends of StaticVarCompensatorDynamics::StaticVarCompensatorSystemDynamics with other classes 585
Table 670 – Attributes of StatcomDynamics::StatcomDynamics 586
Table 671 – Association ends of StatcomDynamics::StatcomDynamics with other classes 587
Table 672 – Attributes of StatcomDynamics::StatcomIEC 587
Table 673 – Association ends of StatcomDynamics::StatcomIEC with other classes 587
Table 674 – Attributes of WECCDynamics::WeccDynamicsLookupTable 590
Table 675 – Association ends of WECCDynamics::WeccDynamicsLookupTable with other classes 590
Table 676 – Literals of WECCDynamics::WeccLookupTableFunctionKind 590
Table 677 – Attributes of WECCDynamics::WeccDERA 591
Table 678 – Association ends of WECCDynamics::WeccDERA with other classes 592
Table 679 – Attributes of WECCDynamics::WeccDERApvmod 593
Table 680 – Association ends of WECCDynamics::WeccDERApvmod with other classes 593
Table 681 – Attributes of WECCDynamics::WeccPVD1 593
Table 682 – Association ends of WECCDynamics::WeccPVD1 with other classes 594
Table 683 – Attributes of WECCDynamics::WeccREECA 595
Table 684 – Association ends of WECCDynamics::WeccREECA with other classes 597
Table 685 – Attributes of WECCDynamics::WeccREECB 597
Table 686 – Association ends of WECCDynamics::WeccREECB with other classes 598

Documents
Document Sharing Hub

Full document details: E DIN EN IEC 61970-302:2023-06

Table 687 – Attributes of WECCDynamics::WeccREECC 599
Table 688 – Association ends of WECCDynamics::WeccREECC with other classes 600
Table 689 – Attributes of WECCDynamics::WeccREGCA 601
Table 690 – Association ends of WECCDynamics::WeccREGCA with other classes 601
Table 691 – Attributes of WECCDynamics::WeccREPCA 602
Table 692 – Association ends of WECCDynamics::WeccREPCA with other classes 603
Table 693 – Attributes of WECCDynamics::WeccWT12T 603
Table 694 – Association ends of WECCDynamics::WeccWT12T with other classes 603
Table 695 – Attributes of WECCDynamics::WeccWT1PB 604
Table 696 – Association ends of WECCDynamics::WeccWT1PB with other classes 604
Table 697 – Attributes of WECCDynamics::WeccWT2E 605
Table 698 – Association ends of WECCDynamics::WeccWT2E with other classes 605
Table 699 – Attributes of WECCDynamics::WeccWTGARA 606
Table 700 – Association ends of WECCDynamics::WeccWTGARA with other classes 606
Table 701 – Attributes of WECCDynamics::WeccWTGPTA 606
Table 702 – Association ends of WECCDynamics::WeccWTGPTA with other classes 607
Table 703 – Attributes of WECCDynamics::WeccWTGTRQA 607
Table 704 – Association ends of WECCDynamics::WeccWTGTRQA with other classes 608
Table 705 – Attributes of WECCDynamics::WeccWTGTA 608
Table 706 – Association ends of WECCDynamics::WeccWTGTA with other classes 609
Table 707 – Attributes of WECCDynamics::WeccDynamics 609
Table 708 – Association ends of WECCDynamics::WeccDynamics with other classes 609
Table 709 – Attributes of WECCDynamics::WeccBESS 610
Table 710 – Association ends of WECCDynamics::WeccBESS with other classes 610
Table 711 – Literals of IEEE1547Dynamics::NormalOPcatKind 611
Table 712 – Literals of IEEE1547Dynamics::AbnormalOPcatKind 612
Table 713 – Literals of IEEE1547Dynamics::SupportedModesKind 612
Table 714 – Attributes of IEEE1547Dynamics::DERNameplateData 612
Table 715 – Association ends of IEEE1547Dynamics::DERNameplateData with other classes 613
Table 716 – Attributes of IEEE1547Dynamics::PowerLimitSettings 613
Table 717 – Association ends of IEEE1547Dynamics::PowerLimitSettings with other classes 613
Table 718 – Attributes of IEEE1547Dynamics::ServiceSettings 614
Table 719 – Association ends of IEEE1547Dynamics::ServiceSettings with other classes 614
Table 720 – Literals of IEEE1547Dynamics::ConstantPowerFactorSettingKind 615
Table 721 – Attributes of IEEE1547Dynamics::ConstantPowerFactorSettings 615
Table 722 – Association ends of IEEE1547Dynamics::ConstantPowerFactorSettings with other classes 615
Table 723 – Attributes of IEEE1547Dynamics::ConstantReactivePowerSettings 616
Table 724 – Association ends of IEEE1547Dynamics::ConstantReactivePowerSettings with other classes 616

Documents
Document Sharing Hub

Full document details: E DIN EN IEC 61970-302:2023-06

Table 725 – Attributes of IEEE1547Dynamics::VoltVarSettings 616
Table 726 – Association ends of IEEE1547Dynamics::VoltVarSettings with other classes 617
Table 727 – Attributes of IEEE1547Dynamics::WattVarSettings 617
Table 728 – Association ends of IEEE1547Dynamics::WattVarSettings with other classes 618
Table 729 – Attributes of IEEE1547Dynamics::VoltWattSettings 619
Table 730 – Association ends of IEEE1547Dynamics::VoltWattSettings with other classes 619
Table 731 – Attributes of IEEE1547Dynamics::VoltageTripSettings 619
Table 732 – Association ends of IEEE1547Dynamics::VoltageTripSettings with other classes 620
Table 733 – Attributes of IEEE1547Dynamics::FrequencyTripSettings 620
Table 734 – Association ends of IEEE1547Dynamics::FrequencyTripSettings with other classes 621
Table 735 – Attributes of IEEE1547Dynamics::FrequencyDroopSettings 621
Table 736 – Association ends of IEEE1547Dynamics::FrequencyDroopSettings with other classes 622
Table 737 – Attributes of IEEE1547Dynamics::MomentaryCessationSettings 622
Table 738 – Association ends of IEEE1547Dynamics::MomentaryCessationSettings with other classes 622
Table 739 – Attributes of IEEE1547Dynamics::DERIEEEType1 623
Table 740 – Association ends of IEEE1547Dynamics::DERIEEEType1 with other classes 623
Table 741 – Attributes of IEEE1547Dynamics::DERDynamics 624
Table 742 – Association ends of IEEE1547Dynamics::DERDynamics with other classes 624
Table 743 – Attributes of IEEE1547Dynamics::DERNameplateDataApplied 625
Table 744 – Association ends of IEEE1547Dynamics::DERNameplateDataApplied with other classes 625
Table 745 – Attributes of UserDefinedModels::SynchronousMachineUserDefined 627
Table 746 – Association ends of UserDefinedModels::SynchronousMachineUserDefined with other classes 627
Table 747 – Attributes of UserDefinedModels::AsynchronousMachineUserDefined 628
Table 748 – Association ends of UserDefinedModels::AsynchronousMachineUserDefined with other classes 628
Table 749 – Attributes of UserDefinedModels::TurbineGovernorUserDefined 629
Table 750 – Association ends of UserDefinedModels::TurbineGovernorUserDefined with other classes 629
Table 751 – Attributes of UserDefinedModels::TurbineLoadControllerUserDefined 630
Table 752 – Association ends of UserDefinedModels::TurbineLoadControllerUserDefined with other classes 630
Table 753 – Attributes of UserDefinedModels::MechanicalLoadUserDefined 630
Table 754 – Association ends of UserDefinedModels::MechanicalLoadUserDefined with other classes 631
Table 755 – Attributes of UserDefinedModels::ExcitationSystemUserDefined 631
Table 756 – Association ends of UserDefinedModels::ExcitationSystemUserDefined with other classes 631
Table 757 – Attributes of UserDefinedModels::OverexcitationLimiterUserDefined 632

Documents
Document Sharing Hub

Full document details: E DIN EN IEC 61970-302:2023-06

Table 758 – Association ends of UserDefinedModels::OverexcitationLimiterUserDefined with other classes 632
Table 759 – Attributes of UserDefinedModels::UnderexcitationLimiterUserDefined 633
Table 760 – Association ends of UserDefinedModels::UnderexcitationLimiterUserDefined with other classes 633
Table 761 – Attributes of UserDefinedModels::PowerSystemStabilizerUserDefined 634
Table 762 – Association ends of UserDefinedModels::PowerSystemStabilizerUserDefined with other classes 634
Table 763 – Attributes of UserDefinedModels::DiscontinuousExcitationControlUserDefined 634
Table 764 – Association ends of UserDefinedModels::DiscontinuousExcitationControlUserDefined with other classes 635
Table 765 – Attributes of UserDefinedModels::PFVArControllerType1UserDefined 635
Table 766 – Association ends of UserDefinedModels::PFVArControllerType1UserDefined with other classes 635
Table 767 – Attributes of UserDefinedModels::VoltageAdjusterUserDefined 636
Table 768 – Association ends of UserDefinedModels::VoltageAdjusterUserDefined with other classes 636
Table 769 – Attributes of UserDefinedModels::PFVArControllerType2UserDefined 637
Table 770 – Association ends of UserDefinedModels::PFVArControllerType2UserDefined with other classes 637
Table 771 – Attributes of UserDefinedModels::VoltageCompensatorUserDefined 638
Table 772 – Association ends of UserDefinedModels::VoltageCompensatorUserDefined with other classes 638
Table 773 – Attributes of UserDefinedModels::LoadUserDefined 638
Table 774 – Association ends of UserDefinedModels::LoadUserDefined with other classes 639
Table 775 – Attributes of UserDefinedModels::WindType1or2UserDefined 639
Table 776 – Association ends of UserDefinedModels::WindType1or2UserDefined with other classes 639
Table 777 – Attributes of UserDefinedModels::WindType3or4UserDefined 640
Table 778 – Association ends of UserDefinedModels::WindType3or4UserDefined with other classes 640
Table 779 – Attributes of UserDefinedModels::WindPlantUserDefined 641
Table 780 – Association ends of UserDefinedModels::WindPlantUserDefined with other classes 641
Table 781 – Attributes of UserDefinedModels::CSCUserDefined 642
Table 782 – Association ends of UserDefinedModels::CSCUserDefined with other classes 642
Table 783 – Attributes of UserDefinedModels::VSCUserDefined 642
Table 784 – Association ends of UserDefinedModels::VSCUserDefined with other classes 643
Table 785 – Attributes of UserDefinedModels::SVCUserDefined 643
Table 786 – Association ends of UserDefinedModels::SVCUserDefined with other classes 643
Table 787 – Attributes of UserDefinedModels::StatorCurrentLimiterUserDefined 644
Table 788 – Association ends of UserDefinedModels::StatorCurrentLimiterUserDefined with other classes 644
Table 789 – Attributes of UserDefinedModels::ProprietaryParameterDynamics 645
Table 790 – Association ends of UserDefinedModels::ProprietaryParameterDynamics with other classes 645

Documents
Document Sharing Hub

Full document details: E DIN EN IEC 61970-302:2023-06

Table 791 – Attributes of UserDefinedModels::StatcomUserDefined 646
Table 792 – Association ends of UserDefinedModels::StatcomUserDefined with other classes 646
Table 793 – Attributes of UserDefinedModels::HVDCInterconnectionUserDefined 647
Table 794 – Association ends of UserDefinedModels::HVDCInterconnectionUserDefined with other classes 647
Table 795 – Attributes of UserDefinedModels::RelayUserDefined 648
Table 796 – Association ends of UserDefinedModels::RelayUserDefined with other classes 648
Table 797 – Attributes of DetailedModelDescription::DetailedModelTypeDynamics 649
Table 798 – Association ends of DetailedModelDescription::DetailedModelTypeDynamics with other classes 650
Table 799 – Attributes of DetailedModelDescription::DetailedModelDescriptorArtifact 650
Table 800 – Association ends of DetailedModelDescription::DetailedModelDescriptorArtifact with other classes 650
Table 801 – Attributes of DetailedModelDescription::DetailedModelDocumentationArtifact 651
Table 802 – Association ends of DetailedModelDescription::DetailedModelDocumentationArtifact with other classes 651
Table 803 – Attributes of DetailedModelDescription::FunctionDescriptor 651
Table 804 – Association ends of DetailedModelDescription::FunctionDescriptor with other classes 652
Table 805 – Attributes of DetailedModelDescription::InputOutputDescriptor 652
Table 806 – Association ends of DetailedModelDescription::InputOutputDescriptor with other classes 652
Table 807 – Attributes of DetailedModelDescription::LimiterDescriptor 653
Table 808 – Association ends of DetailedModelDescription::LimiterDescriptor with other classes 653
Table 809 – Attributes of DetailedModelDescription::OperatorDescriptor 653
Table 810 – Association ends of DetailedModelDescription::OperatorDescriptor with other classes 654
Table 811 – Attributes of DetailedModelDescription::ParameterDesctiptor 654
Table 812 – Association ends of DetailedModelDescription::ParameterDesctiptor with other classes 655
Table 813 – Attributes of DetailedModelDescription::ParameterValue 655
Table 814 – Association ends of DetailedModelDescription::ParameterValue with other classes 655
Table 815 – Attributes of DetailedModelDescription::SignalDescriptor 655
Table 816 – Association ends of DetailedModelDescription::SignalDescriptor with other classes 656
Table 817 – Attributes of DetailedModelDescription::DetailedModelDescriptor 656
Table 818 – Association ends of DetailedModelDescription::DetailedModelDescriptor with other classes 656
Table 819 – Attributes of DetailedModelDescription::DetailedModelDynamics 657
Table 820 – Association ends of DetailedModelDescription::DetailedModelDynamics with other classes 657
Table 821 – Literals of DetailedModelDescription::ConstraintKind 657
Table 822 – Literals of DetailedModelDescription::LogicalKind 658
Table 823 – Literals of DetailedModelDescription::EquationLanguageKind 658
Table 824 – Literals of DetailedModelDescription::OperatorDescriptorKind 658
Table 825 – Literals of DetailedModelDescription::ParameterKind 659

Documents
Document Sharing Hub

Full document details: E DIN EN IEC 61970-302:2023-06

Table 826 – Literals of DetailedModelDescription::XSDDatatypeKind 659
Table 827 – Attributes of SimulationResult::SimulationResult 661
Table 828 – Association ends of SimulationResult::SimulationResult with other classes 661
Table 829 – Attributes of SimulationResult::SimulationResultCharacteristic 661
Table 830 – Association ends of SimulationResult::SimulationResultCharacteristic with other classes 662
Table 831 – Attributes of SimulationResult::PowerFlowSettings 662
Table 832 – Association ends of SimulationResult::PowerFlowSettings with other classes 663
Table 833 – Literals of SimulationResult::PowerFlowAlgorithmKind 664
Table 834 – Literals of SimulationResult::SlackDistributionKind 664
Table 835 – Literals of SimulationResult::PowerShiftKind 664
Table 836 – Attributes of SimulationResult::SimulationSettings 665
Table 837 – Association ends of SimulationResult::SimulationSettings with other classes 665
Table 838 – Attributes of SimulationResult::SignalRecorder 665
Table 839 – Association ends of SimulationResult::SignalRecorder with other classes 666
Table 840 – Literals of SimulationResult::SignalKind 666
Table 841 – Attributes of SimulationResult::ParameterEvent 666
Table 842 – Association ends of SimulationResult::ParameterEvent with other classes 667
Table 843 – Literals of SimulationResult::ParameterChangeKind 667
Table 844 – Attributes of SimulationResult::ClearSimulationEvent 668
Table 845 – Association ends of SimulationResult::ClearSimulationEvent with other classes 668
Table 846 – Attributes of SimulationResult::SimulationEvents 668
Table 847 – Association ends of SimulationResult::SimulationEvents with other classes 668
Table 848 – Attributes of SimulationResult::SignalConfiguration 669
Table 849 – Association ends of SimulationResult::SignalConfiguration with other classes 669

Documents
Document Sharing Hub

Full document details: E DIN EN IEC 61970-302:2023-06

INTRODUCTION

This International Standard is one of the IEC 61970 series which defines an application program interface (API) for an energy management system (EMS).

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

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

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

IEC 61970-301 defines the CIM Base set of packages which provide a logical view of the functional aspects of an energy management system.

This part of the standard, IEC 61970-302, builds on IEC 61970-301 and provides the specifications for the exchange models representing dynamic behaviour of the majority of power system components in common use today by utilities to perform system simulation studies for system dynamic assessment and for planning purposes.

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

Part 302: Common information model (CIM) dynamics

1 Scope

The common information model (CIM) is an abstract model that represents all the major objects in an electric utility enterprise typically involved in utility operations. By providing a standard way of representing power system resources as object classes and attributes, along with their relationships, the CIM facilitates the integration of energy management system (EMS) applications developed independently by different vendors, between entire EMSs developed independently, or between an EMS and other systems concerned with different aspects of power system operations, such as generation or distribution management. SCADA is modelled to the extent necessary to support power system simulation and communication between control centres. The CIM facilitates integration by defining a common language (i.e. semantics) based on the CIM to enable these applications or systems to access public data and exchange information independent of how such information is represented internally.

Due to the size of the complete CIM, the object classes contained in the CIM are grouped into a number of logical packages, each of which represents a certain part of the overall power system being modelled. Collections of these packages are being developed as separate International Standards.

This particular document specifies a Dynamics package which contains part of the CIM to support the exchange of models between software applications that perform analysis of the steady-state stability (small-signal stability) or transient stability of a power system as defined by IEEE/CIGRE *Definition and classification of power system stability IEEE/CIGRE joint task force on stability terms and definitions*.

The model descriptions in this standard provide specifications for each type of dynamic model as well as the information that needs to be included in dynamic case exchanges between planning/study applications.

The scope of the CIM Dynamics package specified in this standard includes:

- standard models: a simplified approach to describing dynamic models, where models representing dynamic behaviour of elements of the power system are contained in predefined libraries of classes which are interconnected in a standard manner. Only the names of the selected elements of the models along with their attributes are needed to describe dynamic behaviour.
- proprietary user-defined models: an approach providing users the ability to define the parameters of a dynamic behaviour model representing a vendor or user proprietary device where an explicit description of the model is not provided by the standard. The same libraries and standard interconnections are used for both proprietary user-defined models and standard models. The behavioural details of the model are not documented in the standard, only the model parameters.
- A model to enable exchange of models' descriptions. This approach can be used to describe user defined and standard models.
- A model to enable exchange of simulation results.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 60050 (all parts), *International Electrotechnical Vocabulary*

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

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

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3 Terms and definitions

For the purposes of this document, the terms and definitions contained in IEC 60050 (for general glossary), IEC 61970-2 (for EMS-API glossary definitions) and the following apply.

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

3.1
application program interface
API
set of public functions provided by an executable application component for use by other executable application components

3.2
common information model
CIM
refers to the work and standards created by IEC TC57 in the 61970-, 61968- and 62325-series with the purpose of creating and sharing the use of a common canonical data model describing the electrical grid and relevant utility operations

Note 1 to entry: Edition 1 term: " abstract model that represents all the major objects in an electric utility enterprise typically contained in an EMS information model.

3.3
CIMXML
serialisation format for exchange of XML data as defined in this document

3.4
energy management system
EMS
computer system comprising a software platform providing basic support services and a set of applications providing the functionality needed for the effective operation of electrical generation and transmission facilities so as to assure adequate security of energy supply at minimum cost

3.5
model
collection of data describing objects or entities real or computed, the semantics of which is defined by profiles (3.9) in the context of CIM

Note 1 to entry: In power system analysis, a model is a set of static data describing the power system. Examples of models include the static network model, the topology solution, and the network solution produced by a power flow or state estimator application.

3.6
application profile
defined structured collection of data element specifications chosen to satisfy the particular needs of a community or communities

Note 1 to entry: This definition includes what sometimes called "profile", "metadata application profiles", or "metadata profiles".

Note 2 to entry: IEC 61970-301:2020 defines profile as: "subset of CIM classes, associations and attributes needed to accomplish a specific type of Interface".

Note 3 to entry: DX-PROF defines profile as: "A specification that constrains, extends, combines, or provides guidance or explanation about the usage of other specifications."

[SOURCE: ISO/IEC 19788-1:2011, 3.1]

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3.7
Resource Description Framework
RDF
a standard model for data interchange on the Web. RDF has features that facilitate data merging even if the underlying schemas differ, and it specifically support the evolution of schemas over time without requiring all the data consumers to be changed.
RDF extends the linking structure of the Web to use URIs to name the relationship between things as well as the two ends of the link (this is usually referred to as a "triple").

[SOURCE: www.w3.org/RDF/]

3.8
RDF schema
a general-purpose language for representing simple RDF vocabularies on the Web. Other vocabulary definition technologies, like OWL or SKOS, build on RDFS and provide language for defining structured, Web-based ontologies which enable richer integration and interoperability of data among descriptive communities

[SOURCE: https://www.w3.org/2001/sw/wiki/RDFS]

3.9
real-world objects
objects that belong to the real world problem domain as distinguished from interface objects and controller objects within the implementation

Note 1 to entry: The real-world objects for the EMS domain are defined as classes in IEC 61970-301.

Note 2 to entry: Classes and objects model what is in a power system that needs to be represented in a common way to EMS applications. A class is a description of an object found in the real world, such as a PowerTransformer, GeneratingUnit, or Load that needs to be represented as part of the overall power system model in an EMS. Other types of objects include things such as schedules and measurements that EMS applications also need to process, analyze, and store. Such objects need a common representation to achieve the purposes of the EMS-API standard for plug-compatibility and interoperability. A particular object in a power system with a unique identity is modelled as an instance of the class to which it belongs.

3.10
Standard Generalized Markup Language
SGML
international standard for the definition of device-independent, system-independent methods of representing texts in electronic form

Note 1 to entry: HTML and XML are derived from SGML.

3.11
Unified Modeling Language
UML
object-oriented modelling language and methodology for specifying, visualizing, constructing, and documenting the artefacts of a system-intensive process

3.12
uniform resource identifier
URI
standard Web syntax and semantics for identifying (referencing) resources such as files, documents, and images

3.13
eXtensible Markup Language
XML
subset of Standard Generalized Markup Language (SGML), ISO 8879, for putting structured data in a text file

Note 1 to entry: This is an endorsed recommendation from the W3C. It is license-free, platform-independent and well-supported by many readily available software tools.

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3.14
eXtensible Stylesheet Language
XSL
language for expressing style sheets for XML documents

4 CIM Dynamics specification

4.1 General

The content is generated from UML model file CIM100_501-20v01_302CDV20v26_457-20v22.eap.

CIM for dynamics uses the following prefix and the uri of the namespace:

– Prefix: cim

– URI: http://iec.ch/TC57/CIM100#

It should be noted that due to the nature of the CIM for Dynamics, it could be combined with other CIM versions however some limitations can be observed due to lack of classes where dynamics models could connect to the static model. Therefore, an impact analysis is necessary when applying this model to other CIM versions.

This edition is based on the IEC 61970 UML version ‘IEC61970CIM17v40’, dated ‘2020-08-24’.

4.2 Document structure

Subclause 5.1 provides general information on the scope and use of CIM dynamic models.

Subclause 5.2 describes the standard interconnection of models for various types of equipment.

Subclause 5.3 contains the standard model specifications grouped by type of equipment being modelled.

Subclause 5.4 contains user-defined model classes.

Subclause 5.5 illustrates typical CIM dynamics model usage by means of instance diagrams.

Annex A describes the Dynamics package symbol representation conventions.

Annex B contains the rationale behind the use of the per unit data type.

Annex C describes the process by which updates to Dynamics standard models can be requested and provides a form for making requests.

5 Common Information Model Dynamics package

5.1 General

[nsuri = http://iec.ch/TC57/CIM100#, nsprefix = cim]

The CIM dynamic model definitions reflect the most common IEEE or, in the case of wind models, IEC, representations of models as well as models included in some of the transient stability software widely used by utilities.

These dynamic models are intended to ensure interoperability between different vendors’ software products currently in use by electric utility energy companies, utilities, Transmission System Operators (TSOs), Regional Transmission Organizations (RTOs), and Independent System Operators (ISOs). It is important to note that each vendor is free to select its own internal implementation of these models. Differences in vendor results, as long as they are within accepted engineering practice, caused by different internal representations, are acceptable.

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Unless explicitly stated otherwise, the following modelling conventions are followed:

– limited integrators are of the non-windup type;

– it shall be possible to enter a time constant of zero (where it makes sense).

5.2 Package StandardInterconnections

5.2.1 General

This subclause describes the standard interconnections for various types of equipment. These interconnections are understood by the application programs and can be identified based on the presence of one of the key classes with a relationship to the static power flow model: SynchronousMachineDynamics, AsynchronousMachineDynamics, EnergyConsumerDynamics or WindTurbineType3or4Dynamics.

The relationships between classes expressed in the interconnection diagrams are intended to support dynamic behaviour described by either standard models or user-defined models.

In the interconnection diagrams, boxes which are black in colour represent function blocks whose functionality can be provided by one of many standard models or by a user-defined model. Blue boxes represent specific standard models. A dashed box means that the function block or specific standard model is optional.

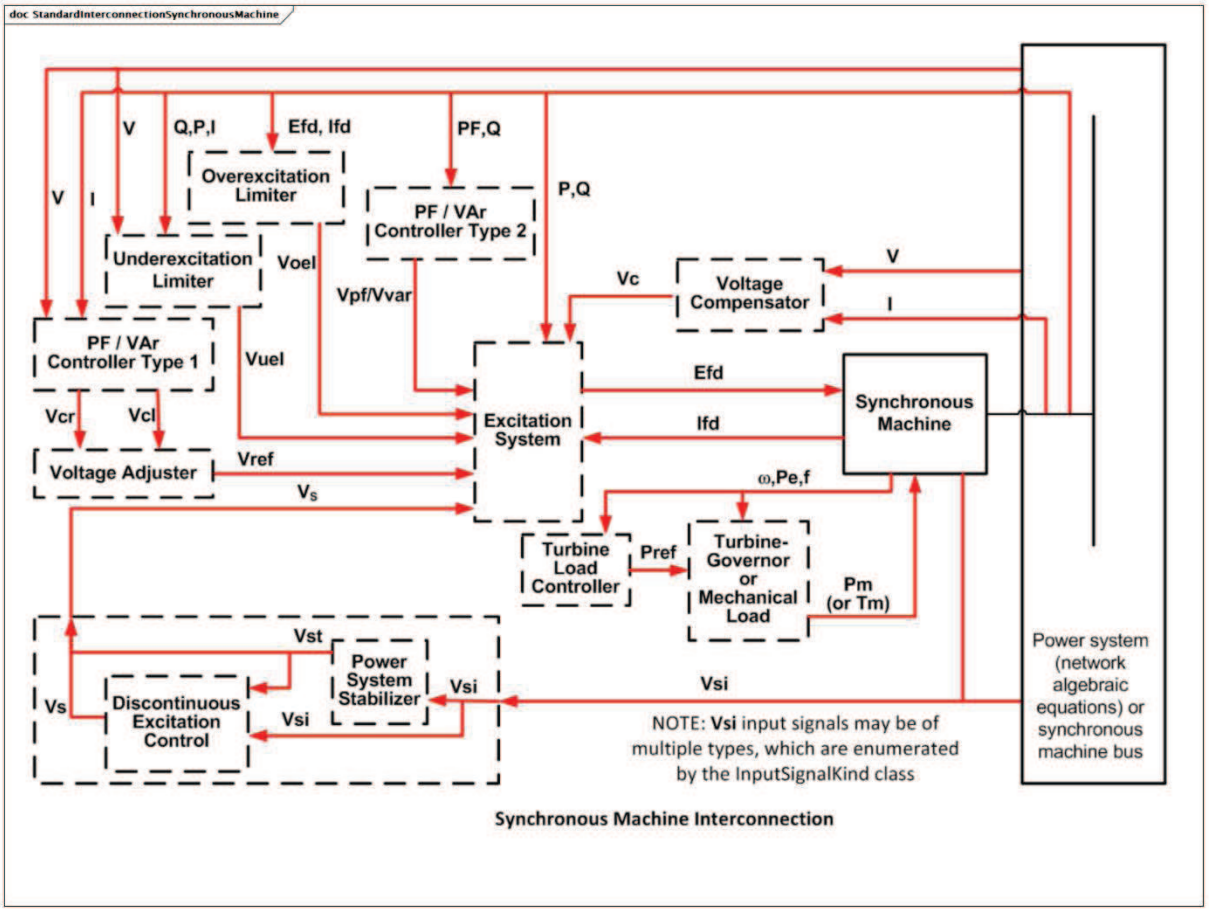


Figure 1 – StandardInterconnectionSynchronousMachine

Figure 1: A dynamic model that includes a single synchronous machine (generator, motor or condenser) and its related equipment models (function blocks) is associated with a synchronous machine in the static (power flow) model and has the standard interconnection shown above.

The interface between the dynamic synchronous machine and the network algebraic equations is application dependent. The variables used for this interface do not need to be identified since they are internal to the application program, well-defined and not necessary to be exchanged between applications.

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The interfaces between different blocks in the above figure are indicative of the variety of input and output signals that are defined by the individual standard models. The figure provides information on most of the alternative interfaces, for instance, the turbine-governor (for generators) or the mechanical load (for motors) and the dynamic synchronous machine can be mechanical torque (Tm) or mechanical power (Pm).

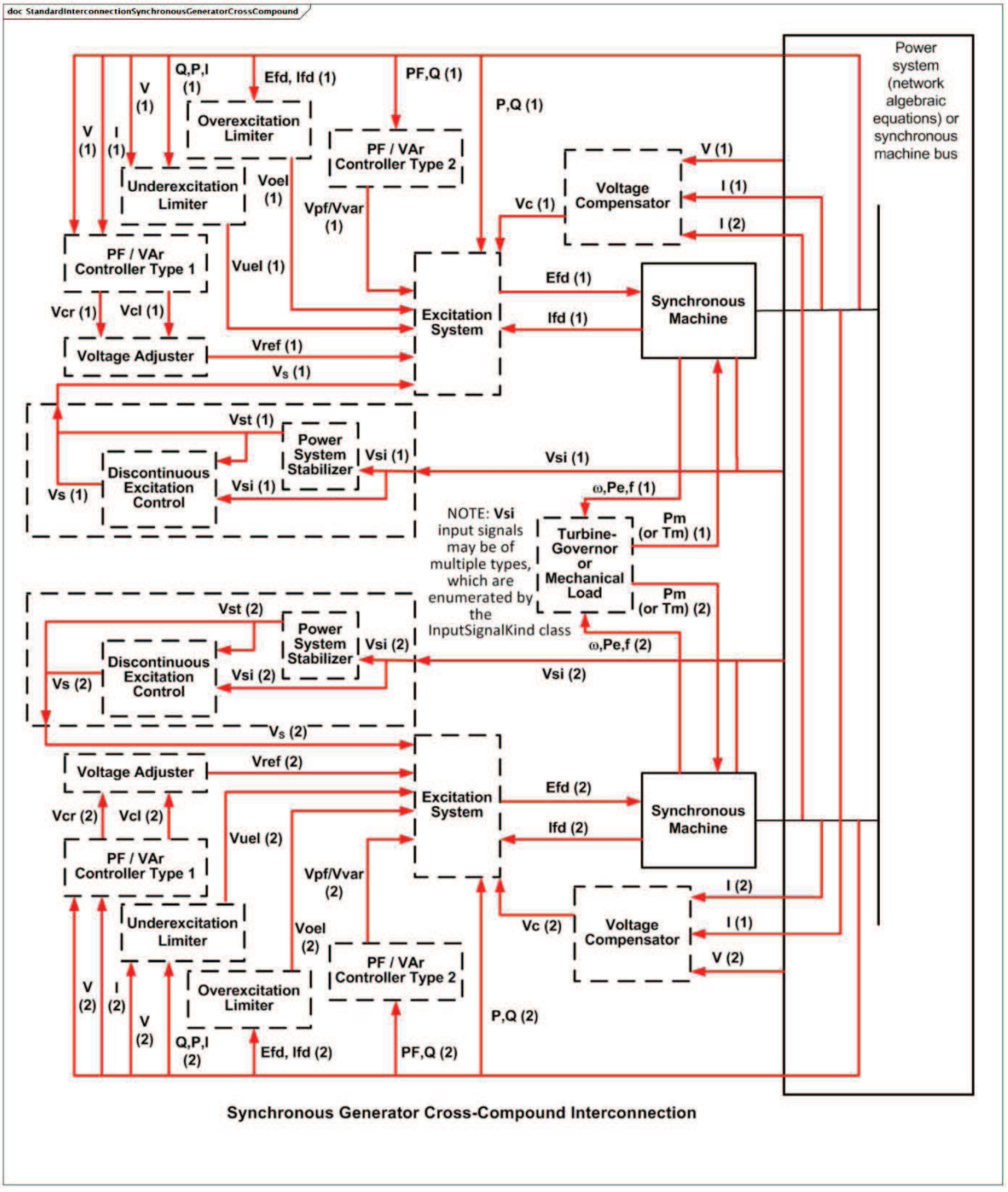


Figure 2 – StandardInterconnectionSynchronousGeneratorCrossCompound

Figure 2: A cross-compound dynamic model that includes multiple synchronous generators and their related equipment models (function blocks), is associated with multiple synchronous machines in the static (power flow) model and has the standard interconnection shown above.

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Generator 2 is the second unit of a cross-compound pair of generators and is usually connected to the same terminal bus. A single turbine-governor model determines the mechanical power for both units.

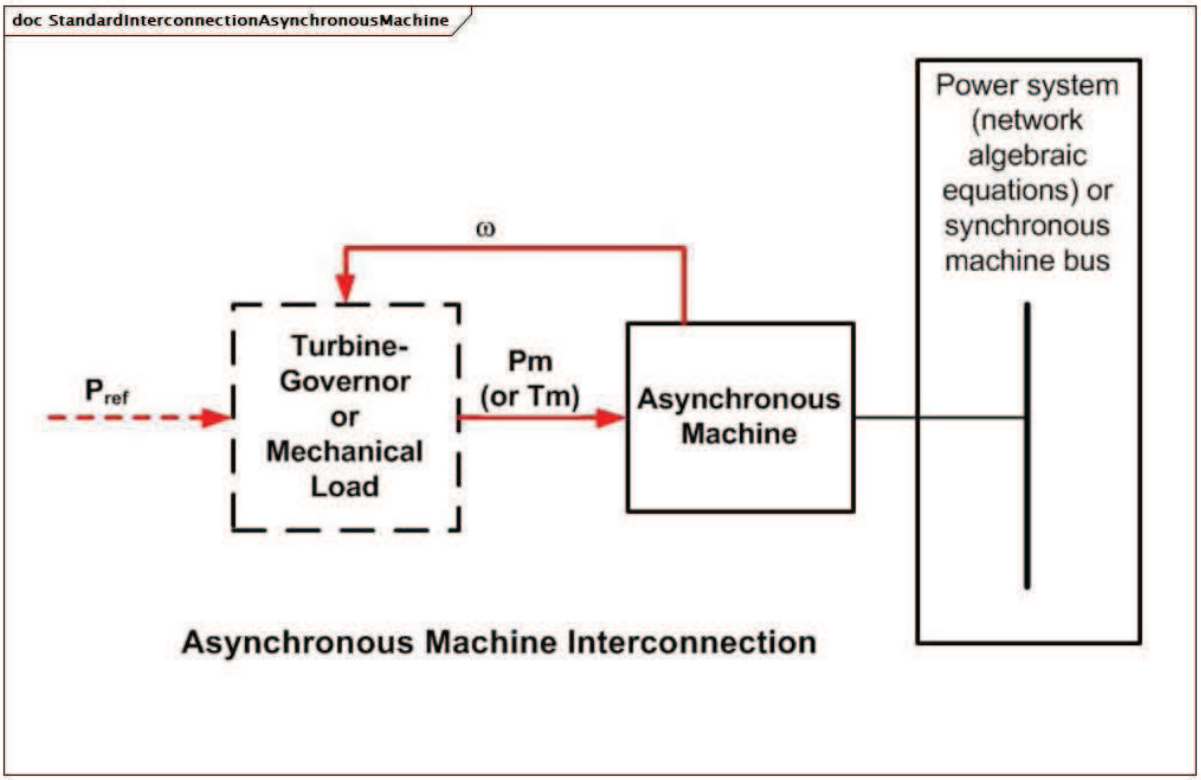


Figure 3 – StandardInterconnectionAsynchronousMachine

Figure 3: A dynamic model including an asynchronous machine (either a generator or motor) and its related equipment models (function blocks) is associated with an asynchronous machine in the static (power flow) model and has the standard interconnection shown above.

This interconnection is for a “squirrel-cage” induction machine or a wound-rotor induction machine with short-circuited field windings. Other models and a different interconnection are required for a wound-rotor machine with external connections to the field windings.

The interface between the dynamic asynchronous machine and the network algebraic equations is application-dependent.

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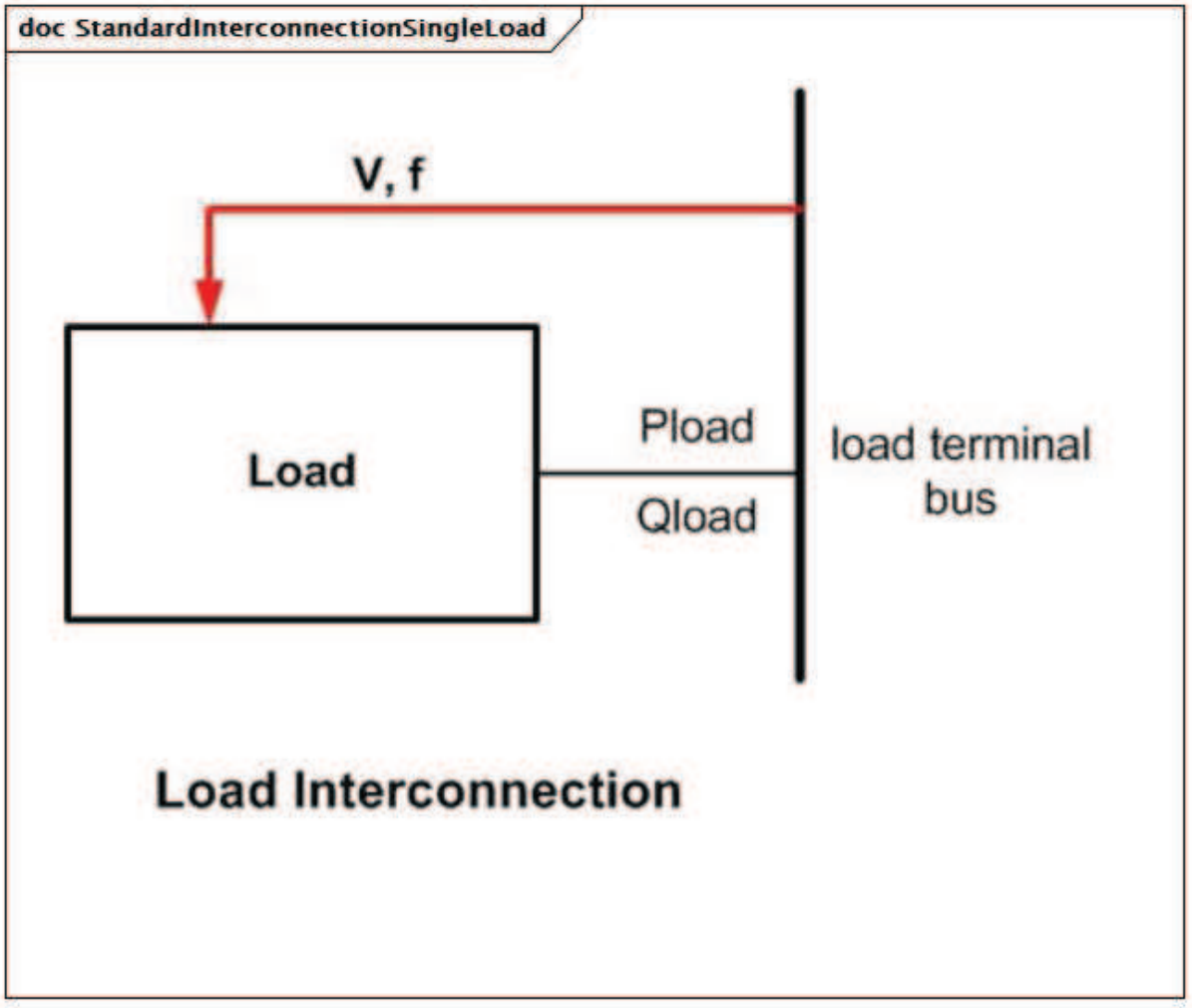


Figure 4 – StandardInterconnectionSingleLoad

Figure 4: A load model is associated with an energy consumer in the power flow data and has no standard interconnection with other models.

The P and Q consumption of the load are determined as a function of the magnitude and frequency of the voltage at the terminal bus as shown above.

The interface between the model and the network algebraic equations is application-dependent. Dynamic (motor) load models generally interface with the network equations in a similar manner to motor models.

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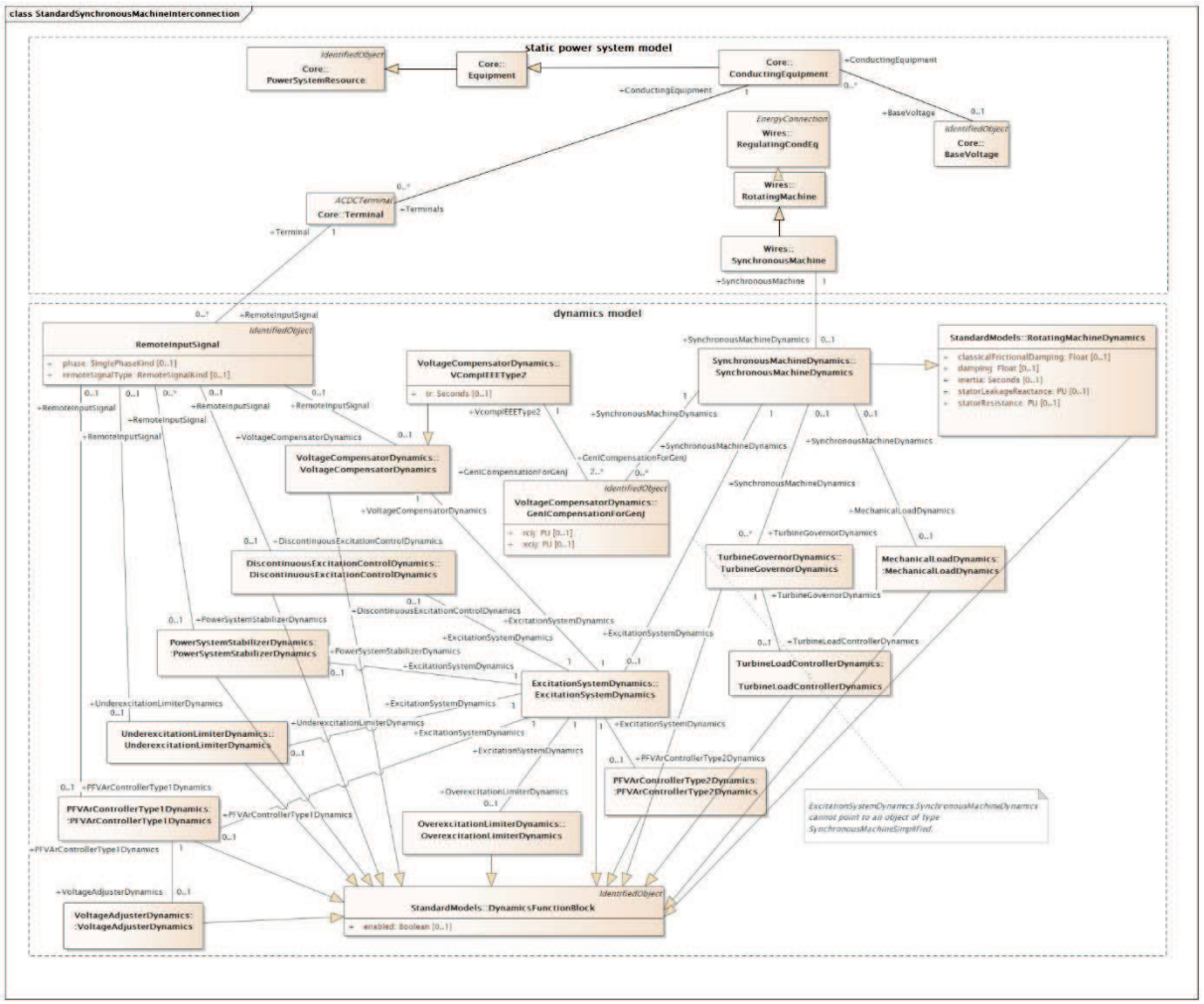


Figure 5 – Class diagram
StandardInterconnections::StandardSynchronousMachineInterconnection

Figure 5: This diagram shows the classes necessary for both of the two types of synchronous machine interconnection models: standard synchronous machine and standard synchronous generator cross-compound.

A standard synchronous machine interconnection has a single instance of a SynchronousMachineDynamics child class whereas a generator cross-compound connection has multiple instances of SynchronousMachine Dynamics child classes related by a single instance of a TurbineGovernorDynamics child class.

A valid standard synchronous machine interconnection model reflects the following rules.

– It can have:

  + one instance of TurbineGovernorDynamics child class, but only if SynchronousMachine.operating Mode = generator;

  + one instance of MechanicalLoadDynamics child class, but only if SynchronousMachine.operating Mode = motor or SynchronousMachine.operatingMode = condenser.

– It cannot have any instance of GenICompensationForGenJ.

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A generator cross-compound interconnection model reflects the following rules.

– It can have:
  + multiple instances of SynchronousMachineDynamics child classes, each of which has its related SynchronousMachine.operatingMode = generator;
  + one instance of TurbineGovernorDynamics child class.
– It shall have two or more instances of GenICompensationForGenJ associated with each instance of a SynchronousMachineDynamics child class.

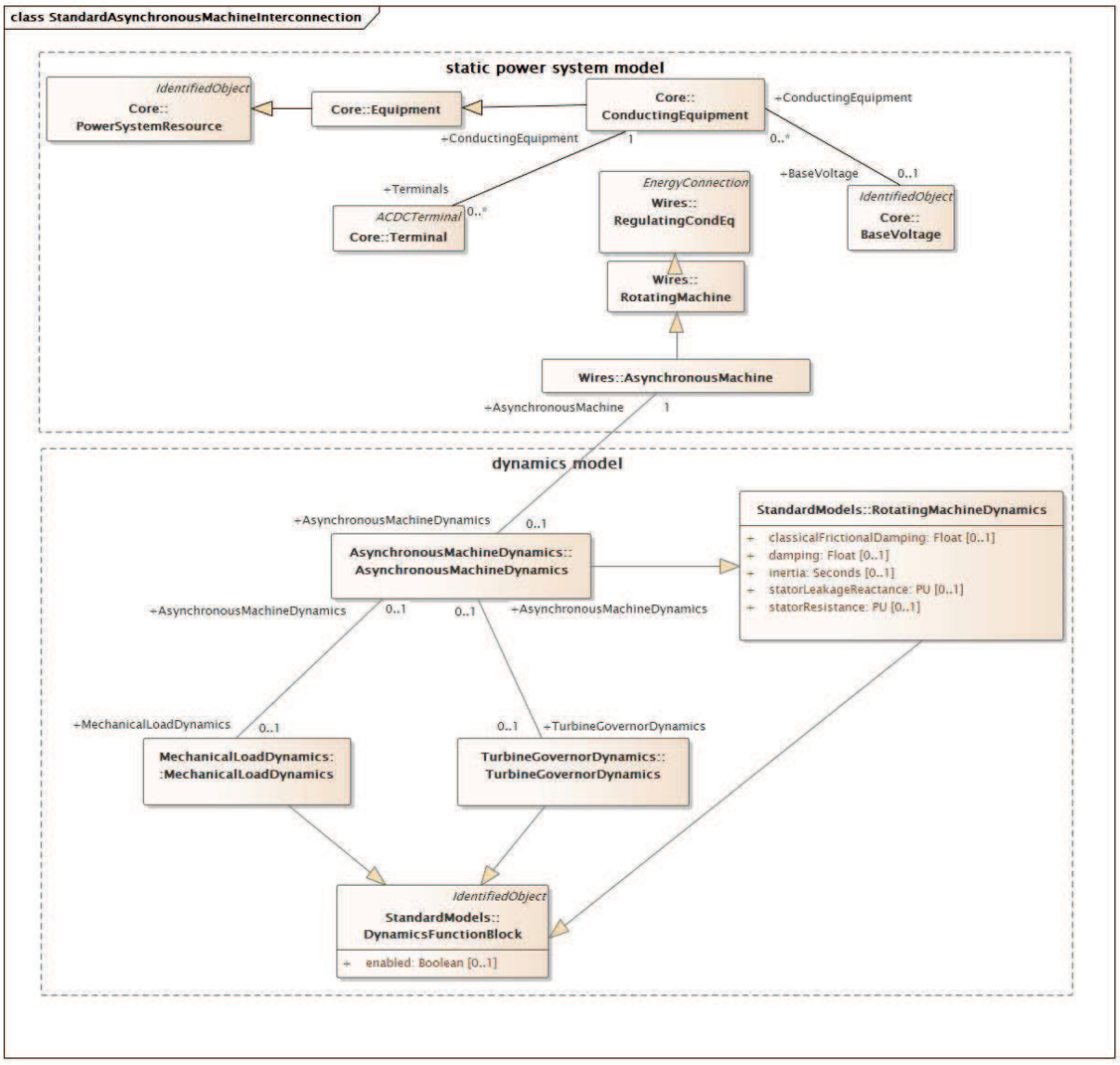


Figure 6 – Class diagram
StandardInterconnections::StandardAsynchronousMachineInterconnection

Figure 6: This diagram shows the classes necessary for the asynchronous machine interconnection model.

A standard asynchronous machine interconnection has a single instance of an AsynchronousMachine Dynamics child class.

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