

STN	Rozhranie aplikačného programu pre systémy riadenia elektrickej energie (EMS-API) Časť 457: Profil dynamiky	STN EN IEC 61970-457 33 4621
------------	--	--

Energy management system application program interface (EMS-API) - Part 457: Dynamics profile

Táto norma obsahuje anglickú verziu európskej normy.
This standard includes the English version of the European Standard.

Táto norma bola oznámená vo Vestníku ÚNMS SR č. 06/24

Obsahuje: EN IEC 61970-457:2024, IEC 61970-457:2024

Oznámením tejto normy sa od 15.03.2027 ruší
STN EN IEC 61970-457 (33 4621) z augusta 2021

138724



Úrad pre normalizáciu, metrológiu a skúšobníctvo Slovenskej republiky, 2024
Slovenská technická norma a technická normalizačná informácia je chránená zákonom č. 60/2018 Z. z. o technickej normalizácii v znení neskorších predpisov.

EUROPEAN STANDARD
NORME EUROPÉENNE
EUROPÄISCHE NORM

EN IEC 61970-457

March 2024

ICS 33.200

Supersedes EN IEC 61970-457:2021

English Version

**Energy management system application program interface
(EMS-API) - Part 457: Dynamics profile
(IEC 61970-457:2024)**

Interface de programmation d'application pour système de
gestion d'énergie (EMS-API) - Partie 457: Profil de régimes
dynamiques
(IEC 61970-457:2024)

Schnittstelle für Anwendungsprogramme für
Netzführungssysteme (EMS-API) - Teil 457: Dynamik-Profil
(IEC 61970-457:2024)

This European Standard was approved by CENELEC on 2024-03-15. CENELEC members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

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

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

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



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

CEN-CENELEC Management Centre: Rue de la Science 23, B-1040 Brussels

EN IEC 61970-457:2024 (E)

European foreword

The text of document 57/2621/FDIS, future edition 2 of IEC 61970-457, prepared by IEC/TC 57 "Power systems management and associated information exchange" was submitted to the IEC-CENELEC parallel vote and approved by CENELEC as EN IEC 61970-457:2024.

The following dates are fixed:

- latest date by which the document has to be implemented at national (dop) 2024-12-15 level by publication of an identical national standard or by endorsement
- latest date by which the national standards conflicting with the (dow) 2027-03-15 document have to be withdrawn

This document supersedes EN IEC 61970-457:2021 and all of its amendments and corrigenda (if any).

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

Any feedback and questions on this document should be directed to the users' national committee. A complete listing of these bodies can be found on the CENELEC website.

Endorsement notice

The text of the International Standard IEC 61970-457:2024 was approved by CENELEC as a European Standard without any modification.

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

IEC 61400-27-1:2020 NOTE Approved as EN IEC 61400-27-1:2020 (not modified)

IEC 61970-501:2006 NOTE Approved as EN 61970-501:2006 (not modified)

IEC 61970-552:2016 NOTE Approved as EN 61970-552:2016 (not modified)

Annex ZA (normative)

Normative references to international publications with their corresponding European publications

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.

NOTE 1 Where an International Publication has been modified by common modifications, indicated by (mod), the relevant EN/HD applies.

NOTE 2 Up-to-date information on the latest versions of the European Standards listed in this annex is available here: www.cencenelec.eu.

<u>Publication</u>	<u>Year</u>	<u>Title</u>	<u>EN/HD</u>	<u>Year</u>
IEC 61970-301	2020	Energy management system application program interface (EMS-API) - Part 301: Common information model (CIM) base	EN IEC 61970-301	2020
+ AMD1	2022		+ A1	2022
IEC 61970-302	-	Energy management system application program interface (EMS-API) - Part 302: Common information model (CIM) dynamics	EN IEC 61970-302	-
IEC 61970-452	2021	Energy management system application program interface (EMS-API) - Part 452: CIM static transmission network model profiles	EN IEC 61970-452	2021
IEC 61970-456	2021	Energy management system application program interface (EMS-API) - Part 456: Solved power system state profiles	EN IEC 61970-456	2022

CIM UML Model for 61970-302 & 61970-457, available at <https://cimug.ucaiug.org>



IEC 61970-457

Edition 2.0 2024-02

INTERNATIONAL STANDARD

NORME INTERNATIONALE



**Energy management system application program interface (EMS-API) –
Part 457: Dynamics profile**

**Interface de programmation d'application pour système de gestion d'énergie
(EMS-API) –
Partie 457: Profil de régimes dynamiques**



THIS PUBLICATION IS COPYRIGHT PROTECTED
Copyright © 2024 IEC, Geneva, Switzerland

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from either IEC or IEC's member National Committee in the country of the requester. If you have any questions about IEC copyright or have an enquiry about obtaining additional rights to this publication, please contact the address below or your local IEC member National Committee for further information.

Droits de reproduction réservés. Sauf indication contraire, aucune partie de cette publication ne peut être reproduite ni utilisée sous quelque forme que ce soit et par aucun procédé, électronique ou mécanique, y compris la photocopie et les microfilms, sans l'accord écrit de l'IEC ou du Comité national de l'IEC du pays du demandeur. Si vous avez des questions sur le copyright de l'IEC ou si vous désirez obtenir des droits supplémentaires sur cette publication, utilisez les coordonnées ci-après ou contactez le Comité national de l'IEC de votre pays de résidence.

IEC Secretariat
3, rue de Varembe
CH-1211 Geneva 20
Switzerland

Tel.: +41 22 919 02 11
info@iec.ch
www.iec.ch

About the IEC

The International Electrotechnical Commission (IEC) is the leading global organization that prepares and publishes International Standards for all electrical, electronic and related technologies.

About IEC publications

The technical content of IEC publications is kept under constant review by the IEC. Please make sure that you have the latest edition, a corrigendum or an amendment might have been published.

IEC publications search - webstore.iec.ch/advsearchform

The advanced search enables to find IEC publications by a variety of criteria (reference number, text, technical committee, ...). It also gives information on projects, replaced and withdrawn publications.

IEC Just Published - webstore.iec.ch/justpublished

Stay up to date on all new IEC publications. Just Published details all new publications released. Available online and once a month by email.

IEC Customer Service Centre - webstore.iec.ch/csc

If you wish to give us your feedback on this publication or need further assistance, please contact the Customer Service Centre: sales@iec.ch.

IEC Products & Services Portal - products.iec.ch

Discover our powerful search engine and read freely all the publications previews, graphical symbols and the glossary. With a subscription you will always have access to up to date content tailored to your needs.

Electropedia - www.electropedia.org

The world's leading online dictionary on electrotechnology, containing more than 22 500 terminological entries in English and French, with equivalent terms in 25 additional languages. Also known as the International Electrotechnical Vocabulary (IEV) online.

A propos de l'IEC

La Commission Electrotechnique Internationale (IEC) est la première organisation mondiale qui élabore et publie des Normes internationales pour tout ce qui a trait à l'électricité, à l'électronique et aux technologies apparentées.

A propos des publications IEC

Le contenu technique des publications IEC est constamment revu. Veuillez vous assurer que vous possédez l'édition la plus récente, un corrigendum ou amendement peut avoir été publié.

Recherche de publications IEC -

webstore.iec.ch/advsearchform

La recherche avancée permet de trouver des publications IEC en utilisant différents critères (numéro de référence, texte, comité d'études, ...). Elle donne aussi des informations sur les projets et les publications remplacées ou retirées.

IEC Just Published - webstore.iec.ch/justpublished

Restez informé sur les nouvelles publications IEC. Just Published détaille les nouvelles publications parues. Disponible en ligne et une fois par mois par email.

Service Clients - webstore.iec.ch/csc

Si vous désirez nous donner des commentaires sur cette publication ou si vous avez des questions contactez-nous: sales@iec.ch.

IEC Products & Services Portal - products.iec.ch

Découvrez notre puissant moteur de recherche et consultez gratuitement tous les aperçus des publications, symboles graphiques et le glossaire. Avec un abonnement, vous aurez toujours accès à un contenu à jour adapté à vos besoins.

Electropedia - www.electropedia.org

Le premier dictionnaire d'électrotechnologie en ligne au monde, avec plus de 22 500 articles terminologiques en anglais et en français, ainsi que les termes équivalents dans 25 langues additionnelles. Egalement appelé Vocabulaire Electrotechnique International (IEV) en ligne.



IEC 61970-457

Edition 2.0 2024-02

INTERNATIONAL STANDARD

NORME INTERNATIONALE



**Energy management system application program interface (EMS-API) –
Part 457: Dynamics profile**

**Interface de programmation d'application pour système de gestion d'énergie
(EMS-API) –
Partie 457: Profil de régimes dynamiques**

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

COMMISSION
ELECTROTECHNIQUE
INTERNATIONALE

ICS 33.200

ISBN 978-2-8322-5588-9

**Warning! Make sure that you obtained this publication from an authorized distributor.
Attention! Veuillez vous assurer que vous avez obtenu cette publication via un distributeur agréé.**

CONTENTS

FOREWORD.....	39
INTRODUCTION.....	42
1 Scope.....	43
2 Normative references	43
3 Terms and definitions	44
4 Profile specification	44
4.1 General.....	44
4.2 Version information.....	46
4.2.1 Dynamics profile.....	46
4.2.2 Detailed model configuration profile.....	46
4.2.3 Detailed model parameterisation profile.....	46
4.2.4 Simulation settings profile.....	47
4.2.5 Simulation results profile	47
4.3 Requirements and constraints.....	47
5 Overview	50
6 Use cases	51
6.1 General.....	51
6.2 Dynamic assessment studies	51
7 Architecture and usage.....	52
7.1 General.....	52
7.2 Dynamics profile	52
7.3 Detailed model configuration profile	56
7.4 Detailed model parameterisation profile	56
7.5 Simulation settings profile	56
7.6 Simulation results profile.....	56
7.7 Instance file (distribution) packaging and dependency	57
8 Dynamics profile.....	58
8.1 General.....	58
8.2 Package DynamicsBase.....	58
8.2.1 General	58
8.2.2 (Description) DCConverterUnit	59
8.2.3 (abstract) AsynchronousMachine	60
8.2.4 (abstract) ACDCTerminal.....	60
8.2.5 (abstract) Equipment	60
8.2.6 (abstract) PowerSystemResource	61
8.2.7 (abstract) PowerElectronicsConnection	61
8.2.8 (Description) DCLine	61
8.2.9 (abstract) RotatingMachine.....	62
8.2.10 (abstract) ConductingEquipment.....	62
8.2.11 (abstract) ACDCConverter	63
8.2.12 (abstract) DCEquipmentContainer	63
8.2.13 (abstract) EnergyConnection	63
8.2.14 (abstract) Terminal	64
8.2.15 (abstract) StaticVarCompensator	64
8.2.16 (abstract) VsConverter.....	64
8.2.17 (abstract) RegulatingCondEq.....	65

8.2.18	(abstract) IdentifiedObject root class	65
8.2.19	(abstract) ConnectivityNodeContainer.....	66
8.2.20	(abstract) ProtectionEquipment.....	66
8.2.21	(abstract) EquipmentContainer	66
8.2.22	(abstract) ShuntCompensator	67
8.2.23	(abstract) SynchronousMachine.....	67
8.2.24	(abstract) CsConverter	67
8.2.25	(Description) EnergyConsumer	68
8.3	Package StandardInterconnections	69
8.3.1	General	69
8.3.2	RemoteInputSignal	77
8.3.3	Package WindModels	78
8.4	Package StandardModels	85
8.4.1	General	85
8.4.2	(abstract) DynamicsFunctionBlock	86
8.4.3	(abstract) RotatingMachineDynamics.....	86
8.4.4	Package SynchronousMachineDynamics	87
8.4.5	Package AsynchronousMachineDynamics	115
8.4.6	Package TurbineGovernorDynamics	123
8.4.7	Package TurbineLoadControllerDynamics.....	245
8.4.8	Package MechanicalLoadDynamics	249
8.4.9	Package ExcitationSystemDynamics.....	252
8.4.10	Package OverexcitationLimiterDynamics	388
8.4.11	Package UnderexcitationLimiterDynamics	402
8.4.12	Package PowerSystemStabilizerDynamics.....	414
8.4.13	Package DiscontinuousExcitationControlDynamics	458
8.4.14	Package PFVArControllerType1Dynamics	463
8.4.15	Package PFVArControllerType2Dynamics	467
8.4.16	Package VoltageAdjusterDynamics.....	473
8.4.17	Package VoltageCompensatorDynamics	476
8.4.18	Package WindDynamics	481
8.4.19	Package WindDynamicsEd2	512
8.4.20	Package LoadDynamics.....	547
8.4.21	Package HVDCDynamics.....	565
8.4.22	Package RelayDynamics	567
8.4.23	Package StaticVarCompensatorDynamics	571
8.4.24	Package StatorCurrentLimiterDynamics.....	584
8.4.25	Package ShuntCompensatorDynamics	589
8.4.26	Package StatcomDynamics	591
8.4.27	Package WECCDynamics.....	594
8.4.28	Package IEEE1547Dynamics.....	634
8.5	Package UserDefinedModels	648
8.5.1	General	648
8.5.2	CSCUserDefined	649
8.5.3	SVCUserDefined	650
8.5.4	StatcomUserDefined	651
8.5.5	VSCUserDefined	651
8.5.6	WindPlantUserDefined.....	652
8.5.7	WindType1or2UserDefined	653

8.5.8	WindType3or4UserDefined	653
8.5.9	SynchronousMachineUserDefined	654
8.5.10	AsynchronousMachineUserDefined	655
8.5.11	TurbineGovernorUserDefined	656
8.5.12	TurbineLoadControllerUserDefined	657
8.5.13	MechanicalLoadUserDefined	658
8.5.14	ExcitationSystemUserDefined	658
8.5.15	OverexcitationLimiterUserDefined	659
8.5.16	UnderexcitationLimiterUserDefined	660
8.5.17	PowerSystemStabilizerUserDefined	660
8.5.18	DiscontinuousExcitationControlUserDefined	661
8.5.19	PFVArControllerType1UserDefined	662
8.5.20	VoltageAdjusterUserDefined	662
8.5.21	PFVArControllerType2UserDefined	663
8.5.22	VoltageCompensatorUserDefined	664
8.5.23	StatorCurrentLimiterUserDefined	664
8.5.24	ShuntCompensatorUserDefined	665
8.5.25	LoadUserDefined	666
8.5.26	HVDCInterconnectionUserDefined	666
8.5.27	RelayUserDefined	667
8.5.28	ProprietaryParameterDynamics root class	667
8.6	Package DynamicsDatatypes	669
8.6.1	General	669
8.6.2	CurrentFlow datatype	671
8.6.3	PerCent datatype	672
8.6.4	ReactivePower datatype	672
8.6.5	Susceptance datatype	672
8.6.6	Voltage datatype	672
8.6.7	ActivePower datatype	673
8.6.8	AngleDegrees datatype	673
8.6.9	ApparentPower datatype	673
8.6.10	Area datatype	674
8.6.11	Frequency datatype	674
8.6.12	Length datatype	674
8.6.13	PU datatype	674
8.6.14	Seconds datatype	675
8.6.15	Temperature datatype	675
8.6.16	VolumeFlowRate datatype	675
8.6.17	DateTime primitive	676
8.6.18	Float primitive	676
8.6.19	Boolean primitive	676
8.6.20	Date primitive	676
8.6.21	Integer primitive	676
8.6.22	String primitive	676
8.6.23	UnitSymbol enumeration	676
8.6.24	UnitMultiplier enumeration	681
8.6.25	SinglePhaseKind enumeration	682
8.6.26	OverExcitationLimiterInputKind enumeration	683
8.6.27	InputsST4CKind enumeration	683

8.6.28	InputsST6CKind enumeration	683
8.6.29	InputsST7CKind enumeration	684
8.6.30	VoellInputKind enumeration	684
8.6.31	VscllInputKind enumeration	684
8.6.32	VsInputKind enumeration	684
8.6.33	VuellInputKind enumeration	685
8.6.34	DroopSignalFeedbackKind enumeration	685
8.6.35	ExcIEEST1AUELselectorKind enumeration	685
8.6.36	ExcREXSFeedbackSignalKind enumeration	686
8.6.37	ExcST6BOELselectorKind enumeration	686
8.6.38	ExcST7BOELselectorKind enumeration	686
8.6.39	ExcST7BUELselectorKind enumeration	687
8.6.40	FrancisGovernorControlKind enumeration	687
8.6.41	GenericNonLinearLoadModelKind enumeration	688
8.6.42	GovHydro4ModelKind enumeration	688
8.6.43	IldBaseKind enumeration	688
8.6.44	InputSignalKind enumeration	688
8.6.45	RemoteSignalKind enumeration	689
8.6.46	RotorKind enumeration	690
8.6.47	StaticLoadModelKind enumeration	690
8.6.48	SynchronousMachineModelKind enumeration	690
8.6.49	WindLookupTableFunctionKind enumeration	691
8.6.50	WindPlantQcontrolModeKind enumeration	693
8.6.51	WindQcontrolModeKind enumeration	693
8.6.52	WindUVRTQcontrolModeKind enumeration	693
8.6.53	WindPlantQcontrolModeKind2 enumeration	694
8.6.54	WindLookupTableFunctionKind2 enumeration	694
8.6.55	WindFRTQcontrolModeKind enumeration	695
8.6.56	WindQcontrolModeKind2 enumeration	696
9	Detailed Model Configuration Profile	696
9.1	General	696
9.2	DetailedModelTypeDynamics	697
9.3	(abstract) DetailedModelDescriptor	698
9.4	DetailedModelDescriptorArtifact	698
9.5	DetailedModelDocumentationArtifact	699
9.6	(abstract) DynamicsFunctionBlock	699
9.7	FunctionDescriptor	700
9.8	(abstract) IdentifiedObject root class	700
9.9	InputOutputDescriptor	701
9.10	LimiterDescriptor	701
9.11	OperatorDescriptor	702
9.12	ParameterDescriptor	703
9.13	SignalDescriptor	703
9.14	LogicalKind enumeration	704
9.15	EquationLanguageKind enumeration	704
9.16	OperatorDescriptorKind enumeration	705
9.17	ConstraintKind enumeration	705
9.18	ParameterKind enumeration	705
9.19	XSDDatatypeKind enumeration	706

9.20	Integer primitive	706
9.21	Float primitive	707
9.22	DateTime primitive	707
9.23	Date primitive	707
9.24	String primitive	707
9.25	Boolean primitive	707
10	Detailed Model Parameterisation Profile	707
10.1	General	707
10.2	Boolean primitive	708
10.3	(abstract) DetailedModelTypeDynamics	708
10.4	(abstract) DetailedModelDescriptor	709
10.5	(abstract) ACDCTerminal root class	709
10.6	(abstract) IdentifiedObject root class	709
10.7	ParameterValue root class	709
10.8	(abstract) PowerSystemResource	710
10.9	String primitive	710
10.10	(abstract) DynamicsFunctionBlock	710
10.11	(abstract) Equipment	711
10.12	(abstract) ParameterDescriptor	711
10.13	(Description) SignalDescriptor root class	711
10.14	DetailedModelDynamics	712
11	Simulation Settings Profile	712
11.1	General	712
11.2	(abstract) ACLineSegment root class	715
11.3	(abstract) Terminal	716
11.4	(abstract) Equipment root class	716
11.5	EquipmentFault	716
11.6	(abstract) Fault	717
11.7	FaultCauseType	718
11.8	LineFault	718
11.9	(abstract) ACDCTerminal	719
11.10	ClearSimulationEvent	719
11.11	(abstract) DetailedModelDescriptor	719
11.12	(abstract) DynamicsFunctionBlock	720
11.13	(abstract) IdentifiedObject root class	720
11.14	ParameterEvent	721
11.15	PowerFlowSettings	722
11.16	SignalConfiguration	724
11.17	(abstract) SignalDescriptor	724
11.18	SignalRecorder	724
11.19	SimulationEvents	725
11.20	SimulationSettings	725
11.21	FaultImpedance compound	726
11.22	UnitSymbol enumeration	727
11.23	UnitMultiplier enumeration	732
11.24	PhaseCode enumeration	733
11.25	PhaseConnectedFaultKind enumeration	734
11.26	ParameterChangeKind enumeration	734
11.27	PowerFlowAlgorithmKind enumeration	735

11.28	PowerShiftKind enumeration	735
11.29	SlackDistributionKind enumeration	735
11.30	SignalKind enumeration	736
11.31	Length datatype	736
11.32	PU datatype	736
11.33	Reactance datatype	737
11.34	AngleDegrees datatype	737
11.35	ActivePower datatype	737
11.36	ReactivePower datatype	738
11.37	Seconds datatype	738
11.38	Resistance datatype	738
11.39	Float primitive	738
11.40	Boolean primitive	738
11.41	DateTime primitive	739
11.42	Date primitive	739
11.43	Duration primitive	739
11.44	Integer primitive	739
11.45	String primitive	739
12	Simulation Results Profile	739
12.1	General	739
12.2	(abstract) Curve	740
12.3	CurveData root class	741
12.4	(abstract) IdentifiedObject root class	741
12.5	(abstract) SignalConfiguration	742
12.6	(abstract) SignalRecorder	742
12.7	(abstract) SimulationEvents	742
12.8	SimulationResult	742
12.9	SimulationResultCharacteristic	743
12.10	(abstract) SimulationSettings	744
12.11	CurveStyle enumeration	744
12.12	UnitMultiplier enumeration	744
12.13	UnitSymbol enumeration	745
12.14	Float primitive	751
12.15	String primitive	751
12.16	IRI primitive	751
Annex A (normative) Implementation clarifications related to the models inherited from RotatingMachineDynamics class		752
Annex B (informative) Examples using IEC 61970-552 serialisation (instance data, i.e., non executable code, not a code component)		754
B.1	Overview	754
B.2	Standard models	754
B.3	User-defined models	760
B.4	Detailed model configuration	767
B.5	Detailed model parameterisation	771
B.6	Simulation settings	772
B.7	Simulation results	775
Bibliography		777
Figure 1 – Interconnection diagram for a synchronous machine		53

Figure 2 – Standard connections for a synchronous machine	54
Figure 3 – SynchronousMachineDynamics association	55
Figure 4 – Profile relationships	55
Figure 5 – Instance file dependency.....	57
Figure 6 – Class diagram DynamicsBase::DynamicsBase	59
Figure 7 – StandardInterconnectionSynchronousMachine	69
Figure 8 – StandardInterconnectionSynchronousGeneratorCrossCompound	70
Figure 9 – StandardInterconnectionAsynchronousMachine	71
Figure 10 – StandardInterconnectionSingleLoad	72
Figure 11 – Class diagram StandardInterconnections:: StandardSynchronousMachineInterconnection	73
Figure 12 – Class diagram StandardInterconnections:: StandardAsynchronousMachineInterconnection	74
Figure 13 – Class diagram StandardInterconnections::StandardLoadInterconnection	75
Figure 14 – Class diagram StandardInterconnections::StandardHVDCInterconnection	76
Figure 15 – Class diagram StandardInterconnections:: StandardStaticVarCompensatorInterconnection	76
Figure 16 – Class diagram StandardInterconnections:: StandardShuntCompensatorInterconnection	77
Figure 17 – StandardInterconnectionWindTurbineType1Aand1B	79
Figure 18 – StandardInterconnectionWindTurbineType2	80
Figure 19 – StandardInterconnectionWindTurbineType3	81
Figure 20 – StandardInterconnectionWindTurbineType4Aand4B	82
Figure 21 – Class diagram WindModels::StandardWindType1and2Interconnection	83
Figure 22 – Class diagram WindModels::StandardWindType3and4Interconnection	84
Figure 23 – Class diagram SynchronousMachineDynamics:: SynchronousMachineDynamics.....	88
Figure 24 – SynchronousGeneratorInterconnectionAndVariables	89
Figure 25 – SynchronousMotorInterconnectionAndVariables	90
Figure 26 – SynchronousMachineSaturationParameters	91
Figure 27 – SynchronousGeneratorMechanicalEquation	92
Figure 28 – SynchronousMotorMechanicalEquation	93
Figure 29 – SynchronousGeneratorPhasor.....	94
Figure 30 – SynchronousMotorPhasor	95
Figure 31 – Simplified	96
Figure 32 – SubtransientRoundRotor	100
Figure 33 – SubtransientSalientPole	101
Figure 34 – SubtransientTypeF	102
Figure 35 – SubtransientTypeJ	103
Figure 36 – SubtransientRoundRotorSimplified	104
Figure 37 – SubtransientSalientPoleSimplified	106
Figure 38 – SubtransientRoundRotorSimplifiedDirectAxis	108
Figure 39 – SubtransientSalientPoleSimplifiedDirectAxis	110
Figure 40 – SynchronousEquivalentCircuit.....	114
Figure 41 – AsynchronousGeneratorInterconnectionAndVariables	116

Figure 42 – AsynchronousMotorInterconnectionAndVariables	116
Figure 43 – Class diagram AsynchronousMachineDynamics:: AsynchronousMachineDynamics	117
Figure 44 – AsynchronousGeneratorMechanicalEquation.....	118
Figure 45 – AsynchronousMotorMechanicalEquation	118
Figure 46 – AsynchronousEquivalentCircuit	122
Figure 47 – TurbineGovernorInterconnectionAndVariables.....	123
Figure 48 – Class diagram TurbineGovernorDynamics::GasTurbineGovernorDynamics	124
Figure 49 – Class diagram TurbineGovernorDynamics::HydroTurbineGovernorDynamics	125
Figure 50 – Class diagram TurbineGovernorDynamics::SteamTurbineGovernorDynamics	125
Figure 51 – GovHydroIEEE0	153
Figure 52 – GovHydroIEEE2	155
Figure 53 – GovSteamIEEE1	157
Figure 54 – GovCT1	160
Figure 55 – GovCT2	164
Figure 56 – GovGAST	168
Figure 57 – GovGAST1	169
Figure 58 – GovGAST2	172
Figure 59 – GovGAST3	174
Figure 60 – GovGAST3ExhaustTemperature.....	175
Figure 61 – GovGAST4	177
Figure 62 – GovGASTWD	179
Figure 63 – GovHydro1	182
Figure 64 – GovHydro2	184
Figure 65 – GovHydro3	187
Figure 66 – GovHydro4	190
Figure 67 – GovHydro4SimpleHydroTurbine	191
Figure 68 – GovHydro4FrancisPeltonTurbine.....	192
Figure 69 – GovHydro4KaplanTurbine	193
Figure 70 – GovHydroDD	196
Figure 71 – GovHydroFrancis	199
Figure 72 – GovHydroFrancisNonLinearGainAndEfficiency	200
Figure 73 – DetailedHydroModelHydraulicSystem	201
Figure 74 – GovHydroPelton	203
Figure 75 – GovHydroPeltonNonLinearGainAndEfficiency.....	204
Figure 76 – GovHydroPID	207
Figure 77 – GovHydroPID2	210
Figure 78 – GovHydroR	213
Figure 79 – GovHydroWEH.....	216
Figure 80 – GovHydroWPID	220
Figure 81 – GovSteam0	222
Figure 82 – GovSteam1	223

Figure 83 – GovSteam1BacklashHysteresis	224
Figure 84 – GovSteam1InputSpeedDeadband	225
Figure 85 – GovSteam2	228
Figure 86 – GovSteamBB	229
Figure 87 – GovSteamCC	231
Figure 88 – GovSteamEU	233
Figure 89 – GovSteamFV2	236
Figure 90 – GovSteamFV3	238
Figure 91 – GovSteamFV4	241
Figure 92 – GovSteamSGO	244
Figure 93 – Class diagram TurbineLoadControllerDynamics:: TurbineLoadControllerDynamics	246
Figure 94 – TurbLCFB1	247
Figure 95 – MechanicalLoadInterconnectionAndVariables	249
Figure 96 – MechanicalLoadEquations	250
Figure 97 – Class diagram MechanicalLoadDynamics::MechanicalLoadDynamics	250
Figure 98 – ExcitationSystemInterconnectionAndVariables	253
Figure 99 – Class diagram ExcitationSystemDynamics::ExcitationSystemDynamics	254
Figure 100 – ExcAC1A	255
Figure 101 – ExcAC2A	257
Figure 102 – ExcAC3A	260
Figure 103 – ExcAC4A	262
Figure 104 – ExcAC5A	263
Figure 105 – ExcAC6A	265
Figure 106 – ExcAC8B	267
Figure 107 – ExcANS	270
Figure 108 – ExcAVR1	271
Figure 109 – ExcAVR2	273
Figure 110 – ExcAVR3	274
Figure 111 – ExcAVR4	275
Figure 112 – ExcAVR5	277
Figure 113 – ExcAVR7	278
Figure 114 – ExcBBC	280
Figure 115 – ExcCZ	282
Figure 116 – ExcDC1A	283
Figure 117 – ExcDC2A	285
Figure 118 – ExcDC3A	287
Figure 119 – ExcDC3A1	289
Figure 120 – ExcELIN1	291
Figure 121 – ExcELIN2	293
Figure 122 – ExcHU	295
Figure 123 – ExcNI	296
Figure 124 – ExcOEX3T	298

Figure 125 – ExcPIC	300
Figure 126 – ExcREXS	302
Figure 127 – ExcRQB	305
Figure 128 – ExcSCRX	307
Figure 129 – ExcSEXS	308
Figure 130 – ExcSK	310
Figure 131 – ExcST1A	312
Figure 132 – ExcST2A	314
Figure 133 – ExcST3A	316
Figure 134 – ExcST4B	318
Figure 135 – ExcST6B	320
Figure 136 – ExcST7B	322
Figure 137 – Class diagram IEEE4215from2016::IEEE4215from2016	323
Figure 138 – Class diagram IEEE4215from2005::IEEE4215from2005	361
Figure 139 – Class diagram OverexcitationLimiterDynamics:: OverexcitationLimiterDynamics	389
Figure 140 – OverexcLim2	390
Figure 141 – OverexcLimX1	392
Figure 142 – OverexcLimX1TimeCharacteristic	393
Figure 143 – OverexcLimX2	395
Figure 144 – OverexcLimX2TimeCharacteristic	395
Figure 145 – Class diagram UnderexcitationLimiterDynamics:: UnderexcitationLimiterDynamics	403
Figure 146 – UnderexcLim2Simplified	410
Figure 147 – UnderexcLimX1	411
Figure 148 – UnderexcLimX2	413
Figure 149 – PowerSystemStabilizerInterconnectionAndVariables	414
Figure 150 – Class diagram PowerSystemStabilizerDynamics:: PowerSystemStabilizerDynamics	415
Figure 151 – Pss1	436
Figure 152 – Pss1A	437
Figure 153 – Pss2B	439
Figure 154 – Pss2ST	441
Figure 155 – Pss5	442
Figure 156 – PssELIN2	444
Figure 157 – PssPTIST1	446
Figure 158 – PssPTIST3	447
Figure 159 – PssRQB	449
Figure 160 – PssSB4	451
Figure 161 – PssSH	452
Figure 162 – PssSK	454
Figure 163 – PssSTAB2A	455
Figure 164 – PssWECC	456
Figure 165 – DiscontinuousExcitationControlInterconnectionAndVariables	458

Figure 166 – Class diagram DiscontinuousExcitationControlDynamics:: DiscontinuousExcitationControlDynamics	459
Figure 167 – Class diagram PFVArControllerType1Dynamics:: PFVArControllerType1Dynamics	463
Figure 168 – Class diagram PFVArControllerType2Dynamics:: PFVArControllerType2Dynamics	468
Figure 169 – PFVArType2Common1	469
Figure 170 – Class diagram VoltageAdjusterDynamics::VoltageAdjusterDynamics	474
Figure 171 – VoltageCompensatorInterconnectionAndVariables	477
Figure 172 – Class diagram VoltageCompensatorDynamics:: VoltageCompensatorDynamics	478
Figure 173 – Class diagram WindDynamics::WindDynamicsType1or2	482
Figure 174 – Class diagram WindDynamics::WindDynamicsType3	483
Figure 175 – Class diagram WindDynamics::WindDynamicsType4	484
Figure 176 – Class diagram WindDynamics::WindDynamicsPlant	485
Figure 177 – Class diagram WindDynamicsEd2::WindDynamicsType1or2	513
Figure 178 – Class diagram WindDynamicsEd2::WindDynamicsType3	514
Figure 179 – Class diagram WindDynamicsEd2::WindDynamicsType4	515
Figure 180 – Class diagram WindDynamicsEd2::WindDynamicsPlant	516
Figure 181 – LoadInterconnectionAndVariables	548
Figure 182 – Class diagram LoadDynamics::LoadDynamics	549
Figure 183 – LoadCompositeEquations	550
Figure 184 – LoadGenericNonLinearTypeEquations	551
Figure 185 – LoadStaticTypeEquations	554
Figure 186 – LoadMotor	557
Figure 187 – Class diagram LoadCompositeWECC::LoadCompositeWECC	559
Figure 188 – Class diagram HVDCDynamics::HVDCDynamics	565
Figure 189 – Class diagram RelayDynamics::RelayDynamics	568
Figure 190 – Class diagram StaticVarCompensatorDynamics:: StaticVarCompensatorDynamics	572
Figure 191 – Class diagram StatorCurrentLimiterDynamics:: StatorCurrentLimiterDynamics	584
Figure 192 – Class diagram ShuntCompensatorDynamics::ShuntCompensatorDynamics	590
Figure 193 – Class diagram StatcomDynamics::StatcomIEC	591
Figure 194 – Class diagram StatcomDynamics::StatcomDynamics	592
Figure 195 – Class diagram WECCDynamics::WeccDynamics	594
Figure 196 – Class diagram WECCDynamics::WeccBESS	595
Figure 197 – Class diagram IEEE1547Dynamics::IEEE1547Dynamics	634
Figure 198 – Class diagram UserDefinedModels::ProprietaryUserDefinedModels	649
Figure 199 – Class diagram DynamicsDatatypes::Primitives	669
Figure 200 – Class diagram DynamicsDatatypes::DataTypes	670
Figure 201 – Class diagram DynamicsDatatypes::Enumerations	671
Figure 202 – Class diagram DetailedModelConfigurationProfile:: DetailedModelConfigurationProfile	697

Figure 203 – Class diagram DetailedModelParameterisationProfile::DetailedModelParameterisationProfile	708
Figure 204 – Class diagram SimulationSettingsProfile::SimulationSettings	713
Figure 205 – Class diagram SimulationSettingsProfile::SignalConfiguration	714
Figure 206 – Class diagram SimulationSettingsProfile::SimulationEvents	715
Figure 207 – Class diagram SimulationResultsProfile::SimulationResultsProfile	740
Figure B.1 – Dynamics model header	754
Figure B.2 – SynchronousMachineDynamics model	756
Figure B.3 – TurbineGovernorDynamics model	757
Figure B.4 – ExcitationSystemDynamics model	758
Figure B.5 – PowerSystemStabilizerDynamics model	759
Figure B.6 – Link between the dynamics model and static model	761
Figure B.7 – User-defined model class for excitation systems	761
Figure B.8 – User-defined model for turbine governor	762
Figure B.9 – Block diagram of the ExcSEXS model	763
Figure B.10 – Example of a simplified excitation model instance described using the ExcSEXS class	763
Figure B.11 – Example of a simplified excitation model instance expressed using proprietary user-defined classes	766
Figure B.12 – Example of a part of a detailed model configuration	770
Figure B.13 – Example of parameterisation of the part of detailed model configuration	771
Figure B.14 – Example of simulation settings	775
Figure B.15 – Example of a simulation results	776
Table 1 – Attributes of DynamicsBase::DCConverterUnit	59
Table 2 – Association ends of DynamicsBase::DCConverterUnit with other classes	60
Table 3 – Attributes of DynamicsBase::AsynchronousMachine	60
Table 4 – Attributes of DynamicsBase::ACDCTerminal	60
Table 5 – Attributes of DynamicsBase::Equipment	61
Table 6 – Attributes of DynamicsBase::PowerSystemResource	61
Table 7 – Attributes of DynamicsBase::PowerElectronicsConnection	61
Table 8 – Attributes of DynamicsBase::DCLine	62
Table 9 – Association ends of DynamicsBase::DCLine with other classes	62
Table 10 – Attributes of DynamicsBase::RotatingMachine	62
Table 11 – Attributes of DynamicsBase::ConductingEquipment	62
Table 12 – Attributes of DynamicsBase::ACDCConverter	63
Table 13 – Attributes of DynamicsBase::DCEquipmentContainer	63
Table 14 – Association ends of DynamicsBase:: DCEquipmentContainer with other classes	63
Table 15 – Attributes of DynamicsBase::EnergyConnection	64
Table 16 – Attributes of DynamicsBase::Terminal	64
Table 17 – Attributes of DynamicsBase::StaticVarCompensator	64
Table 18 – Attributes of DynamicsBase::VsConverter	65
Table 19 – Attributes of DynamicsBase::RegulatingCondEq	65

Table 20 – Attributes of DynamicsBase::IdentifiedObject	65
Table 21 – Attributes of DynamicsBase::ConnectivityNodeContainer	66
Table 22 – Attributes of DynamicsBase::ProtectionEquipment	66
Table 23 – Attributes of DynamicsBase::EquipmentContainer	66
Table 24 – Attributes of DynamicsBase::ShuntCompensator	67
Table 25 – Attributes of DynamicsBase::SynchronousMachine	67
Table 26 – Attributes of DynamicsBase::CsConverter	68
Table 27 – Attributes of DynamicsBase::EnergyConsumer	68
Table 28 – Association ends of DynamicsBase::EnergyConsumer with other classes	68
Table 29 – Attributes of StandardInterconnections::RemoteInputSignal	77
Table 30 – Association ends of StandardInterconnections:: RemoteInputSignal with other classes	78
Table 31 – Attributes of StandardModels::DynamicsFunctionBlock	86
Table 32 – Attributes of StandardModels::RotatingMachineDynamics	86
Table 33 – Attributes of SynchronousMachineDynamics:: SynchronousMachineSimplified	96
Table 34 – Association ends of SynchronousMachineDynamics:: SynchronousMachineSimplified with other classes	97
Table 35 – Attributes of SynchronousMachineDynamics:: SynchronousMachineDynamics	97
Table 36 – Association ends of SynchronousMachineDynamics:: SynchronousMachineDynamics with other classes	98
Table 37 – Attributes of SynchronousMachineDynamics::SynchronousMachineDetailed	98
Table 38 – Association ends of SynchronousMachineDynamics:: SynchronousMachineDetailed with other classes	99
Table 39 – Attributes of SynchronousMachineDynamics:: SynchronousMachineTimeConstantReactance	111
Table 40 – Association ends of SynchronousMachineDynamics:: SynchronousMachineTimeConstantReactance with other classes	112
Table 41 – Attributes of SynchronousMachineDynamics:: SynchronousMachineEquivalentCircuit	114
Table 42 – Association ends of SynchronousMachineDynamics:: SynchronousMachineEquivalentCircuit with other classes	115
Table 43 – Attributes of AsynchronousMachineDynamics:: AsynchronousMachineDynamics	119
Table 44 – Association ends of AsynchronousMachineDynamics:: AsynchronousMachineDynamics with other classes	119
Table 45 – Attributes of AsynchronousMachineDynamics:: AsynchronousMachineTimeConstantReactance	120
Table 46 – Association ends of AsynchronousMachineDynamics:: AsynchronousMachineTimeConstantReactance with other classes	121
Table 47 – Attributes of AsynchronousMachineDynamics:: AsynchronousMachineEquivalentCircuit	122
Table 48 – Association ends of AsynchronousMachineDynamics:: AsynchronousMachineEquivalentCircuit with other classes	123
Table 49 – Attributes of TurbineGovernorDynamics:: CombinedCycleGasTurbineDynamics	126
Table 50 – Association ends of TurbineGovernorDynamics:: CombinedCycleGasTurbineDynamics with other classes	126

Table 51 – Attributes of TurbineGovernorDynamics:: CrossCompoundTurbineGovernorDynamics	127
Table 52 – Association ends of TurbineGovernorDynamics:: CrossCompoundTurbineGovernorDynamics with other classes	127
Table 53 – Attributes of TurbineGovernorDynamics::HydroGovernorDynamics	127
Table 54 – Association ends of TurbineGovernorDynamics:: HydroGovernorDynamics with other classes	127
Table 55 – Attributes of TurbineGovernorDynamics::HydroWaterColumnDynamics	128
Table 56 – Association ends of TurbineGovernorDynamics:: HydroWaterColumnDynamics with other classes	128
Table 57 – Attributes of TurbineGovernorDynamics::SteamTurbineGeneratorDynamics	128
Table 58 – Association ends of TurbineGovernorDynamics:: SteamTurbineGeneratorDynamics with other classes	129
Table 59 – Attributes of TurbineGovernorDynamics::TurbineGovernorDynamics	129
Table 60 – Association ends of TurbineGovernorDynamics:: TurbineGovernorDynamics with other classes	129
Table 61 – Attributes of TurbineGovernorDynamics::GovSteamIEEETGOV5	130
Table 62 – Association ends of TurbineGovernorDynamics:: GovSteamIEEETGOV5 with other classes	132
Table 63 – Attributes of TurbineGovernorDynamics::GovSteamIEEEG1Aug	132
Table 64 – Association ends of TurbineGovernorDynamics:: GovSteamIEEEG1Aug with other classes	134
Table 65 – Attributes of TurbineGovernorDynamics::GovIEEEHydroDD	134
Table 66 – Association ends of TurbineGovernorDynamics:: GovIEEEHydroDD with other classes	135
Table 67 – Attributes of TurbineGovernorDynamics::GovIEEEHydroLL	135
Table 68 – Association ends of TurbineGovernorDynamics:: GovIEEEHydroLL with other classes	136
Table 69 – Attributes of TurbineGovernorDynamics::GovIEEEHydroMech	137
Table 70 – Association ends of TurbineGovernorDynamics:: GovIEEEHydroMech with other classes	137
Table 71 – Attributes of TurbineGovernorDynamics::GovIEEEHydroPID	138
Table 72 – Association ends of TurbineGovernorDynamics:: GovIEEEHydroPID with other classes	138
Table 73 – Attributes of TurbineGovernorDynamics::GovIEEEHydroPIDspt	139
Table 74 – Association ends of TurbineGovernorDynamics:: GovIEEEHydroPIDspt with other classes	140
Table 75 – Attributes of TurbineGovernorDynamics::GovCIGREGT	140
Table 76 – Association ends of TurbineGovernorDynamics:: GovCIGREGT with other classes	142
Table 77 – Attributes of TurbineGovernorDynamics::GovIEEEGT1	143
Table 78 – Association ends of TurbineGovernorDynamics:: GovIEEEGT1 with other classes	145
Table 79 – Attributes of TurbineGovernorDynamics::TurbCIGREHRSGST	145
Table 80 – Association ends of TurbineGovernorDynamics:: TurbCIGREHRSGST with other classes	146
Table 81 – Attributes of TurbineGovernorDynamics::TurbIEEEGenericHRSGST	147

Table 82 – Association ends of TurbineGovernorDynamics:: TurbIEEEGenericHRSGST with other classes	148
Table 83 – Attributes of TurbineGovernorDynamics::TurbIEEEHydroWCgen	148
Table 84 – Association ends of TurbineGovernorDynamics:: TurbIEEEHydroWCgen with other classes	149
Table 85 – Attributes of TurbineGovernorDynamics::TurbIEEEHydroWClinear	149
Table 86 – Association ends of TurbineGovernorDynamics:: TurbIEEEHydroWClinear with other classes	150
Table 87 – Attributes of TurbineGovernorDynamics::TurbIEEEHydroWCNonLinear	150
Table 88 – Association ends of TurbineGovernorDynamics:: TurbIEEEHydroWCNonLinear with other classes	151
Table 89 – Attributes of TurbineGovernorDynamics::TurbIEEEHydroWCNonLinearA	151
Table 90 – Association ends of TurbineGovernorDynamics:: TurbIEEEHydroWCNonLinearA with other classes	152
Table 91 – Attributes of TurbineGovernorDynamics::TurbIEEEHydroWCNonLinearB	152
Table 92 – Association ends of TurbineGovernorDynamics:: TurbIEEEHydroWCNonLinearB with other classes	153
Table 93 – Attributes of TurbineGovernorDynamics::GovHydroIEEE0	154
Table 94 – Association ends of TurbineGovernorDynamics:: GovHydroIEEE0 with other classes	154
Table 95 – Attributes of TurbineGovernorDynamics::GovHydroIEEE2	155
Table 96 – Association ends of TurbineGovernorDynamics:: GovHydroIEEE2 with other classes	156
Table 97 – Attributes of TurbineGovernorDynamics::GovSteamIEEE1	158
Table 98 – Association ends of TurbineGovernorDynamics:: GovSteamIEEE1 with other classes	159
Table 99 – Attributes of TurbineGovernorDynamics::GovCT1	161
Table 100 – Association ends of TurbineGovernorDynamics::GovCT1 with other classes	163
Table 101 – Attributes of TurbineGovernorDynamics::GovCT2	165
Table 102 – Association ends of TurbineGovernorDynamics::GovCT2 with other classes	167
Table 103 – Attributes of TurbineGovernorDynamics::GovGAST	168
Table 104 – Association ends of TurbineGovernorDynamics:: GovGAST with other classes	169
Table 105 – Attributes of TurbineGovernorDynamics::GovGAST1	170
Table 106 – Association ends of TurbineGovernorDynamics:: GovGAST1 with other classes	171
Table 107 – Attributes of TurbineGovernorDynamics::GovGAST2	172
Table 108 – Association ends of TurbineGovernorDynamics:: GovGAST2 with other classes	174
Table 109 – Attributes of TurbineGovernorDynamics::GovGAST3	175
Table 110 – Association ends of TurbineGovernorDynamics:: GovGAST3 with other classes	176
Table 111 – Attributes of TurbineGovernorDynamics::GovGAST4	177
Table 112 – Association ends of TurbineGovernorDynamics:: GovGAST4 with other classes	178
Table 113 – Attributes of TurbineGovernorDynamics::GovGASTWD	179

Table 114 – Association ends of TurbineGovernorDynamics:: GovGASTWD with other classes	181
Table 115 – Attributes of TurbineGovernorDynamics::GovHydro1	183
Table 116 – Association ends of TurbineGovernorDynamics:: GovHydro1 with other classes	183
Table 117 – Attributes of TurbineGovernorDynamics::GovHydro2	185
Table 118 – Association ends of TurbineGovernorDynamics:: GovHydro2 with other classes	186
Table 119 – Attributes of TurbineGovernorDynamics::GovHydro3	188
Table 120 – Association ends of TurbineGovernorDynamics:: GovHydro3 with other classes	189
Table 121 – Attributes of TurbineGovernorDynamics::GovHydro4	193
Table 122 – Association ends of TurbineGovernorDynamics:: GovHydro4 with other classes	196
Table 123 – Attributes of TurbineGovernorDynamics::GovHydroDD	197
Table 124 – Association ends of TurbineGovernorDynamics:: GovHydroDD with other classes	198
Table 125 – Attributes of TurbineGovernorDynamics::GovHydroFrancis.....	201
Table 126 – Association ends of TurbineGovernorDynamics:: GovHydroFrancis with other classes	203
Table 127 – Attributes of TurbineGovernorDynamics::GovHydroPelton	205
Table 128 – Association ends of TurbineGovernorDynamics:: GovHydroPelton with other classes	206
Table 129 – Attributes of TurbineGovernorDynamics::GovHydroPID	208
Table 130 – Association ends of TurbineGovernorDynamics:: GovHydroPID with other classes	209
Table 131 – Attributes of TurbineGovernorDynamics::GovHydroPID2	211
Table 132 – Association ends of TurbineGovernorDynamics:: GovHydroPID2 with other classes	212
Table 133 – Attributes of TurbineGovernorDynamics::GovHydroR.....	214
Table 134 – Association ends of TurbineGovernorDynamics:: GovHydroR with other classes	215
Table 135 – Attributes of TurbineGovernorDynamics::GovHydroWEH	217
Table 136 – Association ends of TurbineGovernorDynamics:: GovHydroWEH with other classes	219
Table 137 – Attributes of TurbineGovernorDynamics::GovHydroWPID	220
Table 138 – Association ends of TurbineGovernorDynamics:: GovHydroWPID with other classes	221
Table 139 – Attributes of TurbineGovernorDynamics::GovSteam0	222
Table 140 – Association ends of TurbineGovernorDynamics:: GovSteam0 with other classes	223
Table 141 – Attributes of TurbineGovernorDynamics::GovSteam1	225
Table 142 – Association ends of TurbineGovernorDynamics:: GovSteam1 with other classes	227
Table 143 – Attributes of TurbineGovernorDynamics::GovSteam2	228
Table 144 – Association ends of TurbineGovernorDynamics:: GovSteam2 with other classes	229
Table 145 – Attributes of TurbineGovernorDynamics::GovSteamBB.....	229

Table 146 – Association ends of TurbineGovernorDynamics:: GovSteamBB with other classes	230
Table 147 – Attributes of TurbineGovernorDynamics::GovSteamCC	232
Table 148 – Association ends of TurbineGovernorDynamics:: GovSteamCC with other classes	233
Table 149 – Attributes of TurbineGovernorDynamics::GovSteamEU.....	234
Table 150 – Association ends of TurbineGovernorDynamics:: GovSteamEU with other classes	236
Table 151 – Attributes of TurbineGovernorDynamics::GovSteamFV2	236
Table 152 – Association ends of TurbineGovernorDynamics:: GovSteamFV2 with other classes	237
Table 153 – Attributes of TurbineGovernorDynamics::GovSteamFV3	238
Table 154 – Association ends of TurbineGovernorDynamics:: GovSteamFV3 with other classes	240
Table 155 – Attributes of TurbineGovernorDynamics::GovSteamFV4	242
Table 156 – Association ends of TurbineGovernorDynamics:: GovSteamFV4 with other classes	244
Table 157 – Attributes of TurbineGovernorDynamics::GovSteamSGO	245
Table 158 – Association ends of TurbineGovernorDynamics:: GovSteamSGO with other classes	245
Table 159 – Attributes of TurbineLoadControllerDynamics:: TurbineLoadControllerDynamics	246
Table 160 – Association ends of TurbineLoadControllerDynamics:: TurbineLoadControllerDynamics with other classes	247
Table 161 – Attributes of TurbineLoadControllerDynamics::TurbLCFB1	248
Table 162 – Association ends of TurbineLoadControllerDynamics:: TurbLCFB1 with other classes	249
Table 163 – Attributes of MechanicalLoadDynamics::MechanicalLoadDynamics	251
Table 164 – Association ends of MechanicalLoadDynamics:: MechanicalLoadDynamics with other classes	251
Table 165 – Attributes of MechanicalLoadDynamics::MechLoad1	252
Table 166 – Association ends of MechanicalLoadDynamics:: MechLoad1 with other classes	252
Table 167 – Attributes of ExcitationSystemDynamics::ExcitationSystemDynamics	254
Table 168 – Association ends of ExcitationSystemDynamics:: ExcitationSystemDynamics with other classes	255
Table 169 – Attributes of ExcitationSystemDynamics::ExcAC1A	256
Table 170 – Association ends of ExcitationSystemDynamics:: ExcAC1A with other classes	257
Table 171 – Attributes of ExcitationSystemDynamics::ExcAC2A	258
Table 172 – Association ends of ExcitationSystemDynamics:: ExcAC2A with other classes	259
Table 173 – Attributes of ExcitationSystemDynamics::ExcAC3A	260
Table 174 – Association ends of ExcitationSystemDynamics:: ExcAC3A with other classes	262
Table 175 – Attributes of ExcitationSystemDynamics::ExcAC4A	262
Table 176 – Association ends of ExcitationSystemDynamics:: ExcAC4A with other classes	263

Table 177 – Attributes of ExcitationSystemDynamics::ExcAC5A	264
Table 178 – Association ends of ExcitationSystemDynamics:: ExcAC5A with other classes	265
Table 179 – Attributes of ExcitationSystemDynamics::ExcAC6A	266
Table 180 – Association ends of ExcitationSystemDynamics:: ExcAC6A with other classes	267
Table 181 – Attributes of ExcitationSystemDynamics::ExcAC8B	268
Table 182 – Association ends of ExcitationSystemDynamics:: ExcAC8B with other classes	269
Table 183 – Attributes of ExcitationSystemDynamics::ExcANS	270
Table 184 – Association ends of ExcitationSystemDynamics::ExcANS with other classes	271
Table 185 – Attributes of ExcitationSystemDynamics::ExcAVR1	272
Table 186 – Association ends of ExcitationSystemDynamics:: ExcAVR1 with other classes	272
Table 187 – Attributes of ExcitationSystemDynamics::ExcAVR2	273
Table 188 – Association ends of ExcitationSystemDynamics:: ExcAVR2 with other classes	274
Table 189 – Attributes of ExcitationSystemDynamics::ExcAVR3	274
Table 190 – Association ends of ExcitationSystemDynamics:: ExcAVR3 with other classes	275
Table 191 – Attributes of ExcitationSystemDynamics::ExcAVR4	276
Table 192 – Association ends of ExcitationSystemDynamics:: ExcAVR4 with other classes	276
Table 193 – Attributes of ExcitationSystemDynamics::ExcAVR5	277
Table 194 – Association ends of ExcitationSystemDynamics:: ExcAVR5 with other classes	278
Table 195 – Attributes of ExcitationSystemDynamics::ExcAVR7	278
Table 196 – Association ends of ExcitationSystemDynamics:: ExcAVR7 with other classes	279
Table 197 – Attributes of ExcitationSystemDynamics::ExcBBC	280
Table 198 – Association ends of ExcitationSystemDynamics:: ExcBBC with other classes	281
Table 199 – Attributes of ExcitationSystemDynamics::ExcCZ.....	282
Table 200 – Association ends of ExcitationSystemDynamics::ExcCZ with other classes	283
Table 201 – Attributes of ExcitationSystemDynamics::ExcDC1A	284
Table 202 – Association ends of ExcitationSystemDynamics:: ExcDC1A with other classes	285
Table 203 – Attributes of ExcitationSystemDynamics::ExcDC2A	286
Table 204 – Association ends of ExcitationSystemDynamics:: ExcDC2A with other classes	287
Table 205 – Attributes of ExcitationSystemDynamics::ExcDC3A	288
Table 206 – Association ends of ExcitationSystemDynamics:: ExcDC3A with other classes	289
Table 207 – Attributes of ExcitationSystemDynamics::ExcDC3A1	290
Table 208 – Association ends of ExcitationSystemDynamics:: ExcDC3A1 with other classes	290
Table 209 – Attributes of ExcitationSystemDynamics::ExcELIN1	291

Table 210 – Association ends of ExcitationSystemDynamics:: ExcELIN1 with other classes	292
Table 211 – Attributes of ExcitationSystemDynamics::ExcELIN2.....	293
Table 212 – Association ends of ExcitationSystemDynamics:: ExcELIN2 with other classes	294
Table 213 – Attributes of ExcitationSystemDynamics::ExcHU	295
Table 214 – Association ends of ExcitationSystemDynamics:: ExcHU with other classes	296
Table 215 – Attributes of ExcitationSystemDynamics::ExcNI.....	297
Table 216 – Association ends of ExcitationSystemDynamics::ExcNI with other classes	297
Table 217 – Attributes of ExcitationSystemDynamics::ExcOEX3T	298
Table 218 – Association ends of ExcitationSystemDynamics:: ExcOEX3T with other classes	299
Table 219 – Attributes of ExcitationSystemDynamics::ExcPIC	300
Table 220 – Association ends of ExcitationSystemDynamics::ExcPIC with other classes	301
Table 221 – Attributes of ExcitationSystemDynamics::ExcREXS	303
Table 222 – Association ends of ExcitationSystemDynamics:: ExcREXS with other classes	305
Table 223 – Attributes of ExcitationSystemDynamics::ExcRQB	305
Table 224 – Association ends of ExcitationSystemDynamics:: ExcRQB with other classes	306
Table 225 – Attributes of ExcitationSystemDynamics::ExcSCRX.....	307
Table 226 – Association ends of ExcitationSystemDynamics:: ExcSCRX with other classes	308
Table 227 – Attributes of ExcitationSystemDynamics::ExcSEXS	309
Table 228 – Association ends of ExcitationSystemDynamics:: ExcSEXS with other classes	309
Table 229 – Attributes of ExcitationSystemDynamics::ExcSK.....	311
Table 230 – Association ends of ExcitationSystemDynamics::ExcSK with other classes	312
Table 231 – Attributes of ExcitationSystemDynamics::ExcST1A.....	313
Table 232 – Association ends of ExcitationSystemDynamics:: ExcST1A with other classes	314
Table 233 – Attributes of ExcitationSystemDynamics::ExcST2A.....	314
Table 234 – Association ends of ExcitationSystemDynamics:: ExcST2A with other classes	315
Table 235 – Attributes of ExcitationSystemDynamics::ExcST3A.....	316
Table 236 – Association ends of ExcitationSystemDynamics:: ExcST3A with other classes	317
Table 237 – Attributes of ExcitationSystemDynamics::ExcST4B.....	318
Table 238 – Association ends of ExcitationSystemDynamics:: ExcST4B with other classes	319
Table 239 – Attributes of ExcitationSystemDynamics::ExcST6B.....	320
Table 240 – Association ends of ExcitationSystemDynamics:: ExcST6B with other classes	321
Table 241 – Attributes of ExcitationSystemDynamics::ExcST7B.....	322
Table 242 – Association ends of ExcitationSystemDynamics:: ExcST7B with other classes	323

Table 243 – Attributes of IEEE4215from2016::ExcIEEEEST1C	324
Table 244 – Association ends of IEEE4215from2016::ExcIEEEEST1C with other classes	325
Table 245 – Attributes of IEEE4215from2016::ExcIEEEEAC8C	325
Table 246 – Association ends of IEEE4215from2016::ExcIEEEEAC8C with other classes	327
Table 247 – Attributes of IEEE4215from2016::ExcIEEEEST9C	327
Table 248 – Association ends of IEEE4215from2016::ExcIEEEEST9C with other classes	328
Table 249 – Attributes of IEEE4215from2016::ExcIEEEEST2C	328
Table 250 – Association ends of IEEE4215from2016::ExcIEEEEST2C with other classes	329
Table 251 – Attributes of IEEE4215from2016::ExcIEEEEAC10C	330
Table 252 – Association ends of IEEE4215from2016::ExcIEEEEAC10C with other classes	332
Table 253 – Attributes of IEEE4215from2016::ExcIEEEEAC5C	332
Table 254 – Association ends of IEEE4215from2016::ExcIEEEEAC5C with other classes	333
Table 255 – Attributes of IEEE4215from2016::ExcIEEEEST3C	334
Table 256 – Association ends of IEEE4215from2016::ExcIEEEEST3C with other classes	335
Table 257 – Attributes of IEEE4215from2016::ExcIEEEEAC3C	335
Table 258 – Association ends of IEEE4215from2016::ExcIEEEEAC3C with other classes	336
Table 259 – Attributes of IEEE4215from2016::ExcIEEEEAC6C	337
Table 260 – Association ends of IEEE4215from2016::ExcIEEEEAC6C with other classes	338
Table 261 – Attributes of IEEE4215from2016::ExcIEEEEST7C	338
Table 262 – Association ends of IEEE4215from2016::ExcIEEEEST7C with other classes	339
Table 263 – Attributes of IEEE4215from2016::ExcIEEEEDC1C	340
Table 264 – Association ends of IEEE4215from2016::ExcIEEEEDC1C with other classes	340
Table 265 – Attributes of IEEE4215from2016::ExcIEEEEAC7C	341
Table 266 – Association ends of IEEE4215from2016::ExcIEEEEAC7C with other classes	342
Table 267 – Attributes of IEEE4215from2016::ExcIEEEEAC9C	343
Table 268 – Association ends of IEEE4215from2016::ExcIEEEEAC9C with other classes	345
Table 269 – Attributes of IEEE4215from2016::ExcIEEEEST10C	345
Table 270 – Association ends of IEEE4215from2016::ExcIEEEEST10C with other classes	346
Table 271 – Attributes of IEEE4215from2016::ExcIEEEEAC4C	347
Table 272 – Association ends of IEEE4215from2016::ExcIEEEEAC4C with other classes	347
Table 273 – Attributes of IEEE4215from2016::ExcIEEEEST6C	348
Table 274 – Association ends of IEEE4215from2016::ExcIEEEEST6C with other classes	349
Table 275 – Attributes of IEEE4215from2016::ExcIEEEEST8C	349
Table 276 – Association ends of IEEE4215from2016::ExcIEEEEST8C with other classes	350
Table 277 – Attributes of IEEE4215from2016::ExcIEEEEAC2C	351
Table 278 – Association ends of IEEE4215from2016::ExcIEEEEAC2C with other classes	352
Table 279 – Attributes of IEEE4215from2016::ExcIEEEEAC1C	352
Table 280 – Association ends of IEEE4215from2016::ExcIEEEEAC1C with other classes	353
Table 281 – Attributes of IEEE4215from2016::ExcIEEEEST5C	354
Table 282 – Association ends of IEEE4215from2016::ExcIEEEEST5C with other classes	355
Table 283 – Attributes of IEEE4215from2016::ExcIEEEEDC4C	355
Table 284 – Association ends of IEEE4215from2016::ExcIEEEEDC4C with other classes	356

Table 285 – Attributes of IEEE4215from2016::ExcIEEEAC11C	357
Table 286 – Association ends of IEEE4215from2016::ExcIEEEAC11C with other classes	358
Table 287 – Attributes of IEEE4215from2016::ExcIEEEEST4C	359
Table 288 – Association ends of IEEE4215from2016::ExcIEEEEST4C with other classes	360
Table 289 – Attributes of IEEE4215from2016::ExcIEEEEDC2C	360
Table 290 – Association ends of IEEE4215from2016::ExcIEEEEDC2C with other classes.....	361
Table 291 – Attributes of IEEE4215from2005::ExcIEEEAC1A	362
Table 292 – Association ends of IEEE4215from2005::ExcIEEEAC1A with other classes	363
Table 293 – Attributes of IEEE4215from2005::ExcIEEEAC2A	363
Table 294 – Association ends of IEEE4215from2005::ExcIEEEAC2A with other classes	364
Table 295 – Attributes of IEEE4215from2005::ExcIEEEAC3A	365
Table 296 – Association ends of IEEE4215from2005::ExcIEEEAC3A with other classes	366
Table 297 – Attributes of IEEE4215from2005::ExcIEEEAC4A	366
Table 298 – Association ends of IEEE4215from2005::ExcIEEEAC4A with other classes	367
Table 299 – Attributes of IEEE4215from2005::ExcIEEEAC5A	367
Table 300 – Association ends of IEEE4215from2005::ExcIEEEAC5A with other classes	368
Table 301 – Attributes of IEEE4215from2005::ExcIEEEAC6A	368
Table 302 – Association ends of IEEE4215from2005::ExcIEEEAC6A with other classes	370
Table 303 – Attributes of IEEE4215from2005::ExcIEEEAC7B	370
Table 304 – Association ends of IEEE4215from2005::ExcIEEEAC7B with other classes	371
Table 305 – Attributes of IEEE4215from2005::ExcIEEEAC8B	372
Table 306 – Association ends of IEEE4215from2005::ExcIEEEAC8B with other classes	373
Table 307 – Attributes of IEEE4215from2005::ExcIEEEEDC1A	373
Table 308 – Association ends of IEEE4215from2005::ExcIEEEEDC1A with other classes.....	374
Table 309 – Attributes of IEEE4215from2005::ExcIEEEEDC2A	375
Table 310 – Association ends of IEEE4215from2005::ExcIEEEEDC2A with other classes.....	376
Table 311 – Attributes of IEEE4215from2005::ExcIEEEEDC3A	376
Table 312 – Association ends of IEEE4215from2005::ExcIEEEEDC3A with other classes.....	377
Table 313 – Attributes of IEEE4215from2005::ExcIEEEEDC4B	378
Table 314 – Association ends of IEEE4215from2005::ExcIEEEEDC4B with other classes.....	379
Table 315 – Attributes of IEEE4215from2005::ExcIEEEEST1A.....	379
Table 316 – Association ends of IEEE4215from2005::ExcIEEEEST1A with other classes	380
Table 317 – Attributes of IEEE4215from2005::ExcIEEEEST2A.....	380
Table 318 – Association ends of IEEE4215from2005::ExcIEEEEST2A with other classes	381
Table 319 – Attributes of IEEE4215from2005::ExcIEEEEST3A.....	382
Table 320 – Association ends of IEEE4215from2005::ExcIEEEEST3A with other classes	383
Table 321 – Attributes of IEEE4215from2005::ExcIEEEEST4B.....	383
Table 322 – Association ends of IEEE4215from2005::ExcIEEEEST4B with other classes	384
Table 323 – Attributes of IEEE4215from2005::ExcIEEEEST5B.....	385
Table 324 – Association ends of IEEE4215from2005::ExcIEEEEST5B with other classes	385
Table 325 – Attributes of IEEE4215from2005::ExcIEEEEST6B.....	386
Table 326 – Association ends of IEEE4215from2005::ExcIEEEEST6B with other classes	387

Table 327 – Attributes of IEEE4215from2005::ExcIEEEEST7B.....	387
Table 328 – Association ends of IEEE4215from2005::ExcIEEEEST7B with other classes	388
Table 329 – Attributes of OverexcitationLimiterDynamics::OverexcLim2	390
Table 330 – Association ends of OverexcitationLimiterDynamics:: OverexcLim2 with other classes	390
Table 331 – Attributes of OverexcitationLimiterDynamics::OverexcLimIEEEEOEL5C	391
Table 332 – Association ends of OverexcitationLimiterDynamics:: OverexcLimIEEEEOEL5C with other classes.....	392
Table 333 – Attributes of OverexcitationLimiterDynamics::OverexcLimX1	393
Table 334 – Association ends of OverexcitationLimiterDynamics:: OverexcLimX1 with other classes	394
Table 335 – Attributes of OverexcitationLimiterDynamics::OverexcLimX2	396
Table 336 – Association ends of OverexcitationLimiterDynamics:: OverexcLimX2 with other classes	396
Table 337 – Attributes of OverexcitationLimiterDynamics::OverexcLimIEEEEOEL2C	397
Table 338 – Association ends of OverexcitationLimiterDynamics:: OverexcLimIEEEEOEL2C with other classes.....	399
Table 339 – Attributes of OverexcitationLimiterDynamics:: OverexcitationLimiterDynamics	399
Table 340 – Association ends of OverexcitationLimiterDynamics:: OverexcitationLimiterDynamics with other classes	399
Table 341 – Attributes of OverexcitationLimiterDynamics::OverexcLimIEEEEOEL4C	400
Table 342 – Association ends of OverexcitationLimiterDynamics:: OverexcLimIEEEEOEL4C with other classes.....	400
Table 343 – Attributes of OverexcitationLimiterDynamics::OverexcLimIEEE.....	400
Table 344 – Association ends of OverexcitationLimiterDynamics:: OverexcLimIEEE with other classes	401
Table 345 – Attributes of OverexcitationLimiterDynamics::OverexcLimIEEEEOEL3C	401
Table 346 – Association ends of OverexcitationLimiterDynamics:: OverexcLimIEEEEOEL3C with other classes.....	402
Table 347 – Attributes of UnderexcitationLimiterDynamics::UnderexcLimIEEEEUEL2C.....	403
Table 348 – Association ends of UnderexcitationLimiterDynamics:: UnderexcLimIEEEEUEL2C with other classes	405
Table 349 – Attributes of UnderexcitationLimiterDynamics:: UnderexcitationLimiterDynamics	405
Table 350 – Association ends of UnderexcitationLimiterDynamics:: UnderexcitationLimiterDynamics with other classes	406
Table 351 – Attributes of UnderexcitationLimiterDynamics::UnderexcLimIEEE1	406
Table 352 – Association ends of UnderexcitationLimiterDynamics:: UnderexcLimIEEE1 with other classes	407
Table 353 – Attributes of UnderexcitationLimiterDynamics::UnderexcLimIEEE2.....	407
Table 354 – Association ends of UnderexcitationLimiterDynamics:: UnderexcLimIEEE2 with other classes	409
Table 355 – Attributes of UnderexcitationLimiterDynamics::UnderexcLim2Simplified	410
Table 356 – Association ends of UnderexcitationLimiterDynamics:: UnderexcLim2Simplified with other classes.....	411
Table 357 – Attributes of UnderexcitationLimiterDynamics::UnderexcLimX1	412

Table 358 – Association ends of UnderexcitationLimiterDynamics:: UnderexcLimX1 with other classes	412
Table 359 – Attributes of UnderexcitationLimiterDynamics::UnderexcLimX2	413
Table 360 – Association ends of UnderexcitationLimiterDynamics:: UnderexcLimX2 with other classes	413
Table 361 – Attributes of PowerSystemStabilizerDynamics:: PowerSystemStabilizerDynamics	416
Table 362 – Association ends of PowerSystemStabilizerDynamics:: PowerSystemStabilizerDynamics with other classes	416
Table 363 – Attributes of PowerSystemStabilizerDynamics::PssIEEE2C	416
Table 364 – Association ends of PowerSystemStabilizerDynamics:: PssIEEE2C with other classes	418
Table 365 – Attributes of PowerSystemStabilizerDynamics::PssIEEE3C	418
Table 366 – Association ends of PowerSystemStabilizerDynamics:: PssIEEE3C with other classes	419
Table 367 – Attributes of PowerSystemStabilizerDynamics::PssIEEE4C	420
Table 368 – Association ends of PowerSystemStabilizerDynamics:: PssIEEE4C with other classes	423
Table 369 – Attributes of PowerSystemStabilizerDynamics::PssIEEE5C	424
Table 370 – Association ends of PowerSystemStabilizerDynamics:: PssIEEE5C with other classes	424
Table 371 – Attributes of PowerSystemStabilizerDynamics::PssIEEE6C	425
Table 372 – Association ends of PowerSystemStabilizerDynamics:: PssIEEE6C with other classes	426
Table 373 – Attributes of PowerSystemStabilizerDynamics::PssIEEE7C	426
Table 374 – Association ends of PowerSystemStabilizerDynamics:: PssIEEE7C with other classes	428
Table 375 – Attributes of PowerSystemStabilizerDynamics::PssIEEE1A	428
Table 376 – Association ends of PowerSystemStabilizerDynamics:: PssIEEE1A with other classes	429
Table 377 – Attributes of PowerSystemStabilizerDynamics::PssIEEE2B	430
Table 378 – Association ends of PowerSystemStabilizerDynamics:: PssIEEE2B with other classes	431
Table 379 – Attributes of PowerSystemStabilizerDynamics::PssIEEE3B	431
Table 380 – Association ends of PowerSystemStabilizerDynamics:: PssIEEE3B with other classes	432
Table 381 – Attributes of PowerSystemStabilizerDynamics::PssIEEE4B	433
Table 382 – Association ends of PowerSystemStabilizerDynamics:: PssIEEE4B with other classes	435
Table 383 – Attributes of PowerSystemStabilizerDynamics::Pss1	436
Table 384 – Association ends of PowerSystemStabilizerDynamics:: Pss1 with other classes	437
Table 385 – Attributes of PowerSystemStabilizerDynamics::Pss1A	438
Table 386 – Association ends of PowerSystemStabilizerDynamics:: Pss1A with other classes	438
Table 387 – Attributes of PowerSystemStabilizerDynamics::Pss2B	439
Table 388 – Association ends of PowerSystemStabilizerDynamics:: Pss2B with other classes	440

Table 389 – Attributes of PowerSystemStabilizerDynamics::Pss2ST	441
Table 390 – Association ends of PowerSystemStabilizerDynamics:: Pss2ST with other classes	442
Table 391 – Attributes of PowerSystemStabilizerDynamics::Pss5	443
Table 392 – Association ends of PowerSystemStabilizerDynamics:: Pss5 with other classes	444
Table 393 – Attributes of PowerSystemStabilizerDynamics::PssELIN2.....	445
Table 394 – Association ends of PowerSystemStabilizerDynamics:: PssELIN2 with other classes	445
Table 395 – Attributes of PowerSystemStabilizerDynamics::PssPTIST1.....	446
Table 396 – Association ends of PowerSystemStabilizerDynamics:: PssPTIST1 with other classes	447
Table 397 – Attributes of PowerSystemStabilizerDynamics::PssPTIST3.....	448
Table 398 – Association ends of PowerSystemStabilizerDynamics:: PssPTIST3 with other classes	449
Table 399 – Attributes of PowerSystemStabilizerDynamics::PssRQB.....	450
Table 400 – Association ends of PowerSystemStabilizerDynamics:: PssRQB with other classes	450
Table 401 – Attributes of PowerSystemStabilizerDynamics::PssSB4.....	451
Table 402 – Association ends of PowerSystemStabilizerDynamics:: PssSB4 with other classes	452
Table 403 – Attributes of PowerSystemStabilizerDynamics::PssSH	452
Table 404 – Association ends of PowerSystemStabilizerDynamics:: PssSH with other classes	453
Table 405 – Attributes of PowerSystemStabilizerDynamics::PssSK.....	454
Table 406 – Association ends of PowerSystemStabilizerDynamics:: PssSK with other classes	455
Table 407 – Attributes of PowerSystemStabilizerDynamics::PssSTAB2A	456
Table 408 – Association ends of PowerSystemStabilizerDynamics:: PssSTAB2A with other classes	456
Table 409 – Attributes of PowerSystemStabilizerDynamics::PssWECC	457
Table 410 – Association ends of PowerSystemStabilizerDynamics:: PssWECC with other classes	458
Table 411 – Attributes of DiscontinuousExcitationControlDynamics:: DiscontinuousExcitationControlDynamics.....	459
Table 412 – Association ends of DiscontinuousExcitationControlDynamics:: DiscontinuousExcitationControlDynamics with other classes	460
Table 413 – Attributes of DiscontinuousExcitationControlDynamics:: DiscExcContIEEEDEC1A	460
Table 414 – Association ends of DiscontinuousExcitationControlDynamics:: DiscExcContIEEEDEC1A with other classes	461
Table 415 – Attributes of DiscontinuousExcitationControlDynamics:: DiscExcContIEEEDEC2A	461
Table 416 – Association ends of DiscontinuousExcitationControlDynamics:: DiscExcContIEEEDEC2A with other classes	462
Table 417 – Attributes of DiscontinuousExcitationControlDynamics:: DiscExcContIEEEDEC3A	462
Table 418 – Association ends of DiscontinuousExcitationControlDynamics:: DiscExcContIEEEDEC3A with other classes	462

Table 419 – Attributes of PFVArControllerType1Dynamics:: PFVArType1CIEEEVArController	464
Table 420 – Association ends of PFVArControllerType1Dynamics:: PFVArType1CIEEEVArController with other classes	464
Table 421 – Attributes of PFVArControllerType1Dynamics:: PFVArType1CIEEEPFCController	464
Table 422 – Association ends of PFVArControllerType1Dynamics:: PFVArType1CIEEEPFCController with other classes	465
Table 423 – Attributes of PFVArControllerType1Dynamics:: PFVArControllerType1Dynamics	465
Table 424 – Association ends of PFVArControllerType1Dynamics:: PFVArControllerType1Dynamics with other classes	465
Table 425 – Attributes of PFVArControllerType1Dynamics:: PFVArType1IEEEPFCController	466
Table 426 – Association ends of PFVArControllerType1Dynamics:: PFVArType1IEEEPFCController with other classes	466
Table 427 – Attributes of PFVArControllerType1Dynamics:: PFVArType1IEEEVArController	467
Table 428 – Association ends of PFVArControllerType1Dynamics:: PFVArType1IEEEVArController with other classes	467
Table 429 – Attributes of PFVArControllerType2Dynamics:: PFVArControllerType2Dynamics	468
Table 430 – Association ends of PFVArControllerType2Dynamics:: PFVArControllerType2Dynamics with other classes	469
Table 431 – Attributes of PFVArControllerType2Dynamics::PFVArType2Common1	470
Table 432 – Association ends of PFVArControllerType2Dynamics:: PFVArType2Common1 with other classes	470
Table 433 – Attributes of PFVArControllerType2Dynamics:: PFVArType2CIEEEVArController	470
Table 434 – Association ends of PFVArControllerType2Dynamics:: PFVArType2CIEEEVArController with other classes	471
Table 435 – Attributes of PFVArControllerType2Dynamics:: PFVArType2CIEEEPFCController	471
Table 436 – Association ends of PFVArControllerType2Dynamics:: PFVArType2CIEEEPFCController with other classes	472
Table 437 – Attributes of PFVArControllerType2Dynamics:: PFVArType2IEEEVArController	472
Table 438 – Association ends of PFVArControllerType2Dynamics:: PFVArType2IEEEVArController with other classes	472
Table 439 – Attributes of PFVArControllerType2Dynamics:: PFVArType2IEEEPFCController	473
Table 440 – Association ends of PFVArControllerType2Dynamics:: PFVArType2IEEEPFCController with other classes	473
Table 441 – Attributes of VoltageAdjusterDynamics::VAdjIEEE2	474
Table 442 – Association ends of VoltageAdjusterDynamics:: VAdjIEEE2 with other classes	475
Table 443 – Attributes of VoltageAdjusterDynamics::VoltageAdjusterDynamics	475
Table 444 – Association ends of VoltageAdjusterDynamics:: VoltageAdjusterDynamics with other classes	475
Table 445 – Attributes of VoltageAdjusterDynamics::VAdjIEEE	476

Table 446 – Association ends of VoltageAdjusterDynamics:: VAdjIEEE with other classes	476
Table 447 – Attributes of VoltageCompensatorDynamics::VoltageCompensatorDynamics	478
Table 448 – Association ends of VoltageCompensatorDynamics:: VoltageCompensatorDynamics with other classes	478
Table 449 – Attributes of VoltageCompensatorDynamics::VCompIEEEType1	479
Table 450 – Association ends of VoltageCompensatorDynamics:: VCompIEEEType1 with other classes	479
Table 451 – Attributes of VoltageCompensatorDynamics::VCompIEEEType2	480
Table 452 – Association ends of VoltageCompensatorDynamics:: VCompIEEEType2 with other classes	480
Table 453 – Attributes of VoltageCompensatorDynamics::GenICompensationForGenJ	480
Table 454 – Association ends of VoltageCompensatorDynamics:: GenICompensationForGenJ with other classes	481
Table 455 – Attributes of WindDynamics::WindAeroConstIEC	486
Table 456 – Attributes of WindDynamics::WindAeroOneDimIEC	486
Table 457 – Attributes of WindDynamics::WindAeroTwoDimIEC	486
Table 458 – Attributes of WindDynamics::WindContCurrLimIEC	487
Table 459 – Attributes of WindDynamics::WindContPitchAngleIEC	488
Table 460 – Attributes of WindDynamics::WindContPType3IEC	489
Table 461 – Attributes of WindDynamics::WindContPType4aIEC	490
Table 462 – Attributes of WindDynamics::WindContPType4bIEC	491
Table 463 – Attributes of WindDynamics::WindContQIEC	491
Table 464 – Attributes of WindDynamics::WindContQLimIEC	492
Table 465 – Attributes of WindDynamics::WindContQPQLimIEC	493
Table 466 – Attributes of WindDynamics::WindContRotorRIEC	493
Table 467 – Attributes of WindDynamics::WindDynamicsLookupTable	494
Table 468 – Association ends of WindDynamics:: WindDynamicsLookupTable with other classes	494
Table 469 – Attributes of WindDynamics::WindGenTurbineType1aIEC	495
Table 470 – Association ends of WindDynamics:: WindGenTurbineType1aIEC with other classes	495
Table 471 – Attributes of WindDynamics::WindGenTurbineType1bIEC	496
Table 472 – Association ends of WindDynamics:: WindGenTurbineType1bIEC with other classes	496
Table 473 – Attributes of WindDynamics::WindGenTurbineType2IEC	496
Table 474 – Association ends of WindDynamics:: WindGenTurbineType2IEC with other classes	497
Table 475 – Attributes of WindDynamics::WindGenType3aIEC	497
Table 476 – Attributes of WindDynamics::WindGenType3bIEC	498
Table 477 – Attributes of WindDynamics::WindGenType3IEC	498
Table 478 – Attributes of WindDynamics::WindGenType4IEC	499
Table 479 – Attributes of WindDynamics::WindMechIEC	499
Table 480 – Attributes of WindDynamics::WindPitchContPowerIEC	500
Table 481 – Attributes of WindDynamics::WindPlantDynamics	500

Table 482 – Association ends of WindDynamics::WindPlantDynamics with other classes	500
Table 483 – Attributes of WindDynamics::WindPlantFreqPcontrolIEC	501
Table 484 – Attributes of WindDynamics::WindPlantIEC	502
Table 485 – Association ends of WindDynamics::WindPlantIEC with other classes	502
Table 486 – Attributes of WindDynamics::WindPlantReactiveControlIEC.....	503
Table 487 – Attributes of WindDynamics::WindProtectionIEC	504
Table 488 – Attributes of WindDynamics::WindRefFrameRotIEC.....	505
Table 489 – Attributes of WindDynamics::WindTurbineType1or2Dynamics	505
Table 490 – Association ends of WindDynamics:: WindTurbineType1or2Dynamics with other classes	505
Table 491 – Attributes of WindDynamics::WindTurbineType1or2IEC	506
Table 492 – Association ends of WindDynamics:: WindTurbineType1or2IEC with other classes	506
Table 493 – Attributes of WindDynamics::WindTurbineType3IEC	507
Table 494 – Association ends of WindDynamics:: WindTurbineType3IEC with other classes	507
Table 495 – Attributes of WindDynamics::WindTurbineType3or4Dynamics	508
Table 496 – Association ends of WindDynamics:: WindTurbineType3or4Dynamics with other classes	508
Table 497 – Attributes of WindDynamics::WindTurbineType3or4IEC	508
Table 498 – Association ends of WindDynamics:: WindTurbineType3or4IEC with other classes	509
Table 499 – Attributes of WindDynamics::WindTurbineType4aIEC	509
Table 500 – Association ends of WindDynamics:: WindTurbineType4aIEC with other classes	510
Table 501 – Attributes of WindDynamics::WindTurbineType4bIEC	510
Table 502 – Association ends of WindDynamics:: WindTurbineType4bIEC with other classes	511
Table 503 – Attributes of WindDynamics::WindTurbineType4IEC	511
Table 504 – Association ends of WindDynamics:: WindTurbineType4IEC with other classes	512
Table 505 – Attributes of WindDynamicsEd2::CommunicationIEC	517
Table 506 – Attributes of WindDynamicsEd2::CommunicationDelayIEC	517
Table 507 – Attributes of WindDynamicsEd2::LinearCommunicationIEC	517
Table 508 – Attributes of WindDynamicsEd2::WindAeroOneDimIEC2	518
Table 509 – Attributes of WindDynamicsEd2::WindAeroTwoDimIEC2	518
Table 510 – Attributes of WindDynamicsEd2::WindContPitchAngleIEC2	519
Table 511 – Attributes of WindDynamicsEd2::WindContPType3IEC2	520
Table 512 – Attributes of WindDynamicsEd2::WindContPType4aIEC2	522
Table 513 – Attributes of WindDynamicsEd2::WindContPType4bIEC2	522
Table 514 – Attributes of WindDynamicsEd2::WindGenType3aIEC2	523
Table 515 – Attributes of WindDynamicsEd2::WindGenType3bIEC2	524
Table 516 – Attributes of WindDynamicsEd2::WindGenType3IEC2	524
Table 517 – Attributes of WindDynamicsEd2::WindGenType4IEC2	525
Table 518 – Attributes of WindDynamicsEd2::WindPlantBasicIEC.....	525

Table 519 – Association ends of WindDynamicsEd2:: WindPlantBasicIEC with other classes	525
Table 520 – Attributes of WindDynamicsEd2::WindPlantControlCommIEC	526
Table 521 – Association ends of WindDynamicsEd2:: WindPlantControlCommIEC with other classes	526
Table 522 – Attributes of WindDynamicsEd2::WindPlantDynamics2	527
Table 523 – Association ends of WindDynamicsEd2:: WindPlantDynamics2 with other classes	527
Table 524 – Attributes of WindDynamicsEd2::WindPlantPControlIEC	527
Table 525 – Attributes of WindDynamicsEd2::WindPlantQCompensationIEC	528
Table 526 – Association ends of WindDynamicsEd2:: WindPlantQCompensationIEC with other classes	528
Table 527 – Attributes of WindDynamicsEd2::WindPlantQControlIEC	529
Table 528 – Attributes of WindDynamicsEd2::WindTurbineType3IEC2	530
Table 529 – Association ends of WindDynamicsEd2:: WindTurbineType3IEC2 with other classes	530
Table 530 – Attributes of WindDynamicsEd2::WindTurbineType4aIEC2	531
Table 531 – Association ends of WindDynamicsEd2:: WindTurbineType4aIEC2 with other classes	532
Table 532 – Attributes of WindDynamicsEd2::WindTurbineType4bIEC2	532
Table 533 – Association ends of WindDynamicsEd2:: WindTurbineType4bIEC2 with other classes	533
Table 534 – Attributes of WindDynamicsEd2::WindTurbineType4IEC2	534
Table 535 – Association ends of WindDynamicsEd2:: WindTurbineType4IEC2 with other classes	534
Table 536 – Attributes of WindDynamicsEd2::WindContCurrLimIEC2	535
Table 537 – Attributes of WindDynamicsEd2::WindContQIEC2	535
Table 538 – Attributes of WindDynamicsEd2::WindRefFrameRotIEC2	537
Table 539 – Attributes of WindDynamicsEd2::WindAeroConstIEC2	537
Table 540 – Attributes of WindDynamicsEd2::WindContQLimIEC2	538
Table 541 – Attributes of WindDynamicsEd2::WindContQPQULimIEC2	538
Table 542 – Attributes of WindDynamicsEd2::WindContRotorRIEC2	538
Table 543 – Attributes of WindDynamicsEd2::WindDynamicsLookupTable2	539
Table 544 – Association ends of WindDynamicsEd2:: WindDynamicsLookupTable2 with other classes	539
Table 545 – Attributes of WindDynamicsEd2::WindElectricalSystemGamma	540
Table 546 – Attributes of WindDynamicsEd2::WindGenTurbineType1aIEC2	541
Table 547 – Association ends of WindDynamicsEd2:: WindGenTurbineType1aIEC2 with other classes	541
Table 548 – Attributes of WindDynamicsEd2::WindGenTurbineType1bIEC2	541
Table 549 – Association ends of WindDynamicsEd2:: WindGenTurbineType1bIEC2 with other classes	542
Table 550 – Attributes of WindDynamicsEd2::WindGenTurbineType2IEC2	542
Table 551 – Association ends of WindDynamicsEd2:: WindGenTurbineType2IEC2 with other classes	543
Table 552 – Attributes of WindDynamicsEd2::WindGridMeasurement	543
Table 553 – Attributes of WindDynamicsEd2::WindMechIEC2	544

Table 554 – Attributes of WindDynamicsEd2::WindPitchContPowerIEC2	544
Table 555 – Attributes of WindDynamicsEd2::WindProtectionIEC2	545
Table 556 – Attributes of WindDynamicsEd2::WindTurbineType1or2IEC2	545
Table 557 – Association ends of WindDynamicsEd2:: WindTurbineType1or2IEC2 with other classes	546
Table 558 – Attributes of WindDynamicsEd2::WindTurbineType3or4IEC2	546
Table 559 – Association ends of WindDynamicsEd2:: WindTurbineType3or4IEC2 with other classes	546
Table 560 – Attributes of LoadDynamics::LoadComposite	550
Table 561 – Attributes of LoadDynamics::LoadGenericNonLinear	552
Table 562 – Attributes of LoadDynamics::LoadDynamics	552
Table 563 – Attributes of LoadDynamics::LoadAggregate	553
Table 564 – Attributes of LoadDynamics::LoadStatic	555
Table 565 – Association ends of LoadDynamics::LoadStatic with other classes	556
Table 566 – Attributes of LoadDynamics::LoadMotor	558
Table 567 – Association ends of LoadDynamics::LoadMotor with other classes	558
Table 568 – Attributes of LoadCompositeWECC::LoadAirCoWECC.....	559
Table 569 – Association ends of LoadCompositeWECC:: LoadAirCoWECC with other classes	560
Table 570 – Attributes of LoadCompositeWECC::LoadStaticWECC	561
Table 571 – Association ends of LoadCompositeWECC:: LoadStaticWECC with other classes	561
Table 572 – Attributes of LoadCompositeWECC::LoadCompositeWECC.....	562
Table 573 – Attributes of LoadCompositeWECC::LoadElectronicWECC.....	563
Table 574 – Association ends of LoadCompositeWECC:: LoadElectronicWECC with other classes	563
Table 575 – Attributes of LoadCompositeWECC::LoadMotorWECC	564
Table 576 – Association ends of LoadCompositeWECC:: LoadMotorWECC with other classes	564
Table 577 – Attributes of HVDCDynamics::HVDCInterconnectionDynamics	566
Table 578 – Attributes of HVDCDynamics::CSCDynamics.....	566
Table 579 – Association ends of HVDCDynamics::CSCDynamics with other classes	566
Table 580 – Attributes of HVDCDynamics::HVDCDynamics	566
Table 581 – Attributes of HVDCDynamics::VSCDynamics.....	567
Table 582 – Association ends of HVDCDynamics::VSCDynamics with other classes.....	567
Table 583 – Attributes of RelayDynamics::WeccTIOCRS	569
Table 584 – Association ends of RelayDynamics::WeccTIOCRS with other classes	569
Table 585 – Attributes of RelayDynamics::RelayDynamics.....	570
Table 586 – Association ends of RelayDynamics::RelayDynamics with other classes.....	570
Table 587 – Attributes of RelayDynamics::RateOfChangeOfPowerRelay.....	570
Table 588 – Association ends of RelayDynamics:: RateOfChangeOfPowerRelay with other classes	571
Table 589 – Attributes of StaticVarCompensatorDynamics::SVSMO4.....	573
Table 590 – Association ends of StaticVarCompensatorDynamics:: SVSMO4 with other classes	574
Table 591 – Attributes of StaticVarCompensatorDynamics::SVSMO2.....	575

Table 592 – Association ends of StaticVarCompensatorDynamics:: SVSMO2 with other classes	577
Table 593 – Attributes of StaticVarCompensatorDynamics:: StaticVarCompensatorDynamics	577
Table 594 – Association ends of StaticVarCompensatorDynamics:: StaticVarCompensatorDynamics with other classes	578
Table 595 – Attributes of StaticVarCompensatorDynamics:: StaticVarCompensatorSystemDynamics	578
Table 596 – Association ends of StaticVarCompensatorDynamics:: StaticVarCompensatorSystemDynamics with other classes	578
Table 597 – Attributes of StaticVarCompensatorDynamics::SVSMO1.....	579
Table 598 – Association ends of StaticVarCompensatorDynamics:: SVSMO1 with other classes	581
Table 599 – Attributes of StaticVarCompensatorDynamics::SVSMO3.....	581
Table 600 – Association ends of StaticVarCompensatorDynamics:: SVSMO3 with other classes	583
Table 601 – Attributes of StatorCurrentLimiterDynamics::StatorCurrentLimiterDynamics.....	584
Table 602 – Association ends of StatorCurrentLimiterDynamics::StatorCurrentLimiterDynamics with other classes	585
Table 603 – Attributes of StatorCurrentLimiterDynamics::StatorCurrentLimIEEEESCL1C	585
Table 604 – Association ends of StatorCurrentLimiterDynamics::StatorCurrentLimIEEEESCL1C with other classes	586
Table 605 – Attributes of StatorCurrentLimiterDynamics::StatorCurrentLimIEEEESCL2C	586
Table 606 – Attributes of ShuntCompensatorDynamics::ShuntCompensatorDynamics	590
Table 607 – Association ends of ShuntCompensatorDynamics:: ShuntCompensatorDynamics with other classes	591
Table 608 – Attributes of StatcomDynamics::StatcomIEC.....	592
Table 609 – Association ends of StatorCurrentLimiterDynamics::StatorCurrentLimIEEEESCL2C with other classes	593
Table 610 – Association ends of StatcomDynamics::StatcomIEC with other classes	593
Table 611 – Attributes of StatcomDynamics::StatcomDynamics	593
Table 612 – Association ends of StatcomDynamics:: StatcomDynamics with other classes	594
Table 613 – Attributes of WECCDynamics::WeccBESS.....	595
Table 614 – Association ends of WECCDynamics::WeccBESS with other classes	596
Table 615 – Attributes of WECCDynamics::WeccDERA	596
Table 616 – Association ends of WECCDynamics::WeccDERA with other classes	598
Table 617 – Attributes of WECCDynamics::WeccDERApvmod	599
Table 618 – Association ends of WECCDynamics::WeccDERApvmod with other classes	599
Table 619 – Attributes of WECCDynamics::WeccDynamics.....	599
Table 620 – Association ends of WECCDynamics::WeccDynamics with other classes	600
Table 621 – Attributes of WECCDynamics::WeccPVD1	600
Table 622 – Association ends of WECCDynamics::WeccPVD1 with other classes.....	601
Table 623 – Attributes of WECCDynamics::WeccREEC	601
Table 624 – Association ends of WECCDynamics::WeccREEC with other classes	602
Table 625 – Attributes of WECCDynamics::WeccREECA	602

Table 626 – Association ends of WECCDynamics::WeccREECA with other classes	604
Table 627 – Attributes of WECCDynamics::WeccREECB	605
Table 628 – Association ends of WECCDynamics::WeccREECB with other classes	606
Table 629 – Attributes of WECCDynamics::WeccREECC	607
Table 630 – Association ends of WECCDynamics::WeccREECC with other classes	609
Table 631 – Attributes of WECCDynamics::WeccREECD	609
Table 632 – Association ends of WECCDynamics::WeccREECD with other classes	614
Table 633 – Attributes of WECCDynamics::WeccREGCA	614
Table 634 – Association ends of WECCDynamics::WeccREGCA with other classes	615
Table 635 – Attributes of WECCDynamics::WeccREGCB	615
Table 636 – Association ends of WECCDynamics::WeccREGCB with other classes	616
Table 637 – Attributes of WECCDynamics::WeccREGCC	617
Table 638 – Association ends of WECCDynamics::WeccREGCC with other classes	617
Table 639 – Attributes of WECCDynamics::WeccREPCA	618
Table 640 – Association ends of WECCDynamics::WeccREPCA with other classes	619
Table 641 – Attributes of WECCDynamics::WeccREPC	620
Table 642 – Association ends of WECCDynamics::WeccREPC with other classes	622
Table 643 – Attributes of WECCDynamics::WeccWT12T	623
Table 644 – Association ends of WECCDynamics::WeccWT12T with other classes	623
Table 645 – Attributes of WECCDynamics::WeccWT1PB	623
Table 646 – Association ends of WECCDynamics::WeccWT1PB with other classes	624
Table 647 – Attributes of WECCDynamics::WeccWT2E	624
Table 648 – Association ends of WECCDynamics::WeccWT2E with other classes	624
Table 649 – Attributes of WECCDynamics::WeccWTGARA	625
Table 650 – Association ends of WECCDynamics::WeccWTGARA with other classes	625
Table 651 – Attributes of WECCDynamics::WeccWTGPTA	626
Table 652 – Association ends of WECCDynamics::WeccWTGPTA with other classes	626
Table 653 – Attributes of WECCDynamics::WeccWTGPB	627
Table 654 – Association ends of WECCDynamics::WeccWTGPB with other classes	627
Table 655 – Attributes of WECCDynamics::WeccWTGTA	628
Table 656 – Association ends of WECCDynamics::WeccWTGTA with other classes	628
Table 657 – Attributes of WECCDynamics::WeccWTGTB	628
Table 658 – Association ends of WECCDynamics::WeccWTGTB with other classes	629
Table 659 – Attributes of WECCDynamics::WeccWTGIBFFRA	629
Table 660 – Association ends of WECCDynamics::WeccWTGIBFFRA with other classes	631
Table 661 – Attributes of WECCDynamics::WeccWTGTRQA	631
Table 662 – Association ends of WECCDynamics::WeccWTGTRQA with other classes	631
Table 663 – Attributes of WECCDynamics::WeccWTGWGOA	632
Table 664 – Association ends of WECCDynamics::WeccWTGWGOA with other classes	632
Table 665 – Attributes of WECCDynamics::WeccDynamicsLookupTable	633
Table 666 – Association ends of WECCDynamics:: WeccDynamicsLookupTable with other classes	633
Table 667 – Literals of WECCDynamics::WeccLookupTableFunctionKind	633

Table 668 – Attributes of IEEE1547Dynamics::ConstantPowerFactorSettings	635
Table 669 – Attributes of IEEE1547Dynamics::ConstantReactivePowerSettings	635
Table 670 – Attributes of IEEE1547Dynamics::DERDynamics	636
Table 671 – Association ends of IEEE1547Dynamics::DERDynamics with other classes.....	636
Table 672 – Attributes of IEEE1547Dynamics::DERIEEEType1	637
Table 673 – Association ends of IEEE1547Dynamics::DERIEEEType1 with other classes	637
Table 674 – Attributes of IEEE1547Dynamics::DERNameplateData	638
Table 675 – Attributes of IEEE1547Dynamics::DERNameplateDataApplied	639
Table 676 – Association ends of IEEE1547Dynamics:: DERNameplateDataApplied with other classes	639
Table 677 – Attributes of IEEE1547Dynamics::FrequencyDroopSettings	640
Table 678 – Attributes of IEEE1547Dynamics::FrequencyTripSettings	640
Table 679 – Attributes of IEEE1547Dynamics::MomentaryCessationSettings	641
Table 680 – Attributes of IEEE1547Dynamics::PowerLimitSettings	642
Table 681 – Attributes of IEEE1547Dynamics::ServiceSettings	642
Table 682 – Attributes of IEEE1547Dynamics::VoltageTripSettings	643
Table 683 – Attributes of IEEE1547Dynamics::VoltVarSettings	644
Table 684 – Attributes of IEEE1547Dynamics::VoltWattSettings	645
Table 685 – Attributes of IEEE1547Dynamics::WattVarSettings	646
Table 686 – Literals of IEEE1547Dynamics::ConstantPowerFactorSettingKind	647
Table 687 – Literals of IEEE1547Dynamics::NormalOPcatKind	647
Table 688 – Literals of IEEE1547Dynamics::AbnormalOPcatKind	647
Table 689 – Attributes of UserDefinedModels::CSCUserDefined	650
Table 690 – Association ends of UserDefinedModels:: CSCUserDefined with other classes	650
Table 691 – Attributes of UserDefinedModels::SVCUserDefined	650
Table 692 – Association ends of UserDefinedModels:: SVCUserDefined with other classes	651
Table 693 – Attributes of UserDefinedModels::StatcomUserDefined	651
Table 694 – Association ends of UserDefinedModels:: StatcomUserDefined with other classes	651
Table 695 – Attributes of UserDefinedModels::VSCUserDefined	652
Table 696 – Association ends of UserDefinedModels:: VSCUserDefined with other classes	652
Table 697 – Attributes of UserDefinedModels::WindPlantUserDefined	652
Table 698 – Association ends of UserDefinedModels:: WindPlantUserDefined with other classes	653
Table 699 – Attributes of UserDefinedModels::WindType1or2UserDefined	653
Table 700 – Association ends of UserDefinedModels:: WindType1or2UserDefined with other classes	653
Table 701 – Attributes of UserDefinedModels::WindType3or4UserDefined	654
Table 702 – Association ends of UserDefinedModels:: WindType3or4UserDefined with other classes	654
Table 703 – Attributes of UserDefinedModels::SynchronousMachineUserDefined	655

Table 704 – Association ends of UserDefinedModels:: SynchronousMachineUserDefined with other classes	655
Table 705 – Attributes of UserDefinedModels::AsynchronousMachineUserDefined	656
Table 706 – Association ends of UserDefinedModels:: AsynchronousMachineUserDefined with other classes	656
Table 707 – Attributes of UserDefinedModels::TurbineGovernorUserDefined	657
Table 708 – Association ends of UserDefinedModels:: TurbineGovernorUserDefined with other classes	657
Table 709 – Attributes of UserDefinedModels::TurbineLoadControllerUserDefined	657
Table 710 – Association ends of UserDefinedModels:: TurbineLoadControllerUserDefined with other classes	658
Table 711 – Attributes of UserDefinedModels::MechanicalLoadUserDefined	658
Table 712 – Association ends of UserDefinedModels:: MechanicalLoadUserDefined with other classes	658
Table 713 – Attributes of UserDefinedModels::ExcitationSystemUserDefined	659
Table 714 – Association ends of UserDefinedModels:: ExcitationSystemUserDefined with other classes	659
Table 715 – Attributes of UserDefinedModels::OverexcitationLimiterUserDefined	659
Table 716 – Association ends of UserDefinedModels:: OverexcitationLimiterUserDefined with other classes	660
Table 717 – Attributes of UserDefinedModels::UnderexcitationLimiterUserDefined	660
Table 718 – Association ends of UserDefinedModels:: UnderexcitationLimiterUserDefined with other classes	660
Table 719 – Attributes of UserDefinedModels::PowerSystemStabilizerUserDefined	661
Table 720 – Association ends of UserDefinedModels:: PowerSystemStabilizerUserDefined with other classes	661
Table 721 – Attributes of UserDefinedModels:: DiscontinuousExcitationControlUserDefined	661
Table 722 – Association ends of UserDefinedModels:: DiscontinuousExcitationControlUserDefined with other classes	662
Table 723 – Attributes of UserDefinedModels::PFVArControllerType1UserDefined	662
Table 724 – Association ends of UserDefinedModels:: PFVArControllerType1UserDefined with other classes	662
Table 725 – Attributes of UserDefinedModels::VoltageAdjusterUserDefined.....	663
Table 726 – Association ends of UserDefinedModels:: VoltageAdjusterUserDefined with other classes	663
Table 727 – Attributes of UserDefinedModels::PFVArControllerType2UserDefined	663
Table 728 – Association ends of UserDefinedModels:: PFVArControllerType2UserDefined with other classes	664
Table 729 – Attributes of UserDefinedModels::VoltageCompensatorUserDefined.....	664
Table 730 – Association ends of UserDefinedModels:: VoltageCompensatorUserDefined with other classes	664
Table 731 – Attributes of UserDefinedModels::StatorCurrentLimiterUserDefined.....	665
Table 732 – Association ends of UserDefinedModels::StatorCurrentLimiterUserDefined with other classes	665
Table 733 – Attributes of UserDefinedModels::ShuntCompensatorUserDefined	665
Table 734 – Association ends of UserDefinedModels:: ShuntCompensatorUserDefined with other classes	666

Table 735 – Attributes of UserDefinedModels::LoadUserDefined	666
Table 736 – Attributes of UserDefinedModels::HVDCInterconnectionUserDefined	666
Table 737 – Attributes of UserDefinedModels::RelayUserDefined	667
Table 738 – Association ends of UserDefinedModels:: RelayUserDefined with other classes	667
Table 739 – Attributes of UserDefinedModels::ProprietaryParameterDynamics	668
Table 740 – Association ends of UserDefinedModels:: ProprietaryParameterDynamics with other classes	668
Table 741 – Attributes of DynamicsDatatypes::CurrentFlow	672
Table 742 – Attributes of DynamicsDatatypes::PerCent	672
Table 743 – Attributes of DynamicsDatatypes::ReactivePower	672
Table 744 – Attributes of DynamicsDatatypes::Susceptance	672
Table 745 – Attributes of DynamicsDatatypes::Voltage	673
Table 746 – Attributes of DynamicsDatatypes::ActivePower	673
Table 747 – Attributes of DynamicsDatatypes::AngleDegrees	673
Table 748 – Attributes of DynamicsDatatypes::ApparentPower	673
Table 749 – Attributes of DynamicsDatatypes::Area	674
Table 750 – Attributes of DynamicsDatatypes::Frequency	674
Table 751 – Attributes of DynamicsDatatypes::Length	674
Table 752 – Attributes of DynamicsDatatypes::PU	675
Table 753 – Attributes of DynamicsDatatypes::Seconds	675
Table 754 – Attributes of DynamicsDatatypes::Temperature	675
Table 755 – Attributes of DynamicsDatatypes::VolumeFlowRate	675
Table 756 – Literals of DynamicsDatatypes::UnitSymbol	677
Table 757 – Literals of DynamicsDatatypes::UnitMultiplier	682
Table 758 – Literals of DynamicsDatatypes::SinglePhaseKind	683
Table 759 – Literals of DynamicsDatatypes::OverExcitationLimiterInputKind	683
Table 760 – Literals of DynamicsDatatypes::InputsST4CKind	683
Table 761 – Literals of DynamicsDatatypes::InputsST6CKind	683
Table 762 – Literals of DynamicsDatatypes::InputsST7CKind	684
Table 763 – Literals of DynamicsDatatypes::VoellInputKind	684
Table 764 – Literals of DynamicsDatatypes::VscllInputKind	684
Table 765 – Literals of DynamicsDatatypes::VsInputKind	685
Table 766 – Literals of DynamicsDatatypes::VuellInputKind	685
Table 767 – Literals of DynamicsDatatypes::DroopSignalFeedbackKind	685
Table 768 – Literals of DynamicsDatatypes::ExcIEEEST1AUELselectorKind	686
Table 769 – Literals of DynamicsDatatypes::ExcREXSFeedbackSignalKind	686
Table 770 – Literals of DynamicsDatatypes::ExcST6BOELselectorKind	686
Table 771 – Literals of DynamicsDatatypes::ExcST7BOELselectorKind	687
Table 772 – Literals of DynamicsDatatypes::ExcST7BUELselectorKind	687
Table 773 – Literals of DynamicsDatatypes::FrancisGovernorControlKind	687
Table 774 – Literals of DynamicsDatatypes::GenericNonLinearLoadModelKind	688
Table 775 – Literals of DynamicsDatatypes::GovHydro4ModelKind	688
Table 776 – Literals of DynamicsDatatypes::lfdBaseKind	688

Table 777 – Literals of DynamicsDatatypes::InputSignalKind	689
Table 778 – Literals of DynamicsDatatypes::RemoteSignalKind	689
Table 779 – Literals of DynamicsDatatypes::RotorKind	690
Table 780 – Literals of DynamicsDatatypes::StaticLoadModelKind	690
Table 781 – Literals of DynamicsDatatypes::SynchronousMachineModelKind	691
Table 782 – Literals of DynamicsDatatypes::WindLookupTableFunctionKind	692
Table 783 – Literals of DynamicsDatatypes::WindPlantQcontrolModeKind	693
Table 784 – Literals of DynamicsDatatypes::WindQcontrolModeKind	693
Table 785 – Literals of DynamicsDatatypes::WindUVRTQcontrolModeKind	693
Table 786 – Literals of DynamicsDatatypes::WindPlantQcontrolModeKind2	694
Table 787 – Literals of DynamicsDatatypes::WindLookupTableFunctionKind2	694
Table 788 – Literals of DynamicsDatatypes::WindFRTQcontrolModeKind	695
Table 789 – Literals of DynamicsDatatypes::WindQcontrolModeKind2	696
Table 790 – Attributes of DetailedModelConfigurationProfile:: DetailedModelTypeDynamics	697
Table 791 – Attributes of DetailedModelConfigurationProfile::DetailedModelDescriptor	698
Table 792 – Association ends of DetailedModelConfigurationProfile:: DetailedModelDescriptor with other classes	698
Table 793 – Attributes of DetailedModelConfigurationProfile:: DetailedModelDescriptorArtifact	698
Table 794 – Association ends of DetailedModelConfigurationProfile:: DetailedModelDescriptorArtifact with other classes	699
Table 795 – Attributes of DetailedModelConfigurationProfile:: DetailedModelDocumentationArtifact	699
Table 796 – Association ends of DetailedModelConfigurationProfile:: DetailedModelDocumentationArtifact with other classes	699
Table 797 – Attributes of DetailedModelConfigurationProfile::DynamicsFunctionBlock	699
Table 798 – Attributes of DetailedModelConfigurationProfile::FunctionDescriptor	700
Table 799 – Association ends of DetailedModelConfigurationProfile:: FunctionDescriptor with other classes	700
Table 800 – Attributes of DetailedModelConfigurationProfile::IdentifiedObject	701
Table 801 – Attributes of DetailedModelConfigurationProfile::InputOutputDescriptor	701
Table 802 – Association ends of DetailedModelConfigurationProfile:: InputOutputDescriptor with other classes	701
Table 803 – Attributes of DetailedModelConfigurationProfile::LimiterDescriptor	702
Table 804 – Association ends of DetailedModelConfigurationProfile:: LimiterDescriptor with other classes	702
Table 805 – Attributes of DetailedModelConfigurationProfile::OperatorDescriptor	702
Table 806 – Association ends of DetailedModelConfigurationProfile:: OperatorDescriptor with other classes	702
Table 807 – Attributes of DetailedModelConfigurationProfile::ParameterDescriptor	703
Table 808 – Association ends of DetailedModelConfigurationProfile:: ParameterDescriptor with other classes	703
Table 809 – Attributes of DetailedModelConfigurationProfile::SignalDescriptor	704
Table 810 – Association ends of DetailedModelConfigurationProfile:: SignalDescriptor with other classes	704
Table 811 – Literals of DetailedModelConfigurationProfile::LogicalKind	704

Table 812 – Literals of DetailedModelConfigurationProfile::EquationLanguageKind	705
Table 813 – Literals of DetailedModelConfigurationProfile::OperatorDescriptorKind	705
Table 814 – Literals of DetailedModelConfigurationProfile::ConstraintKind	705
Table 815 – Literals of DetailedModelConfigurationProfile::ParameterKind	706
Table 816 – Literals of DetailedModelConfigurationProfile::XSDDatatypeKind	706
Table 817 – Attributes of DetailedModelParameterisationProfile:: DetailedModelTypeDynamics	708
Table 818 – Attributes of DetailedModelParameterisationProfile:: DetailedModelDescriptor	709
Table 819 – Attributes of DetailedModelParameterisationProfile::IdentifiedObject	709
Table 820 – Attributes of DetailedModelParameterisationProfile::ParameterValue	710
Table 821 – Association ends of DetailedModelParameterisationProfile:: ParameterValue with other classes	710
Table 822 – Attributes of DetailedModelParameterisationProfile::PowerSystemResource	710
Table 823 – Attributes of DetailedModelParameterisationProfile:: DynamicsFunctionBlock	711
Table 824 – Attributes of DetailedModelParameterisationProfile::Equipment	711
Table 825 – Attributes of DetailedModelParameterisationProfile::ParameterDescriptor	711
Table 826 – Association ends of DetailedModelParameterisationProfile:: SignalDescriptor with other classes	712
Table 827 – Attributes of DetailedModelParameterisationProfile:: DetailedModelDynamics	712
Table 828 – Association ends of DetailedModelParameterisationProfile:: DetailedModelDynamics with other classes	712
Table 829 – Attributes of SimulationSettingsProfile::Terminal	716
Table 830 – Attributes of SimulationSettingsProfile::EquipmentFault	716
Table 831 – Association ends of SimulationSettingsProfile:: EquipmentFault with other classes	717
Table 832 – Attributes of SimulationSettingsProfile::Fault	717
Table 833 – Association ends of SimulationSettingsProfile::Fault with other classes	717
Table 834 – Attributes of SimulationSettingsProfile::FaultCauseType	718
Table 835 – Attributes of SimulationSettingsProfile::LineFault	718
Table 836 – Association ends of SimulationSettingsProfile::LineFault with other classes	718
Table 837 – Attributes of SimulationSettingsProfile::ACDCTerminal	719
Table 838 – Attributes of SimulationSettingsProfile::ClearSimulationEvent	719
Table 839 – Association ends of SimulationSettingsProfile:: ClearSimulationEvent with other classes	719
Table 840 – Attributes of SimulationSettingsProfile::DetailedModelDescriptor	720
Table 841 – Attributes of SimulationSettingsProfile::DynamicsFunctionBlock	720
Table 842 – Attributes of SimulationSettingsProfile::IdentifiedObject	720
Table 843 – Attributes of SimulationSettingsProfile::ParameterEvent	721
Table 844 – Association ends of SimulationSettingsProfile:: ParameterEvent with other classes	721
Table 845 – Attributes of SimulationSettingsProfile::PowerFlowSettings	722
Table 846 – Attributes of SimulationSettingsProfile::SignalConfiguration	724

Table 847 – Attributes of SimulationSettingsProfile::SignalDescriptor	724
Table 848 – Attributes of SimulationSettingsProfile::SignalRecorder	725
Table 849 – Association ends of SimulationSettingsProfile:: SignalRecorder with other classes	725
Table 850 – Attributes of SimulationSettingsProfile::SimulationEvents	725
Table 851 – Attributes of SimulationSettingsProfile::SimulationSettings	726
Table 852 – Association ends of SimulationSettingsProfile:: SimulationSettings with other classes	726
Table 853 – Attributes of SimulationSettingsProfile::FaultImpedance	726
Table 854 – Literals of SimulationSettingsProfile::UnitSymbol.....	727
Table 855 – Literals of SimulationSettingsProfile::UnitMultiplier	732
Table 856 – Literals of SimulationSettingsProfile::PhaseCode	733
Table 857 – Literals of SimulationSettingsProfile::PhaseConnectedFaultKind	734
Table 858 – Literals of SimulationSettingsProfile::ParameterChangeKind	735
Table 859 – Literals of SimulationSettingsProfile::PowerFlowAlgorithmKind.....	735
Table 860 – Literals of SimulationSettingsProfile::PowerShiftKind.....	735
Table 861 – Literals of SimulationSettingsProfile::SlackDistributionKind	736
Table 862 – Literals of SimulationSettingsProfile::SignalKind.....	736
Table 863 – Attributes of SimulationSettingsProfile::Length	736
Table 864 – Attributes of SimulationSettingsProfile::PU	737
Table 865 – Attributes of SimulationSettingsProfile::Reactance	737
Table 866 – Attributes of SimulationSettingsProfile::AngleDegrees	737
Table 867 – Attributes of SimulationSettingsProfile::ActivePower.....	737
Table 868 – Attributes of SimulationSettingsProfile::ReactivePower.....	738
Table 869 – Attributes of SimulationSettingsProfile::Seconds	738
Table 870 – Attributes of SimulationSettingsProfile::Resistance.....	738
Table 871 – Attributes of SimulationResultsProfile::Curve.....	740
Table 872 – Attributes of SimulationResultsProfile::CurveData	741
Table 873 – Association ends of SimulationResultsProfile::CurveData with other classes	741
Table 874 – Attributes of SimulationResultsProfile::IdentifiedObject	741
Table 875 – Attributes of SimulationResultsProfile::SignalConfiguration	742
Table 876 – Attributes of SimulationResultsProfile::SignalRecorder.....	742
Table 877 – Attributes of SimulationResultsProfile::SimulationEvents	742
Table 878 – Attributes of SimulationResultsProfile::SimulationResult.....	743
Table 879 – Association ends of SimulationResultsProfile:: SimulationResult with other classes	743
Table 880 – Attributes of SimulationResultsProfile::SimulationResultCharacteristic	743
Table 881 – Association ends of SimulationResultsProfile:: SimulationResultCharacteristic with other classes.....	744
Table 882 – Attributes of SimulationResultsProfile::SimulationSettings	744
Table 883 – Literals of SimulationResultsProfile::CurveStyle	744
Table 884 – Literals of SimulationResultsProfile::UnitMultiplier	745
Table 885 – Literals of SimulationResultsProfile::UnitSymbol.....	746
Table A.1 – Models, their identification and specific details.....	753

INTERNATIONAL ELECTROTECHNICAL COMMISSION

**ENERGY MANAGEMENT SYSTEM APPLICATION
PROGRAM INTERFACE (EMS-API) –****Part 457: Dynamics profile****FOREWORD**

- 1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
- 2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
- 3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
- 4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
- 5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
- 6) All users should ensure that they have the latest edition of this publication.
- 7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
- 8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
- 9) IEC draws attention to the possibility that the implementation of this document may involve the use of (a) patent(s). IEC takes no position concerning the evidence, validity or applicability of any claimed patent rights in respect thereof. As of the date of publication of this document, IEC had not received notice of (a) patent(s), which may be required to implement this document. However, implementers are cautioned that this may not represent the latest information, which may be obtained from the patent database available at <https://patents.iec.ch>. IEC shall not be held responsible for identifying any or all such patent rights.

IEC 61970-457 has been prepared by IEC technical committee 57: Power systems management and associated information exchange. It is an International Standard.

This second edition cancels and replaces the first edition published in 2021. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

- a) The majority of issues detected in IEC 61970-302:2018 and fixed in IEC 61970-302:2022 led to update of this document;

- b) IEEE 421.5-2016 on Excitation systems is fully covered;
- c) IEEE turbine report from 2013 was considered and as a result a number of gas, steam and hydro turbines/governors are added;
- d) IEC 61400-27-1:2020 on wind turbines is fully incorporated;
- e) WECC Inverter-Based Resource (IBR) models, Hybrid STATCOM models and storage models are added;
- f) The user defined models approach was enhanced in IEC 61970-302:2022 adding a model which enables modelling of a detailed dynamic model. This results in the creation of two additional profiles in this document. These are the Detailed Model Configuration profile and Detailed Model Parameterisation profile;
- g) A model to enable exchange of simulation results was added in IEC 61970-302:2022. This results in the creation of two additional profiles in this document. These are the Simulation Settings profile and Simulation Results profile;
- h) The work on the HVDC models is not complete. The HVDC dynamics models are a complex domain in which there are no models that are approved or widely recognised on international level, i.e. there are only project-based models. At this stage IEC 61970-302:2022 only specifies some general classes. However, it is recognised that better coverage of HVDC will require a further edition of this document as well as next edition of IEC 61970-302;
- i) Models from IEEE 1547-2018 “IEEE Standard for Interconnection and Interoperability of Distributed Energy Resources with Associated Electric Power Systems Interfaces” are added.
- j) The IEC and technical experts are in the process of clarifying the ownership of intellectual property in the standards. Older documents (that may be referred to) will not have these clarifications. Statements have been added to certain figures, tables, schemas, and enumerations throughout the document that indicate that they are reproduced with the permission of the UCA International User Group (UCAIug). These items are derived from the Common Information Model (CIM).

The text of this International Standard is based on the following documents:

Draft	Report on voting
57/2621/FDIS	57/2634/RVD

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

The language used for the development of this International Standard is English.

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

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/standardsdev/publications.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under webstore.iec.ch in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn, or
- revised.

IMPORTANT – The "colour inside" logo on the cover page of this document indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

INTRODUCTION

The IEC 61970-300 series of documents specify the common information model (CIM). The CIM is an abstract model that represents the objects in an electric utility enterprise typically needed to model the operational aspects of a utility.

This document is one of the IEC 61970-400 series of profile standards that specify the semantic structure of data exchanged between components (or applications) and/or made publicly available data by a component. This document describes the payload that would be carried if applications are communicating via a messaging system, but the document does not include the method of exchange, and therefore is applicable to a variety of exchange implementations. All examples provided in this document are serialised according to in the IEC 61970-552:2016.

This document specifies the profile (or subset) of the CIM required to describe the exchanged dynamic model information needed to support the analysis of the steady state stability (small-signal stability) and/or transient stability of a power system or parts of it. The information is described with reference to a power system model that conforms to IEC 61970-452 and IEC 61970-456 in this series of related standards. Thus, equipment and other related power flow model data is not repeated in the information exchanged with this document. The schema(s) for expressing the dynamic model information are derived directly from the CIM, more specifically from IEC 61970-302.

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

Part 457: Dynamics profile

1 Scope

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

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

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

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

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

2 Normative references

The following 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 61970-301:2020, *Energy management system application program interface (EMS-API) - Part 301: Common information model (CIM) base*
IEC 61970-301:2020/AMD1:2022

IEC 61970-302¹, *Energy management system application program interface (EMS-API) - Part 302: Common information model (CIM) dynamics*

IEC 61970-452:2021, *Energy management system application program interface (EMS-API) - Part 452: CIM static transmission network model profiles*

IEC 61970-456:2021, *Energy management system application program interface (EMS-API) - Part 456: Solved power system state profiles*

CIM UML Model for 61970-302 & 61970-457, available at <https://cimug.ucaiug.org>

koniec náhľadu – text ďalej pokračuje v platenej verzii STN