

INTERNATIONAL STANDARD

NORME INTERNATIONALE



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

**Interface de programmation d'application pour système de gestion d'énergie
(EMS-API) –
Partie 302: Régimes dynamiques de modèle d'information commun (CIM)**



THIS PUBLICATION IS COPYRIGHT PROTECTED

Copyright © 2018 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 Central Office
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 corrigenda or an amendment might have been published.

IEC Catalogue - webstore.iec.ch/catalogue

The stand-alone application for consulting the entire bibliographical information on IEC International Standards, Technical Specifications, Technical Reports and other documents. Available for PC, Mac OS, Android Tablets and iPad.

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 also once a month by email.

Electropedia - www.electropedia.org

The world's leading online dictionary of electronic and electrical terms containing 21 000 terms and definitions in English and French, with equivalent terms in 16 additional languages. Also known as the International Electrotechnical Vocabulary (IEV) online.

IEC Glossary - std.iec.ch/glossary

67 000 electrotechnical terminology entries in English and French extracted from the Terms and Definitions clause of IEC publications issued since 2002. Some entries have been collected from earlier publications of IEC TC 37, 77, 86 and CISPR.

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.

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.

Catalogue IEC - webstore.iec.ch/catalogue

Application autonome pour consulter tous les renseignements bibliographiques sur les Normes internationales, Spécifications techniques, Rapports techniques et autres documents de l'IEC. Disponible pour PC, Mac OS, tablettes Android et iPad.

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 aussi une fois par mois par email.

Electropedia - www.electropedia.org

Le premier dictionnaire en ligne de termes électroniques et électriques. Il contient 21 000 termes et définitions en anglais et en français, ainsi que les termes équivalents dans 16 langues additionnelles. Egalement appelé Vocabulaire Electrotechnique International (IEV) en ligne.

Glossaire IEC - std.iec.ch/glossary

67 000 entrées terminologiques électrotechniques, en anglais et en français, extraites des articles Termes et Définitions des publications IEC parues depuis 2002. Plus certaines entrées antérieures extraites des publications des CE 37, 77, 86 et CISPR de l'IEC.

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.

INTERNATIONAL STANDARD

NORME INTERNATIONALE



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

**Interface de programmation d'application pour système de gestion d'énergie
(EMS-API) –
Partie 302: Régimes dynamiques de modèle d'information commun (CIM)**

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

COMMISSION
ELECTROTECHNIQUE
INTERNATIONALE

ICS 33.200

ISBN 978-2-8322-5527-8

**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.....	23
INTRODUCTION.....	25
1 Scope.....	26
2 Normative references	26
3 Terms and definitions	27
4 Document organization.....	29
5 Package dynamics.....	30
5.1 General.....	30
5.2 Package StandardInterconnections	30
5.2.1 General	30
5.2.2 RemoteInputSignal	46
5.2.3 RemoteSignalKind enumeration.....	47
5.3 Package StandardModels	47
5.3.1 General	47
5.3.2 DynamicsFunctionBlock.....	48
5.3.3 RotatingMachineDynamics.....	48
5.3.4 Package SynchronousMachineDynamics	49
5.3.5 Package AsynchronousMachineDynamics	80
5.3.6 Package TurbineGovernorDynamics	88
5.3.7 Package TurbineLoadControllerDynamics.....	183
5.3.8 Package MechanicalLoadDynamics	187
5.3.9 Package ExcitationSystemDynamics.....	190
5.3.10 Package OverexcitationLimiterDynamics	311
5.3.11 Package UnderexcitationLimiterDynamics	319
5.3.12 Package PowerSystemStabilizerDynamics.....	328
5.3.13 Package DiscontinuousExcitationControlDynamics	362
5.3.14 Package PFVArControllerType1Dynamics	368
5.3.15 Package VoltageAdjusterDynamics.....	372
5.3.16 Package PFVArControllerType2Dynamics	374
5.3.17 Package VoltageCompensatorDynamics.....	379
5.3.18 Package WindDynamics	384
5.3.19 Package LoadDynamics.....	424
5.3.20 Package HVDCDynamics.....	435
5.3.21 Package StaticVarCompensatorDynamics	438
5.4 Package UserDefinedModels	440
5.4.1 General	440
5.4.2 SynchronousMachineUserDefined	441
5.4.3 AsynchronousMachineUserDefined.....	442
5.4.4 TurbineGovernorUserDefined	443
5.4.5 TurbineLoadControllerUserDefined	444
5.4.6 MechanicalLoadUserDefined	445
5.4.7 ExcitationSystemUserDefined.....	446
5.4.8 OverexcitationLimiterUserDefined.....	447
5.4.9 UnderexcitationLimiterUserDefined.....	448
5.4.10 PowerSystemStabilizerUserDefined	449
5.4.11 DiscontinuousExcitationControlUserDefined	449

5.4.12	PFVArControllerType1UserDefined	450
5.4.13	VoltageAdjusterUserDefined	451
5.4.14	PFVArControllerType2UserDefined	452
5.4.15	VoltageCompensatorUserDefined	453
5.4.16	LoadUserDefined	454
5.4.17	WindType1or2UserDefined	454
5.4.18	WindType3or4UserDefined	455
5.4.19	WindPlantUserDefined	456
5.4.20	CSCUserDefined	457
5.4.21	VSCUserDefined	457
5.4.22	SVCUserDefined	458
5.4.23	ProprietaryParameterDynamics root class	459
5.5	Package Examples	460
Annex A (informative)	Dynamics package symbol representation conventions	464
Annex B (informative)	Use of per unit	466
Annex C (informative)	Updates to CIM dynamics standard models	468
Bibliography		473
Figure 1	– StandardInterconnectionSynchronousMachine	31
Figure 2	– StandardInterconnectionSynchronousGeneratorCrossCompound	32
Figure 3	– StandardInterconnectionAsynchronousMachine	33
Figure 4	– StandardInterconnectionWindTurbineType1Aand1B	34
Figure 5	– StandardInterconnectionWindTurbineType2	35
Figure 6	– StandardInterconnectionWindTurbineType3	36
Figure 7	– StandardInterconnectionWindTurbineType4Aand4B	37
Figure 8	– StandardInterconnectionSingleLoad	38
Figure 9	– Class diagram StandardInterconnections::StandardSynchronousMachineInterconnection	39
Figure 10	– Class diagram StandardInterconnections::StandardAsynchronousMachineInterconnection	40
Figure 11	– Class diagram StandardInterconnections::StandardWindType1and2Interconnection	41
Figure 12	– Class diagram StandardInterconnections::StandardWindType3and4Interconnection	43
Figure 13	– Class diagram StandardInterconnections::StandardLoadInterconnection	44
Figure 14	– Class diagram StandardInterconnections::StandardHVDCInterconnection	45
Figure 15	– Class diagram StandardInterconnections::StandardStaticVarCompensatorInterconnection	46
Figure 16	– SynchronousGeneratorInterconnectionAndVariables	50
Figure 17	– SynchronousMotorInterconnectionAndVariables	51
Figure 18	– Class diagram SynchronousMachineDynamics::SynchronousMachineDynamics	52
Figure 19	– SynchronousMachineSaturationParameters	53
Figure 20	– SynchronousGeneratorMechanicalEquation	54
Figure 21	– SynchronousMotorMechanicalEquation	54
Figure 22	– SynchronousGeneratorPhasor	55

Figure 23 – SynchronousMotorPhasor	56
Figure 24 – Simplified	58
Figure 25 – SubtransientRoundRotor	62
Figure 26 – SubtransientSalientPole	63
Figure 27 – SubtransientTypeF	64
Figure 28 – SubtransientTypeJ	65
Figure 29 – SubtransientRoundRotorSimplified	66
Figure 30 – SubtransientSalientPoleSimplified	68
Figure 31 – SubtransientRoundRotorSimplifiedDirectAxis	70
Figure 32 – SubtransientSalientPoleSimplifiedDirectAxis	72
Figure 33 – SynchronousEquivalentCircuit	77
Figure 34 – AsynchronousGeneratorInterconnectionAndVariables	81
Figure 35 – AsynchronousMotorInterconnectionAndVariables	81
Figure 36 – Class diagram AsynchronousMachineDynamics::AsynchronousMachineDynamics	82
Figure 37 – AsynchronousGeneratorMechanicalEquation	83
Figure 38 – AsynchronousMotorMechanicalEquation	83
Figure 39 – AsynchronousEquivalentCircuit	87
Figure 40 – TurbineGovernorInterconnectionAndVariables	89
Figure 41 – Class diagram TurbineGovernorDynamics::TurbineGovernorDynamics	90
Figure 42 – GovHydroIEEE0	92
Figure 43 – GovHydroIEEE2	94
Figure 44 – GovSteamIEEE1	96
Figure 45 – GovCT1	99
Figure 46 – GovCT2	103
Figure 47 – GovGAST	107
Figure 48 – GovGAST1	109
Figure 49 – GovGAST2	111
Figure 50 – GovGAST3	114
Figure 51 – GovGAST3ExhaustTemperature	114
Figure 52 – GovGAST4	116
Figure 53 – GovGASTWD	118
Figure 54 – GovHydro1	120
Figure 55 – GovHydro2	122
Figure 56 – GovHydro3	125
Figure 57 – GovHydro4	128
Figure 58 – GovHydro4SimpleHydroTurbine	129
Figure 59 – GovHydro4FrancisPeltonTurbine	130
Figure 60 – GovHydro4KaplanTurbine	131
Figure 61 – GovHydroDD	134
Figure 62 – GovHydroFrancis	137
Figure 63 – GovHydroFrancisNonLinearGainAndEfficiency	138
Figure 64 – DetailedHydroModelHydraulicSystem	139

Figure 65 – GovHydroPelton	142
Figure 66 – GovHydroPeltonNonLinearGainAndEfficiency.....	143
Figure 67 – GovHydroPID	146
Figure 68 – GovHydroPID2	149
Figure 69 – GovHydroR	152
Figure 70 – GovHydroWEH.....	155
Figure 71 – GovHydroWPID.....	159
Figure 72 – GovSteam0	161
Figure 73 – GovSteam1	162
Figure 74 – GovSteam1BacklashHysteresis.....	163
Figure 75 – GovSteam1InputSpeedDeadband.....	164
Figure 76 – GovSteam2.....	166
Figure 77 – GovSteamBB	168
Figure 78 – GovSteamCC	169
Figure 79 – GovSteamEU	171
Figure 80 – GovSteamFV2.....	173
Figure 81 – GovSteamFV3.....	175
Figure 82 – GovSteamFV4.....	178
Figure 83 – GovSteamSGO.....	181
Figure 84 – Class diagram TurbineLoadControllerDynamics::TurbineLoadControllerDynamics	183
Figure 85 – TurbLCFB1	185
Figure 86 – MechanicalLoadInterconnectionAndVariables.....	187
Figure 87 – MechanicalLoadEquations.....	187
Figure 88 – Class diagram MechanicalLoadDynamics::MechanicalLoadDynamics	188
Figure 89 – ExcitationSystemInterconnectionAndVariables	190
Figure 90 – Class diagram ExcitationSystemDynamics::ExcitationSystemDynamics	191
Figure 91 – ExcAC1A.....	229
Figure 92 – ExcAC2A.....	231
Figure 93 – ExcAC3A.....	234
Figure 94 – ExcAC4A.....	236
Figure 95 – ExcAC5A.....	238
Figure 96 – ExcAC6A.....	240
Figure 97 – ExcAC8B.....	242
Figure 98 – ExcANS	245
Figure 99 – ExcAVR1.....	247
Figure 100 – ExcAVR2.....	249
Figure 101 – ExcAVR3.....	250
Figure 102 – ExcAVR4.....	252
Figure 103 – ExcAVR5.....	254
Figure 104 – ExcAVR7.....	256
Figure 105 – ExcBBC.....	259
Figure 106 – ExcCZ	261

Figure 107 – ExcDC1A	263
Figure 108 – ExcDC2A	265
Figure 109 – ExcDC3A	267
Figure 110 – ExcDC3A1	269
Figure 111 – ExcELIN1	271
Figure 112 – ExcELIN2	273
Figure 113 – ExcHU	275
Figure 114 – ExcNI	277
Figure 115 – ExcOEX3T	280
Figure 116 – ExcPIC	282
Figure 117 – ExcREXS	285
Figure 118 – ExcRQB	289
Figure 119 – ExcSCRX	290
Figure 120 – ExcSEXS	292
Figure 121 – ExcSK	294
Figure 122 – ExcST1A	297
Figure 123 – ExcST2A	299
Figure 124 – ExcST3A	301
Figure 125 – ExcST4B	303
Figure 126 – ExcST6B	305
Figure 127 – ExcST7B	308
Figure 128 – Class diagram OverexcitationLimiterDynamics::OverexcitationLimiterDynamics	312
Figure 129 – OverexcLim2	314
Figure 130 – OverexcLimX1	315
Figure 131 – OverexcLimX1TimeCharacteristic	316
Figure 132 – OverexcLimX2	318
Figure 133 – OverexcLimX2TimeCharacteristic	318
Figure 134 – Class diagram UnderexcitationLimiterDynamics::UnderexcitationLimiterDynamics	320
Figure 135 – UnderexcLim2Simplified	324
Figure 136 – UnderexcLimX1	326
Figure 137 – UnderexcLimX2	327
Figure 138 – PowerSystemStabilizerInterconnectionAndVariables	329
Figure 139 – Class diagram PowerSystemStabilizerDynamics::PowerSystemStabilizerDynamics	330
Figure 140 – Pss1	338
Figure 141 – Pss1A	340
Figure 142 – Pss2B	342
Figure 143 – Pss2ST	344
Figure 144 – Pss5	346
Figure 145 – PssELIN2	348
Figure 146 – PssPTIST1	349
Figure 147 – PssPTIST3	351

Figure 148 – PssRQB	353
Figure 149 – PssSB4	354
Figure 150 – PssSH	356
Figure 151 – PssSK	357
Figure 152 – PssSTAB2A	359
Figure 153 – PssWECC	360
Figure 154 – DiscontinuousExcitationControlInterconnectionAndVariables	363
Figure 155 – Class diagram DiscontinuousExcitationControlDynamics::DiscontinuousExcitationControlDynamics	364
Figure 156 – Class diagram PFVArControllerType1Dynamics::PFVArControllerType1Dynamics	369
Figure 157 – Class diagram VoltageAdjusterDynamics::VoltageAdjusterDynamics	372
Figure 158 – Class diagram PFVArControllerType2Dynamics::PFVArControllerType2Dynamics	375
Figure 159 – PFVArType2Common1	378
Figure 160 – VoltageCompensatorInterconnectionAndVariables	380
Figure 161 – Class diagram VoltageCompensatorDynamics::VoltageCompensatorDynamics	381
Figure 162 – Class diagram WindDynamics::WindDynamicsType1or2	385
Figure 163 – Class diagram WindDynamics::WindDynamicsType3	386
Figure 164 – Class diagram WindDynamics::WindDynamicsType4	387
Figure 165 – Class diagram WindDynamics::WindDynamicsPlant	388
Figure 166 – LoadInterconnectionAndVariables	424
Figure 167 – Class diagram LoadDynamics::LoadDynamics	425
Figure 168 – LoadCompositeEquations	426
Figure 169 – LoadGenericNonLinearTypeEquations	427
Figure 170 – LoadStaticTypeEquations	430
Figure 171 – LoadMotor	433
Figure 172 – Class diagram HVDCDynamics::HVDCDynamics	436
Figure 173 – Class diagram StaticVarCompensatorDynamics::StaticVarCompensatorDynamics	439
Figure 174 – Class diagram UserDefinedModels::ProprietaryUserDefinedModels	441
Figure 175 – Object diagram Examples::ExampleStandardModel	461
Figure 176 – Object diagram Examples::ExampleFunctionBlockProprietaryModel	462
Figure 177 – Object diagram Examples::ExampleCompleteProprietaryModel	463
Table 1 – Attributes of StandardInterconnections::RemoteInputSignal	46
Table 2 – Association ends of StandardInterconnections::RemoteInputSignal with other classes	47
Table 3 – Literals of StandardInterconnections::RemoteSignalKind	47
Table 4 – Attributes of StandardModels::DynamicsFunctionBlock	48
Table 5 – Association ends of StandardModels::DynamicsFunctionBlock with other classes	48
Table 6 – Attributes of StandardModels::RotatingMachineDynamics	49
Table 7 – Association ends of StandardModels::RotatingMachineDynamics with other classes	49

Table 8 – Attributes of SynchronousMachineDynamics::SynchronousMachineDynamics	57
Table 9 – Association ends of SynchronousMachineDynamics::SynchronousMachineDynamics with other classes.....	57
Table 10 – Attributes of SynchronousMachineDynamics::SynchronousMachineSimplified	59
Table 11 – Association ends of SynchronousMachineDynamics::SynchronousMachineSimplified with other classes	59
Table 12 – Attributes of SynchronousMachineDynamics::SynchronousMachineDetailed	60
Table 13 – Association ends of SynchronousMachineDynamics::SynchronousMachineDetailed with other classes	61
Table 14 – Attributes of SynchronousMachineDynamics::SynchronousMachineTimeConstantReactance	74
Table 15 – Association ends of SynchronousMachineDynamics::SynchronousMachineTimeConstantReactance with other classes	75
Table 16 – Attributes of SynchronousMachineDynamics::SynchronousMachineEquivalentCircuit	78
Table 17 – Association ends of SynchronousMachineDynamics::SynchronousMachineEquivalentCircuit with other classes	79
Table 18 – Literals of SynchronousMachineDynamics::IfdBaseKind	79
Table 19 – Literals of SynchronousMachineDynamics::SynchronousMachineModelKind	80
Table 20 – Literals of SynchronousMachineDynamics::RotorKind	80
Table 21 – Attributes of AsynchronousMachineDynamics::AsynchronousMachineDynamics	84
Table 22 – Association ends of AsynchronousMachineDynamics::AsynchronousMachineDynamics with other classes	85
Table 23 – Attributes of AsynchronousMachineDynamics::AsynchronousMachineTimeConstantReactance	86
Table 24 – Association ends of AsynchronousMachineDynamics::AsynchronousMachineTimeConstantReactance with other classes	86
Table 25 – Attributes of AsynchronousMachineDynamics::AsynchronousMachineEquivalentCircuit.....	88
Table 26 – Association ends of AsynchronousMachineDynamics::AsynchronousMachineEquivalentCircuit with other classes	88
Table 27 – Attributes of TurbineGovernorDynamics::CrossCompoundTurbineGovernorDynamics.....	91
Table 28 – Association ends of TurbineGovernorDynamics::CrossCompoundTurbineGovernorDynamics with other classes	91
Table 29 – Attributes of TurbineGovernorDynamics::TurbineGovernorDynamics	91
Table 30 – Association ends of TurbineGovernorDynamics::TurbineGovernorDynamics with other classes	92
Table 31 – Attributes of TurbineGovernorDynamics::GovHydroIEEE0	93
Table 32 – Association ends of TurbineGovernorDynamics::GovHydroIEEE0 with other classes	93
Table 33 – Attributes of TurbineGovernorDynamics::GovHydroIEEE2	95

Table 34 – Association ends of TurbineGovernorDynamics::GovHydroIEEE2 with other classes	96
Table 35 – Attributes of TurbineGovernorDynamics::GovSteamIEEE1	97
Table 36 – Association ends of TurbineGovernorDynamics::GovSteamIEEE1 with other classes	98
Table 37 – Attributes of TurbineGovernorDynamics::GovCT1	101
Table 38 – Association ends of TurbineGovernorDynamics::GovCT1 with other classes	103
Table 39 – Attributes of TurbineGovernorDynamics::GovCT2	104
Table 40 – Association ends of TurbineGovernorDynamics::GovCT2 with other classes	107
Table 41 – Attributes of TurbineGovernorDynamics::GovGAST	108
Table 42 – Association ends of TurbineGovernorDynamics::GovGAST with other classes	108
Table 43 – Attributes of TurbineGovernorDynamics::GovGAST1	110
Table 44 – Association ends of TurbineGovernorDynamics::GovGAST1 with other classes	111
Table 45 – Attributes of TurbineGovernorDynamics::GovGAST2	112
Table 46 – Association ends of TurbineGovernorDynamics::GovGAST2 with other classes	113
Table 47 – Attributes of TurbineGovernorDynamics::GovGAST3	115
Table 48 – Association ends of TurbineGovernorDynamics::GovGAST3 with other classes	115
Table 49 – Attributes of TurbineGovernorDynamics::GovGAST4	117
Table 50 – Association ends of TurbineGovernorDynamics::GovGAST4 with other classes	117
Table 51 – Attributes of TurbineGovernorDynamics::GovGASTWD	119
Table 52 – Association ends of TurbineGovernorDynamics::GovGASTWD with other classes	120
Table 53 – Attributes of TurbineGovernorDynamics::GovHydro1	121
Table 54 – Association ends of TurbineGovernorDynamics::GovHydro1 with other classes	121
Table 55 – Attributes of TurbineGovernorDynamics::GovHydro2	123
Table 56 – Association ends of TurbineGovernorDynamics::GovHydro2 with other classes	124
Table 57 – Attributes of TurbineGovernorDynamics::GovHydro3	126
Table 58 – Association ends of TurbineGovernorDynamics::GovHydro3 with other classes	127
Table 59 – Attributes of TurbineGovernorDynamics::GovHydro4	132
Table 60 – Association ends of TurbineGovernorDynamics::GovHydro4 with other classes	133
Table 61 – Attributes of TurbineGovernorDynamics::GovHydroDD	135
Table 62 – Association ends of TurbineGovernorDynamics::GovHydroDD with other classes	136
Table 63 – Attributes of TurbineGovernorDynamics::GovHydroFrancis	140
Table 64 – Association ends of TurbineGovernorDynamics::GovHydroFrancis with other classes	141
Table 65 – Attributes of TurbineGovernorDynamics::GovHydroPelton	144
Table 66 – Association ends of TurbineGovernorDynamics::GovHydroPelton with other classes	145

Table 67 – Attributes of TurbineGovernorDynamics::GovHydroPID	147
Table 68 – Association ends of TurbineGovernorDynamics::GovHydroPID with other classes	148
Table 69 – Attributes of TurbineGovernorDynamics::GovHydroPID2	150
Table 70 – Association ends of TurbineGovernorDynamics::GovHydroPID2 with other classes	151
Table 71 – Attributes of TurbineGovernorDynamics::GovHydroR	153
Table 72 – Association ends of TurbineGovernorDynamics::GovHydroR with other classes	154
Table 73 – Attributes of TurbineGovernorDynamics::GovHydroWEH	156
Table 74 – Association ends of TurbineGovernorDynamics::GovHydroWEH with other classes	158
Table 75 – Attributes of TurbineGovernorDynamics::GovHydroWPID	160
Table 76 – Association ends of TurbineGovernorDynamics::GovHydroWPID with other classes	160
Table 77 – Attributes of TurbineGovernorDynamics::GovSteam0	161
Table 78 – Association ends of TurbineGovernorDynamics::GovSteam0 with other classes	162
Table 79 – Attributes of TurbineGovernorDynamics::GovSteam1	165
Table 80 – Association ends of TurbineGovernorDynamics::GovSteam1 with other classes	166
Table 81 – Attributes of TurbineGovernorDynamics::GovSteam2	167
Table 82 – Association ends of TurbineGovernorDynamics::GovSteam2 with other classes	167
Table 83 – Attributes of TurbineGovernorDynamics::GovSteamBB	168
Table 84 – Association ends of TurbineGovernorDynamics::GovSteamBB with other classes	169
Table 85 – Attributes of TurbineGovernorDynamics::GovSteamCC	170
Table 86 – Association ends of TurbineGovernorDynamics::GovSteamCC with other classes	171
Table 87 – Attributes of TurbineGovernorDynamics::GovSteamEU	172
Table 88 – Association ends of TurbineGovernorDynamics::GovSteamEU with other classes	173
Table 89 – Attributes of TurbineGovernorDynamics::GovSteamFV2	174
Table 90 – Association ends of TurbineGovernorDynamics::GovSteamFV2 with other classes	174
Table 91 – Attributes of TurbineGovernorDynamics::GovSteamFV3	176
Table 92 – Association ends of TurbineGovernorDynamics::GovSteamFV3 with other classes	177
Table 93 – Attributes of TurbineGovernorDynamics::GovSteamFV4	179
Table 94 – Association ends of TurbineGovernorDynamics::GovSteamFV4 with other classes	180
Table 95 – Attributes of TurbineGovernorDynamics::GovSteamSGO	181
Table 96 – Association ends of TurbineGovernorDynamics::GovSteamSGO with other classes	182
Table 97 – Literals of TurbineGovernorDynamics::DroopSignalFeedbackKind	182
Table 98 – Literals of TurbineGovernorDynamics::FrancisGovernorControlKind	182
Table 99 – Literals of TurbineGovernorDynamics::GovHydro4ModelKind	183

Table 100 – Attributes of TurbineLoadControllerDynamics::TurbineLoadControllerDynamics	184
Table 101 – Association ends of TurbineLoadControllerDynamics::TurbineLoadControllerDynamics with other classes	184
Table 102 – Attributes of TurbineLoadControllerDynamics::TurbLCFB1	186
Table 103 – Association ends of TurbineLoadControllerDynamics::TurbLCFB1 with other classes	186
Table 104 – Attributes of MechanicalLoadDynamics::MechanicalLoadDynamics	188
Table 105 – Association ends of MechanicalLoadDynamics::MechanicalLoadDynamics with other classes	189
Table 106 – Attributes of MechanicalLoadDynamics::MechLoad1	189
Table 107 – Association ends of MechanicalLoadDynamics::MechLoad1 with other classes	189
Table 108 – Attributes of ExcitationSystemDynamics::ExcitationSystemDynamics	192
Table 109 – Association ends of ExcitationSystemDynamics::ExcitationSystemDynamics with other classes	192
Table 110 – Attributes of ExcitationSystemDynamics::ExcIEEEAC1A	193
Table 111 – Association ends of ExcitationSystemDynamics::ExcIEEEAC1A with other classes	194
Table 112 – Attributes of ExcitationSystemDynamics::ExcIEEEAC2A	195
Table 113 – Association ends of ExcitationSystemDynamics::ExcIEEEAC2A with other classes	196
Table 114 – Attributes of ExcitationSystemDynamics::ExcIEEEAC3A	197
Table 115 – Association ends of ExcitationSystemDynamics::ExcIEEEAC3A with other classes	198
Table 116 – Attributes of ExcitationSystemDynamics::ExcIEEEAC4A	199
Table 117 – Association ends of ExcitationSystemDynamics::ExcIEEEAC4A with other classes	199
Table 118 – Attributes of ExcitationSystemDynamics::ExcIEEEAC5A	200
Table 119 – Association ends of ExcitationSystemDynamics::ExcIEEEAC5A with other classes	201
Table 120 – Attributes of ExcitationSystemDynamics::ExcIEEEAC6A	202
Table 121 – Association ends of ExcitationSystemDynamics::ExcIEEEAC6A with other classes	203
Table 122 – Attributes of ExcitationSystemDynamics::ExcIEEEAC7B	204
Table 123 – Association ends of ExcitationSystemDynamics::ExcIEEEAC7B with other classes	205
Table 124 – Attributes of ExcitationSystemDynamics::ExcIEEEAC8B	206
Table 125 – Association ends of ExcitationSystemDynamics::ExcIEEEAC8B with other classes	207
Table 126 – Attributes of ExcitationSystemDynamics::ExcIEEEDC1A	208
Table 127 – Association ends of ExcitationSystemDynamics::ExcIEEEDC1A with other classes	209
Table 128 – Attributes of ExcitationSystemDynamics::ExcIEEEDC2A	210
Table 129 – Association ends of ExcitationSystemDynamics::ExcIEEEDC2A with other classes	211
Table 130 – Attributes of ExcitationSystemDynamics::ExcIEEEDC3A	212

Table 131 – Association ends of ExcitationSystemDynamics::ExcIEEEDC3A with other classes	213
Table 132 – Attributes of ExcitationSystemDynamics::ExcIEEEDC4B	214
Table 133 – Association ends of ExcitationSystemDynamics::ExcIEEEDC4B with other classes	215
Table 134 – Attributes of ExcitationSystemDynamics::ExcIEEEST1A	216
Table 135 – Association ends of ExcitationSystemDynamics::ExcIEEEST1A with other classes	217
Table 136 – Attributes of ExcitationSystemDynamics::ExcIEEEST2A	218
Table 137 – Association ends of ExcitationSystemDynamics::ExcIEEEST2A with other classes	219
Table 138 – Attributes of ExcitationSystemDynamics::ExcIEEEST3A	220
Table 139 – Association ends of ExcitationSystemDynamics::ExcIEEEST3A with other classes	221
Table 140 – Attributes of ExcitationSystemDynamics::ExcIEEEST4B	222
Table 141 – Association ends of ExcitationSystemDynamics::ExcIEEEST4B with other classes	223
Table 142 – Attributes of ExcitationSystemDynamics::ExcIEEEST5B	224
Table 143 – Association ends of ExcitationSystemDynamics::ExcIEEEST5B with other classes	225
Table 144 – Attributes of ExcitationSystemDynamics::ExcIEEEST6B	226
Table 145 – Association ends of ExcitationSystemDynamics::ExcIEEEST6B with other classes	227
Table 146 – Attributes of ExcitationSystemDynamics::ExcIEEEST7B	228
Table 147 – Association ends of ExcitationSystemDynamics::ExcIEEEST7B with other classes	229
Table 148 – Attributes of ExcitationSystemDynamics::ExcAC1A	230
Table 149 – Association ends of ExcitationSystemDynamics::ExcAC1A with other classes	231
Table 150 – Attributes of ExcitationSystemDynamics::ExcAC2A	232
Table 151 – Association ends of ExcitationSystemDynamics::ExcAC2A with other classes	233
Table 152 – Attributes of ExcitationSystemDynamics::ExcAC3A	235
Table 153 – Association ends of ExcitationSystemDynamics::ExcAC3A with other classes	236
Table 154 – Attributes of ExcitationSystemDynamics::ExcAC4A	237
Table 155 – Association ends of ExcitationSystemDynamics::ExcAC4A with other classes	237
Table 156 – Attributes of ExcitationSystemDynamics::ExcAC5A	239
Table 157 – Association ends of ExcitationSystemDynamics::ExcAC5A with other classes	240
Table 158 – Attributes of ExcitationSystemDynamics::ExcAC6A	241
Table 159 – Association ends of ExcitationSystemDynamics::ExcAC6A with other classes	242
Table 160 – Attributes of ExcitationSystemDynamics::ExcAC8B	243
Table 161 – Association ends of ExcitationSystemDynamics::ExcAC8B with other classes	244
Table 162 – Attributes of ExcitationSystemDynamics::ExcANS	246

Table 163 – Association ends of ExcitationSystemDynamics::ExcANS with other classes	247
Table 164 – Attributes of ExcitationSystemDynamics::ExcAVR1	248
Table 165 – Association ends of ExcitationSystemDynamics::ExcAVR1 with other classes	248
Table 166 – Attributes of ExcitationSystemDynamics::ExcAVR2	249
Table 167 – Association ends of ExcitationSystemDynamics::ExcAVR2 with other classes	250
Table 168 – Attributes of ExcitationSystemDynamics::ExcAVR3	251
Table 169 – Association ends of ExcitationSystemDynamics::ExcAVR3 with other classes	251
Table 170 – Attributes of ExcitationSystemDynamics::ExcAVR4	253
Table 171 – Association ends of ExcitationSystemDynamics::ExcAVR4 with other classes	254
Table 172 – Attributes of ExcitationSystemDynamics::ExcAVR5	255
Table 173 – Association ends of ExcitationSystemDynamics::ExcAVR5 with other classes	255
Table 174 – Attributes of ExcitationSystemDynamics::ExcAVR7	257
Table 175 – Association ends of ExcitationSystemDynamics::ExcAVR7 with other classes	258
Table 176 – Attributes of ExcitationSystemDynamics::ExcBBC	260
Table 177 – Association ends of ExcitationSystemDynamics::ExcBBC with other classes	261
Table 178 – Attributes of ExcitationSystemDynamics::ExcCZ	262
Table 179 – Association ends of ExcitationSystemDynamics::ExcCZ with other classes	262
Table 180 – Attributes of ExcitationSystemDynamics::ExcDC1A	264
Table 181 – Association ends of ExcitationSystemDynamics::ExcDC1A with other classes	265
Table 182 – Attributes of ExcitationSystemDynamics::ExcDC2A	266
Table 183 – Association ends of ExcitationSystemDynamics::ExcDC2A with other classes	267
Table 184 – Attributes of ExcitationSystemDynamics::ExcDC3A	268
Table 185 – Association ends of ExcitationSystemDynamics::ExcDC3A with other classes	269
Table 186 – Attributes of ExcitationSystemDynamics::ExcDC3A1	270
Table 187 – Association ends of ExcitationSystemDynamics::ExcDC3A1 with other classes	271
Table 188 – Attributes of ExcitationSystemDynamics::ExcELIN1	272
Table 189 – Association ends of ExcitationSystemDynamics::ExcELIN1 with other classes	273
Table 190 – Attributes of ExcitationSystemDynamics::ExcELIN2	274
Table 191 – Association ends of ExcitationSystemDynamics::ExcELIN2 with other classes	275
Table 192 – Attributes of ExcitationSystemDynamics::ExcHU	276
Table 193 – Association ends of ExcitationSystemDynamics::ExcHU with other classes	276
Table 194 – Attributes of ExcitationSystemDynamics::ExcNI	278
Table 195 – Association ends of ExcitationSystemDynamics::ExcNI with other classes	279

Table 196 – Attributes of ExcitationSystemDynamics::ExcOEX3T	281
Table 197 – Association ends of ExcitationSystemDynamics::ExcOEX3T with other classes	282
Table 198 – Attributes of ExcitationSystemDynamics::ExcPIC	283
Table 199 – Association ends of ExcitationSystemDynamics::ExcPIC with other classes	284
Table 200 – Attributes of ExcitationSystemDynamics::ExcREXS	287
Table 201 – Association ends of ExcitationSystemDynamics::ExcREXS with other classes	288
Table 202 – Attributes of ExcitationSystemDynamics::ExcRQB	289
Table 203 – Association ends of ExcitationSystemDynamics::ExcRQB with other classes	290
Table 204 – Attributes of ExcitationSystemDynamics::ExcSCRX	291
Table 205 – Association ends of ExcitationSystemDynamics::ExcSCRX with other classes	291
Table 206 – Attributes of ExcitationSystemDynamics::ExcSEXS	292
Table 207 – Association ends of ExcitationSystemDynamics::ExcSEXS with other classes	293
Table 208 – Attributes of ExcitationSystemDynamics::ExcSK	295
Table 209 – Association ends of ExcitationSystemDynamics::ExcSK with other classes	296
Table 210 – Attributes of ExcitationSystemDynamics::ExcST1A	298
Table 211 – Association ends of ExcitationSystemDynamics::ExcST1A with other classes	299
Table 212 – Attributes of ExcitationSystemDynamics::ExcST2A	300
Table 213 – Association ends of ExcitationSystemDynamics::ExcST2A with other classes	301
Table 214 – Attributes of ExcitationSystemDynamics::ExcST3A	302
Table 215 – Association ends of ExcitationSystemDynamics::ExcST3A with other classes	303
Table 216 – Attributes of ExcitationSystemDynamics::ExcST4B	304
Table 217 – Association ends of ExcitationSystemDynamics::ExcST4B with other classes	305
Table 218 – Attributes of ExcitationSystemDynamics::ExcST6B	306
Table 219 – Association ends of ExcitationSystemDynamics::ExcST6B with other classes	307
Table 220 – Attributes of ExcitationSystemDynamics::ExcST7B	309
Table 221 – Association ends of ExcitationSystemDynamics::ExcST7B with other classes	310
Table 222 – Literals of ExcitationSystemDynamics::ExcIEEEST1AUELselectorKind	310
Table 223 – Literals of ExcitationSystemDynamics::ExcREXSFeedbackSignalKind	310
Table 224 – Literals of ExcitationSystemDynamics::ExcST6BOELselectorKind	311
Table 225 – Literals of ExcitationSystemDynamics::ExcST7BOELselectorKind	311
Table 226 – Literals of ExcitationSystemDynamics::ExcST7BUELselectorKind	311
Table 227 – Attributes of OverexcitationLimiterDynamics::OverexcitationLimiterDynamics	312
Table 228 – Association ends of OverexcitationLimiterDynamics::OverexcitationLimiterDynamics with other classes	313

Table 229 – Attributes of OverexcitationLimiterDynamics::OverexcLimIEEE	313
Table 230 – Association ends of OverexcitationLimiterDynamics::OverexcLimIEEE with other classes	313
Table 231 – Attributes of OverexcitationLimiterDynamics::OverexcLim2	314
Table 232 – Association ends of OverexcitationLimiterDynamics::OverexcLim2 with other classes	315
Table 233 – Attributes of OverexcitationLimiterDynamics::OverexcLimX1	317
Table 234 – Association ends of OverexcitationLimiterDynamics::OverexcLimX1 with other classes	317
Table 235 – Attributes of OverexcitationLimiterDynamics::OverexcLimX2	319
Table 236 – Association ends of OverexcitationLimiterDynamics::OverexcLimX2 with other classes	319
Table 237 – Attributes of UnderexcitationLimiterDynamics::UnderexcitationLimiterDynamics	320
Table 238 – Association ends of UnderexcitationLimiterDynamics::UnderexcitationLimiterDynamics with other classes	321
Table 239 – Attributes of UnderexcitationLimiterDynamics::UnderexcLimIEEE1	321
Table 240 – Association ends of UnderexcitationLimiterDynamics::UnderexcLimIEEE1 with other classes	322
Table 241 – Attributes of UnderexcitationLimiterDynamics::UnderexcLimIEEE2	322
Table 242 – Association ends of UnderexcitationLimiterDynamics::UnderexcLimIEEE2 with other classes	323
Table 243 – Attributes of UnderexcitationLimiterDynamics::UnderexcLim2Simplified	325
Table 244 – Association ends of UnderexcitationLimiterDynamics::UnderexcLim2Simplified with other classes	325
Table 245 – Attributes of UnderexcitationLimiterDynamics::UnderexcLimX1	326
Table 246 – Association ends of UnderexcitationLimiterDynamics::UnderexcLimX1 with other classes	327
Table 247 – Attributes of UnderexcitationLimiterDynamics::UnderexcLimX2	328
Table 248 – Association ends of UnderexcitationLimiterDynamics::UnderexcLimX2 with other classes	328
Table 249 – Attributes of PowerSystemStabilizerDynamics::PowerSystemStabilizerDynamics	331
Table 250 – Association ends of PowerSystemStabilizerDynamics::PowerSystemStabilizerDynamics with other classes	331
Table 251 – Attributes of PowerSystemStabilizerDynamics::PssIEEE1A	332
Table 252 – Association ends of PowerSystemStabilizerDynamics::PssIEEE1A with other classes	332
Table 253 – Attributes of PowerSystemStabilizerDynamics::PssIEEE2B	333
Table 254 – Association ends of PowerSystemStabilizerDynamics::PssIEEE2B with other classes	334
Table 255 – Attributes of PowerSystemStabilizerDynamics::PssIEEE3B	335
Table 256 – Association ends of PowerSystemStabilizerDynamics::PssIEEE3B with other classes	335
Table 257 – Attributes of PowerSystemStabilizerDynamics::PssIEEE4B	336
Table 258 – Association ends of PowerSystemStabilizerDynamics::PssIEEE4B with other classes	338
Table 259 – Attributes of PowerSystemStabilizerDynamics::Pss1	339

Table 260 – Association ends of PowerSystemStabilizerDynamics::Pss1 with other classes	339
Table 261 – Attributes of PowerSystemStabilizerDynamics::Pss1A	341
Table 262 – Association ends of PowerSystemStabilizerDynamics::Pss1A with other classes	342
Table 263 – Attributes of PowerSystemStabilizerDynamics::Pss2B	343
Table 264 – Association ends of PowerSystemStabilizerDynamics::Pss2B with other classes	344
Table 265 – Attributes of PowerSystemStabilizerDynamics::Pss2ST	345
Table 266 – Association ends of PowerSystemStabilizerDynamics::Pss2ST with other classes	345
Table 267 – Attributes of PowerSystemStabilizerDynamics::Pss5	347
Table 268 – Association ends of PowerSystemStabilizerDynamics::Pss5 with other classes	348
Table 269 – Attributes of PowerSystemStabilizerDynamics::PssELIN2	349
Table 270 – Association ends of PowerSystemStabilizerDynamics::PssELIN2 with other classes	349
Table 271 – Attributes of PowerSystemStabilizerDynamics::PssPTIST1	350
Table 272 – Association ends of PowerSystemStabilizerDynamics::PssPTIST1 with other classes	350
Table 273 – Attributes of PowerSystemStabilizerDynamics::PssPTIST3	352
Table 274 – Association ends of PowerSystemStabilizerDynamics::PssPTIST3 with other classes	353
Table 275 – Attributes of PowerSystemStabilizerDynamics::PssRQB	354
Table 276 – Association ends of PowerSystemStabilizerDynamics::PssRQB with other classes	354
Table 277 – Attributes of PowerSystemStabilizerDynamics::PssSB4	355
Table 278 – Association ends of PowerSystemStabilizerDynamics::PssSB4 with other classes	355
Table 279 – Attributes of PowerSystemStabilizerDynamics::PssSH	356
Table 280 – Association ends of PowerSystemStabilizerDynamics::PssSH with other classes	357
Table 281 – Attributes of PowerSystemStabilizerDynamics::PssSK	358
Table 282 – Association ends of PowerSystemStabilizerDynamics::PssSK with other classes	358
Table 283 – Attributes of PowerSystemStabilizerDynamics::PssSTAB2A	359
Table 284 – Association ends of PowerSystemStabilizerDynamics::PssSTAB2A with other classes	359
Table 285 – Attributes of PowerSystemStabilizerDynamics::PssWECC	361
Table 286 – Association ends of PowerSystemStabilizerDynamics::PssWECC with other classes	362
Table 287 – Literals of PowerSystemStabilizerDynamics::InputSignalKind	362
Table 288 – Attributes of DiscontinuousExcitationControlDynamics::DiscontinuousExcitationControlDynamics	364
Table 289 – Association ends of DiscontinuousExcitationControlDynamics::DiscontinuousExcitationControlDynamics with other classes	365
Table 290 – Attributes of DiscontinuousExcitationControlDynamics::DiscExcContIEEEDEC1A	366

Table 291 – Association ends of DiscontinuousExcitationControlDynamics::DiscExcContIEEEDEC1A with other classes	366
Table 292 – Attributes of DiscontinuousExcitationControlDynamics::DiscExcContIEEEDEC2A.....	367
Table 293 – Association ends of DiscontinuousExcitationControlDynamics::DiscExcContIEEEDEC2A with other classes	367
Table 294 – Attributes of DiscontinuousExcitationControlDynamics::DiscExcContIEEEDEC3A.....	368
Table 295 – Association ends of DiscontinuousExcitationControlDynamics::DiscExcContIEEEDEC3A with other classes	368
Table 296 – Attributes of PFVArControllerType1Dynamics::PFVArControllerType1Dynamics	369
Table 297 – Association ends of PFVArControllerType1Dynamics::PFVArControllerType1Dynamics with other classes	370
Table 298 – Attributes of PFVArControllerType1Dynamics::PFVArType1IEEEPFController	370
Table 299 – Association ends of PFVArControllerType1Dynamics::PFVArType1IEEEPFController with other classes	371
Table 300 – Attributes of PFVArControllerType1Dynamics::PFVArType1IEEEVArController.....	371
Table 301 – Association ends of PFVArControllerType1Dynamics::PFVArType1IEEEVArController with other classes	372
Table 302 – Attributes of VoltageAdjusterDynamics::VoltageAdjusterDynamics	373
Table 303 – Association ends of VoltageAdjusterDynamics::VoltageAdjusterDynamics with other classes	373
Table 304 – Attributes of VoltageAdjusterDynamics::VAdjIEEE	374
Table 305 – Association ends of VoltageAdjusterDynamics::VAdjIEEE with other classes	374
Table 306 – Attributes of PFVArControllerType2Dynamics::PFVArControllerType2Dynamics	375
Table 307 – Association ends of PFVArControllerType2Dynamics::PFVArControllerType2Dynamics with other classes	376
Table 308 – Attributes of PFVArControllerType2Dynamics::PFVArType2IEEEPFController	376
Table 309 – Association ends of PFVArControllerType2Dynamics::PFVArType2IEEEPFController with other classes	377
Table 310 – Attributes of PFVArControllerType2Dynamics::PFVArType2IEEEVArController.....	377
Table 311 – Association ends of PFVArControllerType2Dynamics::PFVArType2IEEEVArController with other classes	378
Table 312 – Attributes of PFVArControllerType2Dynamics::PFVArType2Common1	379
Table 313 – Association ends of PFVArControllerType2Dynamics::PFVArType2Common1 with other classes	379
Table 314 – Attributes of VoltageCompensatorDynamics::VoltageCompensatorDynamics	381
Table 315 – Association ends of VoltageCompensatorDynamics::VoltageCompensatorDynamics with other classes	382
Table 316 – Attributes of VoltageCompensatorDynamics::VCompIEEEType1	382
Table 317 – Association ends of VoltageCompensatorDynamics::VCompIEEEType1 with other classes	383

Table 318 – Attributes of VoltageCompensatorDynamics::VCompIEEEType2	383
Table 319 – Association ends of VoltageCompensatorDynamics::VCompIEEEType2 with other classes	383
Table 320 – Attributes of VoltageCompensatorDynamics::GenICompensationForGenJ	384
Table 321 – Association ends of VoltageCompensatorDynamics::GenICompensationForGenJ with other classes	384
Table 322 – Attributes of WindDynamics::WindPlantIEC	389
Table 323 – Association ends of WindDynamics::WindPlantIEC with other classes	389
Table 324 – Attributes of WindDynamics::WindPlantDynamics	390
Table 325 – Association ends of WindDynamics::WindPlantDynamics with other classes	390
Table 326 – Attributes of WindDynamics::WindTurbineType1or2Dynamics	390
Table 327 – Association ends of WindDynamics::WindTurbineType1or2Dynamics with other classes	391
Table 328 – Attributes of WindDynamics::WindTurbineType3or4Dynamics	391
Table 329 – Association ends of WindDynamics::WindTurbineType3or4Dynamics with other classes	391
Table 330 – Attributes of WindDynamics::WindTurbineType1or2IEC	392
Table 331 – Association ends of WindDynamics::WindTurbineType1or2IEC with other classes	392
Table 332 – Attributes of WindDynamics::WindTurbineType3or4IEC	392
Table 333 – Association ends of WindDynamics::WindTurbineType3or4IEC with other classes	393
Table 334 – Attributes of WindDynamics::WindTurbineType3IEC	393
Table 335 – Association ends of WindDynamics::WindTurbineType3IEC with other classes	394
Table 336 – Attributes of WindDynamics::WindTurbineType4IEC	394
Table 337 – Association ends of WindDynamics::WindTurbineType4IEC with other classes	395
Table 338 – Attributes of WindDynamics::WindGenTurbineType1aIEC	395
Table 339 – Association ends of WindDynamics::WindGenTurbineType1aIEC with other classes	396
Table 340 – Attributes of WindDynamics::WindGenTurbineType1bIEC	396
Table 341 – Association ends of WindDynamics::WindGenTurbineType1bIEC with other classes	396
Table 342 – Attributes of WindDynamics::WindGenTurbineType2IEC	397
Table 343 – Association ends of WindDynamics::WindGenTurbineType2IEC with other classes	397
Table 344 – Attributes of WindDynamics::WindGenType3IEC	398
Table 345 – Association ends of WindDynamics::WindGenType3IEC with other classes	398
Table 346 – Attributes of WindDynamics::WindTurbineType4aIEC	398
Table 347 – Association ends of WindDynamics::WindTurbineType4aIEC with other classes	399
Table 348 – Attributes of WindDynamics::WindTurbineType4bIEC	399
Table 349 – Association ends of WindDynamics::WindTurbineType4bIEC with other classes	400
Table 350 – Attributes of WindDynamics::WindGenType3aIEC	400

Table 351 – Association ends of WindDynamics::WindGenType3aIEC with other classes	401
Table 352 – Attributes of WindDynamics::WindGenType3bIEC	401
Table 353 – Association ends of WindDynamics::WindGenType3bIEC with other classes	401
Table 354 – Attributes of WindDynamics::WindGenType4IEC	402
Table 355 – Association ends of WindDynamics::WindGenType4IEC with other classes	402
Table 356 – Attributes of WindDynamics::WindRefFrameRotIEC	403
Table 357 – Association ends of WindDynamics::WindRefFrameRotIEC with other classes	403
Table 358 – Attributes of WindDynamics::WindAeroConstIEC	403
Table 359 – Association ends of WindDynamics::WindAeroConstIEC with other classes	404
Table 360 – Attributes of WindDynamics::WindAeroOneDimIEC	404
Table 361 – Association ends of WindDynamics::WindAeroOneDimIEC with other classes	404
Table 362 – Attributes of WindDynamics::WindAeroTwoDimIEC	405
Table 363 – Association ends of WindDynamics::WindAeroTwoDimIEC with other classes	405
Table 364 – Attributes of WindDynamics::WindMechIEC	406
Table 365 – Association ends of WindDynamics::WindMechIEC with other classes	406
Table 366 – Attributes of WindDynamics::WindPitchContPowerIEC	407
Table 367 – Association ends of WindDynamics::WindPitchContPowerIEC with other classes	407
Table 368 – Attributes of WindDynamics::WindContRotorRIEC	408
Table 369 – Association ends of WindDynamics::WindContRotorRIEC with other classes	408
Table 370 – Attributes of WindDynamics::WindContPType3IEC	409
Table 371 – Association ends of WindDynamics::WindContPType3IEC with other classes	410
Table 372 – Attributes of WindDynamics::WindContPType4aIEC	410
Table 373 – Association ends of WindDynamics::WindContPType4aIEC with other classes	410
Table 374 – Attributes of WindDynamics::WindContPType4bIEC	411
Table 375 – Association ends of WindDynamics::WindContPType4bIEC with other classes	411
Table 376 – Attributes of WindDynamics::WindContQIEC	412
Table 377 – Association ends of WindDynamics::WindContQIEC with other classes	413
Table 378 – Attributes of WindDynamics::WindContCurrLimIEC	413
Table 379 – Association ends of WindDynamics::WindContCurrLimIEC with other classes	414
Table 380 – Attributes of WindDynamics::WindContQLimIEC	414
Table 381 – Association ends of WindDynamics::WindContQLimIEC with other classes	414
Table 382 – Attributes of WindDynamics::WindContQPQULimIEC	415
Table 383 – Association ends of WindDynamics::WindContQPQULimIEC with other classes	415
Table 384 – Attributes of WindDynamics::WindContPitchAngleIEC	416

Table 385 – Association ends of WindDynamics::WindContPitchAngleIEC with other classes	416
Table 386 – Attributes of WindDynamics::WindProtectionIEC	417
Table 387 – Association ends of WindDynamics::WindProtectionIEC with other classes	417
Table 388 – Attributes of WindDynamics::WindPlantReactiveControlIEC	418
Table 389 – Association ends of WindDynamics::WindPlantReactiveControlIEC with other classes	419
Table 390 – Attributes of WindDynamics::WindPlantFreqPcontrolIEC	420
Table 391 – Association ends of WindDynamics::WindPlantFreqPcontrolIEC with other classes	420
Table 392 – Attributes of WindDynamics::WindDynamicsLookupTable	421
Table 393 – Association ends of WindDynamics::WindDynamicsLookupTable with other classes	421
Table 394 – Literals of WindDynamics::WindQcontrolModeKind	422
Table 395 – Literals of WindDynamics::WindUVRTQcontrolModeKind	422
Table 396 – Literals of WindDynamics::WindLookupTableFunctionKind	423
Table 397 – Literals of WindDynamics::WindPlantQcontrolModeKind	423
Table 398 – Attributes of LoadDynamics::LoadComposite	426
Table 399 – Association ends of LoadDynamics::LoadComposite with other classes	427
Table 400 – Attributes of LoadDynamics::LoadGenericNonLinear	428
Table 401 – Association ends of LoadDynamics::LoadGenericNonLinear with other classes	428
Table 402 – Attributes of LoadDynamics::LoadDynamics	428
Table 403 – Association ends of LoadDynamics::LoadDynamics with other classes	429
Table 404 – Attributes of LoadDynamics::LoadAggregate	429
Table 405 – Association ends of LoadDynamics::LoadAggregate with other classes	429
Table 406 – Attributes of LoadDynamics::LoadStatic	431
Table 407 – Association ends of LoadDynamics::LoadStatic with other classes	432
Table 408 – Attributes of LoadDynamics::LoadMotor	434
Table 409 – Association ends of LoadDynamics::LoadMotor with other classes	434
Table 410 – Literals of LoadDynamics::GenericNonLinearLoadModelKind	435
Table 411 – Literals of LoadDynamics::StaticLoadModelKind	435
Table 412 – Attributes of HVDCDynamics::HVDCDynamics	436
Table 413 – Association ends of HVDCDynamics::HVDCDynamics with other classes	437
Table 414 – Attributes of HVDCDynamics::CSCDynamics	437
Table 415 – Association ends of HVDCDynamics::CSCDynamics with other classes	437
Table 416 – Attributes of HVDCDynamics::VSCDynamics	438
Table 417 – Association ends of HVDCDynamics::VSCDynamics with other classes	438
Table 418 – Attributes of StaticVarCompensatorDynamics::StaticVarCompensatorDynamics	439
Table 419 – Association ends of StaticVarCompensatorDynamics::StaticVarCompensatorDynamics with other classes	440
Table 420 – Attributes of UserDefinedModels::SynchronousMachineUserDefined	442
Table 421 – Association ends of UserDefinedModels::SynchronousMachineUserDefined with other classes	442
Table 422 – Attributes of UserDefinedModels::AsynchronousMachineUserDefined	443

Table 423 – Association ends of UserDefinedModels::AsynchronousMachineUserDefined with other classes	443
Table 424 – Attributes of UserDefinedModels::TurbineGovernorUserDefined	444
Table 425 – Association ends of UserDefinedModels::TurbineGovernorUserDefined with other classes	444
Table 426 – Attributes of UserDefinedModels::TurbineLoadControllerUserDefined	445
Table 427 – Association ends of UserDefinedModels::TurbineLoadControllerUserDefined with other classes	445
Table 428 – Attributes of UserDefinedModels::MechanicalLoadUserDefined	445
Table 429 – Association ends of UserDefinedModels::MechanicalLoadUserDefined with other classes	446
Table 430 – Attributes of UserDefinedModels::ExcitationSystemUserDefined	446
Table 431 – Association ends of UserDefinedModels::ExcitationSystemUserDefined with other classes	447
Table 432 – Attributes of UserDefinedModels::OverexcitationLimiterUserDefined	447
Table 433 – Association ends of UserDefinedModels::OverexcitationLimiterUserDefined with other classes	448
Table 434 – Attributes of UserDefinedModels::UnderexcitationLimiterUserDefined	448
Table 435 – Association ends of UserDefinedModels::UnderexcitationLimiterUserDefined with other classes	448
Table 436 – Attributes of UserDefinedModels::PowerSystemStabilizerUserDefined	449
Table 437 – Association ends of UserDefinedModels::PowerSystemStabilizerUserDefined with other classes	449
Table 438 – Attributes of UserDefinedModels::DiscontinuousExcitationControlUserDefined	450
Table 439 – Association ends of UserDefinedModels::DiscontinuousExcitationControlUserDefined with other classes	450
Table 440 – Attributes of UserDefinedModels::PFVArControllerType1UserDefined	451
Table 441 – Association ends of UserDefinedModels::PFVArControllerType1UserDefined with other classes	451
Table 442 – Attributes of UserDefinedModels::VoltageAdjusterUserDefined	452
Table 443 – Association ends of UserDefinedModels::VoltageAdjusterUserDefined with other classes	452
Table 444 – Attributes of UserDefinedModels::PFVArControllerType2UserDefined	452
Table 445 – Association ends of UserDefinedModels::PFVArControllerType2UserDefined with other classes	453
Table 446 – Attributes of UserDefinedModels::VoltageCompensatorUserDefined	453
Table 447 – Association ends of UserDefinedModels::VoltageCompensatorUserDefined with other classes	453
Table 448 – Attributes of UserDefinedModels::LoadUserDefined	454
Table 449 – Association ends of UserDefinedModels::LoadUserDefined with other classes	454
Table 450 – Attributes of UserDefinedModels::WindType1or2UserDefined	455
Table 451 – Association ends of UserDefinedModels::WindType1or2UserDefined with other classes	455
Table 452 – Attributes of UserDefinedModels::WindType3or4UserDefined	455
Table 453 – Association ends of UserDefinedModels::WindType3or4UserDefined with other classes	456

Table 454 – Attributes of UserDefinedModels::WindPlantUserDefined	456
Table 455 – Association ends of UserDefinedModels::WindPlantUserDefined with other classes	457
Table 456 – Attributes of UserDefinedModels::CSCUserDefined	457
Table 457 – Association ends of UserDefinedModels::CSCUserDefined with other classes	457
Table 458 – Attributes of UserDefinedModels::VSCUserDefined	458
Table 459 – Association ends of UserDefinedModels::VSCUserDefined with other classes	458
Table 460 – Attributes of UserDefinedModels::SVCUserDefined	458
Table 461 – Association ends of UserDefinedModels::SVCUserDefined with other classes	459
Table 462 – Attributes of UserDefinedModels::ProprietaryParameterDynamics	459
Table 463 – Association ends of UserDefinedModels::ProprietaryParameterDynamics with other classes	460

This document is a preview generated by EVS

INTERNATIONAL ELECTROTECHNICAL COMMISSION

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

Part 302: Common information model (CIM) dynamics

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

International Standard IEC 61970-302 has been prepared by IEC technical committee 57: Power systems management and associated information exchange.

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

FDIS	Report on voting
57/1954/FDIS	57/1977/RVD

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

This document has been drafted in accordance with the ISO/IEC Directives, Part 2.

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

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

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

IMPORTANT – The 'colour inside' logo on the cover page of this publication 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

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

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

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

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

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

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

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

Part 302: Common information model (CIM) dynamics

1 Scope

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

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

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

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

The scope of the CIM extensions specified in this standard includes:

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

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60050 (all parts), *International Electrotechnical Vocabulary*

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

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

3 Terms and definitions

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

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

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

3.1

application program interface API

set of public functions provided by an executable application component for use by other executable application components

3.2

common information model CIM

abstract model that represents all the major objects in an electric utility enterprise typically contained in an EMS information model

Note 1 to entry: By providing a standard way of representing power system resources as object classes and attributes, along with their relationships, the CIM facilitates the integration of EMS applications developed independently by different vendors, between entire EMSs developed independently, or between an EMS and other systems concerned with different aspects of power system operations, such as generation or distribution management.

3.3

CIMXML

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

3.4

Document Object Model DOM

platform- and language-neutral interface defined by the World Wide Web Consortium (W3C) that allows programs and scripts to dynamically access and exchange the content, structure and style of documents

3.5

document type definition DTD

specific document for describing the vocabulary and syntax associated with an XML document

Note 1 to entry: XML Schema and RDF are other forms that can be used.