



BSI Standards Publication

Energy management system application program interface (EMS-API)

Part 302: Common information model (CIM) dynamics

National foreword

This British Standard is the UK implementation of EN IEC 61970-302:2024. It is identical to IEC 61970-302:2024. It supersedes BS EN IEC 61970-302:2018, which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee PEL/57, Power systems management and associated information exchange.

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dynamics
(IEC 61970-302:2024)

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(IEC 61970-302:2024)

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European foreword

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- latest date by which the document has to be implemented at national (dop) 2024-12-06 level by publication of an identical national standard or by endorsement
- latest date by which the national standards conflicting with the (dow) 2027-03-06 document have to be withdrawn

This document supersedes EN IEC 61970-302:2018 and all of its amendments and corrigenda (if any).

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Endorsement notice

The text of the International Standard IEC 61970-302:2024 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)

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.cenelec.eu.

<u>Publication</u>	<u>Year</u>	<u>Title</u>	<u>EN/HD</u>	<u>Year</u>
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CONTENTS

FOREWORD.....	36
INTRODUCTION.....	38
1 Scope.....	39
2 Normative references	40
3 Terms and definitions	40
4 CIM Dynamics specification	41
4.1 General.....	41
4.2 Document structure.....	43
5 Common Information Model Dynamics package.....	43
5.1 General.....	43
5.2 Package StandardInterconnections	43
5.2.1 General	43
5.2.2 RemoteInputSignal	53
5.2.3 RemoteSignalKind enumeration.....	54
5.2.4 Package WindModels	55
5.3 Package StandardModels	64
5.3.1 General	64
5.3.2 DynamicsFunctionBlock.....	64
5.3.3 RotatingMachineDynamics.....	65
5.3.4 Package SynchronousMachineDynamics	66
5.3.5 Package AsynchronousMachineDynamics	99
5.3.6 Package TurbineGovernorDynamics	108
5.3.7 Package TurbineLoadControllerDynamics.....	255
5.3.8 Package MechanicalLoadDynamics	260
5.3.9 Package ExcitationSystemDynamics.....	264
5.3.10 Package OverexcitationLimiterDynamics	458
5.3.11 Package UnderexcitationLimiterDynamics	475
5.3.12 Package PowerSystemStabilizerDynamics.....	489
5.3.13 Package DiscontinuousExcitationControlDynamics	544
5.3.14 Package PFVArControllerType1Dynamics	551
5.3.15 Package PFVArControllerType2Dynamics	558
5.3.16 Package VoltageAdjusterDynamics.....	567
5.3.17 Package VoltageCompensatorDynamics.....	571
5.3.18 Package WindDynamics	577
5.3.19 Package WindDynamicsEd2	627
5.3.20 Package LoadDynamics.....	686
5.3.21 Package HVDCDynamics.....	709
5.3.22 Package RelayDynamics	713
5.3.23 Package StatorCurrentLimiterDynamics.....	718
5.3.24 Package StaticVarCompensatorDynamics	726
5.3.25 Package ShuntCompensatorDynamics	741
5.3.26 Package StatcomDynamics	743
5.3.27 Package WECCDynamics.....	747
5.3.28 Package IEEE1547Dynamics.....	797
5.4 Package UserDefinedModels	817
5.4.1 General	817

5.4.2	SynchronousMachineUserDefined	818
5.4.3	AsynchronousMachineUserDefined	820
5.4.4	TurbineGovernorUserDefined	821
5.4.5	TurbineLoadControllerUserDefined	822
5.4.6	MechanicalLoadUserDefined	823
5.4.7	ExcitationSystemUserDefined	825
5.4.8	OverexcitationLimiterUserDefined	826
5.4.9	UnderexcitationLimiterUserDefined	827
5.4.10	PowerSystemStabilizerUserDefined	828
5.4.11	DiscontinuousExcitationControlUserDefined	829
5.4.12	PFVArControllerType1UserDefined	831
5.4.13	VoltageAdjusterUserDefined	832
5.4.14	PFVArControllerType2UserDefined	833
5.4.15	VoltageCompensatorUserDefined	834
5.4.16	LoadUserDefined	835
5.4.17	WindType1or2UserDefined	836
5.4.18	WindType3or4UserDefined	837
5.4.19	WindPlantUserDefined	838
5.4.20	CSCUserDefined	840
5.4.21	VSCUserDefined	841
5.4.22	SVCUserDefined	842
5.4.23	StatorCurrentLimiterUserDefined	843
5.4.24	ShuntCompensatorUserDefined	844
5.4.25	ProprietaryParameterDynamics root class	845
5.4.26	StatcomUserDefined	846
5.4.27	HVDCInterconnectionUserDefined	847
5.4.28	RelayUserDefined	849
5.5	Package DetailedModelDescription	850
5.5.1	General	850
5.5.2	DetailedModelTypeDynamics	851
5.5.3	DetailedModelDescriptorArtifact	851
5.5.4	DetailedModelDocumentationArtifact	852
5.5.5	FunctionDescriptor	853
5.5.6	InputOutputDescriptor	854
5.5.7	LimiterDescriptor	855
5.5.8	OperatorDescriptor	856
5.5.9	ParameterDescriptor	857
5.5.10	ParameterValue root class	859
5.5.11	SignalDescriptor	859
5.5.12	DetailedModelDescriptor	860
5.5.13	DetailedModelDynamics	861
5.5.14	ConstraintKind enumeration	862
5.5.15	LogicalKind enumeration	862
5.5.16	EquationLanguageKind enumeration	863
5.5.17	OperatorDescriptorKind enumeration	863
5.5.18	ParameterKind enumeration	864
5.5.19	XSDDatatypeKind enumeration	864
5.5.20	IRI primitive	865
5.6	Package SimulationResult	

5.6.1	General	865
5.6.2	ParameterChangeKind enumeration	866
5.6.3	ClearSimulationEvent	866
5.6.4	ParameterEvent.....	867
5.6.5	PowerFlowSettings	868
5.6.6	PowerFlowAlgorithmKind enumeration	871
5.6.7	PowerShiftKind enumeration.....	871
5.6.8	SimulationResultCharacteristic	871
5.6.9	SignalRecorder.....	872
5.6.10	SignalConfiguration	873
5.6.11	SimulationEvents	874
5.6.12	SlackDistributionKind enumeration	875
5.6.13	SimulationResult.....	875
5.6.14	SimulationSettings.....	876
5.6.15	SignalKind enumeration.....	878
5.7	Package Examples	878
Annex A (informative)	Dynamics package symbol representation conventions	882
Annex B (informative)	Use of per unit.....	884
Annex C (informative)	Updates to CIM dynamics standard models	886
Bibliography.....		891
Figure 1 – StandardInterconnectionSynchronousMachine		44
Figure 2 – StandardInterconnectionSynchronousGeneratorCrossCompound		45
Figure 3 – StandardInterconnectionAsynchronousMachine		46
Figure 4 – StandardInterconnectionSingleLoad		47
Figure 5 – Class diagram StandardInterconnections:: StandardSynchronousMachineInterconnection		48
Figure 6 – Class diagram StandardInterconnections:: StandardAsynchronousMachineInterconnection		49
Figure 7 – Class diagram StandardInterconnections::StandardLoadInterconnection		50
Figure 8 – Class diagram StandardInterconnections::StandardHVDCInterconnection		51
Figure 9 – Class diagram StandardInterconnections:: StandardStaticVarCompensatorInterconnection		52
Figure 10 – Class diagram StandardInterconnections:: StandardShuntCompensatorInterconnection		53
Figure 11 – StandardInterconnectionWindTurbineType1Aand1B		56
Figure 12 – StandardInterconnectionWindTurbineType2		57
Figure 13 – StandardInterconnectionWindTurbineType3		58
Figure 14 – StandardInterconnectionWindTurbineType4Aand4B		59
Figure 15 – Class diagram WindModels::StandardWindType1and2Interconnection		61
Figure 16 – Class diagram WindModels::StandardWindType3and4Interconnection		63
Figure 17 – SynchronousGeneratorInterconnectionAndVariables		67
Figure 18 – SynchronousMotorInterconnectionAndVariables		68
Figure 19 – Class diagram SynchronousMachineDynamics:: SynchronousMachineDynamics.....		69
Figure 20 – SynchronousMachineSaturationParameters		70
Figure 21 – SynchronousGeneratorMechanicalEquation		71

Figure 22 – SynchronousMotorMechanicalEquation	72
Figure 23 – SynchronousGeneratorPhasor.....	73
Figure 24 – SynchronousMotorPhasor	74
Figure 25 – Simplified	76
Figure 26 – SubtransientRoundRotor	81
Figure 27 – SubtransientSalientPole	82
Figure 28 – SubtransientTypeF	83
Figure 29 – SubtransientTypeJ	84
Figure 30 – SubtransientRoundRotorSimplified	85
Figure 31 – SubtransientSalientPoleSimplified	87
Figure 32 – SubtransientRoundRotorSimplifiedDirectAxis	89
Figure 33 – SubtransientSalientPoleSimplifiedDirectAxis	91
Figure 34 – SynchronousEquivalentCircuit.....	95
Figure 35 – AsynchronousGeneratorInterconnectionAndVariables	99
Figure 36 – AsynchronousMotorInterconnectionAndVariables	100
Figure 37 – Class diagram AsynchronousMachineDynamics:: AsynchronousMachineDynamics	101
Figure 38 – AsynchronousGeneratorMechanicalEquation.....	102
Figure 39 – AsynchronousMotorMechanicalEquation	102
Figure 40 – AsynchronousEquivalentCircuit	107
Figure 41 – TurbineGovernorInterconnectionAndVariables.....	109
Figure 42 – Class diagram TurbineGovernorDynamics::GasTurbineGovernorDynamics	110
Figure 43 – Class diagram TurbineGovernorDynamics::HydroTurbineGovernorDynamics	110
Figure 44 – Class diagram TurbineGovernorDynamics::SteamTurbineGovernorDynamics	111
Figure 45 – GovHydroIEEE0	149
Figure 46 – GovHydroIEEE2	151
Figure 47 – GovSteamIEEE1	154
Figure 48 – GovCT1	157
Figure 49 – GovCT2	161
Figure 50 – GovGAST.....	166
Figure 51 – GovGAST1.....	168
Figure 52 – GovGAST2.....	171
Figure 53 – GovGAST3.....	174
Figure 54 – GovGAST3ExhaustTemperature.....	174
Figure 55 – GovGAST4.....	177
Figure 56 – GovGASTWD	179
Figure 57 – GovHydro1	182
Figure 58 – GovHydro2.....	184
Figure 59 – GovHydro3.....	188
Figure 60 – GovHydro4.....	191
Figure 61 – GovHydro4SimpleHydroTurbine	192
Figure 62 – GovHydro4FrancisPeltonTurbine.....	199

Figure 63 – GovHydro4KaplanTurbine	194
Figure 64 – GovHydroDD	198
Figure 65 – GovHydroFrancis	201
Figure 66 – GovHydroFrancisNonLinearGainAndEfficiency	202
Figure 67 – DetailedHydroModelHydraulicSystem	203
Figure 68 – GovHydroPelton	206
Figure 69 – GovHydroPeltonNonLinearGainAndEfficiency	207
Figure 70 – GovHydroPID	210
Figure 71 – GovHydroPID2	213
Figure 72 – GovHydroR	216
Figure 73 – GovHydroWEH	220
Figure 74 – GovHydroWPID	225
Figure 75 – GovSteam0	227
Figure 76 – GovSteam1	229
Figure 77 – GovSteam1BacklashHysteresis	230
Figure 78 – GovSteam1InputSpeedDeadband	231
Figure 79 – GovSteam2	234
Figure 80 – GovSteamBB	236
Figure 81 – GovSteamCC	238
Figure 82 – GovSteamEU	241
Figure 83 – GovSteamFV2	244
Figure 84 – GovSteamFV3	246
Figure 85 – GovSteamFV4	249
Figure 86 – GovSteamSGO	253
Figure 87 – Class diagram TurbineLoadControllerDynamics:: TurbineLoadControllerDynamics	256
Figure 88 – TurbLCFB1	258
Figure 89 – MechanicalLoadInterconnectionAndVariables	261
Figure 90 – MechanicalLoadEquations	261
Figure 91 – Class diagram MechanicalLoadDynamics::MechanicalLoadDynamics	262
Figure 92 – ExcitationSystemInterconnectionAndVariables	265
Figure 93 – Class diagram ExcitationSystemDynamics::ExcitationSystemDynamics	266
Figure 94 – ExcAC1A	268
Figure 95 – ExcAC2A	271
Figure 96 – ExcAC3A	274
Figure 97 – ExcAC4A	277
Figure 98 – ExcAC5A	279
Figure 99 – ExcAC6A	281
Figure 100 – ExcAC8B	284
Figure 101 – ExcANS	287
Figure 102 – ExcAVR1	290
Figure 103 – ExcAVR2	292
Figure 104 – ExcAVR3	294

Figure 105 – ExcAVR4.....	296
Figure 106 – ExcAVR5.....	298
Figure 107 – ExcAVR7.....	300
Figure 108 – ExcBBC.....	302
Figure 109 – ExcCZ.....	305
Figure 110 – ExcDC1A.....	307
Figure 111 – ExcDC2A.....	310
Figure 112 – ExcDC3A.....	313
Figure 113 – ExcDC3A1.....	315
Figure 114 – ExcELIN1.....	318
Figure 115 – ExcELIN2.....	320
Figure 116 – ExcHU.....	323
Figure 117 – ExcNI.....	325
Figure 118 – ExcOEX3T.....	327
Figure 119 – ExcPIC.....	329
Figure 120 – ExcREXS.....	332
Figure 121 – ExcRQB.....	336
Figure 122 – ExcSCRX.....	338
Figure 123 – ExcSEXS.....	340
Figure 124 – ExcSK.....	342
Figure 125 – ExcST1A.....	345
Figure 126 – ExcST2A.....	348
Figure 127 – ExcST3A.....	350
Figure 128 – ExcST4B.....	353
Figure 129 – ExcST6B.....	355
Figure 130 – ExcST7B.....	358
Figure 131 – Class diagram IEEE4215from2016::IEEE4215from2016.....	362
Figure 132 – Class diagram IEEE4215from2005::IEEE4215from2005.....	418
Figure 133 – Class diagram OverexcitationLimiterDynamics::OverexcitationLimiterDynamics.....	458
Figure 134 – OverexcLim2.....	468
Figure 135 – OverexcLimX1.....	470
Figure 136 – OverexcLimX1TimeCharacteristic.....	470
Figure 137 – OverexcLimX2.....	472
Figure 138 – OverexcLimX2TimeCharacteristic.....	473
Figure 139 – Class diagram UnderexcitationLimiterDynamics:: UnderexcitationLimiterDynamics.....	475
Figure 140 – UnderexcLim2Simplified.....	484
Figure 141 – UnderexcLimX1.....	486
Figure 142 – UnderexcLimX2.....	488
Figure 143 – PowerSystemStabilizerInterconnectionAndVariables.....	490
Figure 144 – Class diagram PowerSystemStabilizerDynamics:: PowerSystemStabilizerDynamics.....	491
Figure 145 – Pss1.....	

Figure 146 – Pss1A	518
Figure 147 – Pss2B	520
Figure 148 – Pss2ST	522
Figure 149 – Pss5.....	524
Figure 150 – PssELIN2	527
Figure 151 – PssPTIST1	528
Figure 152 – PssPTIST3	530
Figure 153 – PssRQB	533
Figure 154 – PssSB4	535
Figure 155 – PssSH	536
Figure 156 – PssSK	538
Figure 157 – PssSTAB2A	540
Figure 158 – PssWECC	542
Figure 159 – DiscontinuousExcitationControlInterconnectionAndVariables	545
Figure 160 – Class diagram DiscontinuousExcitationControlDynamics:: DiscontinuousExcitationControlDynamics.....	546
Figure 161 – Class diagram PFVArControllerType1Dynamics::PFVArControllerType1Dynamics	552
Figure 162 – Class diagram PFVArControllerType2Dynamics:: PFVArControllerType2Dynamics	559
Figure 163 – PFVArType2Common1	560
Figure 164 – Class diagram VoltageAdjusterDynamics::VoltageAdjusterDynamics	567
Figure 165 – VoltageCompensatorInterconnectionAndVariables	572
Figure 166 – Class diagram VoltageCompensatorDynamics::VoltageCompensatorDynamics	573
Figure 167 – Class diagram WindDynamics::WindDynamicsType1or2	578
Figure 168 – Class diagram WindDynamics::WindDynamicsType3.....	579
Figure 169 – Class diagram WindDynamics::WindDynamicsType4	580
Figure 170 – Class diagram WindDynamics::WindDynamicsPlant	581
Figure 171 – Class diagram WindDynamicsEd2::WindDynamicsType1or2.....	629
Figure 172 – Class diagram WindDynamicsEd2::WindDynamicsType3.....	630
Figure 173 – Class diagram WindDynamicsEd2::WindDynamicsType4.....	631
Figure 174 – Class diagram WindDynamicsEd2::WindDynamicsPlant	632
Figure 175 – LoadInterconnectionAndVariables	687
Figure 176 – Class diagram LoadDynamics::LoadDynamics.....	688
Figure 177 – LoadCompositeEquations.....	689
Figure 178 – LoadGenericNonLinearTypeEquations.....	691
Figure 179 – LoadStaticTypeEquations.....	695
Figure 180 – LoadMotor.....	698
Figure 181 – Class diagram LoadCompositeWECC::LoadCompositeWECC	701
Figure 182 – Class diagram HVDCDynamics::HVDCDynamics.....	709
Figure 183 – Class diagram RelayDynamics::RelayDynamics	714
Figure 184 – Class diagram StatorCurrentLimiterDynamics:: StatorCurrentLimiterDynamics	719

Figure 185 – Class diagram StaticVarCompensatorDynamics::StaticVarCompensatorDynamics	726
Figure 186 – Class diagram ShuntCompensatorDynamics::ShuntCompensatorDynamics	741
Figure 187 – Class diagram StatcomDynamics::StatcomIEC	743
Figure 188 – Class diagram StatcomDynamics::StatcomDynamics	744
Figure 189 – Class diagram WECCDynamics::WeccDynamics	747
Figure 190 – Class diagram WECCDynamics::WeccBESS	748
Figure 191 – Class diagram IEEE1547Dynamics::IEEE1547Dynamics	797
Figure 192 – Class diagram UserDefinedModels::ProprietaryUserDefinedModels	818
Figure 193 – Class diagram DetailedModelDescription::DetailedModelDescription	850
Figure 194 – Class diagram SimulationResult::SimulationResult	865
Figure 195 – Object diagram Examples::ExampleStandardModel	879
Figure 196 – Object diagram Examples::ExampleFunctionBlockProprietaryModel	880
Figure 197 – Object diagram Examples::ExampleCompleteProprietaryModel	881
Table 1 – Attributes of StandardInterconnections::RemoteInputSignal	53
Table 2 – Association ends of StandardInterconnections:: RemoteInputSignal with other classes	54
Table 3 – Literals of StandardInterconnections::RemoteSignalKind	55
Table 4 – Attributes of StandardModels::DynamicsFunctionBlock	64
Table 5 – Association ends of StandardModels:: DynamicsFunctionBlock with other classes	65
Table 6 – Attributes of StandardModels::RotatingMachineDynamics	65
Table 7 – Association ends of StandardModels:: RotatingMachineDynamics with other classes	66
Table 8 – Attributes of SynchronousMachineDynamics::SynchronousMachineDynamics	75
Table 9 – Association ends of SynchronousMachineDynamics:: SynchronousMachineDynamics with other classes	75
Table 10 – Attributes of SynchronousMachineDynamics:: SynchronousMachineSimplified	77
Table 11 – Association ends of SynchronousMachineDynamics:: SynchronousMachineSimplified with other classes	77
Table 12 – Attributes of SynchronousMachineDynamics::SynchronousMachineDetailed	78
Table 13 – Association ends of SynchronousMachineDynamics:: SynchronousMachineDetailed with other classes	79
Table 14 – Attributes of SynchronousMachineDynamics:: SynchronousMachineTimeConstantReactance	92
Table 15 – Association ends of SynchronousMachineDynamics:: SynchronousMachineTimeConstantReactance with other classes	94
Table 16 – Attributes of SynchronousMachineDynamics:: SynchronousMachineEquivalentCircuit	96
Table 17 – Association ends of SynchronousMachineDynamics:: SynchronousMachineEquivalentCircuit with other classes	97
Table 18 – Literals of SynchronousMachineDynamics::IfdBaseKind	97
Table 19 – Literals of SynchronousMachineDynamics::SynchronousMachineModelKind	98
Table 20 – Literals of SynchronousMachineDynamics::RotorKind	98

Table 21 – Attributes of AsynchronousMachineDynamics:: AsynchronousMachineDynamics	103
Table 22 – Association ends of AsynchronousMachineDynamics:: AsynchronousMachineDynamics with other classes	104
Table 23 – Attributes of AsynchronousMachineDynamics:: AsynchronousMachineTimeConstantReactance	105
Table 24 – Association ends of AsynchronousMachineDynamics:: AsynchronousMachineTimeConstantReactance with other classes	105
Table 25 – Attributes of AsynchronousMachineDynamics:: AsynchronousMachineEquivalentCircuit	107
Table 26 – Association ends of AsynchronousMachineDynamics:: AsynchronousMachineEquivalentCircuit with other classes	108
Table 27 – Attributes of TurbineGovernorDynamics::TurbineGovernorDynamics	111
Table 28 – Association ends of TurbineGovernorDynamics:: TurbineGovernorDynamics with other classes	112
Table 29 – Attributes of TurbineGovernorDynamics:: CombinedCycleGasTurbineDynamics	112
Table 30 – Association ends of TurbineGovernorDynamics:: CombinedCycleGasTurbineDynamics with other classes	113
Table 31 – Attributes of TurbineGovernorDynamics::HydroGovernorDynamics	113
Table 32 – Association ends of TurbineGovernorDynamics:: HydroGovernorDynamics with other classes	114
Table 33 – Attributes of TurbineGovernorDynamics::HydroWaterColumnDynamics	114
Table 34 – Association ends of TurbineGovernorDynamics:: HydroWaterColumnDynamics with other classes	115
Table 35 – Attributes of TurbineGovernorDynamics::SteamTurbineGeneratorDynamics	115
Table 36 – Association ends of TurbineGovernorDynamics:: SteamTurbineGeneratorDynamics with other classes	116
Table 37 – Attributes of TurbineGovernorDynamics:: CrossCompoundTurbineGovernorDynamics	116
Table 38 – Association ends of TurbineGovernorDynamics:: CrossCompoundTurbineGovernorDynamics with other classes	117
Table 39 – Attributes of TurbineGovernorDynamics::GovCIGREGT	117
Table 40 – Association ends of TurbineGovernorDynamics:: GovCIGREGT with other classes	120
Table 41 – Attributes of TurbineGovernorDynamics::GovIEEEGT1	120
Table 42 – Association ends of TurbineGovernorDynamics:: GovIEEEGT1 with other classes	123
Table 43 – Attributes of TurbineGovernorDynamics::GovIEEEHydroDD	123
Table 44 – Association ends of TurbineGovernorDynamics:: GovIEEEHydroDD with other classes	124
Table 45 – Attributes of TurbineGovernorDynamics::GovIEEEHydroLL	125
Table 46 – Association ends of TurbineGovernorDynamics:: GovIEEEHydroLL with other classes	126
Table 47 – Attributes of TurbineGovernorDynamics::GovIEEEHydroMech	127
Table 48 – Association ends of TurbineGovernorDynamics:: GovIEEEHydroMech with other classes	128
Table 49 – Attributes of TurbineGovernorDynamics::GovIEEEHydroPID	128

Table 50 – Association ends of TurbineGovernorDynamics:: GovIEEEHydroPID with other classes	129
Table 51 – Attributes of TurbineGovernorDynamics::GovIEEEHydroPIDspt.....	130
Table 52 – Association ends of TurbineGovernorDynamics:: GovIEEEHydroPIDspt with other classes	131
Table 53 – Attributes of TurbineGovernorDynamics::GovSteamIEEEG1Aug.....	132
Table 54 – Association ends of TurbineGovernorDynamics:: GovSteamIEEEG1Aug with other classes	134
Table 55 – Attributes of TurbineGovernorDynamics::GovSteamIEEETGOV5.....	134
Table 56 – Association ends of TurbineGovernorDynamics:: GovSteamIEEETGOV5 with other classes	136
Table 57 – Attributes of TurbineGovernorDynamics::TurbCIGREHRSGST	137
Table 58 – Association ends of TurbineGovernorDynamics:: TurbCIGREHRSGST with other classes	139
Table 59 – Attributes of TurbineGovernorDynamics::TurbIEEEGenericHRSGST	140
Table 60 – Association ends of TurbineGovernorDynamics:: TurbIEEEGenericHRSGST with other classes	141
Table 61 – Attributes of TurbineGovernorDynamics::TurbIEEEHydroWCgen	142
Table 62 – Association ends of TurbineGovernorDynamics:: TurbIEEEHydroWCgen with other classes	142
Table 63 – Attributes of TurbineGovernorDynamics::TurbIEEEHydroWClinear	143
Table 64 – Association ends of TurbineGovernorDynamics:: TurbIEEEHydroWClinear with other classes	144
Table 65 – Attributes of TurbineGovernorDynamics::TurbIEEEHydroWCNonLinear.....	144
Table 66 – Association ends of TurbineGovernorDynamics:: TurbIEEEHydroWCNonLinear with other classes	145
Table 67 – Attributes of TurbineGovernorDynamics::TurbIEEEHydroWCNonLinearA	146
Table 68 – Association ends of TurbineGovernorDynamics:: TurbIEEEHydroWCNonLinearA with other classes	147
Table 69 – Attributes of TurbineGovernorDynamics::TurbIEEEHydroWCNonLinearB	147
Table 70 – Association ends of TurbineGovernorDynamics:: TurbIEEEHydroWCNonLinearB with other classes	148
Table 71 – Attributes of TurbineGovernorDynamics::GovHydroIEEE0	149
Table 72 – Association ends of TurbineGovernorDynamics:: GovHydroIEEE0 with other classes	150
Table 73 – Attributes of TurbineGovernorDynamics::GovHydroIEEE2	151
Table 74 – Association ends of TurbineGovernorDynamics:: GovHydroIEEE2 with other classes	153
Table 75 – Attributes of TurbineGovernorDynamics::GovSteamIEEE1	154
Table 76 – Association ends of TurbineGovernorDynamics:: GovSteamIEEE1 with other classes	156
Table 77 – Attributes of TurbineGovernorDynamics::GovCT1.....	158
Table 78 – Association ends of TurbineGovernorDynamics::GovCT1 with other classes	160
Table 79 – Attributes of TurbineGovernorDynamics::GovCT2.....	162
Table 80 – Association ends of TurbineGovernorDynamics::GovCT2 with other classes	165
Table 81 – Attributes of TurbineGovernorDynamics::GovGAST	166
Table 82 – Association ends of TurbineGovernorDynamics:: GovGAST with other classes	167

Table 83 – Attributes of TurbineGovernorDynamics::GovGAST1	169
Table 84 – Association ends of TurbineGovernorDynamics:: GovGAST1 with other classes	170
Table 85 – Attributes of TurbineGovernorDynamics::GovGAST2	172
Table 86 – Association ends of TurbineGovernorDynamics:: GovGAST2 with other classes	173
Table 87 – Attributes of TurbineGovernorDynamics::GovGAST3	175
Table 88 – Association ends of TurbineGovernorDynamics:: GovGAST3 with other classes	176
Table 89 – Attributes of TurbineGovernorDynamics::GovGAST4	177
Table 90 – Association ends of TurbineGovernorDynamics:: GovGAST4 with other classes	178
Table 91 – Attributes of TurbineGovernorDynamics::GovGASTWD	179
Table 92 – Association ends of TurbineGovernorDynamics:: GovGASTWD with other classes	181
Table 93 – Attributes of TurbineGovernorDynamics::GovHydro1	183
Table 94 – Association ends of TurbineGovernorDynamics:: GovHydro1 with other classes	184
Table 95 – Attributes of TurbineGovernorDynamics::GovHydro2	185
Table 96 – Association ends of TurbineGovernorDynamics:: GovHydro2 with other classes	186
Table 97 – Attributes of TurbineGovernorDynamics::GovHydro3	189
Table 98 – Association ends of TurbineGovernorDynamics:: GovHydro3 with other classes	190
Table 99 – Attributes of TurbineGovernorDynamics::GovHydro4	195
Table 100 – Association ends of TurbineGovernorDynamics:: GovHydro4 with other classes	197
Table 101 – Attributes of TurbineGovernorDynamics::GovHydroDD	199
Table 102 – Association ends of TurbineGovernorDynamics:: GovHydroDD with other classes	200
Table 103 – Attributes of TurbineGovernorDynamics::GovHydroFrancis.....	203
Table 104 – Association ends of TurbineGovernorDynamics:: GovHydroFrancis with other classes	205
Table 105 – Attributes of TurbineGovernorDynamics::GovHydroPelton	207
Table 106 – Association ends of TurbineGovernorDynamics:: GovHydroPelton with other classes	209
Table 107 – Attributes of TurbineGovernorDynamics::GovHydroPID	211
Table 108 – Association ends of TurbineGovernorDynamics:: GovHydroPID with other classes	212
Table 109 – Attributes of TurbineGovernorDynamics::GovHydroPID2	214
Table 110 – Association ends of TurbineGovernorDynamics:: GovHydroPID2 with other classes	215
Table 111 – Attributes of TurbineGovernorDynamics::GovHydroR.....	217
Table 112 – Association ends of TurbineGovernorDynamics:: GovHydroR with other classes	219
Table 113 – Attributes of TurbineGovernorDynamics::GovHydroWEH	221
Table 114 – Association ends of TurbineGovernorDynamics:: GovHydroWEH with other classes	

Table 115 – Attributes of TurbineGovernorDynamics::GovHydroWPID	225
Table 116 – Association ends of TurbineGovernorDynamics:: GovHydroWPID with other classes	226
Table 117 – Attributes of TurbineGovernorDynamics::GovSteam0	227
Table 118 – Association ends of TurbineGovernorDynamics:: GovSteam0 with other classes	228
Table 119 – Attributes of TurbineGovernorDynamics::GovSteam1	232
Table 120 – Association ends of TurbineGovernorDynamics:: GovSteam1 with other classes	234
Table 121 – Attributes of TurbineGovernorDynamics::GovSteam2	235
Table 122 – Association ends of TurbineGovernorDynamics:: GovSteam2 with other classes	235
Table 123 – Attributes of TurbineGovernorDynamics::GovSteamBB.....	236
Table 124 – Association ends of TurbineGovernorDynamics:: GovSteamBB with other classes	237
Table 125 – Attributes of TurbineGovernorDynamics::GovSteamCC	239
Table 126 – Association ends of TurbineGovernorDynamics:: GovSteamCC with other classes	240
Table 127 – Attributes of TurbineGovernorDynamics::GovSteamEU.....	242
Table 128 – Association ends of TurbineGovernorDynamics:: GovSteamEU with other classes	243
Table 129 – Attributes of TurbineGovernorDynamics::GovSteamFV2.....	245
Table 130 – Association ends of TurbineGovernorDynamics:: GovSteamFV2 with other classes	245
Table 131 – Attributes of TurbineGovernorDynamics::GovSteamFV3.....	247
Table 132 – Association ends of TurbineGovernorDynamics:: GovSteamFV3 with other classes	248
Table 133 – Attributes of TurbineGovernorDynamics::GovSteamFV4	250
Table 134 – Association ends of TurbineGovernorDynamics:: GovSteamFV4 with other classes	252
Table 135 – Attributes of TurbineGovernorDynamics::GovSteamSGO.....	253
Table 136 – Association ends of TurbineGovernorDynamics:: GovSteamSGO with other classes	254
Table 137 – Literals of TurbineGovernorDynamics::DroopSignalFeedbackKind	255
Table 138 – Literals of TurbineGovernorDynamics::FrancisGovernorControlKind	255
Table 139 – Literals of TurbineGovernorDynamics::GovHydro4ModelKind	255
Table 140 – Attributes of TurbineLoadControllerDynamics:: TurbineLoadControllerDynamics	256
Table 141 – Association ends of TurbineLoadControllerDynamics:: TurbineLoadControllerDynamics with other classes	257
Table 142 – Attributes of TurbineLoadControllerDynamics::TurbLCFB1	259
Table 143 – Association ends of TurbineLoadControllerDynamics:: TurbLCFB1 with other classes	260
Table 144 – Attributes of MechanicalLoadDynamics::MechanicalLoadDynamics	262
Table 145 – Association ends of MechanicalLoadDynamics:: MechanicalLoadDynamics with other classes	263
Table 146 – Attributes of MechanicalLoadDynamics::MechLoad1	263

Table 147 – Association ends of MechanicalLoadDynamics:: MechLoad1 with other classes	264
Table 148 – Attributes of ExcitationSystemDynamics::ExcitationSystemDynamics	267
Table 149 – Association ends of ExcitationSystemDynamics:: ExcitationSystemDynamics with other classes	267
Table 150 – Attributes of ExcitationSystemDynamics::ExcAC1A	268
Table 151 – Association ends of ExcitationSystemDynamics:: ExcAC1A with other classes	270
Table 152 – Attributes of ExcitationSystemDynamics::ExcAC2A	271
Table 153 – Association ends of ExcitationSystemDynamics:: ExcAC2A with other classes	273
Table 154 – Attributes of ExcitationSystemDynamics::ExcAC3A	274
Table 155 – Association ends of ExcitationSystemDynamics:: ExcAC3A with other classes	276
Table 156 – Attributes of ExcitationSystemDynamics::ExcAC4A	277
Table 157 – Association ends of ExcitationSystemDynamics:: ExcAC4A with other classes	278
Table 158 – Attributes of ExcitationSystemDynamics::ExcAC5A	279
Table 159 – Association ends of ExcitationSystemDynamics:: ExcAC5A with other classes	280
Table 160 – Attributes of ExcitationSystemDynamics::ExcAC6A	282
Table 161 – Association ends of ExcitationSystemDynamics:: ExcAC6A with other classes	283
Table 162 – Attributes of ExcitationSystemDynamics::ExcAC8B	285
Table 163 – Association ends of ExcitationSystemDynamics:: ExcAC8B with other classes	286
Table 164 – Attributes of ExcitationSystemDynamics::ExcANS	288
Table 165 – Association ends of ExcitationSystemDynamics::ExcANS with other classes	289
Table 166 – Attributes of ExcitationSystemDynamics::ExcAVR1	290
Table 167 – Association ends of ExcitationSystemDynamics:: ExcAVR1 with other classes	291
Table 168 – Attributes of ExcitationSystemDynamics::ExcAVR2	292
Table 169 – Association ends of ExcitationSystemDynamics:: ExcAVR2 with other classes	293
Table 170 – Attributes of ExcitationSystemDynamics::ExcAVR3	294
Table 171 – Association ends of ExcitationSystemDynamics:: ExcAVR3 with other classes	295
Table 172 – Attributes of ExcitationSystemDynamics::ExcAVR4	296
Table 173 – Association ends of ExcitationSystemDynamics:: ExcAVR4 with other classes	297
Table 174 – Attributes of ExcitationSystemDynamics::ExcAVR5	298
Table 175 – Association ends of ExcitationSystemDynamics:: ExcAVR5 with other classes	299
Table 176 – Attributes of ExcitationSystemDynamics::ExcAVR7	300
Table 177 – Association ends of ExcitationSystemDynamics:: ExcAVR7 with other classes	301
Table 178 – Attributes of ExcitationSystemDynamics::ExcBBC	

Table 179 – Association ends of ExcitationSystemDynamics:: ExcBBC with other classes	303
Table 180 – Attributes of ExcitationSystemDynamics::ExcCZ.....	305
Table 181 – Association ends of ExcitationSystemDynamics::ExcCZ with other classes	306
Table 182 – Attributes of ExcitationSystemDynamics::ExcDC1A	307
Table 183 – Association ends of ExcitationSystemDynamics:: ExcDC1A with other classes	308
Table 184 – Attributes of ExcitationSystemDynamics::ExcDC2A	310
Table 185 – Association ends of ExcitationSystemDynamics:: ExcDC2A with other classes	312
Table 186 – Attributes of ExcitationSystemDynamics::ExcDC3A	313
Table 187 – Association ends of ExcitationSystemDynamics:: ExcDC3A with other classes	314
Table 188 – Attributes of ExcitationSystemDynamics::ExcDC3A1	316
Table 189 – Association ends of ExcitationSystemDynamics:: ExcDC3A1 with other classes	317
Table 190 – Attributes of ExcitationSystemDynamics::ExcELIN1	318
Table 191 – Association ends of ExcitationSystemDynamics:: ExcELIN1 with other classes	319
Table 192 – Attributes of ExcitationSystemDynamics::ExcELIN2.....	320
Table 193 – Association ends of ExcitationSystemDynamics:: ExcELIN2 with other classes	322
Table 194 – Attributes of ExcitationSystemDynamics::ExcHU	323
Table 195 – Association ends of ExcitationSystemDynamics::ExcHU with other classes	324
Table 196 – Attributes of ExcitationSystemDynamics::ExcNI.....	325
Table 197 – Association ends of ExcitationSystemDynamics::ExcNI with other classes	326
Table 198 – Attributes of ExcitationSystemDynamics::ExcOEX3T	328
Table 199 – Association ends of ExcitationSystemDynamics:: ExcOEX3T with other classes	328
Table 200 – Attributes of ExcitationSystemDynamics::ExcPIC	330
Table 201 – Association ends of ExcitationSystemDynamics::ExcPIC with other classes	331
Table 202 – Attributes of ExcitationSystemDynamics::ExcREXS	333
Table 203 – Association ends of ExcitationSystemDynamics:: ExcREXS with other classes	335
Table 204 – Attributes of ExcitationSystemDynamics::ExcRQB	336
Table 205 – Association ends of ExcitationSystemDynamics:: ExcRQB with other classes	337
Table 206 – Attributes of ExcitationSystemDynamics::ExcSCRX.....	338
Table 207 – Association ends of ExcitationSystemDynamics:: ExcSCRX with other classes	339
Table 208 – Attributes of ExcitationSystemDynamics::ExcSEXS	340
Table 209 – Association ends of ExcitationSystemDynamics:: ExcSEXS with other classes	341
Table 210 – Attributes of ExcitationSystemDynamics::ExcSK.....	343
Table 211 – Association ends of ExcitationSystemDynamics::ExcSK with other classes	344
Table 212 – Attributes of ExcitationSystemDynamics::ExcST1A.....	345

Table 213 – Association ends of ExcitationSystemDynamics:: ExcST1A with other classes	346
Table 214 – Attributes of ExcitationSystemDynamics::ExcST2A.....	348
Table 215 – Association ends of ExcitationSystemDynamics:: ExcST2A with other classes	349
Table 216 – Attributes of ExcitationSystemDynamics::ExcST3A.....	351
Table 217 – Association ends of ExcitationSystemDynamics:: ExcST3A with other classes	352
Table 218 – Attributes of ExcitationSystemDynamics::ExcST4B.....	353
Table 219 – Association ends of ExcitationSystemDynamics:: ExcST4B with other classes	354
Table 220 – Attributes of ExcitationSystemDynamics::ExcST6B.....	356
Table 221 – Association ends of ExcitationSystemDynamics:: ExcST6B with other classes	357
Table 222 – Attributes of ExcitationSystemDynamics::ExcST7B.....	358
Table 223 – Association ends of ExcitationSystemDynamics:: ExcST7B with other classes	359
Table 224 – Literals of ExcitationSystemDynamics::ExcREXSFeedbackSignalKind	360
Table 225 – Literals of ExcitationSystemDynamics::ExcST6BOELselectorKind	360
Table 226 – Literals of ExcitationSystemDynamics::ExcST7BOELselectorKind	361
Table 227 – Literals of ExcitationSystemDynamics::ExcST7BUELselectorKind	361
Table 228 – Attributes of IEEE4215from2016::ExcIEEEST4C	362
Table 229 – Association ends of IEEE4215from2016::ExcIEEEST4C with other classes	363
Table 230 – Literals of IEEE4215from2016::VuellInputKind	364
Table 231 – Attributes of IEEE4215from2016::ExcIEEEAC5C	365
Table 232 – Association ends of IEEE4215from2016::ExcIEEEAC5C with other classes	366
Table 233 – Attributes of IEEE4215from2016::ExcIEEEST1C	367
Table 234 – Association ends of IEEE4215from2016::ExcIEEEST1C with other classes	368
Table 235 – Attributes of IEEE4215from2016::ExcIEEEST6C	369
Table 236 – Association ends of IEEE4215from2016::ExcIEEEST6C with other classes	370
Table 237 – Attributes of IEEE4215from2016::ExcIEEEST3C	371
Table 238 – Association ends of IEEE4215from2016::ExcIEEEST3C with other classes	372
Table 239 – Attributes of IEEE4215from2016::ExcIEEEAC3C	373
Table 240 – Association ends of IEEE4215from2016::ExcIEEEAC3C with other classes	375
Table 241 – Attributes of IEEE4215from2016::ExcIEEEAC6C	376
Table 242 – Association ends of IEEE4215from2016::ExcIEEEAC6C with other classes	377
Table 243 – Attributes of IEEE4215from2016::ExcIEEEDC2C	378
Table 244 – Association ends of IEEE4215from2016::ExcIEEEDC2C with other classes	379
Table 245 – Attributes of IEEE4215from2016::ExcIEEEST5C	380
Table 246 – Association ends of IEEE4215from2016::ExcIEEEST5C with other classes	381
Table 247 – Attributes of IEEE4215from2016::ExcIEEEST9C	382
Table 248 – Association ends of IEEE4215from2016::ExcIEEEST9C with other classes	383
Table 249 – Literals of IEEE4215from2016::InputsST7CKind	384
Table 250 – Attributes of IEEE4215from2016::ExcIEEEAC9C	384
Table 251 – Association ends of IEEE4215from2016::ExcIEEEAC9C with other classes	384

Table 252 – Attributes of IEEE4215from2016::ExcIEEEAC11C	387
Table 253 – Association ends of IEEE4215from2016::ExcIEEEAC11C with other classes	389
Table 254 – Attributes of IEEE4215from2016::ExcIEEEDC1C	390
Table 255 – Association ends of IEEE4215from2016::ExcIEEEDC1C with other classes.....	391
Table 256 – Attributes of IEEE4215from2016::ExcIEEEST2C	392
Table 257 – Association ends of IEEE4215from2016::ExcIEEEST2C with other classes	393
Table 258 – Attributes of IEEE4215from2016::ExcIEEEDC4C	394
Table 259 – Association ends of IEEE4215from2016::ExcIEEEDC4C with other classes.....	395
Table 260 – Literals of IEEE4215from2016::InputsST4CKind	396
Table 261 – Attributes of IEEE4215from2016::ExcIEEEAC2C	396
Table 262 – Association ends of IEEE4215from2016::ExcIEEEAC2C with other classes.....	397
Table 263 – Attributes of IEEE4215from2016::ExcIEEEST10C	398
Table 264 – Association ends of IEEE4215from2016::ExcIEEEST10C with other classes	400
Table 265 – Literals of IEEE4215from2016::VscIInputKind	401
Table 266 – Attributes of IEEE4215from2016::ExcIEEEAC10C	401
Table 267 – Association ends of IEEE4215from2016::ExcIEEEAC10C with other classes	403
Table 268 – Literals of IEEE4215from2016::VsIInputKind	404
Table 269 – Attributes of IEEE4215from2016::ExcIEEEAC4C	404
Table 270 – Association ends of IEEE4215from2016::ExcIEEEAC4C with other classes.....	405
Table 271 – Attributes of IEEE4215from2016::ExcIEEEAC1C	406
Table 272 – Association ends of IEEE4215from2016::ExcIEEEAC1C with other classes.....	407
Table 273 – Literals of IEEE4215from2016::InputsST6CKind	408
Table 274 – Attributes of IEEE4215from2016::ExcIEEEAC7C	409
Table 275 – Association ends of IEEE4215from2016::ExcIEEEAC7C with other classes.....	410
Table 276 – Attributes of IEEE4215from2016::ExcIEEEST7C	411
Table 277 – Association ends of IEEE4215from2016::ExcIEEEST7C with other classes	412
Table 278 – Attributes of IEEE4215from2016::ExcIEEEAC8C	413
Table 279 – Association ends of IEEE4215from2016::ExcIEEEAC8C with other classes.....	415
Table 280 – Literals of IEEE4215from2016::VoellInputKind	415
Table 281 – Attributes of IEEE4215from2016::ExcIEEEST8C	416
Table 282 – Association ends of IEEE4215from2016::ExcIEEEST8C with other classes	417
Table 283 – Attributes of IEEE4215from2005::ExcIEEEAC1A	419
Table 284 – Association ends of IEEE4215from2005::ExcIEEEAC1A with other classes	420
Table 285 – Attributes of IEEE4215from2005::ExcIEEEAC2A	421
Table 286 – Association ends of IEEE4215from2005::ExcIEEEAC2A with other classes.....	422
Table 287 – Attributes of IEEE4215from2005::ExcIEEEAC3A	423
Table 288 – Association ends of IEEE4215from2005::ExcIEEEAC3A with other classes	424
Table 289 – Attributes of IEEE4215from2005::ExcIEEEAC4A	425
Table 290 – Association ends of IEEE4215from2005::ExcIEEEAC4A with other classes	426
Table 291 – Attributes of IEEE4215from2005::ExcIEEEAC5A	427
Table 292 – Association ends of IEEE4215from2005::ExcIEEEAC5A with other classes	428

Table 293 – Attributes of IEEE4215from2005::ExcIEEEAC6A	429
Table 294 – Association ends of IEEE4215from2005::ExcIEEEAC6A with other classes	430
Table 295 – Attributes of IEEE4215from2005::ExcIEEEAC7B	431
Table 296 – Association ends of IEEE4215from2005::ExcIEEEAC7B with other classes	432
Table 297 – Attributes of IEEE4215from2005::ExcIEEEAC8B	433
Table 298 – Association ends of IEEE4215from2005::ExcIEEEAC8B with other classes	434
Table 299 – Attributes of IEEE4215from2005::ExcIEEEDC1A	435
Table 300 – Association ends of IEEE4215from2005::ExcIEEEDC1A with other classes	437
Table 301 – Attributes of IEEE4215from2005::ExcIEEEDC2A	438
Table 302 – Association ends of IEEE4215from2005::ExcIEEEDC2A with other classes	439
Table 303 – Attributes of IEEE4215from2005::ExcIEEEDC3A	440
Table 304 – Association ends of IEEE4215from2005::ExcIEEEDC3A with other classes	441
Table 305 – Attributes of IEEE4215from2005::ExcIEEEDC4B	442
Table 306 – Association ends of IEEE4215from2005::ExcIEEEDC4B with other classes	443
Table 307 – Attributes of IEEE4215from2005::ExcIEEEST1A.....	444
Table 308 – Association ends of IEEE4215from2005::ExcIEEEST1A with other classes	445
Table 309 – Attributes of IEEE4215from2005::ExcIEEEST2A.....	446
Table 310 – Association ends of IEEE4215from2005::ExcIEEEST2A with other classes	447
Table 311 – Attributes of IEEE4215from2005::ExcIEEEST3A.....	448
Table 312 – Association ends of IEEE4215from2005::ExcIEEEST3A with other classes	449
Table 313 – Attributes of IEEE4215from2005::ExcIEEEST4B.....	450
Table 314 – Association ends of IEEE4215from2005::ExcIEEEST4B with other classes	451
Table 315 – Attributes of IEEE4215from2005::ExcIEEEST5B.....	452
Table 316 – Association ends of IEEE4215from2005::ExcIEEEST5B with other classes	453
Table 317 – Attributes of IEEE4215from2005::ExcIEEEST6B.....	454
Table 318 – Association ends of IEEE4215from2005::ExcIEEEST6B with other classes	455
Table 319 – Attributes of IEEE4215from2005::ExcIEEEST7B.....	456
Table 320 – Association ends of IEEE4215from2005::ExcIEEEST7B with other classes	457
Table 321 – Literals of IEEE4215from2005::ExcIEEEST1AUeLselectorKind	457
Table 322 – Attributes of OverexcitationLimiterDynamics::OverexcLimIEEEOEL2C	459
Table 323 – Association ends of OverexcitationLimiterDynamics::OverexcLimIEEEOEL2C with other classes.....	460
Table 324 – Attributes of OverexcitationLimiterDynamics::OverexcLimIEEEOEL3C	461
Table 325 – Association ends of OverexcitationLimiterDynamics::OverexcLimIEEEOEL3C with other classes.....	462
Table 326 – Attributes of OverexcitationLimiterDynamics::OverexcLimIEEEOEL4C	463
Table 327 – Association ends of OverexcitationLimiterDynamics:: OverexcLimIEEEOEL4C with other classes.....	463
Table 328 – Attributes of OverexcitationLimiterDynamics::OverexcLimIEEEOEL5C	464
Table 329 – Association ends of OverexcitationLimiterDynamics:: OverexcLimIEEEOEL5C with other classes.....	465
Table 330 – Attributes of OverexcitationLimiterDynamics:: OverexcitationLimiterDynamics	466
Table 331 – Association ends of OverexcitationLimiterDynamics:: OverexcitationLimiterDynamics with other classes	466

Table 332 – Attributes of OverexcitationLimiterDynamics::OverexcLimIEEE.....	467
Table 333 – Association ends of OverexcitationLimiterDynamics:: OverexcLimIEEE with other classes	467
Table 334 – Attributes of OverexcitationLimiterDynamics::OverexcLim2	469
Table 335 – Association ends of OverexcitationLimiterDynamics:: OverexcLim2 with other classes	469
Table 336 – Attributes of OverexcitationLimiterDynamics::OverexcLimX1	471
Table 337 – Association ends of OverexcitationLimiterDynamics:: OverexcLimX1 with other classes	471
Table 338 – Attributes of OverexcitationLimiterDynamics::OverexcLimX2	473
Table 339 – Association ends of OverexcitationLimiterDynamics:: OverexcLimX2 with other classes	474
Table 340 – Literals of OverexcitationLimiterDynamics::OverExcitationLimiterInputKind	475
Table 341 – Attributes of UnderexcitationLimiterDynamics:: UnderexcitationLimiterDynamics	476
Table 342 – Association ends of UnderexcitationLimiterDynamics:: UnderexcitationLimiterDynamics with other classes	476
Table 343 – Attributes of UnderexcitationLimiterDynamics::UnderexcLimIEEE1	477
Table 344 – Association ends of UnderexcitationLimiterDynamics:: UnderexcLimIEEE1 with other classes	478
Table 345 – Attributes of UnderexcitationLimiterDynamics::UnderexcLimIEEE2	478
Table 346 – Association ends of UnderexcitationLimiterDynamics:: UnderexcLimIEEE2 with other classes	480
Table 347 – Attributes of UnderexcitationLimiterDynamics::UnderexcLimIEEEUEL2C	481
Table 348 – Association ends of UnderexcitationLimiterDynamics:: UnderexcLimIEEEUEL2C with other classes	483
Table 349 – Attributes of UnderexcitationLimiterDynamics::UnderexcLim2Simplified	484
Table 350 – Association ends of UnderexcitationLimiterDynamics:: UnderexcLim2Simplified with other classes	485
Table 351 – Attributes of UnderexcitationLimiterDynamics::UnderexcLimX1	486
Table 352 – Association ends of UnderexcitationLimiterDynamics:: UnderexcLimX1 with other classes	487
Table 353 – Attributes of UnderexcitationLimiterDynamics::UnderexcLimX2	488
Table 354 – Association ends of UnderexcitationLimiterDynamics:: UnderexcLimX2 with other classes	489
Table 355 – Attributes of PowerSystemStabilizerDynamics:: PowerSystemStabilizerDynamics	492
Table 356 – Association ends of PowerSystemStabilizerDynamics:: PowerSystemStabilizerDynamics with other classes	492
Table 357 – Attributes of PowerSystemStabilizerDynamics::PssIEEE2C	493
Table 358 – Association ends of PowerSystemStabilizerDynamics:: PssIEEE2C with other classes	494
Table 359 – Attributes of PowerSystemStabilizerDynamics::PssIEEE3C	495
Table 360 – Association ends of PowerSystemStabilizerDynamics:: PssIEEE3C with other classes	496
Table 361 – Attributes of PowerSystemStabilizerDynamics::PssIEEE4C	497
Table 362 – Association ends of PowerSystemStabilizerDynamics:: PssIEEE4C with other classes	500

Table 363 – Attributes of PowerSystemStabilizerDynamics::PssIEEE5C	501
Table 364 – Association ends of PowerSystemStabilizerDynamics:: PssIEEE5C with other classes	502
Table 365 – Attributes of PowerSystemStabilizerDynamics::PssIEEE6C	503
Table 366 – Association ends of PowerSystemStabilizerDynamics:: PssIEEE6C with other classes	504
Table 367 – Attributes of PowerSystemStabilizerDynamics::PssIEEE7C	505
Table 368 – Association ends of PowerSystemStabilizerDynamics:: PssIEEE7C with other classes	506
Table 369 – Attributes of PowerSystemStabilizerDynamics::PssIEEE1A	507
Table 370 – Association ends of PowerSystemStabilizerDynamics:: PssIEEE1A with other classes	508
Table 371 – Attributes of PowerSystemStabilizerDynamics::PssIEEE2B	509
Table 372 – Association ends of PowerSystemStabilizerDynamics:: PssIEEE2B with other classes	510
Table 373 – Attributes of PowerSystemStabilizerDynamics::PssIEEE3B	511
Table 374 – Association ends of PowerSystemStabilizerDynamics:: PssIEEE3B with other classes	512
Table 375 – Attributes of PowerSystemStabilizerDynamics::PssIEEE4B	513
Table 376 – Association ends of PowerSystemStabilizerDynamics:: PssIEEE4B with other classes	515
Table 377 – Attributes of PowerSystemStabilizerDynamics::Pss1	517
Table 378 – Association ends of PowerSystemStabilizerDynamics:: Pss1 with other classes	517
Table 379 – Attributes of PowerSystemStabilizerDynamics::Pss1A	518
Table 380 – Association ends of PowerSystemStabilizerDynamics:: Pss1A with other classes	519
Table 381 – Attributes of PowerSystemStabilizerDynamics::Pss2B	520
Table 382 – Association ends of PowerSystemStabilizerDynamics:: Pss2B with other classes	522
Table 383 – Attributes of PowerSystemStabilizerDynamics::Pss2ST	523
Table 384 – Association ends of PowerSystemStabilizerDynamics:: Pss2ST with other classes	524
Table 385 – Attributes of PowerSystemStabilizerDynamics::Pss5	525
Table 386 – Association ends of PowerSystemStabilizerDynamics:: Pss5 with other classes	526
Table 387 – Attributes of PowerSystemStabilizerDynamics::PssELIN2.....	527
Table 388 – Association ends of PowerSystemStabilizerDynamics:: PssELIN2 with other classes	528
Table 389 – Attributes of PowerSystemStabilizerDynamics::PssPTIST1.....	529
Table 390 – Association ends of PowerSystemStabilizerDynamics:: PssPTIST1 with other classes	529
Table 391 – Attributes of PowerSystemStabilizerDynamics::PssPTIST3.....	531
Table 392 – Association ends of PowerSystemStabilizerDynamics:: PssPTIST3 with other classes	532
Table 393 – Attributes of PowerSystemStabilizerDynamics::PssRQB.....	533
Table 394 – Association ends of PowerSystemStabilizerDynamics:: PssRQB with other classes	534

Table 395 – Attributes of PowerSystemStabilizerDynamics::PssSB4	535
Table 396 – Association ends of PowerSystemStabilizerDynamics:: PssSB4 with other classes	536
Table 397 – Attributes of PowerSystemStabilizerDynamics::PssSH	537
Table 398 – Association ends of PowerSystemStabilizerDynamics:: PssSH with other classes	537
Table 399 – Attributes of PowerSystemStabilizerDynamics::PssSK.....	539
Table 400 – Association ends of PowerSystemStabilizerDynamics:: PssSK with other classes	539
Table 401 – Attributes of PowerSystemStabilizerDynamics::PssSTAB2A	540
Table 402 – Association ends of PowerSystemStabilizerDynamics:: PssSTAB2A with other classes	541
Table 403 – Attributes of PowerSystemStabilizerDynamics::PssWECC	542
Table 404 – Association ends of PowerSystemStabilizerDynamics:: PssWECC with other classes	543
Table 405 – Literals of PowerSystemStabilizerDynamics::InputSignalKind	544
Table 406 – Attributes of DiscontinuousExcitationControlDynamics:: DiscontinuousExcitationControlDynamics.....	546
Table 407 – Association ends of DiscontinuousExcitationControlDynamics:: DiscontinuousExcitationControlDynamics with other classes	547
Table 408 – Attributes of DiscontinuousExcitationControlDynamics:: DiscExcContIEEEDEC1A	547
Table 409 – Association ends of DiscontinuousExcitationControlDynamics:: DiscExcContIEEEDEC1A with other classes	548
Table 410 – Attributes of DiscontinuousExcitationControlDynamics:: DiscExcContIEEEDEC2A	549
Table 411 – Association ends of DiscontinuousExcitationControlDynamics:: DiscExcContIEEEDEC2A with other classes	550
Table 412 – Attributes of DiscontinuousExcitationControlDynamics::DiscExcContIEEEDEC3A.....	550
Table 413 – Association ends of DiscontinuousExcitationControlDynamics:: DiscExcContIEEEDEC3A with other classes	551
Table 414 – Attributes of PFVArControllerType1Dynamics:: PFVArType1IEEEVArController	553
Table 415 – Association ends of PFVArControllerType1Dynamics:: PFVArType1IEEEVArController with other classes.....	553
Table 416 – Attributes of PFVArControllerType1Dynamics:: PFVArControllerType1Dynamics	554
Table 417 – Association ends of PFVArControllerType1Dynamics:: PFVArControllerType1Dynamics with other classes	554
Table 418 – Attributes of PFVArControllerType1Dynamics:: PFVArType1CIEEEPFController	555
Table 419 – Association ends of PFVArControllerType1Dynamics:: PFVArType1CIEEEPFController with other classes.....	555
Table 420 – Attributes of PFVArControllerType1Dynamics:: PFVArType1CIEEEVArController	556
Table 421 – Association ends of PFVArControllerType1Dynamics:: PFVArType1CIEEEVArController with other classes	557
Table 422 – Attributes of PFVArControllerType1Dynamics:: PFVArType1IEEEPFController	557

Table 423 – Association ends of PFVArControllerType1Dynamics:: PFVArType1IEEEPFController with other classes	558
Table 424 – Attributes of PFVArControllerType2Dynamics::PFVArType2Common1	560
Table 425 – Association ends of PFVArControllerType2Dynamics:: PFVArType2Common1 with other classes	561
Table 426 – Attributes of PFVArControllerType2Dynamics:: PFVArType2IEEEPFController	561
Table 427 – Association ends of PFVArControllerType2Dynamics:: PFVArType2IEEEPFController with other classes	562
Table 428 – Attributes of PFVArControllerType2Dynamics:: PFVArType2CIEEEPFController	562
Table 429 – Association ends of PFVArControllerType2Dynamics:: PFVArType2CIEEEPFController with other classes	563
Table 430 – Attributes of PFVArControllerType2Dynamics:: PFVArType2CIEEEVArController	564
Table 431 – Association ends of PFVArControllerType2Dynamics:: PFVArType2CIEEEVArController with other classes	564
Table 432 – Attributes of PFVArControllerType2Dynamics:: PFVArType2IEEEVArController	565
Table 433 – Association ends of PFVArControllerType2Dynamics:: PFVArType2IEEEVArController with other classes	565
Table 434 – Attributes of PFVArControllerType2Dynamics:: PFVArControllerType2Dynamics	566
Table 435 – Association ends of PFVArControllerType2Dynamics:: PFVArControllerType2Dynamics with other classes	566
Table 436 – Attributes of VoltageAdjusterDynamics::VoltageAdjusterDynamics	568
Table 437 – Association ends of VoltageAdjusterDynamics:: VoltageAdjusterDynamics with other classes	568
Table 438 – Attributes of VoltageAdjusterDynamics::VAdjIEEE	569
Table 439 – Association ends of VoltageAdjusterDynamics:: VAdjIEEE with other classes	569
Table 440 – Attributes of VoltageAdjusterDynamics::VAdjIEEE2	570
Table 441 – Association ends of VoltageAdjusterDynamics:: VAdjIEEE2 with other classes	570
Table 442 – Attributes of VoltageCompensatorDynamics::VoltageCompensatorDynamics	573
Table 443 – Association ends of VoltageCompensatorDynamics:: VoltageCompensatorDynamics with other classes	574
Table 444 – Attributes of VoltageCompensatorDynamics::VCompIEEEType1	574
Table 445 – Association ends of VoltageCompensatorDynamics:: VCompIEEEType1 with other classes	575
Table 446 – Attributes of VoltageCompensatorDynamics::VCompIEEEType2	576
Table 447 – Association ends of VoltageCompensatorDynamics:: VCompIEEEType2 with other classes	576
Table 448 – Attributes of VoltageCompensatorDynamics::GenICompensationForGenJ	577
Table 449 – Association ends of VoltageCompensatorDynamics:: GenICompensationForGenJ with other classes	577
Table 450 – Attributes of WindDynamics::WindPlantIEC	582
Table 451 – Association ends of WindDynamics::WindPlantIEC with other classes	582

Table 452 – Attributes of WindDynamics::WindPlantDynamics	583
Table 453 – Association ends of WindDynamics::WindPlantDynamics with other classes	583
Table 454 – Attributes of WindDynamics::WindTurbineType1or2Dynamics	584
Table 455 – Association ends of WindDynamics:: WindTurbineType1or2Dynamics with other classes	584
Table 456 – Attributes of WindDynamics::WindTurbineType3or4Dynamics	585
Table 457 – Association ends of WindDynamics:: WindTurbineType3or4Dynamics with other classes	585
Table 458 – Attributes of WindDynamics::WindTurbineType1or2IEC	586
Table 459 – Association ends of WindDynamics:: WindTurbineType1or2IEC with other classes	587
Table 460 – Attributes of WindDynamics::WindTurbineType3or4IEC	587
Table 461 – Association ends of WindDynamics:: WindTurbineType3or4IEC with other classes	588
Table 462 – Attributes of WindDynamics::WindTurbineType3IEC	589
Table 463 – Association ends of WindDynamics:: WindTurbineType3IEC with other classes	589
Table 464 – Attributes of WindDynamics::WindTurbineType4IEC	590
Table 465 – Association ends of WindDynamics:: WindTurbineType4IEC with other classes	590
Table 466 – Attributes of WindDynamics::WindGenTurbineType1aIEC	591
Table 467 – Association ends of WindDynamics:: WindGenTurbineType1aIEC with other classes	592
Table 468 – Attributes of WindDynamics::WindGenTurbineType1bIEC	592
Table 469 – Association ends of WindDynamics:: WindGenTurbineType1bIEC with other classes	593
Table 470 – Attributes of WindDynamics::WindGenTurbineType2IEC	593
Table 471 – Association ends of WindDynamics:: WindGenTurbineType2IEC with other classes	594
Table 472 – Attributes of WindDynamics::WindGenType3IEC	595
Table 473 – Association ends of WindDynamics::WindGenType3IEC with other classes	595
Table 474 – Attributes of WindDynamics::WindTurbineType4aIEC	596
Table 475 – Association ends of WindDynamics:: WindTurbineType4aIEC with other classes	596
Table 476 – Attributes of WindDynamics::WindTurbineType4bIEC	597
Table 477 – Association ends of WindDynamics:: WindTurbineType4bIEC with other classes	597
Table 478 – Attributes of WindDynamics::WindGenType3aIEC	598
Table 479 – Association ends of WindDynamics::WindGenType3aIEC with other classes	599
Table 480 – Attributes of WindDynamics::WindGenType3bIEC	599
Table 481 – Association ends of WindDynamics::WindGenType3bIEC with other classes	600
Table 482 – Attributes of WindDynamics::WindGenType4IEC	600
Table 483 – Association ends of WindDynamics::WindGenType4IEC with other classes	601
Table 484 – Attributes of WindDynamics::WindRefFrameRotIEC	601

Table 485 – Association ends of WindDynamics:: WindRefFrameRotIEC with other classes	602
Table 486 – Attributes of WindDynamics::WindAeroConstIEC	602
Table 487 – Association ends of WindDynamics::WindAeroConstIEC with other classes.....	602
Table 488 – Attributes of WindDynamics::WindAeroOneDimIEC	603
Table 489 – Association ends of WindDynamics:: WindAeroOneDimIEC with other classes	603
Table 490 – Attributes of WindDynamics::WindAeroTwoDimIEC	604
Table 491 – Association ends of WindDynamics:: WindAeroTwoDimIEC with other classes	605
Table 492 – Attributes of WindDynamics::WindMechIEC	605
Table 493 – Association ends of WindDynamics::WindMechIEC with other classes.....	606
Table 494 – Attributes of WindDynamics::WindPitchContPowerIEC	606
Table 495 – Association ends of WindDynamics:: WindPitchContPowerIEC with other classes	607
Table 496 – Attributes of WindDynamics::WindContRotorRIEC	608
Table 497 – Association ends of WindDynamics::WindContRotorRIEC with other classes	608
Table 498 – Attributes of WindDynamics::WindContPType3IEC	609
Table 499 – Association ends of WindDynamics:: WindContPType3IEC with other classes	610
Table 500 – Attributes of WindDynamics::WindContPType4aIEC	611
Table 501 – Association ends of WindDynamics:: WindContPType4aIEC with other classes	611
Table 502 – Attributes of WindDynamics::WindContPType4bIEC	612
Table 503 – Association ends of WindDynamics:: WindContPType4bIEC with other classes	612
Table 504 – Attributes of WindDynamics::WindContQIEC	613
Table 505 – Association ends of WindDynamics::WindContQIEC with other classes	614
Table 506 – Attributes of WindDynamics::WindContCurrLimIEC.....	615
Table 507 – Association ends of WindDynamics:: WindContCurrLimIEC with other classes	615
Table 508 – Attributes of WindDynamics::WindContQLimIEC.....	616
Table 509 – Association ends of WindDynamics::WindContQLimIEC with other classes	616
Table 510 – Attributes of WindDynamics::WindContQPQULimIEC	617
Table 511 – Association ends of WindDynamics:: WindContQPQULimIEC with other classes	617
Table 512 – Attributes of WindDynamics::WindContPitchAngleIEC	618
Table 513 – Association ends of WindDynamics:: WindContPitchAngleIEC with other classes	619
Table 514 – Attributes of WindDynamics::WindProtectionIEC	619
Table 515 – Association ends of WindDynamics::WindProtectionIEC with other classes	620
Table 516 – Attributes of WindDynamics::WindPlantReactiveControlIEC.....	621
Table 517 – Association ends of WindDynamics:: WindPlantReactiveControlIEC with other classes	622
Table 518 – Attributes of WindDynamics::WindPlantFreqPcontrolIEC	623

Table 519 – Association ends of WindDynamics:: WindPlantFreqPcontrolIEC with other classes	624
Table 520 – Attributes of WindDynamics::WindDynamicsLookupTable	624
Table 521 – Association ends of WindDynamics:: WindDynamicsLookupTable with other classes	625
Table 522 – Literals of WindDynamics::WindQcontrolModeKind	626
Table 523 – Literals of WindDynamics::WindUVRTQcontrolModeKind	626
Table 524 – Literals of WindDynamics::WindLookupTableFunctionKind	626
Table 525 – Literals of WindDynamics::WindPlantQcontrolModeKind	627
Table 526 – Attributes of WindDynamicsEd2::CommunicationDelayIEC	633
Table 527 – Association ends of WindDynamicsEd2:: CommunicationDelayIEC with other classes	633
Table 528 – Attributes of WindDynamicsEd2::CommunicationIEC	634
Table 529 – Association ends of WindDynamicsEd2:: CommunicationIEC with other classes	634
Table 530 – Attributes of WindDynamicsEd2::LinearCommunicationIEC	635
Table 531 – Association ends of WindDynamicsEd2:: LinearCommunicationIEC with other classes	635
Table 532 – Attributes of WindDynamicsEd2::WindPlantControlCommIEC	636
Table 533 – Association ends of WindDynamicsEd2:: WindPlantControlCommIEC with other classes	636
Table 534 – Attributes of WindDynamicsEd2::WindPlantQCompensationIEC	637
Table 535 – Association ends of WindDynamicsEd2:: WindPlantQCompensationIEC with other classes	637
Table 536 – Attributes of WindDynamicsEd2::WindPlantBasicIEC	638
Table 537 – Association ends of WindDynamicsEd2:: WindPlantBasicIEC with other classes	638
Table 538 – Attributes of WindDynamicsEd2::WindPlantDynamics2	639
Table 539 – Association ends of WindDynamicsEd2:: WindPlantDynamics2 with other classes	639
Table 540 – Attributes of WindDynamicsEd2::WindTurbineType1or2IEC2	640
Table 541 – Association ends of WindDynamicsEd2:: WindTurbineType1or2IEC2 with other classes	640
Table 542 – Attributes of WindDynamicsEd2::WindTurbineType3or4IEC2	641
Table 543 – Association ends of WindDynamicsEd2:: WindTurbineType3or4IEC2 with other classes	642
Table 544 – Attributes of WindDynamicsEd2::WindTurbineType3IEC2	643
Table 545 – Association ends of WindDynamicsEd2:: WindTurbineType3IEC2 with other classes	643
Table 546 – Attributes of WindDynamicsEd2::WindTurbineType4IEC2	644
Table 547 – Association ends of WindDynamicsEd2:: WindTurbineType4IEC2 with other classes	645
Table 548 – Attributes of WindDynamicsEd2::WindGenTurbineType1aIEC2	646
Table 549 – Association ends of WindDynamicsEd2:: WindGenTurbineType1aIEC2 with other classes	646
Table 550 – Attributes of WindDynamicsEd2::WindGenTurbineType1bIEC2	647
Table 551 – Association ends of WindDynamicsEd2:: WindGenTurbineType1bIEC2 with other classes	647

Table 552 – Attributes of WindDynamicsEd2::WindGenTurbineType2IEC2	648
Table 553 – Association ends of WindDynamicsEd2:: WindGenTurbineType2IEC2 with other classes	648
Table 554 – Attributes of WindDynamicsEd2::WindGenType3IEC2	649
Table 555 – Association ends of WindDynamicsEd2:: WindGenType3IEC2 with other classes	650
Table 556 – Attributes of WindDynamicsEd2::WindGridMeasurement	650
Table 557 – Association ends of WindDynamicsEd2:: WindGridMeasurement with other classes	651
Table 558 – Attributes of WindDynamicsEd2::WindTurbineType4aIEC2	652
Table 559 – Association ends of WindDynamicsEd2:: WindTurbineType4aIEC2 with other classes	652
Table 560 – Attributes of WindDynamicsEd2::WindTurbineType4bIEC2	653
Table 561 – Association ends of WindDynamicsEd2:: WindTurbineType4bIEC2 with other classes	654
Table 562 – Attributes of WindDynamicsEd2::WindGenType3aIEC2	655
Table 563 – Association ends of WindDynamicsEd2:: WindGenType3aIEC2 with other classes	655
Table 564 – Attributes of WindDynamicsEd2::WindGenType3bIEC2	656
Table 565 – Association ends of WindDynamicsEd2:: WindGenType3bIEC2 with other classes	656
Table 566 – Attributes of WindDynamicsEd2::WindGenType4IEC2	657
Table 567 – Association ends of WindDynamicsEd2:: WindGenType4IEC2 with other classes	657
Table 568 – Attributes of WindDynamicsEd2::WindRefFrameRotIEC2.....	658
Table 569 – Association ends of WindDynamicsEd2:: WindRefFrameRotIEC2 with other classes	658
Table 570 – Attributes of WindDynamicsEd2::WindAeroConstIEC2	659
Table 571 – Association ends of WindDynamicsEd2:: WindAeroConstIEC2 with other classes	659
Table 572 – Attributes of WindDynamicsEd2::WindAeroOneDimIEC2	660
Table 573 – Association ends of WindDynamicsEd2:: WindAeroOneDimIEC2 with other classes	660
Table 574 – Attributes of WindDynamicsEd2::WindAeroTwoDimIEC2	661
Table 575 – Association ends of WindDynamicsEd2:: WindAeroTwoDimIEC2 with other classes	661
Table 576 – Attributes of WindDynamicsEd2::WindElectricalSystemGamma	662
Table 577 – Association ends of WindDynamicsEd2:: WindElectricalSystemGamma with other classes	662
Table 578 – Attributes of WindDynamicsEd2::WindMechIEC2	663
Table 579 – Association ends of WindDynamicsEd2::WindMechIEC2 with other classes.....	663
Table 580 – Attributes of WindDynamicsEd2::WindPitchContPowerIEC2	664
Table 581 – Association ends of WindDynamicsEd2:: WindPitchContPowerIEC2 with other classes	664
Table 582 – Attributes of WindDynamicsEd2::WindContRotorRIEC2	665
Table 583 – Association ends of WindDynamicsEd2:: WindContRotorRIEC2 with other classes	666
Table 584 – Attributes of WindDynamicsEd2::WindContPTType3IEC2	666

Table 585 – Association ends of WindDynamicsEd2:: WindContPType3IEC2 with other classes	668
Table 586 – Attributes of WindDynamicsEd2::WindContPType4aIEC2	668
Table 587 – Association ends of WindDynamicsEd2:: WindContPType4aIEC2 with other classes	669
Table 588 – Attributes of WindDynamicsEd2::WindContPType4bIEC2	670
Table 589 – Association ends of WindDynamicsEd2:: WindContPType4bIEC2 with other classes	670
Table 590 – Attributes of WindDynamicsEd2::WindContQIEC2	671
Table 591 – Association ends of WindDynamicsEd2::WindContQIEC2 with other classes	672
Table 592 – Attributes of WindDynamicsEd2::WindContCurrLimIEC2.....	673
Table 593 – Association ends of WindDynamicsEd2:: WindContCurrLimIEC2 with other classes	674
Table 594 – Attributes of WindDynamicsEd2::WindContQLimIEC2.....	674
Table 595 – Association ends of WindDynamicsEd2:: WindContQLimIEC2 with other classes	675
Table 596 – Attributes of WindDynamicsEd2::WindContQPQULimIEC2	675
Table 597 – Association ends of WindDynamicsEd2:: WindContQPQULimIEC2 with other classes	676
Table 598 – Attributes of WindDynamicsEd2::WindContPitchAngleIEC2	676
Table 599 – Association ends of WindDynamicsEd2:: WindContPitchAngleIEC2 with other classes	677
Table 600 – Attributes of WindDynamicsEd2::WindProtectionIEC2	678
Table 601 – Association ends of WindDynamicsEd2:: WindProtectionIEC2 with other classes	679
Table 602 – Attributes of WindDynamicsEd2::WindPlantQControlIEC	679
Table 603 – Association ends of WindDynamicsEd2:: WindPlantQControlIEC with other classes	681
Table 604 – Attributes of WindDynamicsEd2::WindPlantPControlIEC.....	681
Table 605 – Association ends of WindDynamicsEd2:: WindPlantPControlIEC with other classes	682
Table 606 – Attributes of WindDynamicsEd2::WindDynamicsLookupTable2	683
Table 607 – Association ends of WindDynamicsEd2:: WindDynamicsLookupTable2 with other classes	683
Table 608 – Literals of WindDynamicsEd2::WindQcontrolModeKind2.....	684
Table 609 – Literals of WindDynamicsEd2::WindFRTQcontrolModeKind	684
Table 610 – Literals of WindDynamicsEd2::WindLookupTableFunctionKind2	685
Table 611 – Literals of WindDynamicsEd2::WindPlantQcontrolModeKind2.....	686
Table 612 – Attributes of LoadDynamics::LoadComposite.....	689
Table 613 – Association ends of LoadDynamics::LoadComposite with other classes	690
Table 614 – Attributes of LoadDynamics::LoadGenericNonLinear	691
Table 615 – Association ends of LoadDynamics:: LoadGenericNonLinear with other classes	692
Table 616 – Attributes of LoadDynamics::LoadDynamics	693
Table 617 – Association ends of LoadDynamics::LoadDynamics with other classes	693
Table 618 – Attributes of LoadDynamics::LoadAggregate	694

Table 619 – Association ends of LoadDynamics::LoadAggregate with other classes	694
Table 620 – Attributes of LoadDynamics::LoadStatic	696
Table 621 – Association ends of LoadDynamics::LoadStatic with other classes	697
Table 622 – Attributes of LoadDynamics::LoadMotor	699
Table 623 – Association ends of LoadDynamics::LoadMotor with other classes	700
Table 624 – Literals of LoadDynamics::GenericNonLinearLoadModelKind	700
Table 625 – Literals of LoadDynamics::StaticLoadModelKind.....	700
Table 626 – Attributes of LoadCompositeWECC::LoadAirCoWECC.....	702
Table 627 – Association ends of LoadCompositeWECC:: LoadAirCoWECC with other classes	703
Table 628 – Attributes of LoadCompositeWECC::LoadCompositeWECC.....	703
Table 629 – Association ends of LoadCompositeWECC::LoadCompositeWECC with other classes	705
Table 630 – Attributes of LoadCompositeWECC::LoadElectronicWECC	705
Table 631 – Association ends of LoadCompositeWECC:: LoadElectronicWECC with other classes	706
Table 632 – Attributes of LoadCompositeWECC::LoadMotorWECC	706
Table 633 – Association ends of LoadCompositeWECC:: LoadMotorWECC with other classes	707
Table 634 – Attributes of LoadCompositeWECC::LoadStaticWECC	708
Table 635 – Association ends of LoadCompositeWECC:: LoadStaticWECC with other classes	708
Table 636 – Attributes of HVDCDynamics::HVDCInterconnectionDynamics	710
Table 637 – Association ends of HVDCDynamics:: HVDCInterconnectionDynamics with other classes	710
Table 638 – Attributes of HVDCDynamics::HVDCDynamics	711
Table 639 – Association ends of HVDCDynamics::HVDCDynamics with other classes	711
Table 640 – Attributes of HVDCDynamics::CSCDynamics.....	711
Table 641 – Association ends of HVDCDynamics::CSCDynamics with other classes	712
Table 642 – Attributes of HVDCDynamics::VSCDynamics	712
Table 643 – Association ends of HVDCDynamics::VSCDynamics with other classes.....	713
Table 644 – Attributes of RelayDynamics::RateOfChangeOfPowerRelay.....	714
Table 645 – Association ends of RelayDynamics:: RateOfChangeOfPowerRelay with other classes	715
Table 646 – Attributes of RelayDynamics::WeccTIOCRS	716
Table 647 – Association ends of RelayDynamics::WeccTIOCRS with other classes	717
Table 648 – Attributes of RelayDynamics::RelayDynamics.....	717
Table 649 – Association ends of RelayDynamics::RelayDynamics with other classes.....	718
Table 650 – Attributes of StatorCurrentLimiterDynamics::StatorCurrentLimiterDynamics.....	719
Table 651 – Association ends of StatorCurrentLimiterDynamics:: StatorCurrentLimiterDynamics with other classes.....	720
Table 652 – Attributes of StatorCurrentLimiterDynamics::StatorCurrentLimIEEEESCL1C	720
Table 653 – Association ends of StatorCurrentLimiterDynamics:: StatorCurrentLimIEEEESCL1C with other classes.....	721
Table 654 – Attributes of StatorCurrentLimiterDynamics::StatorCurrentLimIEEEESCL2C	722

Table 655 – Association ends of StatorCurrentLimiterDynamics:: StatorCurrentLimIEEEESCL2C with other classes	725
Table 656 – Attributes of StaticVarCompensatorDynamics::SVSMO4.....	727
Table 657 – Association ends of StaticVarCompensatorDynamics:: SVSMO4 with other classes	729
Table 658 – Attributes of StaticVarCompensatorDynamics::SVSMO1.....	730
Table 659 – Association ends of StaticVarCompensatorDynamics:: SVSMO1 with other classes	732
Table 660 – Attributes of StaticVarCompensatorDynamics::SVSMO3.....	733
Table 661 – Association ends of StaticVarCompensatorDynamics:: SVSMO3 with other classes	735
Table 662 – Attributes of StaticVarCompensatorDynamics:: StaticVarCompensatorDynamics	735
Table 663 – Association ends of StaticVarCompensatorDynamics:: StaticVarCompensatorDynamics with other classes	736
Table 664 – Attributes of StaticVarCompensatorDynamics::SVSMO2.....	736
Table 665 – Association ends of StaticVarCompensatorDynamics:: SVSMO2 with other classes	739
Table 666 – Attributes of StaticVarCompensatorDynamics:: StaticVarCompensatorSystemDynamics	739
Table 667 – Association ends of StaticVarCompensatorDynamics:: StaticVarCompensatorSystemDynamics with other classes.....	740
Table 668 – Attributes of ShuntCompensatorDynamics::ShuntCompensatorDynamics	742
Table 669 – Association ends of ShuntCompensatorDynamics:: ShuntCompensatorDynamics with other classes	742
Table 670 – Attributes of StatcomDynamics::StatcomIEC.....	744
Table 671 – Association ends of StatcomDynamics::StatcomIEC with other classes	745
Table 672 – Attributes of StatcomDynamics::StatcomDynamics	746
Table 673 – Association ends of StatcomDynamics:: StatcomDynamics with other classes	746
Table 674 – Attributes of WECCDynamics::WeccPVD1	749
Table 675 – Association ends of WECCDynamics::WeccPVD1 with other classes.....	750
Table 676 – Attributes of WECCDynamics::WeccWT2E	751
Table 677 – Association ends of WECCDynamics::WeccWT2E with other classes	751
Table 678 – Attributes of WECCDynamics::WeccWTGARA.....	752
Table 679 – Association ends of WECCDynamics::WeccWTGARA with other classes.....	752
Table 680 – Attributes of WECCDynamics::WeccBESS.....	753
Table 681 – Association ends of WECCDynamics::WeccBESS with other classes	753
Table 682 – Attributes of WECCDynamics::WeccREECB	754
Table 683 – Association ends of WECCDynamics::WeccREECB with other classes.....	756
Table 684 – Attributes of WECCDynamics::WeccWT1PB	756
Table 685 – Association ends of WECCDynamics::WeccWT1PB with other classes.....	757
Table 686 – Attributes of WECCDynamics::WeccWTGTA	758
Table 687 – Association ends of WECCDynamics::WeccWTGTA with other classes	758
Table 688 – Attributes of WECCDynamics::WeccREECD	759
Table 689 – Association ends of WECCDynamics::WeccREECD with other classes.....	763

Table 690 – Attributes of WECCDynamics::WeccREPCC	764
Table 691 – Association ends of WECCDynamics::WeccREPCC with other classes	766
Table 692 – Attributes of WECCDynamics::WeccWTGPTA	767
Table 693 – Association ends of WECCDynamics::WeccWTGPTA with other classes	768
Table 694 – Attributes of WECCDynamics::WeccREEC	768
Table 695 – Association ends of WECCDynamics::WeccREEC with other classes	769
Table 696 – Attributes of WECCDynamics::WeccREGCB	769
Table 697 – Association ends of WECCDynamics::WeccREGCB with other classes	770
Table 698 – Attributes of WECCDynamics::WeccWTGWGOA	771
Table 699 – Association ends of WECCDynamics::WeccWTGWGOA with other classes	771
Table 700 – Attributes of WECCDynamics::WeccDERApvmod	772
Table 701 – Association ends of WECCDynamics::WeccDERApvmod with other classes	773
Table 702 – Attributes of WECCDynamics::WeccWTGTB	773
Table 703 – Association ends of WECCDynamics::WeccWTGTB with other classes	774
Table 704 – Attributes of WECCDynamics::WeccREECC	774
Table 705 – Association ends of WECCDynamics::WeccREECC with other classes	777
Table 706 – Attributes of WECCDynamics::WeccWTGIBFFRA	778
Table 707 – Association ends of WECCDynamics::WeccWTGIBFFRA with other classes	779
Table 708 – Attributes of WECCDynamics::WeccREGCC	780
Table 709 – Association ends of WECCDynamics::WeccREGCC with other classes	781
Table 710 – Attributes of WECCDynamics::WeccDERA	782
Table 711 – Association ends of WECCDynamics::WeccDERA with other classes	784
Table 712 – Attributes of WECCDynamics::WeccDynamicsLookupTable	784
Table 713 – Association ends of WECCDynamics:: WeccDynamicsLookupTable with other classes	785
Table 714 – Attributes of WECCDynamics::WeccREECA	785
Table 715 – Association ends of WECCDynamics::WeccREECA with other classes	788
Table 716 – Literals of WECCDynamics::WeccLookupTableFunctionKind	788
Table 717 – Attributes of WECCDynamics::WeccWTGPB	789
Table 718 – Association ends of WECCDynamics::WeccWTGPB with other classes	789
Table 719 – Attributes of WECCDynamics::WeccWTGTRQA	790
Table 720 – Association ends of WECCDynamics::WeccWTGTRQA with other classes	791
Table 721 – Attributes of WECCDynamics::WeccDynamics	791
Table 722 – Association ends of WECCDynamics::WeccDynamics with other classes	792
Table 723 – Attributes of WECCDynamics::WeccWT12T	792
Table 724 – Association ends of WECCDynamics::WeccWT12T with other classes	793
Table 725 – Attributes of WECCDynamics::WeccREGCA	793
Table 726 – Association ends of WECCDynamics::WeccREGCA with other classes	794
Table 727 – Attributes of WECCDynamics::WeccREPCA	795
Table 728 – Association ends of WECCDynamics::WeccREPCA with other classes	796
Table 729 – Attributes of IEEE1547Dynamics::MomentaryCessationSettings	798

Table 730 – Association ends of IEEE1547Dynamics:: MomentaryCessationSettings with other classes	798
Table 731 – Attributes of IEEE1547Dynamics::VoltWattSettings	799
Table 732 – Association ends of IEEE1547Dynamics:: VoltWattSettings with other classes	800
Table 733 – Literals of IEEE1547Dynamics::AbnormalOPcatKind	800
Table 734 – Attributes of IEEE1547Dynamics::DERIEEEType1	801
Table 735 – Association ends of IEEE1547Dynamics::DERIEEEType1 with other classes	801
Table 736 – Attributes of IEEE1547Dynamics::ConstantReactivePowerSettings	802
Table 737 – Association ends of IEEE1547Dynamics:: ConstantReactivePowerSettings with other classes	803
Table 738 – Literals of IEEE1547Dynamics::NormalOPcatKind	803
Table 739 – Attributes of IEEE1547Dynamics::DERNameplateDataApplied	803
Table 740 – Association ends of IEEE1547Dynamics:: DERNameplateDataApplied with other classes	804
Table 741 – Attributes of IEEE1547Dynamics::FrequencyTripSettings	805
Table 742 – Association ends of IEEE1547Dynamics:: FrequencyTripSettings with other classes	805
Table 743 – Attributes of IEEE1547Dynamics::DERDynamics	806
Table 744 – Association ends of IEEE1547Dynamics::DERDynamics with other classes	806
Table 745 – Literals of IEEE1547Dynamics::ConstantPowerFactorSettingKind	807
Table 746 – Attributes of IEEE1547Dynamics::FrequencyDroopSettings	807
Table 747 – Association ends of IEEE1547Dynamics:: FrequencyDroopSettings with other classes	808
Table 748 – Attributes of IEEE1547Dynamics::VoltageTripSettings	808
Table 749 – Association ends of IEEE1547Dynamics:: VoltageTripSettings with other classes	809
Table 750 – Attributes of IEEE1547Dynamics::DERNameplateData	809
Table 751 – Association ends of IEEE1547Dynamics:: DERNameplateData with other classes	810
Table 752 – Attributes of IEEE1547Dynamics::PowerLimitSettings	811
Table 753 – Association ends of IEEE1547Dynamics:: PowerLimitSettings with other classes	811
Table 754 – Attributes of IEEE1547Dynamics::VoltVarSettings	812
Table 755 – Association ends of IEEE1547Dynamics::VoltVarSettings with other classes	813
Table 756 – Attributes of IEEE1547Dynamics::WattVarSettings	813
Table 757 – Association ends of IEEE1547Dynamics:: WattVarSettings with other classes	815
Table 758 – Attributes of IEEE1547Dynamics::ConstantPowerFactorSettings	815
Table 759 – Association ends of IEEE1547Dynamics:: ConstantPowerFactorSettings with other classes	816
Table 760 – Attributes of IEEE1547Dynamics::ServiceSettings	816
Table 761 – Association ends of IEEE1547Dynamics::ServiceSettings with other classes	817
Table 762 – Attributes of UserDefinedModels::SynchronousMachineUserDefined	819

Table 763 – Association ends of UserDefinedModels::	
SynchronousMachineUserDefined with other classes	819
Table 764 – Attributes of UserDefinedModels::AsynchronousMachineUserDefined	820
Table 765 – Association ends of UserDefinedModels::	
AsynchronousMachineUserDefined with other classes	821
Table 766 – Attributes of UserDefinedModels::TurbineGovernorUserDefined	821
Table 767 – Association ends of UserDefinedModels:: TurbineGovernorUserDefined	
with other classes	822
Table 768 – Attributes of UserDefinedModels::TurbineLoadControllerUserDefined	823
Table 769 – Association ends of UserDefinedModels::	
TurbineLoadControllerUserDefined with other classes	823
Table 770 – Attributes of UserDefinedModels::MechanicalLoadUserDefined	824
Table 771 – Association ends of UserDefinedModels:: MechanicalLoadUserDefined	
with other classes	824
Table 772 – Attributes of UserDefinedModels::ExcitationSystemUserDefined	825
Table 773 – Association ends of UserDefinedModels:: ExcitationSystemUserDefined	
with other classes	825
Table 774 – Attributes of UserDefinedModels::OverexcitationLimiterUserDefined	826
Table 775 – Association ends of UserDefinedModels::	
OverexcitationLimiterUserDefined with other classes	827
Table 776 – Attributes of UserDefinedModels::UnderexcitationLimiterUserDefined	827
Table 777 – Association ends of UserDefinedModels::	
UnderexcitationLimiterUserDefined with other classes	828
Table 778 – Attributes of UserDefinedModels::PowerSystemStabilizerUserDefined	828
Table 779 – Association ends of UserDefinedModels::	
PowerSystemStabilizerUserDefined with other classes	829
Table 780 – Attributes of UserDefinedModels::	
DiscontinuousExcitationControlUserDefined	830
Table 781 – Association ends of UserDefinedModels::	
DiscontinuousExcitationControlUserDefined with other classes	830
Table 782 – Attributes of UserDefinedModels::PFVArControllerType1UserDefined	831
Table 783 – Association ends of UserDefinedModels::	
PFVArControllerType1UserDefined with other classes	831
Table 784 – Attributes of UserDefinedModels::VoltageAdjusterUserDefined	832
Table 785 – Association ends of UserDefinedModels:: VoltageAdjusterUserDefined	
with other classes	832
Table 786 – Attributes of UserDefinedModels::PFVArControllerType2UserDefined	833
Table 787 – Association ends of UserDefinedModels::	
PFVArControllerType2UserDefined with other classes	834
Table 788 – Attributes of UserDefinedModels::VoltageCompensatorUserDefined	834
Table 789 – Association ends of UserDefinedModels::	
VoltageCompensatorUserDefined with other classes	835
Table 790 – Attributes of UserDefinedModels::LoadUserDefined	835
Table 791 – Association ends of UserDefinedModels:: LoadUserDefined with other	
classes	836
Table 792 – Attributes of UserDefinedModels::WindType1or2UserDefined	836
Table 793 – Association ends of UserDefinedModels:: WindType1or2UserDefined with	
other classes	837

Table 794 – Attributes of UserDefinedModels::WindType3or4UserDefined	837
Table 795 – Association ends of UserDefinedModels:: WindType3or4UserDefined with other classes	838
Table 796 – Attributes of UserDefinedModels::WindPlantUserDefined	839
Table 797 – Association ends of UserDefinedModels:: WindPlantUserDefined with other classes	839
Table 798 – Attributes of UserDefinedModels::CSCUserDefined	840
Table 799 – Association ends of UserDefinedModels:: CSCUserDefined with other classes	840
Table 800 – Attributes of UserDefinedModels::VSCUserDefined	841
Table 801 – Association ends of UserDefinedModels:: VSCUserDefined with other classes	841
Table 802 – Attributes of UserDefinedModels::SVCUserDefined	842
Table 803 – Association ends of UserDefinedModels:: SVCUserDefined with other classes	842
Table 804 – Attributes of UserDefinedModels::StatorCurrentLimiterUserDefined	843
Table 805 – Association ends of UserDefinedModels:: StatorCurrentLimiterUserDefined with other classes	843
Table 806 – Attributes of UserDefinedModels::ShuntCompensatorUserDefined	844
Table 807 – Association ends of UserDefinedModels:: ShuntCompensatorUserDefined with other classes	844
Table 808 – Attributes of UserDefinedModels::ProprietaryParameterDynamics	845
Table 809 – Association ends of UserDefinedModels:: ProprietaryParameterDynamics with other classes	845
Table 810 – Attributes of UserDefinedModels::StatcomUserDefined	847
Table 811 – Association ends of UserDefinedModels:: StatcomUserDefined with other classes	847
Table 812 – Attributes of UserDefinedModels::HVDCInterconnectionUserDefined	848
Table 813 – Association ends of UserDefinedModels:: HVDCInterconnectionUserDefined with other classes	848
Table 814 – Attributes of UserDefinedModels::RelayUserDefined	849
Table 815 – Association ends of UserDefinedModels:: RelayUserDefined with other classes	849
Table 816 – Attributes of DetailedModelDescription::DetailedModelTypeDynamics	851
Table 817 – Association ends of DetailedModelDescription:: DetailedModelTypeDynamics with other classes	851
Table 818 – Attributes of DetailedModelDescription::DetailedModelDescriptorArtifact	852
Table 819 – Association ends of DetailedModelDescription:: DetailedModelDescriptorArtifact with other classes	852
Table 820 – Attributes of DetailedModelDescription:: DetailedModelDocumentationArtifact	853
Table 821 – Association ends of DetailedModelDescription:: DetailedModelDocumentationArtifact with other classes	853
Table 822 – Attributes of DetailedModelDescription::FunctionDescriptor	853
Table 823 – Association ends of DetailedModelDescription:: FunctionDescriptor with other classes	854
Table 824 – Attributes of DetailedModelDescription::InputOutputDescriptor	855

Table 825 – Association ends of DetailedModelDescription:: InputOutputDescriptor with other classes	855
Table 826 – Attributes of DetailedModelDescription::LimiterDescriptor	856
Table 827 – Association ends of DetailedModelDescription:: LimiterDescriptor with other classes	856
Table 828 – Attributes of DetailedModelDescription::OperatorDescriptor	857
Table 829 – Association ends of DetailedModelDescription:: OperatorDescriptor with other classes	857
Table 830 – Attributes of DetailedModelDescription::ParameterDescriptor	858
Table 831 – Association ends of DetailedModelDescription:: ParameterDescriptor with other classes	858
Table 832 – Attributes of DetailedModelDescription::ParameterValue	859
Table 833 – Association ends of DetailedModelDescription:: ParameterValue with other classes	859
Table 834 – Attributes of DetailedModelDescription::SignalDescriptor	859
Table 835 – Association ends of DetailedModelDescription:: SignalDescriptor with other classes	860
Table 836 – Attributes of DetailedModelDescription::DetailedModelDescriptor	860
Table 837 – Association ends of DetailedModelDescription:: DetailedModelDescriptor with other classes	861
Table 838 – Attributes of DetailedModelDescription::DetailedModelDynamics	861
Table 839 – Association ends of DetailedModelDescription:: DetailedModelDynamics with other classes	862
Table 840 – Literals of DetailedModelDescription::ConstraintKind	862
Table 841 – Literals of DetailedModelDescription::LogicalKind	863
Table 842 – Literals of DetailedModelDescription::EquationLanguageKind	863
Table 843 – Literals of DetailedModelDescription::OperatorDescriptorKind	863
Table 844 – Literals of DetailedModelDescription::ParameterKind	864
Table 845 – Literals of DetailedModelDescription::XSDDatatypeKind	864
Table 846 – Literals of SimulationResult::ParameterChangeKind	866
Table 847 – Attributes of SimulationResult::ClearSimulationEvent	866
Table 848 – Association ends of SimulationResult:: ClearSimulationEvent with other classes	866
Table 849 – Attributes of SimulationResult::ParameterEvent	867
Table 850 – Association ends of SimulationResult::ParameterEvent with other classes	868
Table 851 – Attributes of SimulationResult::PowerFlowSettings	868
Table 852 – Association ends of SimulationResult:: PowerFlowSettings with other classes	870
Table 853 – Literals of SimulationResult::PowerFlowAlgorithmKind	871
Table 854 – Literals of SimulationResult::PowerShiftKind	871
Table 855 – Attributes of SimulationResult::SimulationResultCharacteristic	871
Table 856 – Association ends of SimulationResult:: SimulationResultCharacteristic with other classes	872
Table 857 – Attributes of SimulationResult::SignalRecorder	873
Table 858 – Association ends of SimulationResult::SignalRecorder with other classes	873
Table 859 – Attributes of SimulationResult::SignalConfiguration	874

Table 860 – Association ends of SimulationResult::SignalConfiguration with other classes	874
Table 861 – Attributes of SimulationResult::SimulationEvents	874
Table 862 – Association ends of SimulationResult::SimulationEvents with other classes	875
Table 863 – Literals of SimulationResult::SlackDistributionKind	875
Table 864 – Attributes of SimulationResult::SimulationResult	876
Table 865 – Association ends of SimulationResult::SimulationResult with other classes	876
Table 866 – Attributes of SimulationResult::SimulationSettings	877
Table 867 – Association ends of SimulationResult::SimulationSettings with other classes	877
Table 868 – Literals of SimulationResult::SignalKind	878

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**ENERGY MANAGEMENT SYSTEM APPLICATION
PROGRAM INTERFACE (EMS-API) –****Part 302: Common information model (CIM) dynamics****FOREWORD**

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

This second edition cancels and replaces the first edition published in 2018. 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 are addressed;
- b) IEEE 421.5-2016 on Excitation systems is fully covered;
- c) The 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 are enhanced with a model which enables modelling of detailed dynamic model;
- g) A model to enable exchange of simulation results is added;
- 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;
- 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 standard is based on the following documents:

Draft	Report on voting
57/2620/FDIS	57/2633/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.

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

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.

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

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

The scope of the CIM Dynamics package specified in this document 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 this document. 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 this document, only the model parameters.
- A model to enable exchange of models' descriptions. This approach can be used to describe user defined and standard models.
- A model to enable exchange of simulation results.

2 Normative references

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

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

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

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

3 Terms and definitions

For the purposes of this document, the terms and definitions contained in IEC 60050 (for general glossary), IEC TS 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

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

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

3.3

energy management system

EMS

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

3.4

model

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

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

3.5

Resource Description Framework

RDF

standard model for data interchange on the Web.

Note 1 to entry: RDF has features that facilitate data merging even if the underlying schemas differ, and it specifically support the evolution of schemas over time without requiring all the data consumers to be changed.

Note 2 to entry: RDF extends the linking structure of the Web to use URIs to name the relationship between things as well as the two ends of the link (this is usually referred to as a "triple").

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

3.6

Unified Modeling Language

UML

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

3.7

uniform resource identifier

URI

standard Web syntax and semantics for identifying (referencing) resources such as files, documents, and images

3.8

eXtensible Markup Language

XML

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

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

4 CIM Dynamics specification

4.1 General

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

- Prefix: cim
- URI: <http://cim.ucaiug.io/ns#>

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

This edition is based on the UML and artifacts which are available at: <https://artifact.ucaiug.org/20.500.14284/Dynamics/2.0>.

For each package, the model information for each class is fully described. Attribute and association end information for native and inherited attributes is documented in tables. These tables are reproduced from the UML with the permission of the UCAIug.

CIM for dynamics includes the following packages which are uniquely identified by its URI. In this document all packages have version 1.0.

- Dynamics: <http://cim.ucaiug.io/grid/Dynamics/1.0>
- StandardInterconnections: <http://cim.ucaiug.io/grid/StandardInterconnections/1.0>
- StandardModels: <http://cim.ucaiug.io/grid/StandardModels/1.0>
- UserDefinedModels: <http://cim.ucaiug.io/grid/UserDefinedModels/1.0>
- DetailedModelDescription: <http://cim.ucaiug.io/grid/DetailedModelDescription/1.0>
- SimulationResult: <http://cim.ucaiug.io/grid/SimulationResult/1.0>
- WindModels: <http://cim.ucaiug.io/grid/WindModels/1.0>
- SynchronousMachineDynamics:
<http://cim.ucaiug.io/grid/SynchronousMachineDynamics/1.0>
- AsynchronousMachineDynamics:
<http://cim.ucaiug.io/grid/AsynchronousMachineDynamics/1.0>
- TurbineGovernorDynamics: <http://cim.ucaiug.io/grid/TurbineGovernorDynamics/1.0>
- TurbineLoadControllerDynamics:
<http://cim.ucaiug.io/grid/TurbineLoadControllerDynamics/1.0>
- MechanicalLoadDynamics: <http://cim.ucaiug.io/grid/MechanicalLoadDynamics/1.0>
- ExcitationSystemDynamics: <http://cim.ucaiug.io/grid/ExcitationSystemDynamics/1.0>
- IEEE4215from2005: <http://cim.ucaiug.io/grid/IEEE4215from2005/1.0>
- IEEE4215from2016: <http://cim.ucaiug.io/grid/IEEE4215from2016/1.0>
- OverexcitationLimiterDynamics:
<http://cim.ucaiug.io/grid/OverexcitationLimiterDynamics/1.0>
- UnderexcitationLimiterDynamics:
<http://cim.ucaiug.io/grid/UnderexcitationLimiterDynamics/1.0>
- PowerSystemStabilizerDynamics:
<http://cim.ucaiug.io/grid/PowerSystemStabilizerDynamics/1.0>
- DiscontinuousExcitationControlDynamics:
<http://cim.ucaiug.io/grid/DiscontinuousExcitationControlDynamics/1.0>
- PFVArControllerType1Dynamics:
<http://cim.ucaiug.io/grid/PFVArControllerType1Dynamics/1.0>
- PFVArControllerType2Dynamics:
<http://cim.ucaiug.io/grid/PFVArControllerType2Dynamics/1.0>
- VoltageAdjusterDynamics: <http://cim.ucaiug.io/grid/VoltageAdjusterDynamics/1.0>
- VoltageCompensatorDynamics: <http://cim.ucaiug.io/grid/VoltageCompensatorDynamics/1.0>
- WindDynamics: <http://cim.ucaiug.io/grid/WindDynamics/1.0>
- WindDynamicsEd2: <http://cim.ucaiug.io/grid/WindDynamicsEd2/1.0>
- LoadDynamics: <http://cim.ucaiug.io/grid/LoadDynamics/1.0>
- LoadCompositeWECC: <http://cim.ucaiug.io/grid/LoadCompositeWECC/1.0>
- HVDCDynamics: <http://cim.ucaiug.io/grid/HVDCDynamics/1.0>
- RelayDynamics: <http://cim.ucaiug.io/grid/RelayDynamics/1.0>
- StatorCurrentLimiterDynamics: <http://cim.ucaiug.io/grid/StatorCurrentLimiterDynamics/1.0>
- StaticVarCompensatorDynamics:
<http://cim.ucaiug.io/grid/StaticVarCompensatorDynamics/1.0>
- ShuntCompenstorDynamics: <http://cim.ucaiug.io/grid/ShuntCompenstorDynamics/1.0>
- StatcomDynamics: <http://cim.ucaiug.io/grid/StatcomDynamics/1.0>
- WECCDynamics: <http://cim.ucaiug.io/grid/WECCDynamics/1.0>
- IEEE1547Dynamics: <http://cim.ucaiug.io/grid/IEEE1547Dynamics/1.0>

4.2 Document structure

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

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

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

Subclause 5.4 contains user-defined model classes.

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

Annex A describes the Dynamics package symbol representation conventions.

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

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

5 Common Information Model Dynamics package

5.1 General

[nsuri = <http://cim.ucaiug.io/ns#>, nsprefix = cim]

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

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

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

- limited integrators are of the non-windup type;
- it shall be possible to enter a time constant of zero (where it makes sense).

The information in this entire clause "Common Information Model Dynamics package" is reproduced from the UML with the permission of UCAIug.

5.2 Package StandardInterconnections

5.2.1 General

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

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

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

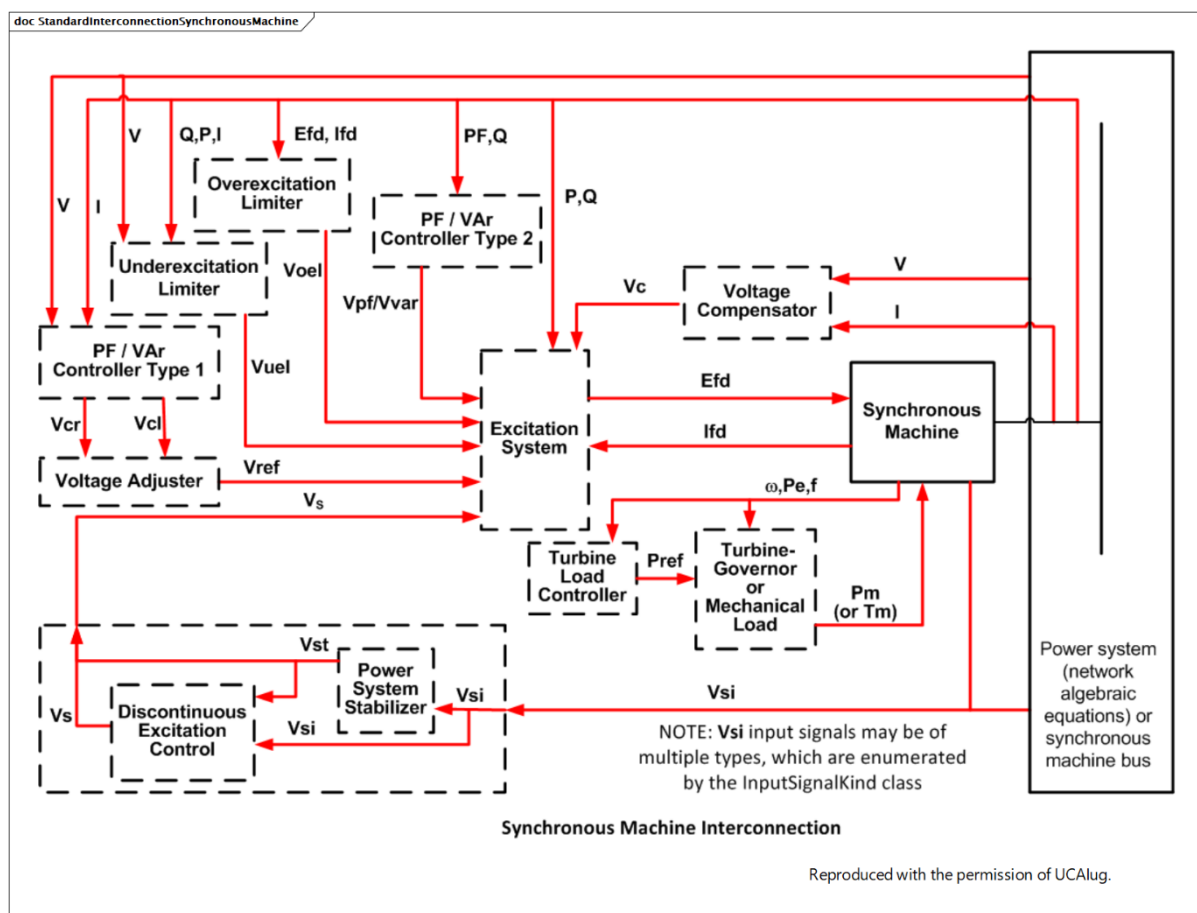


Figure 1 – StandardInterconnectionSynchronousMachine

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

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

The interfaces between different blocks in Figure 1 are indicative of the variety of input and output signals that are defined by the individual standard models. Figure 1 provides information on most of the alternative interfaces, for instance, the turbine-governor (for generators) or the mechanical load (for motors) and the dynamic synchronous machine can be mechanical torque (T_m) or mechanical power (P_m).

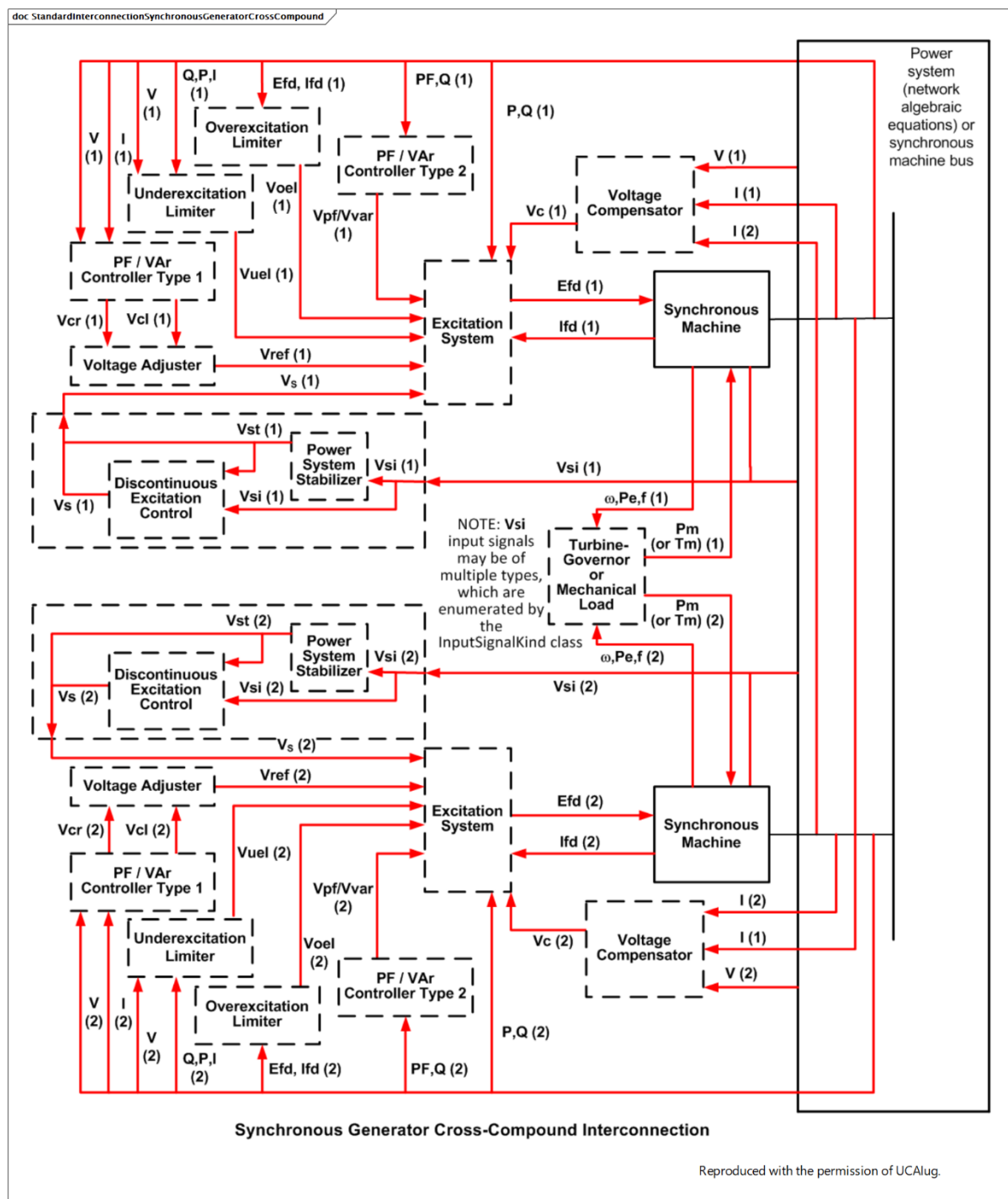


Figure 2 – StandardInterconnectionSynchronousGeneratorCrossCompound

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

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

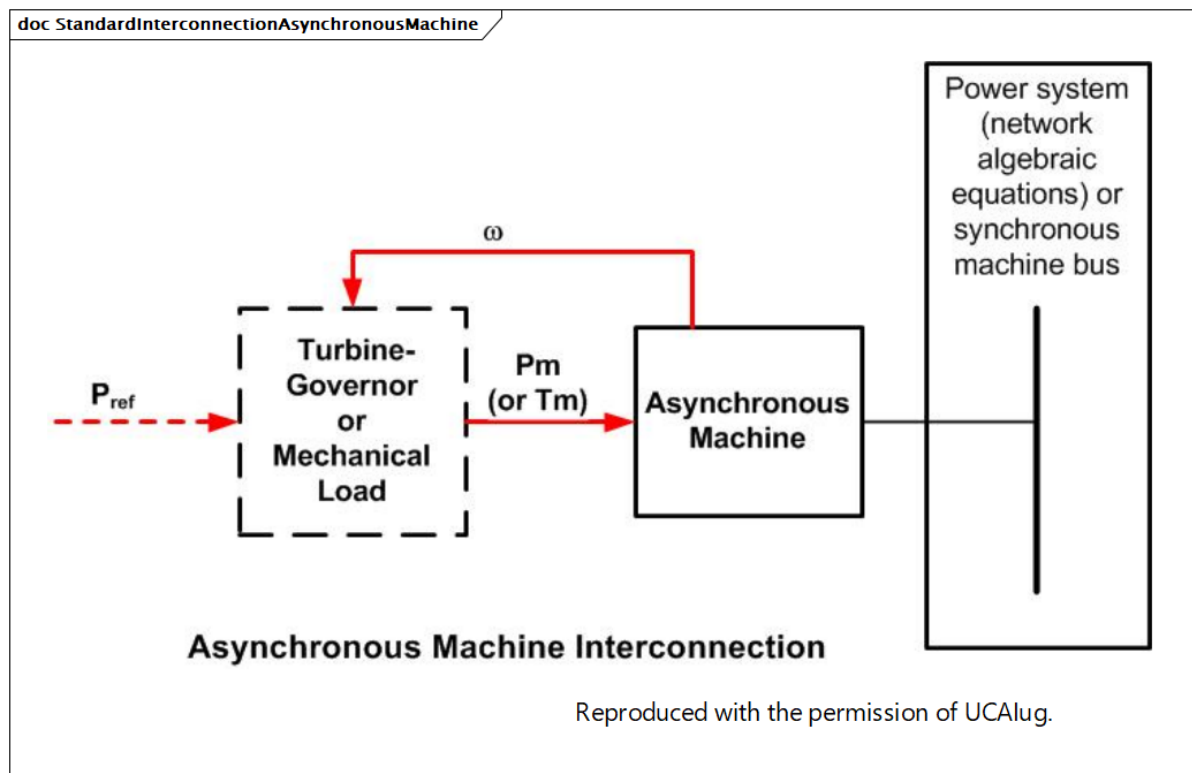


Figure 3 – StandardInterconnectionAsynchronousMachine

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

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

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