



IEC 61970-457

Edition 1.0 2021-03

INTERNATIONAL STANDARD



Energy management system application program interface (EMS-API) –
Part 457: Dynamics profile
standards.iteh.ai

[IEC 61970-457:2021](#)
<https://standards.iteh.ai/catalog/standards/sist/ccfl15a0-949c-4432-a861-2d15951949c2/iec-61970-457-2021>





THIS PUBLICATION IS COPYRIGHT PROTECTED
Copyright © 2021 IEC, Geneva, Switzerland

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

IEC Central Office
3, rue de Varembé
CH-1211 Geneva 20
Switzerland

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

About the IEC

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

About IEC publications

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

IEC publications search - webstore.iec.ch/advsearchform

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 It also gives information on projects, replaced and withdrawn publications.

IEC Just Published - webstore.iec.ch/justpublished

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

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

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

IEC online collection - oc.iec.ch

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

Electropedia - www.electropedia.org

The world's leading online dictionary on electrotechnology, containing more than 22 000 terminological entries in English and French, with equivalent terms in 18 additional languages. Also known as the International Electrotechnical Vocabulary (IEV) online.

IEC 61970-457:2021
https://standards.iteh.ai/catalog/standards/sist/ccf115a0-949c-4432-a861-
2d15951949c2/iec-61970-457-2021



IEC 61970-457

Edition 1.0 2021-03

INTERNATIONAL STANDARD



Energy management system application program interface (EMS-API) –
Part 457: Dynamics profile (standards.iteh.ai)

[IEC 61970-457:2021](#)
<https://standards.iteh.ai/catalog/standards/sist/ccfl15a0-949c-4432-a861-2d15951949c2/iec-61970-457-2021>

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

ICS 33.200

ISBN 978-2-8322-9421-5

Warning! Make sure that you obtained this publication from an authorized distributor.

CONTENTS

FOREWORD	22
INTRODUCTION	24
1 Scope	25
2 Normative references	25
3 Terms and definitions	26
4 Profile specification	26
4.1 General	26
4.2 Requirements and constraints	26
5 Overview	29
6 Use cases	30
6.1 General	30
6.2 Dynamic assessment studies	30
7 Architecture	31
7.1 General	31
7.2 Profile architecture	32
8 Detailed profile specification	34
8.1 General	34
8.2 Package DynamicsProfile	35
8.2.1 General	35
8.2.2 (abstract) DynamicsProfileVersion root class	35
8.2.3 Package Base	35
8.2.4 Package Dynamics	64
Annex A (normative) Implementation clarifications related to the models inherited from RotatingMachineDynamics class	444
Annex B (informative) Examples using IEC 61970-552 serialisation	446
B.1 Overview	446
B.2 Standard models	446
B.3 User-defined models	450
Bibliography	457
Figure 1 – SynchronousMachineDynamics association	32
Figure 2 – Interconnection diagram for a synchronous machine	32
Figure 3 – Standard connections for a synchronous machine	33
Figure 4 – Profile relationships	34
Figure 5 – Class diagram Domain::Primitives	36
Figure 6 – Class diagram Domain::DataTypes	36
Figure 7 – Class diagram Domain::Enumerations	37
Figure 8 – Class diagram Core::Core	55
Figure 9 – Class diagram Wires::Wires	59
Figure 10 – StandardInterconnectionSynchronousMachine	65
Figure 11 – StandardInterconnectionSynchronousGeneratorCrossCompound	66
Figure 12 – StandardInterconnectionAsynchronousMachine	67
Figure 13 – StandardInterconnectionWindTurbineType1Aand1B	68
Figure 14 – StandardInterconnectionWindTurbineType2	69

Figure 15 – StandardInterconnectionWindTurbineType3	70
Figure 16 – StandardInterconnectionWindTurbineType4Aand4B	71
Figure 17 – StandardInterconnectionSingleLoad	72
Figure 18 – Class diagram StandardInterconnections:: StandardSynchronousMachineInterconnection	73
Figure 19 – Class diagram StandardInterconnections:: StandardAsynchronousMachineInterconnection	74
Figure 20 – Class diagram StandardInterconnections:: StandardWindType1and2Interconnection	75
Figure 21 – Class diagram StandardInterconnections:: StandardWindType3and4Interconnection	76
Figure 22 – Class diagram StandardInterconnections::StandardLoadInterconnection	77
Figure 23 – Class diagram StandardInterconnections::StandardHVDCInterconnection	78
Figure 24 – Class diagram StandardInterconnections:: StandardStaticVarCompensatorInterconnection	78
Figure 25 – SynchronousGeneratorInterconnectionAndVariables	81
Figure 26 – SynchronousMotorInterconnectionAndVariables	82
Figure 27 – Class diagram SynchronousMachineDynamics:: SynchronousMachineDynamics	83
Figure 28 – SynchronousMachineSaturationParameters	84
Figure 29 – SynchronousGeneratorMechanicalEquation	85
Figure 30 – SynchronousMotorMechanicalEquation	86
Figure 31 – SynchronousGeneratorPhasor	87
Figure 32 – SynchronousMotorPhasor	88
Figure 33 – Simplified	89
Figure 34 – SubtransientRoundRotor	93
Figure 35 – SubtransientSalientPole	94
Figure 36 – SubtransientTypeF	95
Figure 37 – SubtransientTypeJ	96
Figure 38 – SubtransientRoundRotorSimplified	97
Figure 39 – SubtransientSalientPoleSimplified	99
Figure 40 – SubtransientRoundRotorSimplifiedDirectAxis	101
Figure 41 – SubtransientSalientPoleSimplifiedDirectAxis	103
Figure 42 – SynchronousEquivalentCircuit	107
Figure 43 – AsynchronousGeneratorInterconnectionAndVariables	109
Figure 44 – AsynchronousMotorInterconnectionAndVariables	110
Figure 45 – Class diagram AsynchronousMachineDynamics:: AsynchronousMachineDynamics	111
Figure 46 – AsynchronousGeneratorMechanicalEquation	112
Figure 47 – AsynchronousMotorMechanicalEquation	112
Figure 48 – AsynchronousEquivalentCircuit	116
Figure 49 – TurbineGovernorInterconnectionAndVariables	118
Figure 50 – Class diagram TurbineGovernorDynamics::TurbineGovernorDynamics	119
Figure 51 – GovHydroIEEE0	121
Figure 52 – GovHydroIEEE2	123

Figure 53 – GovSteamIEEE1	125
Figure 54 – GovCT1	128
Figure 55 – GovCT2	132
Figure 56 – GovGAST.....	136
Figure 57 – GovGAST1.....	137
Figure 58 – GovGAST2.....	140
Figure 59 – GovGAST3.....	142
Figure 60 – GovGAST3ExhaustTemperature.....	143
Figure 61 – GovGAST4.....	145
Figure 62 – GovGASTWD	147
Figure 63 – GovHydro1	149
Figure 64 – GovHydro2	151
Figure 65 – GovHydro3	154
Figure 66 – GovHydro4	157
Figure 67 – GovHydro4SimpleHydroTurbine	158
Figure 68 – GovHydro4FrancisPeltonTurbine	159
Figure 69 – GovHydro4KaplanTurbine	160
Figure 70 – GovHydroDD.....	163
Figure 71 – GovHydroFrancis	166
Figure 72 – GovHydroFrancisNonLinearGainAndEfficiency.....	167
Figure 73 – DetailedHydroModelHydraulicSystem	168
Figure 74 – GovHydroPelton	170
Figure 75 – GovHydroPeltonNonLinearGainAndEfficiency.....	171
Figure 76 – GovHydroPID	174
Figure 77 – GovHydroPID2	177
Figure 78 – GovHydroR	179
Figure 79 – GovHydroWEH	183
Figure 80 – GovHydroWPID	187
Figure 81 – GovSteam0	189
Figure 82 – GovSteam1	191
Figure 83 – GovSteam1BacklashHysteresis	192
Figure 84 – GovSteam1InputSpeedDeadband.....	193
Figure 85 – GovSteam2	196
Figure 86 – GovSteamBB	197
Figure 87 – GovSteamCC	199
Figure 88 – GovSteamEU	201
Figure 89 – GovSteamFV2.....	204
Figure 90 – GovSteamFV3.....	205
Figure 91 – GovSteamFV4.....	208
Figure 92 – GovSteamSGO.....	211
Figure 93 – Class diagram TurbineLoadControllerDynamics::TurbineLoadControllerDynamics	213
Figure 94 – TurbLCFB1	214

Figure 95 – MechanicalLoadInterconnectionAndVariables.....	216
Figure 96 – MechanicalLoadEquations.....	217
Figure 97 – Class diagram MechanicalLoadDynamics::MechanicalLoadDynamics	218
Figure 98 – ExcitationSystemInterconnectionAndVariables	220
Figure 99 – Class diagram ExcitationSystemDynamics::ExcitationSystemDynamics	221
Figure 100 – ExcAC1A.....	247
Figure 101 – ExcAC2A.....	249
Figure 102 – ExcAC3A.....	252
Figure 103 – ExcAC4A.....	254
Figure 104 – ExcAC5A.....	255
Figure 105 – ExcAC6A.....	257
Figure 106 – ExcAC8B.....	259
Figure 107 – ExcANS.....	262
Figure 108 – ExcAVR1.....	263
Figure 109 – ExcAVR2.....	265
Figure 110 – ExcAVR3.....	266
Figure 111 – ExcAVR4.....	267
Figure 112 – ExcAVR5.....	269
Figure 113 – ExcAVR7.....	270
Figure 114 – ExcBBC.....	272
Figure 115 – ExcCZ.....	274
Figure 116 – ExcDC1A.....	275
Figure 117 – ExcDC2A	277
Figure 118 – ExcDC3A	279
Figure 119 – ExcDC3A1.....	281
Figure 120 – ExcELIN1	283
Figure 121 – ExcELIN2	285
Figure 122 – ExcHU	287
Figure 123 – ExcNI	288
Figure 124 – ExcOEX3T	290
Figure 125 – ExcPIC	292
Figure 126 – ExcREXS	294
Figure 127 – ExcRQB	297
Figure 128 – ExcSCRX	299
Figure 129 – ExcSEXS	300
Figure 130 – ExcSK	302
Figure 131 – ExcST1A	304
Figure 132 – ExcST2A	306
Figure 133 – ExcST3A	308
Figure 134 – ExcST4B	310
Figure 135 – ExcST6B	312
Figure 136 – ExcST7B	314

iTeh STANDARD PREVIEW
(standards.iteh.ai)

Figure 137 – Class diagram OverexcitationLimiterDynamics:: OverexcitationLimiterDynamics	316
Figure 138 – OverexcLim2	318
Figure 139 – OverexcLimX1	319
Figure 140 – OverexcLimX1TimeCharacteristic	320
Figure 141 – OverexcLimX2	321
Figure 142 – OverexcLimX2TimeCharacteristic	322
Figure 143 – Class diagram UnderexcitationLimiterDynamics::UnderexcitationLimiterDynamics	324
Figure 144 – UnderexcLim2Simplified	328
Figure 145 – UnderexcLimX1	330
Figure 146 – UnderexcLimX2	331
Figure 147 – PowerSystemStabilizerInterconnectionAndVariables	332
Figure 148 – Class diagram PowerSystemStabilizerDynamics:: PowerSystemStabilizerDynamics	333
Figure 149 – Pss1	341
Figure 150 – Pss1A	343
Figure 151 – Pss2B	344
Figure 152 – Pss2ST	346
Figure 153 – Pss5	348
Figure 154 – PssELIN2	350
Figure 155 – PssPTIST1	351
Figure 156 – PssPTIST3	352
Figure 157 – PssRQB	355
Figure 158 – PssSB4	356
Figure 159 – PssSH	357
Figure 160 – PssSK	359
Figure 161 – PssSTAB2A	360
Figure 162 – PssWECC	361
Figure 163 – DiscontinuousExcitationControlInterconnectionAndVariables	363
Figure 164 – Class diagram DiscontinuousExcitationControlDynamics:: DiscontinuousExcitationControlDynamics	364
Figure 165 – Class diagram PFVArControllerType1Dynamics:: PFVArControllerType1Dynamics	368
Figure 166 – Class diagram VoltageAdjusterDynamics::VoltageAdjusterDynamics	371
Figure 167 – Class diagram PFVArControllerType2Dynamics:: PFVArControllerType2Dyanmics	373
Figure 168 – PFVArType2Common1	376
Figure 169 – VoltageCompensatorInterconnectionAndVariables	377
Figure 170 – Class diagram VoltageCompensatorDynamics:: VoltageCompensatorDynamics	378
Figure 171 – Class diagram WindDynamics::WindDynamicsType1or2	382
Figure 172 – Class diagram WindDynamics::WindDynamicsType3	383
Figure 173 – Class diagram WindDynamics::WindDynamicsType4	384
Figure 174 – Class diagram WindDynamics::WindDynamicsPlant	385

Figure 175 – LoadInterconnectionAndVariables	411
Figure 176 – Class diagram LoadDynamics::LoadDynamics.....	412
Figure 177 – LoadCompositeEquations	413
Figure 178 – LoadGenericNonLinearTypeEquations.....	414
Figure 179 – LoadStaticTypeEquations	417
Figure 180 – LoadMotor	420
Figure 181 – Class diagram HVDCDynamics::HVDCDynamics	422
Figure 182 – Class diagram StaticVarCompensatorDynamics:: StaticVarCompensatorDynamics	425
Figure 183 – Class diagram UserDefinedModels::ProprietaryUserDefinedModels	427
Figure B.1 – Dynamics model header.....	446
Figure B.2 – SynchronousMachineDynamics model	447
Figure B.3 –TurbineGovernorDynamics model	448
Figure B.4 – ExcitationSystemDynamics model.....	448
Figure B.5 – PowerSystemStabilizerDynamics model.....	449
Figure B.6 – Link between the dynamics model and static model	451
Figure B.7 – User-defined model class for excitation systems	451
Figure B.8 – User-defined model for turbine governor	452
Figure B.9 – Block diagram of the ExcSEXS model.....	453
Figure B.10 – Example of a simplified excitation model instance described using the ExcSEXS class	453
Figure B.11 – Example of a simplified excitation model instance expressed using proprietary user-defined classes	456
<i>iTech STANDARD PREVIEW</i> <i>(standards.itech.aicatalog/standards/sist/cclf15a0-949c-4432-a861- 2d15951949c2/iec-61970-457-2021)</i>	
Table 1 – Attributes of DynamicsProfile::DynamicsProfileVersion.....	35
Table 2 – Attributes of Domain::ActivePower	37
Table 3 – Attributes of Domain::AngleDegrees.....	38
Table 4 – Attributes of Domain::ApparentPower	38
Table 5 – Attributes of Domain::Area	38
Table 6 – Attributes of Domain::Frequency	39
Table 7 – Attributes of Domain::Length	39
Table 8 – Attributes of Domain::PU	39
Table 9 – Attributes of Domain::Seconds	39
Table 10 – Attributes of Domain::Temperature	40
Table 11 – Attributes of Domain::VolumeFlowRate.....	40
Table 12 – Literals of Domain::DroopSignalFeedbackKind	41
Table 13 – Literals of Domain::ExcIEEEEST1AUELselectorKind	41
Table 14 – Literals of Domain::ExcREXSFeedbackSignalKind.....	41
Table 15 – Literals of Domain::ExcST6BOELselectorKind	42
Table 16 – Literals of Domain::ExcST7BOELselectorKind	42
Table 17 – Literals of Domain::ExcST7BUELselectorKind	42
Table 18 – Literals of Domain::FrancisGovernorControlKind	43
Table 19 – Literals of Domain::GenericNonLinearLoadModelKind	43
Table 20 – Literals of Domain::GovHydro4ModelKind.....	43

Table 21 – Literals of Domain::IfdBaseKind.....	44
Table 22 – Literals of Domain::InputSignalKind	44
Table 23 – Literals of Domain::RemoteSignalKind.....	45
Table 24 – Literals of Domain::RotorKind	45
Table 25 – Literals of Domain::StaticLoadModelKind	45
Table 26 – Literals of Domain::SynchronousMachineModelKind	46
Table 27 – Literals of Domain::UnitMultiplier	47
Table 28 – Literals of Domain::UnitSymbol.....	48
Table 29 – Literals of Domain::WindLookupTableFunctionKind	53
Table 30 – Literals of Domain::WindPlantQcontrolModeKind	54
Table 31 – Literals of Domain::WindQcontrolModeKind	54
Table 32 – Literals of Domain::WindVRTQcontrolModeKind.....	54
Table 33 – Attributes of Core::ACDCTerminal	56
Table 34 – Attributes of Core::ConductingEquipment	56
Table 35 – Attributes of Core::Equipment.....	56
Table 36 – Attributes of Core::IdentifiedObject.....	57
Table 37 – Attributes of Core::PowerSystemResource	57
Table 38 – Attributes of Core::Terminal	57
Table 39 – Association ends of Core::Terminal with other classes	58
Table 40 – Attributes of Wires::AsynchronousMachine.....	60
Table 41 – Attributes of Wires::EnergyConnection	60
Table 42 – Attributes of Wires::EnergyConsumer	60
Table 43 – Association ends of Wires::EnergyConsumer with other classes	60
Table 44 – Attributes of Wires::PowerElectronicsConnection	61
Table 45 – Attributes of Wires::RegulatingCondEq.....	61
Table 46 – Attributes of Wires::RotatingMachine	61
Table 47 – Attributes of Wires::StaticVarCompensator	62
Table 48 – Attributes of Wires::SynchronousMachine.....	62
Table 49 – Attributes of DC::ACDCCConverter	62
Table 50 – Attributes of DC::CsConverter	63
Table 51 – Attributes of DC::VsConverter	63
Table 52 – Attributes of StandardInterconnections::RemoteInputSignal.....	79
Table 53 – Association ends of StandardInterconnections:: RemoteInputSignal with other classes	79
Table 54 – Attributes of StandardModels::DynamicsFunctionBlock.....	80
Table 55 – Attributes of StandardModels::RotatingMachineDynamics	80
Table 56 – Attributes of SynchronousMachineDynamics:: SynchronousMachineSimplified.....	89
Table 57 – Association ends of SynchronousMachineDynamics:: SynchronousMachineSimplified with other classes	90
Table 58 – Attributes of SynchronousMachineDynamics:: SynchronousMachineDynamics.....	90
Table 59 – Association ends of SynchronousMachineDynamics:: SynchronousMachineDynamics with other classes	91
Table 60 – Attributes of SynchronousMachineDynamics::SynchronousMachineDetailed	91

Table 61 – Association ends of SynchronousMachineDynamics:: SynchronousMachineDetailed with other classes	92
Table 62 – Attributes of SynchronousMachineDynamics:: SynchronousMachineTimeConstantReactance	104
Table 63 – Association ends of SynchronousMachineDynamics:: SynchronousMachineTimeConstantReactance with other classes	105
Table 64 – Attributes of SynchronousMachineDynamics:: SynchronousMachineEquivalentCircuit	107
Table 65 – Association ends of SynchronousMachineDynamics:: SynchronousMachineEquivalentCircuit with other classes	108
Table 66 – Attributes of AsynchronousMachineDynamics:: AsynchronousMachineDynamics	113
Table 67 – Association ends of AsynchronousMachineDynamics:: AsynchronousMachineDynamics with other classes	113
Table 68 – Attributes of AsynchronousMachineDynamics:: AsynchronousMachineTimeConstantReactance	114
Table 69 – Association ends of AsynchronousMachineDynamics:: AsynchronousMachineTimeConstantReactance with other classes	115
Table 70 – Attributes of AsynchronousMachineDynamics:: AsynchronousMachineEquivalentCircuit	116
Table 71 – Association ends of AsynchronousMachineDynamics:: AsynchronousMachineEquivalentCircuit with other classes	117
Table 72 – Attributes of TurbineGovernorDynamics:: CrossCompoundTurbineGovernorDynamics	120
Table 73 – Association ends of TurbineGovernorDynamics:: CrossCompoundTurbineGovernorDynamics with other classes	120
Table 74 – Attributes of TurbineGovernorDynamics::TurbineGovernorDynamics	120
Table 75 – Association ends of TurbineGovernorDynamics:: TurbineGovernorDynamics with other classes	121
Table 76 – Attributes of TurbineGovernorDynamics::GovHydroIEEE0	122
Table 77 – Association ends of TurbineGovernorDynamics:: GovHydroIEEE0 with other classes	122
Table 78 – Attributes of TurbineGovernorDynamics::GovHydroIEEE2	123
Table 79 – Association ends of TurbineGovernorDynamics:: GovHydroIEEE2 with other classes	125
Table 80 – Attributes of TurbineGovernorDynamics::GovSteamIEEE1	126
Table 81 – Association ends of TurbineGovernorDynamics:: GovSteamIEEE1 with other classes	127
Table 82 – Attributes of TurbineGovernorDynamics::GovCT1	129
Table 83 – Association ends of TurbineGovernorDynamics::GovCT1 with other classes	131
Table 84 – Attributes of TurbineGovernorDynamics::GovCT2	133
Table 85 – Association ends of TurbineGovernorDynamics::GovCT2 with other classes	135
Table 86 – Attributes of TurbineGovernorDynamics::GovGAST	136
Table 87 – Association ends of TurbineGovernorDynamics:: GovGAST with other classes	137
Table 88 – Attributes of TurbineGovernorDynamics::GovGAST1	138
Table 89 – Association ends of TurbineGovernorDynamics:: GovGAST1 with other classes	139
Table 90 – Attributes of TurbineGovernorDynamics::GovGAST2	140

Table 91 – Association ends of TurbineGovernorDynamics:: GovGAST2 with other classes	142
Table 92 – Attributes of TurbineGovernorDynamics::GovGAST3	143
Table 93 – Association ends of TurbineGovernorDynamics::GovGAST3 with other classes	144
Table 94 – Attributes of TurbineGovernorDynamics::GovGAST4	145
Table 95 – Association ends of TurbineGovernorDynamics:: GovGAST4 with other classes	146
Table 96 – Attributes of TurbineGovernorDynamics::GovGASTWD	147
Table 97 – Association ends of TurbineGovernorDynamics:: GovGASTWD with other classes	148
Table 98 – Attributes of TurbineGovernorDynamics::GovHydro1	150
Table 99 – Association ends of TurbineGovernorDynamics:: GovHydro1 with other classes	150
Table 100 – Attributes of TurbineGovernorDynamics::GovHydro2	151
Table 101 – Association ends of TurbineGovernorDynamics:: GovHydro2 with other classes	153
Table 102 – Attributes of TurbineGovernorDynamics::GovHydro3	155
Table 103 – Association ends of TurbineGovernorDynamics:: GovHydro3 with other classes	156
Table 104 – Attributes of TurbineGovernorDynamics::GovHydro4	161
Table 105 – Association ends of TurbineGovernorDynamics:: GovHydro4 with other classes	163
Table 106 – Attributes of TurbineGovernorDynamics::GovHydroDD	164
Table 107 – Association ends of TurbineGovernorDynamics:: GovHydroDD with other classes	165
Table 108 – Attributes of TurbineGovernorDynamics::GovHydroFrancis	168
Table 109 – Association ends of TurbineGovernorDynamics:: GovHydroFrancis with other classes	170
Table 110 – Attributes of TurbineGovernorDynamics::GovHydroPelton	172
Table 111 – Association ends of TurbineGovernorDynamics:: GovHydroPelton with other classes	173
Table 112 – Attributes of TurbineGovernorDynamics::GovHydroPID	175
Table 113 – Association ends of TurbineGovernorDynamics:: GovHydroPID with other classes	176
Table 114 – Attributes of TurbineGovernorDynamics::GovHydroPID2	178
Table 115 – Association ends of TurbineGovernorDynamics:: GovHydroPID2 with other classes	179
Table 116 – Attributes of TurbineGovernorDynamics::GovHydroR	180
Table 117 – Association ends of TurbineGovernorDynamics:: GovHydroR with other classes	182
Table 118 – Attributes of TurbineGovernorDynamics::GovHydroWEH	184
Table 119 – Association ends of TurbineGovernorDynamics:: GovHydroWEH with other classes	187
Table 120 – Attributes of TurbineGovernorDynamics::GovHydroWPID	188
Table 121 – Association ends of TurbineGovernorDynamics:: GovHydroWPID with other classes	189
Table 122 – Attributes of TurbineGovernorDynamics::GovSteam0	190

Table 123 – Association ends of TurbineGovernorDynamics:: GovSteam0 with other classes	190	
Table 124 – Attributes of TurbineGovernorDynamics::GovSteam1	193	
Table 125 – Association ends of TurbineGovernorDynamics:: GovSteam1 with other classes	195	
Table 126 – Attributes of TurbineGovernorDynamics::GovSteam2	196	
Table 127 – Association ends of TurbineGovernorDynamics:: GovSteam2 with other classes	197	
Table 128 – Attributes of TurbineGovernorDynamics::GovSteamBB.....	197	
Table 129 – Association ends of TurbineGovernorDynamics:: GovSteamBB with other classes	198	
Table 130 – Attributes of TurbineGovernorDynamics::GovSteamCC	200	
Table 131 – Association ends of TurbineGovernorDynamics:: GovSteamCC with other classes	200	
Table 132 – Attributes of TurbineGovernorDynamics::GovSteamEU.....	202	
Table 133 – Association ends of TurbineGovernorDynamics:: GovSteamEU with other classes	203	
Table 134 – Attributes of TurbineGovernorDynamics::GovSteamFV2	204	
Table 135 – Association ends of TurbineGovernorDynamics:: GovSteamFV2 with other classes	205	
Table 136 – Attributes of TurbineGovernorDynamics::GovSteamFV3.....	206	
Table 137 – Association ends of TurbineGovernorDynamics:: GovSteamFV3 with other classes	207	
Table 138 – Attributes of TurbineGovernorDynamics::GovSteamFV4	209	
Table 139 – Association ends of TurbineGovernorDynamics:: GovSteamFV4 with other classes	2d15951949c2/iec-61970-457-2021	211
Table 140 – Attributes of TurbineGovernorDynamics::GovSteamSGO.....	211	
Table 141 – Association ends of TurbineGovernorDynamics:: GovSteamSGO with other classes	212	
Table 142 – Attributes of TurbineLoadControllerDynamics:: TurbineLoadControllerDynamics	213	
Table 143 – Association ends of TurbineLoadControllerDynamics:: TurbineLoadControllerDynamics with other classes	214	
Table 144 – Attributes of TurbineLoadControllerDynamics::TurbLCFB1	215	
Table 145 – Association ends of TurbineLoadControllerDynamics:: TurbLCFB1 with other classes	216	
Table 146 – Attributes of MechanicalLoadDynamics::MechanicalLoadDynamics	218	
Table 147 – Association ends of MechanicalLoadDynamics:: MechanicalLoadDynamics with other classes	219	
Table 148 – Attributes of MechanicalLoadDynamics::MechLoad1	219	
Table 149 – Association ends of MechanicalLoadDynamics:: MechLoad1 with other classes	219	
Table 150 – Attributes of ExcitationSystemDynamics::ExcitationSystemDynamics	222	
Table 151 – Association ends of ExcitationSystemDynamics:: ExcitationSystemDynamics with other classes	222	
Table 152 – Attributes of ExcitationSystemDynamics::ExclEEEAC1A	222	
Table 153 – Association ends of ExcitationSystemDynamics:: ExclEEEAC1A with other classes	223	

Table 154 – Attributes of ExcitationSystemDynamics::ExcIEEEAC2A	224
Table 155 – Association ends of ExcitationSystemDynamics:: ExcIEEEAC2A with other classes	225
Table 156 – Attributes of ExcitationSystemDynamics::ExcIEEEAC3A	225
Table 157 – Association ends of ExcitationSystemDynamics:: ExcIEEEAC3A with other classes	226
Table 158 – Attributes of ExcitationSystemDynamics::ExcIEEEAC4A	227
Table 159 – Association ends of ExcitationSystemDynamics:: ExcIEEEAC4A with other classes	227
Table 160 – Attributes of ExcitationSystemDynamics::ExcIEEEAC5A	228
Table 161 – Association ends of ExcitationSystemDynamics:: ExcIEEEAC5A with other classes	228
Table 162 – Attributes of ExcitationSystemDynamics::ExcIEEEAC6A	229
Table 163 – Association ends of ExcitationSystemDynamics:: ExcIEEEAC6A with other classes	230
Table 164 – Attributes of ExcitationSystemDynamics::ExcIEEEAC7B	230
Table 165 – Association ends of ExcitationSystemDynamics:: ExcIEEEAC7B with other classes	231
Table 166 – Attributes of ExcitationSystemDynamics::ExcIEEEAC8B	232
Table 167 – Association ends of ExcitationSystemDynamics:: ExcIEEEAC8B with other classes	233
Table 168 – Attributes of ExcitationSystemDynamics::ExcIEEEDC1A	233
Table 169 – Association ends of ExcitationSystemDynamics:: ExcIEEEDC1A with other classes	234
Table 170 – Attributes of ExcitationSystemDynamics::ExcIEEEDC2A	235
Table 171 – Association ends of ExcitationSystemDynamics:: ExcIEEEDC2A with other classes	236
Table 172 – Attributes of ExcitationSystemDynamics::ExcIEEEDC3A	236
Table 173 – Association ends of ExcitationSystemDynamics:: ExcIEEEDC3A with other classes	237
Table 174 – Attributes of ExcitationSystemDynamics::ExcIEEEDC4B	237
Table 175 – Association ends of ExcitationSystemDynamics:: ExcIEEEDC4B with other classes	238
Table 176 – Attributes of ExcitationSystemDynamics::ExcIEEEEST1A	239
Table 177 – Association ends of ExcitationSystemDynamics:: ExcIEEEEST1A with other classes	240
Table 178 – Attributes of ExcitationSystemDynamics::ExcIEEEEST2A	240
Table 179 – Association ends of ExcitationSystemDynamics:: ExcIEEEEST2A with other classes	241
Table 180 – Attributes of ExcitationSystemDynamics::ExcIEEEEST3A	241
Table 181 – Association ends of ExcitationSystemDynamics:: ExcIEEEEST3A with other classes	242
Table 182 – Attributes of ExcitationSystemDynamics::ExcIEEEEST4B	243
Table 183 – Association ends of ExcitationSystemDynamics:: ExcIEEEEST4B with other classes	243
Table 184 – Attributes of ExcitationSystemDynamics::ExcIEEEEST5B	244
Table 185 – Association ends of ExcitationSystemDynamics:: ExcIEEEEST5B with other classes	245

Table 186 – Attributes of ExcitationSystemDynamics::ExcIEEST6B	245
Table 187 – Association ends of ExcitationSystemDynamics:: ExcIEEST6B with other classes	246
Table 188 – Attributes of ExcitationSystemDynamics::ExcIEEST7B	246
Table 189 – Association ends of ExcitationSystemDynamics:: ExcIEEST7B with other classes	247
Table 190 – Attributes of ExcitationSystemDynamics::ExcAC1A	248
Table 191 – Association ends of ExcitationSystemDynamics:: ExcAC1A with other classes	249
Table 192 – Attributes of ExcitationSystemDynamics::ExcAC2A	250
Table 193 – Association ends of ExcitationSystemDynamics:: ExcAC2A with other classes	251
Table 194 – Attributes of ExcitationSystemDynamics::ExcAC3A	252
Table 195 – Association ends of ExcitationSystemDynamics:: ExcAC3A with other classes	254
Table 196 – Attributes of ExcitationSystemDynamics::ExcAC4A	254
Table 197 – Association ends of ExcitationSystemDynamics:: ExcAC4A with other classes	255
Table 198 – Attributes of ExcitationSystemDynamics::ExcAC5A	256
Table 199 – Association ends of ExcitationSystemDynamics:: ExcAC5A with other classes	257
Table 200 – Attributes of ExcitationSystemDynamics::ExcAC6A	258
Table 201 – Association ends of ExcitationSystemDynamics:: ExcAC6A with other classes	259
Table 202 – Attributes of ExcitationSystemDynamics::ExcAC8B	260
Table 203 – Association ends of ExcitationSystemDynamics:: ExcAC8B with other classes	261
Table 204 – Attributes of ExcitationSystemDynamics::ExcANS	262
Table 205 – Association ends of ExcitationSystemDynamics::ExcANS with other classes	263
Table 206 – Attributes of ExcitationSystemDynamics::ExcAVR1	264
Table 207 – Association ends of ExcitationSystemDynamics:: ExcAVR1 with other classes	264
Table 208 – Attributes of ExcitationSystemDynamics::ExcAVR2	265
Table 209 – Association ends of ExcitationSystemDynamics:: ExcAVR2 with other classes	266
Table 210 – Attributes of ExcitationSystemDynamics::ExcAVR3	266
Table 211 – Association ends of ExcitationSystemDynamics:: ExcAVR3 with other classes	267
Table 212 – Attributes of ExcitationSystemDynamics::ExcAVR4	268
Table 213 – Association ends of ExcitationSystemDynamics:: ExcAVR4 with other classes	268
Table 214 – Attributes of ExcitationSystemDynamics::ExcAVR5	269
Table 215 – Association ends of ExcitationSystemDynamics:: ExcAVR5 with other classes	270
Table 216 – Attributes of ExcitationSystemDynamics::ExcAVR7	270
Table 217 – Association ends of ExcitationSystemDynamics:: ExcAVR7 with other classes	271