

INTERNATIONAL STANDARD

NORME INTERNATIONALE



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

standards.iteh.ai

Interface de programmation d'application pour système de gestion d'énergie
(EMS-API) –
Partie 301: Base de modèle d'information commun (CIM)

<https://standards.iteh.ai/catalog/standards/sist/1ef3f0d8-c0a0-476a-80f5->



THIS PUBLICATION IS COPYRIGHT PROTECTED
Copyright © 2020 IEC, Geneva, Switzerland

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

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

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

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

About the IEC

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

About IEC publications

The technical content of IEC publications is kept under constant review by the IEC. Please make sure that you have the latest edition, a 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 It also gives information on projects, replaced and withdrawn publications.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 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.

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.

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 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.

<https://standards.iteh.ai/catalog/standards/sist/1ec1008-coao-47ca-8015-0970becbc5/iec-61970-301-2020>

A propos de l'IEC

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

A propos des publications IEC

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

Recherche de publications IEC -

webstore.iec.ch/advsearchform

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

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

IEC Just Published - webstore.iec.ch/justpublished

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

Electropedia - www.electropedia.org

Le premier dictionnaire d'électrotechnologie en ligne au monde, avec plus de 22 000 articles terminologiques en anglais et en français, ainsi que les termes équivalents dans 16 langues additionnelles. Egalement appelé Vocabulaire Electrotechnique International (IEV) en ligne.

Service Clients - webstore.iec.ch/csc

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

IEC online collection - oc.iec.ch

INTERNATIONAL STANDARD

NORME INTERNATIONALE



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

**Interface de programmation d'application pour système de gestion d'énergie
(EMS-API) –
Partie 301: Base de modèle d'information commun (CIM)**

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

COMMISSION
ELECTROTECHNIQUE
INTERNATIONALE

ICS 33.200

ISBN 978-2-8322-1040-8

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

CONTENTS

FOREWORD.....	35
INTRODUCTION.....	37
1 Scope.....	39
2 Normative references	39
3 Terms and definitions	40
4 CIM specification	40
4.1 Overview.....	40
4.2 CIM modelling notation	41
4.3 CIM packages.....	41
4.4 CIM classes and relationships.....	43
4.4.1 Classes	43
4.4.2 Generalization	44
4.4.3 Simple association.....	45
4.4.4 Aggregation.....	46
4.5 CIM model concepts and examples.....	46
4.5.1 Concepts	46
4.5.2 Containment, equipment hierarchies and naming.....	47
4.5.3 Names model	48
4.5.4 Connectivity model	49
4.5.5 Inheritance hierarchy.....	52
4.5.6 Transformer model	54
4.5.7 Transformer tap modelling.....	56
4.5.8 Phase wire modelling.....	69
4.5.9 Grounding devices modelling.....	71
4.5.10 Cuts, clamps and jumpers model	75
4.5.11 Measurements and controls.....	79
4.5.12 Regulating control models	84
4.5.13 DC model for CIM.....	85
4.5.14 Static Var Compensator Voltage Regulation	107
4.5.15 ICCP Configuration Model	108
4.5.16 Feeder Model	115
4.5.17 Control area modelling.....	115
4.6 Modelling guidelines	117
4.6.1 Modelling for change	117
4.6.2 Process for amendments to the CIM	117
4.6.3 Changes to the CIM UML model	118
4.6.4 Changes to the CIM standards documents.....	118
4.6.5 Deprecations	118
4.6.6 CIM profiles	118
4.7 Modelling tools.....	119
4.8 User implementation conventions.....	119
4.8.1 Conventions beyond UML.....	119
4.8.2 Number of terminals for ConductingEquipment objects	119
4.8.3 Nominal quantities	120
4.8.4 Datatypes	120
4.9 CIM modelling examples	120
5 Detailed model	120

5.1	Overview.....	120
5.2	Context.....	120
6	Package Base.....	122
6.1	General.....	122
6.2	Package Domain.....	122
6.2.1	General.....	122
6.2.2	ActivePower datatype.....	128
6.2.3	ActivePowerChangeRate datatype.....	129
6.2.4	ActivePowerPerCurrentFlow datatype.....	129
6.2.5	ActivePowerPerFrequency datatype.....	129
6.2.6	Admittance datatype.....	129
6.2.7	AngleDegrees datatype.....	130
6.2.8	AngleRadians datatype.....	130
6.2.9	ApparentPower datatype.....	130
6.2.10	Area datatype.....	130
6.2.11	Boolean primitive.....	131
6.2.12	Capacitance datatype.....	131
6.2.13	CapacitancePerLength datatype.....	131
6.2.14	Classification datatype.....	131
6.2.15	Conductance datatype.....	131
6.2.16	ConductancePerLength datatype.....	132
6.2.17	CostPerEnergyUnit datatype.....	132
6.2.18	CostPerHeatUnit datatype.....	132
6.2.19	CostPerVolume datatype.....	132
6.2.20	CostRate datatype.....	133
6.2.21	Currency enumeration.....	133
6.2.22	CurrentFlow datatype.....	137
6.2.23	Damping datatype.....	137
6.2.24	Date primitive.....	137
6.2.25	DateInterval compound.....	137
6.2.26	DateTime primitive.....	138
6.2.27	DateTimeInterval compound.....	138
6.2.28	Decimal primitive.....	138
6.2.29	DecimalQuantity compound.....	138
6.2.30	Displacement datatype.....	138
6.2.31	Duration primitive.....	139
6.2.32	Emission datatype.....	139
6.2.33	Float primitive.....	139
6.2.34	FloatQuantity compound.....	139
6.2.35	Frequency datatype.....	139
6.2.36	HeatRate datatype.....	140
6.2.37	Hours datatype.....	140
6.2.38	Impedance datatype.....	140
6.2.39	Inductance datatype.....	140
6.2.40	InductancePerLength datatype.....	141
6.2.41	Integer primitive.....	141
6.2.42	IntegerQuantity compound.....	141
6.2.43	KiloActivePower datatype.....	141
6.2.44	Length datatype.....	142

6.2.45	Mass datatype	142
6.2.46	Minutes datatype	142
6.2.47	Money datatype	142
6.2.48	MonthDay primitive	143
6.2.49	MonthDayInterval compound	143
6.2.50	PU datatype	143
6.2.51	PerCent datatype	143
6.2.52	Pressure datatype	143
6.2.53	Reactance datatype	144
6.2.54	ReactancePerLength datatype	144
6.2.55	ReactivePower datatype	144
6.2.56	RealEnergy datatype	144
6.2.57	Resistance datatype	145
6.2.58	ResistancePerLength datatype	145
6.2.59	RotationSpeed datatype	145
6.2.60	Seconds datatype	146
6.2.61	Speed datatype	146
6.2.62	String primitive	146
6.2.63	StringQuantity compound	146
6.2.64	Susceptance datatype	146
6.2.65	SusceptancePerLength datatype	147
6.2.66	Temperature datatype	147
6.2.67	Time primitive	147
6.2.68	TimeInterval compound	147
6.2.69	UnitMultiplier enumeration	148
6.2.70	UnitSymbol enumeration	149
6.2.71	Voltage datatype	154
6.2.72	VoltagePerReactivePower datatype	154
6.2.73	Volume datatype	154
6.2.74	VolumeFlowRate datatype	155
6.2.75	WaterLevel datatype	155
6.3	Package Core	155
6.3.1	General	155
6.3.2	ACDCTerminal	160
6.3.3	BaseFrequency	161
6.3.4	BasePower	162
6.3.5	BaseVoltage	162
6.3.6	BasicIntervalSchedule	163
6.3.7	Bay	163
6.3.8	BreakerConfiguration enumeration	164
6.3.9	BusbarConfiguration enumeration	165
6.3.10	ConductingEquipment	165
6.3.11	ConnectivityNode	166
6.3.12	ConnectivityNodeContainer	167
6.3.13	Curve	167
6.3.14	CurveData root class	168
6.3.15	CurveStyle enumeration	169
6.3.16	Equipment	169
6.3.17	EquipmentContainer	170

ITeH STANDARD PREVIEW

(standards.iteh.ai)

IEC 61970-301:2020

[https://standards.iteh.ai/catalog/standards/sist/1e510d8-c0a0-476a-8015-](https://standards.iteh.ai/catalog/standards/sist/1e510d8-c0a0-476a-8015-acc6006ecbe5/iec-61970-301-2020)

[acc6006ecbe5/iec-61970-301-2020](https://standards.iteh.ai/catalog/standards/sist/1e510d8-c0a0-476a-8015-acc6006ecbe5/iec-61970-301-2020)

6.3.18	Feeder	171
6.3.19	GeographicalRegion	172
6.3.20	IdentifiedObject root class	173
6.3.21	IrregularIntervalSchedule	174
6.3.22	IrregularTimePoint root class	174
6.3.23	Name root class	175
6.3.24	NameType root class	175
6.3.25	NameTypeAuthority root class	176
6.3.26	OperatingParticipant	176
6.3.27	OperatingShare root class	177
6.3.28	PSRType	177
6.3.29	PhaseCode enumeration	178
6.3.30	PowerSystemResource	179
6.3.31	RegularIntervalSchedule	179
6.3.32	RegularTimePoint root class	180
6.3.33	ReportingGroup	181
6.3.34	ReportingSuperGroup	181
6.3.35	SubGeographicalRegion	182
6.3.36	Substation	183
6.3.37	Terminal	184
6.3.38	VoltageLevel	185
6.4	Package Wires	186
6.4.1	General	186
6.4.2	AsynchronousMachineKind enumeration	201
6.4.3	ACLineSegment	202
6.4.4	ACLineSegmentPhase	203
6.4.5	AsynchronousMachine	204
6.4.6	Breaker	206
6.4.7	BusbarSection	208
6.4.8	Clamp	209
6.4.9	CompositeSwitch	210
6.4.10	Conductor	211
6.4.11	Connector	212
6.4.12	CoolantType enumeration	213
6.4.13	Cut	213
6.4.14	Disconnecter	215
6.4.15	DisconnectingCircuitBreaker	216
6.4.16	EarthFaultCompensator	217
6.4.17	EnergyConnection	218
6.4.18	EnergyConsumer	219
6.4.19	EnergyConsumerPhase	221
6.4.20	EnergySchedulingType	222
6.4.21	EnergySource	222
6.4.22	EnergySourcePhase	224
6.4.23	ExternalNetworkInjection	225
6.4.24	FrequencyConverter	227
6.4.25	Fuse	228
6.4.26	Ground	229
6.4.27	GroundingImpedance	230

6.4.28	GroundDisconnector	231
6.4.29	Jumper	232
6.4.30	Junction	234
6.4.31	Line	234
6.4.32	LinearShuntCompensator	235
6.4.33	LinearShuntCompensatorPhase	237
6.4.34	LoadBreakSwitch	237
6.4.35	MutualCoupling	239
6.4.36	NonlinearShuntCompensator	240
6.4.37	NonlinearShuntCompensatorPhase	241
6.4.38	NonlinearShuntCompensatorPhasePoint root class	242
6.4.39	NonlinearShuntCompensatorPoint root class	243
6.4.40	PerLengthImpedance	243
6.4.41	PerLengthLineParameter	244
6.4.42	PerLengthPhaseImpedance	244
6.4.43	PerLengthSequenceImpedance	245
6.4.44	PetersenCoil	246
6.4.45	PetersenCoilModeKind enumeration	247
6.4.46	PhaseImpedanceData root class	247
6.4.47	PhaseShuntConnectionKind enumeration	248
6.4.48	PhaseTapChanger	249
6.4.49	PhaseTapChangerAsymmetrical	250
6.4.50	PhaseTapChangerLinear	251
6.4.51	PhaseTapChangerNonLinear	252
6.4.52	PhaseTapChangerSymmetrical	254
6.4.53	PhaseTapChangerTable	255
6.4.54	PhaseTapChangerTablePoint	255
6.4.55	PhaseTapChangerTabular	256
6.4.56	Plant	257
6.4.57	PowerElectronicsConnection	258
6.4.58	PowerElectronicsConnectionPhase	259
6.4.59	PowerTransformer	260
6.4.60	PowerTransformerEnd	262
6.4.61	ProtectedSwitch	264
6.4.62	RatioTapChanger	266
6.4.63	RatioTapChangerTable	267
6.4.64	RatioTapChangerTablePoint	267
6.4.65	ReactiveCapabilityCurve	268
6.4.66	Recloser	269
6.4.67	RegulatingCondEq	270
6.4.68	RegulatingControl	271
6.4.69	RegulatingControlModeKind enumeration	273
6.4.70	RegulationSchedule	273
6.4.71	RotatingMachine	274
6.4.72	Sectionalizer	276
6.4.73	SeriesCompensator	277
6.4.74	ShortCircuitRotorKind enumeration	278
6.4.75	ShuntCompensator	278
6.4.76	ShuntCompensatorPhase	280

6.4.77	SinglePhaseKind enumeration	281
6.4.78	StaticVarCompensator	282
6.4.79	SVCControlMode enumeration	283
6.4.80	Switch	283
6.4.81	SwitchPhase	285
6.4.82	SwitchSchedule	286
6.4.83	SynchronousMachine	287
6.4.84	SynchronousMachineOperatingMode enumeration	290
6.4.85	SynchronousMachineKind enumeration	290
6.4.86	TapChanger	290
6.4.87	TapChangerControl	292
6.4.88	TapChangerTablePoint root class	293
6.4.89	TapSchedule	294
6.4.90	TransformerControlMode enumeration	295
6.4.91	TransformerCoreAdmittance	295
6.4.92	TransformerEnd	296
6.4.93	TransformerMeshImpedance	297
6.4.94	TransformerStarImpedance	298
6.4.95	TransformerTank	299
6.4.96	TransformerTankEnd	299
6.4.97	VoltageControlZone	300
6.4.98	WireSegment	301
6.4.99	WireSegmentPhase	302
6.4.100	WindingConnection enumeration	303
6.5	Package LoadModel	303
6.5.1	General	303
6.5.2	ConformLoad	304
6.5.3	ConformLoadGroup	306
6.5.4	ConformLoadSchedule	306
6.5.5	DayType	307
6.5.6	EnergyArea	308
6.5.7	LoadArea	308
6.5.8	LoadGroup	309
6.5.9	LoadResponseCharacteristic	309
6.5.10	NonConformLoad	311
6.5.11	NonConformLoadGroup	312
6.5.12	NonConformLoadSchedule	313
6.5.13	PowerCutZone	314
6.5.14	Season	314
6.5.15	SeasonDayTypeSchedule	315
6.5.16	StationSupply	315
6.5.17	SubLoadArea	317
6.6	Package Generation	317
6.6.1	General	317
6.6.2	Package GenerationTrainingSimulation	318
6.6.3	Package Production	334
6.7	Package DC	386
6.7.1	General	386
6.7.2	ACDCConverter	390

6.7.3	ACDCConverterDCTerminal	393
6.7.4	CsConverter	394
6.7.5	DCTopologicalNode	396
6.7.6	CsOperatingModeKind enumeration.....	397
6.7.7	CsPpccControlKind enumeration	397
6.7.8	DCBaseTerminal	397
6.7.9	DCBreaker.....	398
6.7.10	DCBusbar	399
6.7.11	DCChopper.....	400
6.7.12	DCConductingEquipment.....	401
6.7.13	DCConverterOperatingModeKind enumeration.....	402
6.7.14	DCConverterUnit	402
6.7.15	DCDisconnecter.....	403
6.7.16	DCEquipmentContainer	404
6.7.17	DCGround	405
6.7.18	DCLine	406
6.7.19	DCLineSegment	407
6.7.20	DCNode.....	408
6.7.21	DCPolarityKind enumeration	409
6.7.22	DCSeriesDevice	409
6.7.23	DCShunt.....	410
6.7.24	DCSwitch.....	411
6.7.25	DCTerminal	412
6.7.26	DCTopologicalIsland.....	413
6.7.27	PerLengthDCLineParameter.....	413
6.7.28	VsCapabilityCurve.....	414
6.7.29	VsConverter	414
6.7.30	VsPpccControlKind enumeration.....	417
6.7.31	VsQpccControlKind enumeration	417
6.8	Package Equivalents.....	418
6.8.1	General	418
6.8.2	EquivalentBranch	419
6.8.3	EquivalentEquipment.....	422
6.8.4	EquivalentInjection	423
6.8.5	EquivalentNetwork.....	425
6.8.6	EquivalentShunt	426
6.9	Package AuxiliaryEquipment.....	427
6.9.1	General	427
6.9.2	AuxiliaryEquipment	428
6.9.3	CurrentTransformer	429
6.9.4	FaultIndicator	430
6.9.5	PostLineSensor	431
6.9.6	PotentialTransformer	432
6.9.7	PotentialTransformerKind enumeration	433
6.9.8	Sensor.....	434
6.9.9	SurgeArrester	435
6.9.10	WaveTrap.....	435
6.10	Package Meas	436
6.10.1	General	436

STANDARD PREVIEW
(standards.iteh.ai)

IEC 61970-301:2020

<https://standards.iteh.ai/catalog/standards/sist/1e510d8-c0a0-476a-8015->

ac0800becbe5/iec-61970-301-2020

6.10.2	Accumulator	440
6.10.3	AccumulatorLimit	441
6.10.4	AccumulatorLimitSet	441
6.10.5	AccumulatorReset	442
6.10.6	AccumulatorValue	443
6.10.7	Analog	444
6.10.8	AnalogControl	444
6.10.9	AnalogLimit	445
6.10.10	AnalogLimitSet	446
6.10.11	AnalogValue	446
6.10.12	Command	447
6.10.13	Control	448
6.10.14	Discrete	449
6.10.15	DiscreteValue	450
6.10.16	IOPoint	451
6.10.17	Limit	452
6.10.18	LimitSet	452
6.10.19	Measurement	453
6.10.20	MeasurementValue	454
6.10.21	MeasurementValueQuality	455
6.10.22	MeasurementValueSource	456
6.10.23	Quality61850 root class	456
6.10.24	RaiseLowerCommand	457
6.10.25	SetPoint	458
6.10.26	StringMeasurement	459
6.10.27	StringMeasurementValue	460
6.10.28	Validity enumeration	460
6.10.29	ValueAliasSet	461
6.10.30	ValueToAlias	462
6.11	Package Topology	462
6.11.1	General	462
6.11.2	BusNameMarker	464
6.11.3	TopologicalIsland	464
6.11.4	TopologicalNode	465
6.12	Package DiagramLayout	466
6.12.1	General	466
6.12.2	Diagram	467
6.12.3	DiagramObject	468
6.12.4	DiagramObjectGluePoint root class	469
6.12.5	DiagramObjectPoint root class	470
6.12.6	DiagramObjectStyle	470
6.12.7	DiagramStyle	471
6.12.8	OrientationKind enumeration	471
6.12.9	TextDiagramObject	472
6.12.10	VisibilityLayer	473
6.13	Package OperationalLimits	473
6.13.1	General	473
6.13.2	ActivePowerLimit	475
6.13.3	ApparentPowerLimit	476

6.13.4	BranchGroup	476
6.13.5	BranchGroupTerminal root class	477
6.13.6	CurrentLimit	478
6.13.7	OperationalLimit	478
6.13.8	OperationalLimitDirectionKind enumeration	479
6.13.9	OperationalLimitSet	479
6.13.10	OperationalLimitType	480
6.13.11	VoltageLimit	481
6.14	Package ControlArea	481
6.14.1	General	481
6.14.2	AltGeneratingUnitMeas	483
6.14.3	AltTieMeas	484
6.14.4	ControlArea	485
6.14.5	ControlAreaGeneratingUnit	486
6.14.6	ControlAreaTypeKind enumeration	487
6.14.7	TieFlow	487
6.15	Package Contingency	488
6.15.1	General	488
6.15.2	Contingency	488
6.15.3	ContingencyElement	489
6.15.4	ContingencyEquipment	489
6.15.5	ContingencyEquipmentStatusKind enumeration	490
6.16	Package StateVariables	490
6.16.1	General	490
6.16.2	StateVariable root class	491
6.16.3	SvInjection	491
6.16.4	SvPowerFlow	492
6.16.5	SvShuntCompensatorSections	492
6.16.6	SvStatus	493
6.16.7	SvSwitch	493
6.16.8	SvTapStep	494
6.16.9	SvVoltage	494
6.17	Package Protection	495
6.17.1	General	495
6.17.2	CurrentRelay	496
6.17.3	ProtectionEquipment	497
6.17.4	RecloseSequence	498
6.17.5	SynchrocheckRelay	499
6.18	Package Faults	500
6.18.1	General	500
6.18.2	EquipmentFault	501
6.18.3	Fault	501
6.18.4	FaultCauseType	502
6.18.5	FaultImpedance compound	502
6.18.6	LineFault	503
6.18.7	PhaseConnectedFaultKind enumeration	503
6.19	Package SCADA	504
6.19.1	General	504
6.19.2	CommunicationLink	505

IEC STANDARD PREVIEW
 (standards.iteh.ai)
<https://standards.iteh.ai/catalog/standards/sist/1e510d8-c0a0-476a-8015-ac0800becbe5/iec-61970-301-2020>
 IEC 61970-301:2020

6.19.3	RemoteControl	506
6.19.4	RemotePoint.....	506
6.19.5	RemoteSource.....	507
6.19.6	RemoteUnit	508
6.19.7	RemoteUnitType enumeration.....	508
6.19.8	Source enumeration	509
6.20	Package ICCPConfiguration.....	509
6.20.1	General	509
6.20.2	ApplicationSecurityKind enumeration.....	511
6.20.3	BilateralExchangeActor	512
6.20.4	BilateralExchangeAgreement.....	512
6.20.5	ICCPAccessPrivilegeKind enumeration.....	513
6.20.6	ICCPInformationMessage	513
6.20.7	ICCPPointKind enumeration	514
6.20.8	ICCPProvidedPoint.....	514
6.20.9	ICCPQualityKind enumeration	515
6.20.10	ICCPScopeKind enumeration.....	516
6.20.11	ICCPVCC	516
6.20.12	ICCPVirtualControlCentre	517
6.20.13	IOPointSource	518
6.20.14	IPAccessPoint	519
6.20.15	IPAddressKind enumeration.....	520
6.20.16	ISOUpperLayer.....	520
6.20.17	ProvidedBilateralPoint	521
6.20.18	PublicX509Certificate root class	521
6.20.19	TASE2BilateralTable	522
6.20.20	TCPAccessPoint.....	523
Annex A	(normative) Custom extensions.....	525
A.1	Overview.....	525
A.2	European extensions	525
A.2.1	General	525
A.2.2	Package ExtEuCore.....	525
A.2.3	Package ExtEuOperationalLimits	528
A.2.4	Package ExtEuGeneration	531
Annex B	(Informative) Examples of PST transformer modelling.....	534
B.1	General.....	534
B.2	Detailed calculations and examples	534
B.2.1	Symmetrical phase shifters with two cores.....	534
B.2.2	Quadrature boosters.....	538
B.2.3	Asymmetrical phase shifter.....	542
Annex C	(informative) Use cases HVDC representation	549
C.1	Overview.....	549
C.2	Back-to-back installations	549
C.3	Monopole with ground return.....	550
C.4	Monopole with metallic return	551
C.5	Voltage source converter	552
Bibliography	554

Figure 1 – Defined dependencies between CIM packages and packages' versions information.....	42
Figure 2 – CIM IEC 61970-301 package diagram	43
Figure 3 – Example of generalization	45
Figure 4 – Example of simple association	46
Figure 5 – Example of aggregation	46
Figure 6 – Equipment containers.....	48
Figure 7 – Names	49
Figure 8 – Connectivity model.....	50
Figure 9 – Simple network example	51
Figure 10 – Simple network connectivity modelled with CIM Topology	52
Figure 11 – Equipment inheritance hierarchy	53
Figure 12 – Transformer and Tank model.....	54
Figure 13 – Transformer model.....	56
Figure 14 – Transformer tap model	57
Figure 15 – Phasor diagram and equations	60
Figure 16 – Symmetrical phase shifter impedance variation	61
Figure 17 – Core organization.....	62
Figure 18 – Phasor diagram and equations.....	62
Figure 19 – Core organization.....	63
Figure 20 – Phasor diagram and equations	64
Figure 21 – Core organization.....	65
Figure 22 – Phasor diagram and equations.....	65
Figure 23 – Phasor diagrams and equations	67
Figure 24 – Core organization.....	68
Figure 25 – Phase wire data model.....	70
Figure 26 – Phase connectivity	71
Figure 27 – Grounding device data model.....	73
Figure 28 – Station including Petersen coils drawing example	74
Figure 29 – Instance diagram objects with one terminal coil.....	75
Figure 30 – Cuts, clamps, and jumpers UML model	76
Figure 31 – Example before cuts and jumpers are applied	77
Figure 32 – Example after cuts and jumpers are applied	78
Figure 33 – Example of jumper without cut or clamp	79
Figure 34 – Navigating from PSR to MeasurementValue	81
Figure 35 – Measurement placement	84
Figure 36 – Regulating control models.....	85
Figure 37 – Simplified example of HVDC model representation.....	87
Figure 38 – Detailed example of HVDC model representation with fictitious HVDC substations	88
Figure 39 – Detailed example of HVDC model representation with no fictitious HVDC substations	89
Figure 40 – HVDC bi-polar link from IEC 60633	90
Figure 41 – A point-to-point VSC transmission scheme.....	90

Figure 42 – HVDC power flow model.....	91
Figure 43 – Detailed HVDC power flow model.....	92
Figure 44 – Current Source Converter power flow.....	92
Figure 45 – Voltage Source Converter power flow.....	93
Figure 46 – Power flow cases.....	94
Figure 47 – VSC transmission with a symmetrical monopole illustrated with capacitive earthing on the DC side (IEC 62747).....	95
Figure 48 – VSC P-Q capability curve.....	95
Figure 49 – Bipolar VSC transmission with earth return (IEC 62747).....	96
Figure 50 – Object instances for a bi-polar current source HVDC line.....	97
Figure 51 – Object instances for symmetric monopole VSC HVDC data model.....	98
Figure 52 – Containment structure for a bipolar HVDC line.....	99
Figure 53 – Containment structure for a bipolar back-to-back HVDC station.....	100
Figure 54 – The Basic topology in package Core.....	101
Figure 55 – DC and AC topology.....	102
Figure 56 – Equipment model.....	103
Figure 57 – HVDC line model.....	104
Figure 58 – Legend.....	105
Figure 59 – Simple monopole with measurements.....	105
Figure 60 – Simple bipolar.....	106
Figure 61 – Monopole one side with detailed model.....	106
Figure 62 – V-I Characteristic of SVC.....	107
Figure 63 – ICCP measurements and network models.....	109
Figure 64 – ICCP configuration and start up.....	109
Figure 65 – Measurement value provider and consumer example.....	110
Figure 66 – Generalized bilateral exchange agreement data model.....	112
Figure 67 – ICCP bilateral exchange agreement data model.....	114
Figure 68 – Feeder data model.....	115
Figure 69 – Orientation of the Terminal flow.....	116
Figure 70 – Several ways to describe control area ties.....	117
Figure 71 – CIM top level packages.....	121
Figure 72 – Class diagram Domain::CombinedElectricalDatatypes.....	123
Figure 73 – Class diagram Domain::BasicDatatypes.....	123
Figure 74 – Class diagram Domain::ElectricityDatatypes.....	124
Figure 75 – Class diagram Domain::EnumeratedUnitDatatypes.....	125
Figure 76 – Class diagram Domain::GeneralDatatypes.....	126
Figure 77 – Class diagram Domain::MonetaryDatatypes.....	127
Figure 78 – Class diagram Domain::TimeDatatypes.....	128
Figure 79 – Class diagram Core::Main.....	156
Figure 80 – Class diagram Core::Names.....	157
Figure 81 – Class diagram Core::CurveSchedule.....	157
Figure 82 – Class diagram Core::Datatypes.....	158
Figure 83 – Class diagram Core::FeederContainment.....	159