

© Copyright SEK Svensk Elstandard. Reproduction in any form without permission is prohibited.

Kommunikationsnät och system för kraftföretagsautomation – Del 7-420: Grundläggande kommunikationsstruktur – Logiska noder för decentraliserad elförsörjning

*Communication networks and systems for power utility automation –
Part 7-420: Basic communication structure –
Distributed energy resources logical nodes*

Som svensk standard gäller europastandarden EN IEC 61850-7-420:2021. Den svenska standarden innehåller den officiella engelska språkversionen av EN IEC 61850-7-420:2021.

Nationellt förord

Europastandarden EN IEC 61850-7-420:2021

består av:

- **europastandardens ikraftsättningsdokument**, utarbetat inom CENELEC
- **IEC 61850-7-420, Second edition, 2021 - Communication networks and systems for power utility automation - Part 7-420: Basic communication structure - Distributed energy resources logical nodes**

utarbetad inom International Electrotechnical Commission, IEC.

Tidigare fastställd svensk standard SS-EN 61850-7-420, utgåva 1, 2010, gäller ej fr o m 2024-11-17.

ICS 33.200.00

Denna standard är fastställd av SEK Svensk Elstandard, som också kan lämna upplysningar om **sakinnehållet** i standarden.
Postadress: Box 1284, 164 29 KISTA
Telefon: 08 - 444 14 00.
E-post: sek@elstandard.se. Internet: www.elstandard.se

Standarder underlättar utvecklingen och höjer elsäkerheten

Det finns många fördelar med att ha gemensamma tekniska regler för bl a mätning, säkerhet och provning och för utförande, skötsel och dokumentation av elprodukter och elanläggningar.

Genom att utforma sådana standarder blir säkerhetsfordringar tydliga och utvecklingskostnaderna rimliga samtidigt som marknadens acceptans för produkten eller tjänsten ökar.

Många standarder inom elområdet beskriver tekniska lösningar och metoder som åstadkommer den elsäkerhet som föreskrivs av svenska myndigheter och av EU.

SEK är Sveriges röst i standardiseringsarbetet inom elområdet

SEK Svensk Elstandard svarar för standardiseringen inom elområdet i Sverige och samordnar svensk medverkan i internationell och europeisk standardisering. SEK är en ideell organisation med frivilligt deltagande från svenska myndigheter, företag och organisationer som vill medverka till och påverka utformningen av tekniska regler inom elektrotekniken.

SEK samordnar svenska intressenters medverkan i SEKs tekniska kommittéer och stödjer svenska experters medverkan i internationella och europeiska projekt.

Stora delar av arbetet sker internationellt

Utformningen av standarder sker i allt väsentligt i internationellt och europeiskt samarbete. SEK är svensk nationalkommitté av International Electrotechnical Commission (IEC) och Comité Européen de Normalisation Electrotechnique (CENELEC).

Standardiseringsarbetet inom SEK är organiserat i referensgrupper bestående av ett antal tekniska kommittéer som speglar hur arbetet inom IEC och CENELEC är organiserat.

Arbetet i de tekniska kommittéerna är öppet för alla svenska organisationer, företag, institutioner, myndigheter och statliga verk. Den årliga avgiften för deltagandet och intäkter från försäljning finansierar SEKs standardiseringsverksamhet och medlemsavgift till IEC och CENELEC.

Var med och påverka!

Den som deltar i SEKs tekniska kommittéarbete har möjlighet att påverka framtida standarder och får tidig tillgång till information och dokumentation om utvecklingen inom sitt teknikområde. Arbetet och kontakterna med kollegor, kunder och konkurrenter kan gynnsamt påverka enskilda företags affärsutveckling och bidrar till deltagarnas egen kompetensutveckling.

Du som vill dra nytta av dessa möjligheter är välkommen att kontakta SEKs kansli för mer information.

SEK Svensk Elstandard

Box 1284
164 29 Kista
Tel 08-444 14 00
www.elstandard.se

EUROPEAN STANDARD

EN IEC 61850-7-420

NORME EUROPÉENNE

EUROPÄISCHE NORM

November 2021

ICS 33.200

Supersedes EN 61850-7-420:2009 and all of its amendments and corrigenda (if any)

English Version

**Communication networks and systems for power utility
automation - Part 7-420: Basic communication structure -
Distributed energy resources and distribution automation logical
nodes
(IEC 61850-7-420:2021)**

Réseaux et systèmes de communication pour
l'automatisation des systèmes électriques - Partie 7-420:
Structure de communication de base - Ressources
énergétiques décentralisées et nœuds logiques
d'automatisation de la distribution
(IEC 61850-7-420:2021)

Kommunikationsnetze und -systeme für die
Automatisierung in der elektrischen Energieversorgung -
Teil 7-420: Grundlegende Kommunikationsstruktur-verteilte
Energieerzeuger und logische Knoten der
Verteilungsautomation
(IEC 61850-7-420:2021)

This European Standard was approved by CENELEC on 2021-11-17. CENELEC members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

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

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

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



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

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

© 2021 CENELEC All rights of exploitation in any form and by any means reserved worldwide for CENELEC Members.

Ref. No. EN IEC 61850-7-420:2021 E

SEK Svensk Elstandard

SSS-EN IEC 61850-7-420, utg 2:2022

European foreword

The text of document 57/2392/FDIS, future edition 2 of IEC 61850-7-420, prepared by IEC/TC 57 "Power systems management and associated information exchange" was submitted to the IEC-CENELEC parallel vote and approved by CENELEC as EN IEC 61850-7-420:2021.

The following dates are fixed:

- latest date by which the document has to be implemented at national (dop) 2022-08-17 level by publication of an identical national standard or by endorsement
- latest date by which the national standards conflicting with the (dow) 2024-11-17 document have to be withdrawn

This document supersedes EN 61850-7-420:2009 and all of its amendments and corrigenda (if any).

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

This document has been prepared under a Standardization Request given to CENELEC by the European Commission and the European Free Trade Association.

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

Endorsement notice

The text of the International Standard IEC 61850-7-420:2021 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 standards indicated:

IEC 61400-25-2 NOTE Harmonized as EN 61400-25-2

IEC 61850-7-410 NOTE Harmonized as EN 61850-7-410

IEC 62933 (series) NOTE Harmonized as EN IEC 62933 (series)

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>
IEC 61557-12	2018	Electrical safety in low voltage distribution systems up to 1 000 V AC and 1 500 V DC - Equipment for testing, measuring or monitoring of protective measures - Part 12: Power metering and monitoring devices (PMD)	FprEN 61557-12 ¹	2018
IEC/TS 61850-2	-	Communication networks and systems for power utility automation - Part 2: Glossary	-	-
IEC 61850-7-2	2010	Communication networks and systems for power utility automation - Part 7-2: Basic information and communication structure - Abstract communication service interconnection (ACSI)	EN 61850-7-2	2010
/AMD1	2020		/A1	2020
IEC 61850-7-3	2010	Communication networks and systems for power utility automation - Part 7-3: Basic communication structure - Common data classes	EN 61850-7-3	2011
/AMD1	2020		/A1	2020
IEC 61850-7-4	2010	Communication networks and systems for power utility automation - Part 7-4: Basic communication structure - Compatible logical node classes and data object classes	EN 61850-7-4	2010
/AMD1	2020		/A1	2020
IEC/TS 62786	-	Distributed energy resources connection with the grid	-	-

¹ At draft stage.

EN IEC 61850-7-420:2021 (E)

IEEE 1547	2018	IEEE Standard for Interconnection and Interoperability of Distributed Energy Resources with Associated Electric Power Systems Interfaces	-	-
ISO 4217	-	Codes for the representation of currencies and funds	-	-
		Requirements for generating plants to be connected in parallel with distribution networks	EN 50549	series

INTERNATIONAL STANDARD

NORME INTERNATIONALE



**Communication networks and systems for power utility automation –
Part 7-420: Basic communication structure – Distributed energy resources and
distribution automation logical nodes**

**Réseaux et systèmes de communication pour l'automatisation des systèmes
électriques –
Partie 7-420: Structure de communication de base – Ressources énergétiques
décentralisées et nœuds logiques d'automatisation de la distribution**

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

COMMISSION
ELECTROTECHNIQUE
INTERNATIONALE

ICS 33.200

ISBN 978-2-8322-1019-0

**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.....	15
INTRODUCTION.....	18
1 Scope.....	20
1.1 General.....	20
1.2 Published versions of this standard and related namespace name.....	20
1.3 Data model Namespace name and version.....	20
1.4 Data model Namespace Code Component distribution.....	21
1.5 Changes from IEC 61850-7-420:2009 (Edition 1).....	22
1.6 IEC 61850-7-420 versus IEC 61850-7-520.....	22
1.7 Terminology due to historical usage of terms.....	22
2 Normative references.....	23
3 Terms, definitions and abbreviated terms and acronyms.....	23
3.1 Terms and definitions.....	23
3.2 Generic abbreviations.....	32
3.3 Abbreviated terms.....	33
4 Concepts and constructs for managing DERs.....	46
4.1 Hierarchical concepts for DER facilities and plants.....	46
4.1.1 DER stakeholders.....	46
4.1.2 Conceptual DER hierarchical architecture.....	47
4.1.3 DER information capabilities.....	49
4.1.4 Concept of a recursive model for the term "DER".....	51
4.2 DER generic model and its components.....	51
4.2.1 General.....	51
4.2.2 Editorial rules.....	51
4.2.3 Main principles.....	52
4.2.4 Power management model.....	56
4.2.5 DEResourceLN class structure and composition model.....	61
4.2.6 Common properties of DER as resource class.....	75
4.2.7 DER electrical connection point (ECP) model.....	83
4.2.8 DER operational functions model.....	89
4.3 Interaction mechanisms between DER components.....	89
4.3.1 Handling of computed setpoints.....	89
4.3.2 Interaction between a DEResourceLN and its component LNs.....	89
4.3.3 Interactions between power management function LN and operational functions LN.....	90
4.3.4 Interactions between power management function LN and the resource LN – case of multiple layered resources.....	99
4.3.5 Interactions between ECP LN and LNs related to ECP (measurements, ECP status, etc.).....	100
4.3.6 Interactions between equivalent representations of a same resource.....	100
5 State machine and capabilities of different types of DERs.....	102
5.1 General.....	102
5.2 DER generic state machine for connecting DER at its ECP.....	102
5.2.1 General.....	102
5.2.2 Diagram of the generic DER state machine.....	102
5.2.3 DERStateKind enumeration.....	104
5.2.4 DERStateTransitionKind enumeration.....	105

5.2.5	DER Testing capabilities.....	106
5.3	LN related to generation.....	107
5.3.1	Generic DER generator LNs	107
5.3.2	DER reciprocating (diesel) engine LNs	108
5.3.3	Fuel cell LNs	109
5.3.4	Photovoltaic LNs	110
5.3.5	Combined Heat and Power LNs	114
5.3.6	DER fuel system LNs.....	117
5.3.7	DER excitation LNs	118
5.3.8	DER inverter LNs.....	118
5.4	LN related to storage.....	119
5.4.1	EESS description.....	119
5.4.2	Functional requirements of EESSs.....	120
5.4.3	EESSs participating in grid operations as a DER system	120
5.4.4	Definitions of the capacity and the state of charge of an EESS	123
5.5	LN related to loads.....	124
5.6	Measurement extension functions	125
5.7	Financial-related LNs	125
5.7.1	DER cost LNs	125
5.7.2	Pricing-related LNs	126
6	Operational Functions (including Grid Codes functions).....	126
6.1	General.....	126
6.2	Overview of Logical Nodes for Operational Functions	126
6.3	Main modelling principles.....	127
6.3.1	Benefits of operational functions to manage DER	127
6.3.2	Operational function enabling/disabling (Mod)	128
6.3.3	DER autonomous behavior enabled by operational functions.....	129
6.3.4	Priority, Ideal, Max, Min management between operational functions.....	129
6.3.5	Operational functions operating at a given ECP	131
6.3.6	Different ways to describe operational function curves.....	131
6.3.7	Percentages as size-neutral parameters	131
6.3.8	Hysteresis within operational functions	132
6.3.9	Typical digital signal processing to support operational functions	134
6.3.10	Ramp rate upon enabling an operational function	135
6.3.11	Randomized response times upon enabling an operational function.....	135
6.3.12	Timeout period	135
6.3.13	Multiple usages of a same operational function.....	135
6.3.14	Multiple operational functions	136
6.3.15	Uncertainty of requests from external stakeholders for operational functions.....	136
6.3.16	Expected responses to operational functions versus actual values from direct commands	136
6.4	Cease-to-Energize operational function and its interaction with the power management function.....	137
6.5	Voltage Ride-Through operational function	140
6.5.1	General	140
6.5.2	European and North American voltage ride-through functions.....	141
6.5.3	LN DHVT and DLVT: Voltage ride-through.....	143
6.6	Frequency Ride-Through operational function.....	144

6.6.1	General	144
6.6.2	North American frequency ride-through	144
6.6.3	LN DHFT and DLFT: Frequency Ride-Through	145
6.7	Frequency-Active Power operational functions.....	146
6.7.1	Overview of Frequency-Active Power functions.....	146
6.7.2	LN DHFW: High Frequency-Active Power operational function.....	159
6.7.3	LN DLFW: Low Frequency-Active Power operational function	160
6.8	Active power operational functions.....	160
6.8.1	LN DVWC: Voltage-Active Power (V-W) operational function	160
6.8.2	LN DWGC: Set Active Power for generating or consuming operational function	161
6.8.3	LN DWFL: Active Power Following operational function	161
6.8.4	LN DAGC: Automatic Generation Control (AGC) operational function	163
6.8.5	LN DTCD: Coordinated Charge/Discharge operational function	164
6.8.6	LN DWMX: Limit Maximum Active Power operational function	164
6.8.7	LN DWMN: Limit Minimum Active Power operational function	165
6.9	Power factor operational functions	165
6.9.1	General	165
6.9.2	LN DFPF: Set Fixed Power Factor operational function	165
6.10	Reactive power operational functions.....	166
6.10.1	General	166
6.10.2	LN DVVR: Voltage-Reactive Power (V-var) operational function	166
6.10.3	LN DVAR: Constant Reactive Power operational function	169
6.10.4	LN DWVR: Active Power–Reactive Power (W-Var) operational function.....	170
6.10.5	LN DRGS: Dynamic Reactive Current Support operational function	171
Annex A (normative)	Data model	176
A.1	Global overview	176
A.2	Reminder of the main IEC 61850-7-4 abstract classes used in this document and other rules.....	178
A.3	Namespace data model	179
A.3.1	Logical node classes for distributed energy resources (LogicalNodes_7_420_DER).....	179
A.3.2	DER Operational functions (LogicalNodes_7_420_Operational_Functions)	336
A.3.3	Data semantics.....	451
A.3.4	Enumerated data attribute types	483
Annex B (informative)	DER hierarchy modelling rules and examples.....	508
B.1	Main principles application.....	508
B.1.1	General	508
B.1.2	Applying the DER composition modelling rules	508
B.1.3	Applying the DER class model.....	508
B.1.4	Exposing some DER properties through the generic interface.....	508
B.1.5	Applying the dynamic relationships between the core DER modelling elements.....	508
B.2	Examples.....	508
B.2.1	Global DER models applying to a campus of two buildings	508
B.2.2	Example of modelling a composed DER made of (PV+BAT)+BAT on a single plant.....	513
B.2.3	Global DER modelling applying to shared DER (30 %PV + 30 %BAT) and (70 %PV + 70 %BAT) on a single plant	514

B.2.4	Mapping example in case of a complex storage installation	515
Annex C (normative)	Backward compatibility with IEC 61850-7-420 Edition 1	517
Annex D (informative)	DER operational functions.....	525
D.1	List of DER mandatory grid codes.....	525
D.2	Table of DER functions	525
D.3	Combining DER operational functions using the concepts of Ideal, Max, Min instantiations	533
D.4	Scheduling with Ideal, Max, Min.....	536
Annex E (informative)	Examples of implementation to support Low Voltage ride through.....	538
E.1	Case of European grid codes.....	538
E.2	Case of IEEE 1547 requirements	540
Annex F (Informative)	Handling of setpoints with IEC 61850-7-3 Ed 2.1 and Ed 2.2.....	543
F.1	Main features associated to setpoints	543
F.2	Main 61850 client-server modelling principles	545
F.3	Modelling rules for implementing computed setpoints	545
F.4	Implementing setpoints with Edition 2.1	546
Bibliography.....		548
Figure 1 – Conceptual hierarchical architecture of DER information interactions with other entities.....		48
Figure 2 – Recursive composition of DERs		51
Figure 3 – Graphical UML representation convention		52
Figure 4 – DER generic model: Comprised of 4 types of components		53
Figure 5 – DER generic model: Typical components main interactions (single level).....		54
Figure 6 – DER generic model: Components main interactions (multiple levels).....		55
Figure 7 – DER generic model: simplest interaction implementation in the case of a single source of controls		55
Figure 8 – Power management situation 1: Handling multiple differential active power requests, compatible with the operational capacity of the resource		58
Figure 9 – Power management situation 2: Handling multiple differential active power requests, exceeding the operational capacity of the resource		58
Figure 10 – Power management situation 3: Handling competing multiple total active power at ECP requests		59
Figure 11 – Power management situation 4: Combination of situation 2 and situation 3		59
Figure 12 – Power management situation 5: Multiple competing active power limiting request		60
Figure 13 – Power management situation 6: Combination of all situations.....		60
Figure 14 – Example: Simple DER resource model of a PV generating unit (instance & class).....		62
Figure 15 – Hierarchical class model of DER resources – basic principles		63
Figure 16 – DER composition model principles		64
Figure 17 – Impacts of composition requirements on the DER class model		65
Figure 18 – Needed association to express DER generic capabilities.....		66
Figure 19 – Exposing the generic interfaces of a mixed DER		67
Figure 20 – Exposing the generic interfaces of a storage DER (battery storage as example).....		68

Figure 21 – Typical LN Mapping in case of an EESS resulting from the aggregation of two battery units 69

Figure 22 – Full LN Mapping in case of an EESS resulting from the aggregation of two battery units..... 69

Figure 23 – Other typical LN Mapping in case of an EESS resulting from the aggregation of two battery units 70

Figure 24 – Example of modelling two breakdowns of the same set of resources (first controllable, second not controllable)..... 71

Figure 25 – Example of sorting DER capabilities per type (first controllable, second not controllable)..... 71

Figure 26 – Example of modelling two breakdowns of the same set of resources (first renewable, second not renewable)..... 72

Figure 27 – Example of combining composition and equivalency of resources 73

Figure 28 – Principles which should guide the extensions for supporting other types of energies 74

Figure 29 – Principles of the hierarchical class resource model of DER resources with examples of specific DER types at the lowest level 75

Figure 30 – Producer and Consumer Reference Frame conventions 77

Figure 31 – Power factor sign conventions in the Producer Reference Frame (PRF) 78

Figure 32 – Power factor sign conventions in the Consumer Reference Frame (CRF) 79

Figure 33 – Working areas for DER..... 80

Figure 34 – Example of voltage offsets (VRefOfs) with respect to the reference voltage (VRef) (often the PCC)..... 82

Figure 35 – Implementation example of voltage offsets (VRefOfs) on a generator supporting a V-var operational function with respect to the reference voltage (VRef) 82

Figure 36 – Concept of DERs (coloured circles), electrical connection points (ECP), and the Referenced ECP as a pointer 84

Figure 37 – ECP LN class model, including ECPs, PCCs, and virtual ECPs 86

Figure 38 – Relationships between ECPs and DER resources 87

Figure 39 – ECP connection type..... 88

Figure 40 – Interactions between a DER and its components (example) 90

Figure 41 – "Spatial" interactions between an operational function and the power management function in case of setting a (maximum) limit at ECP (example) 91

Figure 42 – "Temporal" interactions between an operational function and the power management function in case of setting a (maximum) limit at ECP(example) 92

Figure 43 – "Spatial" interactions between an operational function and the power management function in case of setting a setpoint at ECP (example)..... 93

Figure 44 – "Temporal" interactions between an operational function and the power management function in case of setting a setpoint at ECP (example)..... 93

Figure 45 – "Spatial" interactions between an operational function and the power management function in case of setting a differential setpoint (example) 94

Figure 46 – "Temporal" interactions between an operational function and the power management function in case of setting a differential setpoint (example) 95

Figure 47 – Scheduling modelling principles and main associations 96

Figure 48 – Principle of integration of scheduled energy behaviour (example) 97

Figure 49 – Example of interaction between operational functions and power management functions with layered DERs 99

Figure 50 – A single DPMC instance controlling multiple DERresources 100

Figure 51 – generic DER state machine 103

Figure 52 – Definitions of logic connections applying to the generic DER state machine	104
Figure 53 – DER Test typical sequence	106
Figure 54 – Generator DER abstract LNs structure overview	108
Figure 55 – Example of one-line diagram of an interconnected PV system.....	111
Figure 56 – Schematic diagram of a large PV installation with two arrays of several sub-arrays	112
Figure 57 – CHP based on fuel cell systems	114
Figure 58 – CHP based on internal combustion.....	115
Figure 59 – CHP unit includes both domestic hot water and heating loops	116
Figure 60 – CHP unit includes domestic hot water with 2 storage tanks and 2 heating elements.....	116
Figure 61 – CHP unit includes domestic hot water with 1 storage tank and 2 heating elements.....	116
Figure 62 – Inverter / converter configuration.....	118
Figure 63 – Classification of electrical energy storage systems according to energy form. IEC-WP [IEC White Paper Electrical Energy Storage:2011])	119
Figure 64 – Different uses of electrical energy storage in grids, depending on the frequency and duration of use.....	120
Figure 65 – Storage DER abstract LNs structure overview	122
Figure 66 – A simple energy storage system.....	122
Figure 67 – A more complex energy storage system	123
Figure 68 – EESS state of charge: effective and usable capacities and states of charge reflected using the IEC 618650 model naming conventions.....	124
Figure 69 – Load DER abstract LNs structure overview	125
Figure 70 – Overview of Logical Nodes for Operational Functions.....	127
Figure 71 – Example of operational functions associated with different ECPs	128
Figure 72 – Example of sloped hysteresis in V-var curve	133
Figure 73 – Example of single value hysteresis in frequency-active power function.....	133
Figure 74 – Local function block diagram	134
Figure 75 – Time domain response of first order low pass filter.....	134
Figure 76 – Statechart Diagram: Cease-to-energize state machine	138
Figure 77 – Example of interactions between the handler of the Cease-to-Energize request (LN DCTE), the power management function and the DERResourceLN	139
Figure 78 – Possible sequence of steps of the DCTE state machine and the DER energy behavior in case of a Cease-to-energize event.....	140
Figure 79 – European voltage ride-through curve.....	141
Figure 80 – IEEE 1547:2018/AMD1:2020 diagram illustrating the different voltage ride-through profiles.....	142
Figure 81 – Voltage protection LNs (extracted from IEC 61850-7-4:2010/AMD1:2020)	144
Figure 82 – Example of frequency ride-through profile	145
Figure 83 – Frequency protection LNs (extracted from IEC 61850-7-4:2010/AMD1:2020)	146
Figure 84 – Active power frequency response capability of power-generating modules in LFSM-O (ref: RfG)	147
Figure 85 – Maximum power capability reduction with falling frequency (ref: RfG).....	148
Figure 86 – Active power frequency response capability of power-generating modules in LFSM-U (ref: RfG).....	148

Figure 87 – Active power frequency response capability of power-generating modules in FSM illustrating the case of zero deadband and insensitivity (ref: RfG) 149

Figure 88 – For Zone 1 frequency sensitivity, potential use of WMax to determine the gradient 150

Figure 89 – Frequency droop curve from IEEE 1547 151

Figure 90 – Frequency-active power constrained by static boundary: DER to remain within the boundaries of frequency-active power curves..... 152

Figure 91 – For Zone 1, potential use of WMax or WRef to determine the gradient 154

Figure 92 – For Zone 1, use of Frequency-Active Power: frequency slope (WGra) established by P2 and P3, starting from WRef at the snapshot frequency (HzStr) 155

Figure 93 – For Zone 2, use of Frequency-Active Power: slope (DLFW.WGra) established by P1 and P6, but starting from WRef at the snapshot frequency (DLFW.HzStr) 156

Figure 94 – Use of Frequency-Active Power: DER also operating in Zone 3 (charging/consuming) 156

Figure 95 – Use of Frequency-Active Power: For DER with consuming capabilities, the same concepts apply in Zones 3 and 4 157

Figure 96 – Example of hysteresis in Zone 1..... 158

Figure 97 – Example of multiple gradients and hysteresis in Zones 1 and 3 159

Figure 98 – Examples of V-W requirements 160

Figure 99 – Example of V-W curve: stay within bounds (SnptBarEna = false), but do not necessarily go to boundary 161

Figure 100 – Active Power Load Following..... 162

Figure 101 – Active Power Following of Generation 162

Figure 102 – Active Power Following of Generation without a threshold..... 163

Figure 103 – Active Power Following of Generation with percent compensation less than 100 % 163

Figure 104 – Coordinated Charge/Discharge 164

Figure 105 – Example of P-Q capability curve (P: active power; Q: reactive power; S: apparent power)..... 165

Figure 106 – Example Voltage–Reactive Power characteristics 167

Figure 107 – Example of volt-var curve with hysteresis, arrows indicating direction of voltage changes..... 167

Figure 108 – Voltage-Reactive Power operational function with single slope..... 168

Figure 109 – Voltage-Reactive Power operational function with deadband..... 169

Figure 110 – Constant Reactive Power operational function..... 169

Figure 111 – Examples of different Q(P) requirements 170

Figure 112 – Example Active Power–Reactive Power curve 171

Figure 113 – Basic concepts of the Dynamic Reactive Current Support function 172

Figure 114 – Calculation of delta voltage over the filter time window..... 172

Figure 115 – Activation zones for Dynamic Reactive Current Support 173

Figure 116 – Alternative gradient behaviour, selected by ArGraMod 174

Figure 117 – Settings to define a blocking zone 175

Figure A.1 – Global overview of LNs included in this document..... 177

Figure A.2 – Main IEC 61850-7-4 abstract classes used in this document..... 178

Figure A.3 – Class diagram AbstractLNs_7_420:: DER related Abstract LNs of 61850-7-420 (1)..... 182

Figure A.4 – Class diagram AbstractLNs_7_420:: DER related Abstract LNs of 61850-7-420 (2).....	183
Figure A.5 – Class diagram ECP_LNs::ECP_related_Logical_Nodes	206
Figure A.6 – Class diagram DERPowerManagementLN::DER Power Management LN	216
Figure A.7 – Class diagram DERMixedLNs::Mixed DER Logical Nodes.....	222
Figure A.8 – Class diagram DERGeneratorLNs::DER Generators Logical Nodes	229
Figure A.9 – Class diagram DERStorageLNs::DER Storage Logical Nodes	240
Figure A.10 – Class diagram DERLoadLNs::DER Load Logical Nodes	253
Figure A.11 – Class diagram Battery_LNs::Battery_LNs.....	262
Figure A.12 – Class diagram PhotovoltaicLNs::Photovoltaic Logical Nodes.....	271
Figure A.13 – Class diagram ReciprocatingEngineLNs:: Reciprocating Engine Logical Nodes	283
Figure A.14 – Class diagram FuelCellLNs::DER Fuel Cell_Logical_Nodes	288
Figure A.15 – Class diagram FuelSystemLNs::Fuel System Logical Nodes	296
Figure A.16 – Class diagram CHP_LNs::Combined Heat and Power Logical Nodes	302
Figure A.17 – Class diagram DERExcitationLNs::DER Excitation Logical Node.....	310
Figure A.18 – Class diagram DERInverterLNs::DER Inverter Logical Nodes	314
Figure A.19 – Class diagram DERFinancialLNs_7_420::DERFinancialLNs_7_420	324
Figure A.20 – Class diagram MeasurementExtLN::Measurement LN extensions	329
Figure A.21 – Class diagram Overview_Operational_Functions:: DER operational functions LNs overview	339
Figure A.22 – Class diagram AbstractLNs7_420_Operational_Functions::Abstract operational functions LNs overview	340
Figure A.23 – Class diagram CeasetoEnergizeLN::Ceaze to Energize LNs	351
Figure A.24 – Class diagram Voltage_Ride-ThroughLNs::Voltage ride-through LNs	356
Figure A.25 – Class diagram Frequency_Ride-ThroughLNs::Frequency ride-through LNs 364	
Figure A.26 – Class diagram Frequency-ActivePowerLNs:: Frequency vs active power LNs 372	
Figure A.27 – Class diagram ActivePowerLNs::Active Power LNs	386
Figure A.28 – Class diagram PowerFactorLNs::Power Factor LNs	423
Figure A.29 – Class diagram ReactivePowerLNs::Reactive Power LNs	429
Figure A.30 – Class diagram DOEnums_7_420::DOEnums_7_420	484
Figure A.31 – Class diagram DOEnums_7_420::DOEnums_7_420 – 2	485
Figure A.32 – Class diagram DOEnums_7_420::DOEnums_7_420 – 3	486
Figure B.1 – Example of power management hierarchical interactions – architecture case.....	509
Figure B.2 – Example of power management hierarchical interactions – single DER power management architecture (focused on one sub-resource level "building 2")	509
Figure B.3 – Example of power management hierarchical interactions – single DER power management architecture with insight on internal interactions (focused on one sub-resource level "building 2").....	511
Figure B.4 – Example of power management hierarchical interactions – "site" level	512
Figure B.5 – Example of power balancing on a mixed resource (generation and loads).....	512
Figure B.6 – Global DER modelling applying to a composed DER made of (PV+BAT)+BAT on a single plant	513

Figure B.7 – Global DER modelling applying to shared DER (30 %PV + 30 %BAT) and (70 %PV + 70 %BAT) on a single plant 514

Figure B.8 – A simple electrical energy storage system 515

Figure B.9 – A more complex electrical mixed system, including storage – example of possible LN mapping 516

Figure E.1 – European low voltage ride through requirement (EN 50549-1) 538

Figure E.2 – Undervoltage curve one to support European low voltage ride through 538

Figure E.3 – Undervoltage curve two to support European low voltage ride through..... 539

Figure E.4 – LN mapping example to support European low voltage ride through requirements..... 539

Figure E.5 – LN mapping example to support IEEE1547 low voltage ride through requirements of DER category III 541

Figure E.6 – IEC 61850 model for IEEE 1547 voltage disturbances 542

Figure F.1 – (draft) Client/server interaction mechanism to handle setpoints based on IEC 61850-7-3 Ed 2.2 546

Figure F.2 – Client/server interaction mechanism to handle setpoints 547

Table 1 – Tracking information of IEC 61850-7-420:2019A namespace building-up..... 16

Table 2 – Reference between published versions of the standard and related namespace name..... 20

Table 3 – Attributes of IEC 61850-7-420:2019A namespace 21

Table 4 – Generic acronyms and abbreviations..... 33

Table 5 – Normative abbreviations for data object names 34

Table 6 – Normative abbreviations for data object names 35

Table 7 – Producer Reference Frame (PRF)conventions..... 77

Table 8 – Consumer Reference Frame (CRF) conventions..... 78

Table 9 – Literals of ECPCConnKind..... 88

Table 10 – Example of interactions impacts between equivalent resources 101

Table 11 – Literals of DERStateKind..... 105

Table 12 – Literals of DERStateTransitionKind 105

Table 13 – Voltage ride-through boundary curves 142

Table A.1 – List of classes defined in LogicalNodes_7_420_DER package 179

Table A.2 – List of classes defined in AbstractLNs_7_420 package 183

Table A.3 – List of classes defined in AbstractDerLNs_7_420 package..... 185

Table A.4 – Data objects of AllEnergyDERResourceLN..... 185

Table A.5 – Data objects of DER_NameplateRatingsLN..... 186

Table A.6 – Data objects of DER_StateAbstractLN 187

Table A.7 – Data objects of DER_ActualPowerInformationLN 189

Table A.8 – Data objects of DER_OperationalSettingsLN..... 189

Table A.9 – Data objects of NonStorageOperationalSettingsLN 190

Table A.10 – List of classes defined in AbstractEcpLNs_7_420 package 192

Table A.11 – Data objects of ElectricalReferenceLN 192

Table A.12 – Data objects of PhysicalElectricalConnectionPointLN..... 193

Table A.13 – Data objects of VirtualElectricalReferenceLN 194

Table A.14 – List of classes defined in AbstractGenLNs_7_420 package..... 194

Table A.15 – Data objects of DER_GeneratorLN.....	195
Table A.16 – Data objects of GeneratorNameplateRatingsLN	196
Table A.17 – List of classes defined in AbstractStoLNs_7_420 package	197
Table A.18 – Data objects of StorageOperationalSettingsLN.....	198
Table A.19 – Data objects of StorageNameplateRatingsLN.....	200
Table A.20 – Data objects of DER_StorageLN	202
Table A.21 – List of classes defined in AbstractLodLNs_7_420 package.....	203
Table A.22 – Data objects of LoadNameplateRatingsLN	204
Table A.23 – List of classes defined in AbstractOtherLNs_7_420 package.....	204
Table A.24 – Data objects of DERConverterLN	205
Table A.25 – List of classes defined in ECP_LNs package.....	207
Table A.26 – Data objects of DECP	207
Table A.27 – Data objects of DPCC	210
Table A.28 – Data objects of DVER	213
Table A.29 – List of classes defined in DERPowerManagementLN package.....	217
Table A.30 – Data objects of DPMC.....	217
Table A.31 – List of classes defined in DERMixedLNs package	222
Table A.32 – Data objects of DMDR.....	223
Table A.33 – List of classes defined in DERGeneratorLNs package.....	229
Table A.34 – Data objects of DGEN	230
Table A.35 – List of classes defined in DERStorageLNs package	241
Table A.36 – Data objects of DSTO	241
Table A.37 – List of classes defined in DERLoadLNs package	254
Table A.38 – Data objects of DLOD	254
Table A.39 – List of classes defined in Battery_LNs package.....	263
Table A.40 – Data objects of SBAT	263
Table A.41 – Data objects of DBAT.....	267
Table A.42 – List of classes defined in PhotovoltaicLNs package.....	272
Table A.43 – Data objects of DPVA.....	272
Table A.44 – Data objects of DPVM	275
Table A.45 – Data objects of DPVC	277
Table A.46 – Data objects of DTRC	280
Table A.47 – List of classes defined in ReciprocatingEngineLNs package.....	284
Table A.48 – Data objects of DCIP.....	284
Table A.49 – List of classes defined in FuelCellLNs package.....	289
Table A.50 – Data objects of DFCL.....	289
Table A.51 – Data objects of DSTK.....	292
Table A.52 – Data objects of DFPM	294
Table A.53 – List of classes defined in FuelSystemLNs package	297
Table A.54 – Data objects of KFUL	297
Table A.55 – Data objects of KFLV	299
Table A.56 – List of classes defined in CHP_LNs package.....	302
Table A.57 – Data objects of DCHC	303

Table A.58 – Data objects of DCTS.....	306
Table A.59 – Data objects of DCHB	308
Table A.60 – List of classes defined in DERExcitationLNs package	311
Table A.61 – Data objects of DEXC	311
Table A.62 – List of classes defined in DERInverterLNs package.....	315
Table A.63 – Data objects of DINV.....	315
Table A.64 – Data objects of DRTF.....	319
Table A.65 – Data objects of SINV.....	322
Table A.66 – List of classes defined in DERFinancialLNs_7_420 package	324
Table A.67 – Data objects of DCCT	325
Table A.68 – Data objects of DCST.....	327
Table A.69 – List of classes defined in MeasurementExtLN package	330
Table A.70 – Data objects of MMETExt.....	330
Table A.71 – Data objects of MMXUExt	333
Table A.72 – List of classes defined in LogicalNodes_7_420_Operational_Functions package.....	337
Table A.73 – List of classes defined in AbstractLNs7_420_Operational_Functions package.....	341
Table A.74 – List of classes defined in AbstractLNs7_420_Op_Functions package.....	341
Table A.75 – Data objects of LowPassFilterOnFunctionInputLN	342
Table A.76 – Data objects of LowPassFilterOnFunctionOutputLN	342
Table A.77 – Data objects of ElectricalContextReferenceLN	343
Table A.78 – Data objects of OperationalFunctionLN	343
Table A.79 – Data objects of RampRatesLN	344
Table A.80 – Data objects of ActivePowerLN	345
Table A.81 – List of classes defined in AbstractLNs7_420GridCodeModes package	346
Table A.82 – Data objects of HysteresisSnapshotLN.....	346
Table A.83 – Data objects of FrequencyActivePowerLN.....	348
Table A.84 – Data objects of RideThroughLN	349
Table A.85 – Data objects of ReactivePowerLN	350
Table A.86 – List of classes defined in CeasetoEnergizeLN package.....	351
Table A.87 – Data objects of DCTE.....	352
Table A.88 – List of classes defined in Voltage_Ride-ThroughLNs package.....	356
Table A.89 – Data objects of DHVT.....	357
Table A.90 – Data objects of DLVT	360
Table A.91 – List of classes defined in Frequency_Ride-ThroughLNs package	364
Table A.92 – Data objects of DHFT.....	365
Table A.93 – Data objects of DLFT	369
Table A.94 – List of classes defined in Frequency-ActivePowerLNs package	373
Table A.95 – Data objects of DHFW.....	373
Table A.96 – Data objects of DLFW	380
Table A.97 – List of classes defined in ActivePowerLNs package	387
Table A.98 – Data objects of DAGC	388
Table A.99 – Data objects of DTCD	393

Table A.100 – Data objects of DVWC.....	398
Table A.101 – Data objects of DWFL	404
Table A.102 – Data objects of DWGC	409
Table A.103 – Data objects of DWMN	414
Table A.104 – Data objects of DWMX	418
Table A.105 – List of classes defined in PowerFactorLNs package	423
Table A.106 – Data objects of DFPF	424
Table A.107 – List of classes defined in ReactivePowerLNs package.....	430
Table A.108 – Data objects of DVVR	430
Table A.109 – Data objects of DVAR	436
Table A.110 – Data objects of DWVR.....	441
Table A.111 – Data objects of DRGS	446
Table A.112 – Attributes defined on classes of LogicalNodes_7_420 package	451
Table A.113 – List of classes defined in DOEnums_7_420 package.....	486
Table A.114 – Literals of ACSystemKind.....	488
Table A.115 – Literals of ACToDCCConversionKind	488
Table A.116 – Literals of BatteryTypeKind	488
Table A.117 – Literals of BoilerKind	489
Table A.118 – Literals of CeasetoEnergizeStateKind	489
Table A.119 – Literals of CeasetoEnergizeStateTransitionKind	489
Table A.120 – Literals of ChargeSourceKind.....	490
Table A.121 – Literals of CHPEnergyConverterKind.....	490
Table A.122 – Literals of CHPGeneratorKind	490
Table A.123 – Literals of CHPOperatingModeKind	491
Table A.124 – Literals of CoolingMethodKind.....	491
Table A.125 – Literals of DERStateKind.....	491
Table A.126 – Literals of DERStateTransitionKind	492
Table A.127 – Literals of DERSynchronizationKind	493
Table A.128 – Literals of DERUnitKind.....	493
Table A.129 – Literals of ECPConnKind.....	494
Table A.130 – Literals of ECPIslandStateKind	494
Table A.131 – Literals of EquipmentTestResultKind.....	495
Table A.132 – Literals of ExciterKind	495
Table A.133 – Literals of FrequencyActivePowerRefParamKind	495
Table A.134 – Literals of FuelDeliveryKind.....	496
Table A.135 – Literals of FuelKind	496
Table A.136 – Literals of FuelProcessingInFuelKind	497
Table A.137 – Literals of FuelProcessingKind	498
Table A.138 – Literals of FuelProcessingOutFuelKind.....	498
Table A.139 – Literals of GroundingSystemKind	498
Table A.140 – Literals of InverterControlSourceKind.....	499
Table A.141 – Literals of InverterSwitchKind.....	499
Table A.142 – Literals of IsolationKind.....	499

Table A.143 – Literals of OutputFilterKind.....	500
Table A.144 – Literals of PhaseFeedKind	500
Table A.145 – Literals of PhaseKind	501
Table A.146 – Literals of PVArrayControlModeKind	501
Table A.147 – Literals of PVAssemblyKind	501
Table A.148 – Literals of PVConfigKind	502
Table A.149 – Literals of PVControlStateKind	502
Table A.150 – Literals of PVGroundingKind	502
Table A.151 – Literals of PVTrackingControlKind	503
Table A.152 – Literals of PVTrackingKind	503
Table A.153 – Literals of PVTrackingStatusKind	504
Table A.154 – Literals of PVTrackingTechnologyKind	504
Table A.155 – Literals of QuadrantRunningStateKind.....	504
Table A.156 – Literals of ReactivePowerRefParamKind	505
Table A.157 – Literals of ThermalEnergyMediumKind	505
Table A.158 – Literals of ThermalEnergyStorageKind	506
Table A.159 – Literals of VoltageRegulationKind.....	506
Table A.160 – Literals of WaveformConditioningKind	506
Table A.161 – Literals of VoltageActivePowerRefParamKind	507
Table C.1 – Compatibility assessment	517
Table C.2 – Compatibility tables	517
Table D.1 – DER functions and operational functions.....	526
Table D.2 – Ideal, Max, Min, & Priority of DTCD and DWFL over a day.....	534
Table E.1 – IEEE 1547 shall trip requirements for DER category III	540
Table E.2 – IEEE 1547 voltage ride through requirements for DER category III.....	540
Table E.3 – LN instances for Voltage disturbances of DER category III according to IEEE 1547	541

INTERNATIONAL ELECTROTECHNICAL COMMISSION

**COMMUNICATION NETWORKS AND
SYSTEMS FOR POWER UTILITY AUTOMATION –****Part 7-420: Basic communication structure –
Distributed energy resources and distribution automation logical nodes**

FOREWORD

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

International standard IEC 61850-7-420 has been prepared by IEC Technical Committee 57: Power system control and associated communications.

This second edition cancels and replaces the first edition published in 2009. This edition constitutes a technical revision.

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

- a) Generic approach of modelling to support any kinds of DER including generation, storage and controllable loads;
- b) Generic approach to support physical and virtual aggregation of DERs;
- c) Full support of a wide range of operational functions to cover in particular grid codes functions as expressed in IEEE 1547 and EN 50549 or IEC 62786.

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

FDIS	Report on voting
57/2392/FDIS	57/2403/RVD

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

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

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 61850 series, under the general title: *Communication networks and systems for power utility automation*, can be found on the IEC website. This IEC standard includes Code Components i.e. components that are intended to be directly processed by a computer.

Such content is any text found in Annex A.

The purchase of this IEC standard carries a copyright license for the purchaser to sell software containing Code Components from this standard to end users either directly or via distributors, subject to IEC software licensing conditions, which can be found at: <http://www.iec.ch/CCv1>.

Table 1 shows all tracking information of IEC 61850-7-420:2019A namespace building-up.

Table 1 – Tracking information of IEC 61850-7-420:2019A namespace building-up

Attribute	Content
Namespace IEC specific information	
Version of the UML model used for generating the document (informative)	WG17build8
Date of the UML model used for generating the document (informative)	2021-09-09
Autogeneration software name and version(informative)	j61850DocBuilder 01v04 based on jCleanCim noNS beta8 (derived from jCleanCim 02-02)
Namespace Changes	
Version from which the list of Tissues is built	2009
Revision of the version from which the list of Tissues is built	A
List of Applied Tissues	642-646, 648, 651, 654, 666, 701, 703, 704, 888-889, 903-907, 916, 917, 921-923, 945-947, 955-960, 975-976, 978-989, 992-995, 999-1001, 1003-1006, 1008-1024, 1027-1028, 1031-1033, 1035, 1073-1074, 1087-1090, 1094-1115, 1124, 1126, 1132, 1134, 1153, 1158, 1182, 1183, 1206, 1210, 1215-1219, 1225, 1314, 1320, 1323, 1366, 1392-1394, 1414
Namespace History	
List of merged namespaces into this namespace release	IEC/TR 61850-90-7, IEC/TR 61850-90-9

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

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

INTRODUCTION

Increasing numbers of DER (distributed energy resources) systems are being interconnected to electric power systems throughout the world. As DER technology evolves and as the impact of dispersed generation on distribution power systems becomes a growing challenge – and opportunity – nations worldwide are recognizing the economic, social, and environmental benefits of integrating DER technology within their electric infrastructure.

The manufacturers of DER devices are facing the age-old issues of what communication standards and protocols to provide to their customers for monitoring and controlling DER devices, in particular when they are interconnected with the electric power system. In the past, DER manufacturers developed their own proprietary communication technology. However, as distribution system operators (DSOs), aggregators, and other energy service providers start to manage DER devices which are interconnected with the power system, they are finding that coping with these different communication technologies present major technical difficulties, implementation costs, and maintenance costs. Therefore, DSOs and DER manufacturers recognize the growing need to have one international standard that defines the communication and control interfaces for all DER devices. Such standards, along with associated guidelines and uniform procedures would simplify implementation, reduce installation costs, reduce maintenance costs, and improve reliability of power system operations.

The information concepts discussed in this document are focused on DERs, but may also be applicable to central-station generation installations that are comprised of groupings of multiple units of the same types of energy conversion systems that are covered in this document. This applicability to central-station generation is strongest for photovoltaics and fuel cells, due to their modular nature.

Communications for DER plants involve not only local communications between DER units and the plant management system, but also between the DER plant and the operators or aggregators who manage the DER plant as a virtual source of energy and/or ancillary services.

In particular, new DER functions are being defined, and in some cases, becoming mandatory. The mandatory "grid codes" have been defined by various groups in terms of power system interconnection and operational requirements. These grid codes have been assessed for the communication requirements which are included in this DER information model.

In basic terms and in this context, "communications" can be separated into four high-level parts:

- information modelling (the types of data to be exchanged – nouns),
- services modelling (the read, write, or other actions to take on the data – verbs),
- communication protocols (mapping the noun and verb models to actual bits and bytes),
- telecommunication media (fibre optics, radio systems, wireless systems, and other physical equipment)

The general technology for information modelling has developed to become well-established as the most effective method for managing information exchanges. In particular, the IEC 61850-7-x information models for the exchange of information have become International Standards for substation automation, for interaction with and between DER, for hydro plants and, by extension in IEC 61400-25-2, for wind power plants. Many of the new concepts developed in this document for DER can also be reused for information models in those other domains as well as for information models in new, yet-to-be-developed domains.

This document addresses the IEC 61850 information modelling for DER, although some types and aspects of DER information models have been developed or are being developed separately through technical reports before they are added to this international standard DER model. These consist of the following:

- IEC TR 61850-90-7: Object models for power converters in distributed energy resources (DER) systems – Its integration however has led to a quite in-depth re-assessment. So, from a functional perspective, functions originally covered by the IEC TR 61850-90-7 are now covered by this new edition of 61850-7-420, but in many cases the original LNs of IEC 61850-90-7 have been deprecated.
- IEC TR 61850-90-9: Use of IEC 61850 for Electrical Storage Systems

In the other way, logical nodes related to scheduling (DSCH, DSCC), originally published as part as IEC 61850-7-420:2009 have first been re-assessed within IEC TR 61850-90-10 and renamed FSCH and FSCC, and are now fully integrated into IEC 61850-7-4:2010+AMD1:2020. The coming IEC TR 61850-7-5 Edition 2¹ should provide some additional examples of case of use of these specific LNs.

Other IEC 61850 documents address the services modelling (IEC 61850-7-2) and the mapping to communication protocols (IEC 61850-8-x). In addition, systems configuration language (SCL) (IEC 61850-6) can already support in a very large extend the configuration of DER management systems, especially in the case of set of physically connected DERs.

This document provides an information model for DER that can be used in simple DER facilities as well as for more complex installations of multiple DER types with different resource capabilities, operational functions, and intra-facility interactions. This document provides significant information on how these interactions and functions are modelled, while IEC 61850-7-520 will provide additional use cases to help clarify the different interactions that this information model can support.

¹ Under preparation. Stage at the time of publication: IEC/ADTR 61850-7-5:2021.

COMMUNICATION NETWORKS AND SYSTEMS FOR POWER UTILITY AUTOMATION –

Part 7-420: Basic communication structure – Distributed energy resources and distribution automation logical nodes

1 Scope

1.1 General

This part of IEC 61850 defines the IEC 61850 information models to be used in the exchange of information with distributed energy resources (DER) and Distribution Automation (DA) systems. DERs include distribution-connected generation systems, energy storage systems, and controllable loads, as well as facility DER management systems, including aggregated DER, such as plant control systems, facility DER energy management systems (EMS), building EMS, campus EMS, community EMS, microgrid EMS, etc. DA equipment includes equipment used to manage distribution circuits, including automated switches, fault indicators, capacitor banks, voltage regulators, and other power management devices.

The IEC 61850 DER information model standard utilizes existing IEC 61850-7-4 logical nodes where possible, while defining DER and DA specific logical nodes to provide the necessary data objects for DER and DA functions, including for the DER interconnection grid codes specified by various countries and regions.

Although this document explicitly addresses distribution-connected resources, most of the resource capabilities, operational functions, and architectures are also applicable to transmission-connected resources.

1.2 Published versions of this standard and related namespace name

Table 2 provides a reference between all IEC editions, amendments or corrigenda and the full name of the namespace:

**Table 2 – Reference between published versions of the standard
and related namespace name**

Edition	Publication date	Webstore	Namespace NSD
Edition 1.0	2009-03	IEC 61850-7-420:2009	Not published
Edition 2.0 (this document)	2021-04	IEC 61850-7-420:2020	IEC 61850-7-420:2020

Detailed information on backward compatibility with Edition 1 are provided in Annex C.

1.3 Data model Namespace name and version

This new subclause is mandatory for any IEC 61850 namespace (as defined by IEC 61850-7-1:2011).

Table 3 shows all attributes of IEC 61850-7-420:2019A namespace.

Table 3 – Attributes of IEC 61850-7-420:2019A namespace

Attribute	Content
Namespace nameplate	
Namespace Identifier	IEC 61850-7-420
Version	2019
Revision	A
Release	4
Full Namespace Name	IEC 61850-7-420:2019A
Full Code Component Name	IEC_61850-7-420.NSD.2019A.Full
Light Code Component Name	IEC_61850-7-420.NSD.2019A.Light
Namespace Type	domain
Namespace dependencies	
includes	IEC 61850-7-4:2007B version:2007 revision:B

1.4 Data model Namespace Code Component distribution

This document is associated with Code components. Each Code Component is a ZIP package containing at least the electronic representation of the Code Component itself and a file describing the content of the package (IECManifest.xml).

The life cycle of a code component is not restricted to the life cycle of this document. The publication life cycle goes through two stages, "Version" (corresponding to an edition) and "Revision" (corresponding to an amendment). A third publication stage (Release) allows publication of Code Component in case of urgent fixes of InterOp Tissues, thus without need to publish an amendment.

Consequently, new release(s) of the Code Component(s) may be released, which supersede(s) the previous release, and will be distributed through the IEC web site at: <http://www.iec.ch/tc57/supportdocuments>.

The latest version/release of the document will be found by selecting the file for the code component with the highest value for VersionStateInfo, e.g. *IEC_61850-7-420.NSD.{VersionStateInfo}.Light*.

The Code Components associated with this document are reflecting the data model specified in this document formatted in NSD files as described in IEC 61850-7-7. They are available in light and full version:

- The full version is named: *IEC_61850-7-420.NSD.2019A.Full*. It contains definition of the whole data model defined in this document with the documentation associated and access is restricted to purchaser of this document.
- The light version is named: *IEC_61850-7-420.NSD.2019A.Light*. It does not contain any documentation but contains the whole data model as per full version, and this light version is freely accessible on the IEC website for download at: <http://www.iec.ch/tc57/supportdocuments>, but the usage remains under the licensing conditions.

The light version is freely accessible on the IEC website for download at: <http://www.iec.ch/tc57/supportdocuments> but its usage remains under the licensing conditions.

In case of any differences between the downloadable code and the IEC pdf published content, the downloadable code(s) is(are) the valid one; it may be subject to updates. See included history files.

1.5 Changes from IEC 61850-7-420:2009 (Edition 1)

This Edition 2 has added operational functions for many grid codes that have recently been identified as mandatory or necessary for specific operations. As a result, many deletions and modifications were made to LNs existing in Edition 1 since the change to defining operational functions caused many structural changes to the model. It is also expected that additional operational functions will be added as these are identified and better defined.

The new release of IEC 61850-7-420 includes all functions treated by IEC TR 61850-90-7, however with a different modelling approach.

Another change is the need to include different types of DER, in particular storage DERs (initially modelled in the IEC TR 61850-90-9 namespace, but this namespace is now deprecated.) and eventually controllable loads that can act as DERs.

In addition, the models for DERs needed to extend various modelling concepts since DERs are typically complex systems which are often aggregated and controlled locally by power management systems. These new concepts are discussed in more detail in Clause 3.

As a result, the Logical Nodes associated with DER plants and other higher level DER structures have been significantly altered. However, the Logical Nodes associated with individual types of DER, such as reciprocating engines, photovoltaic systems, fuel cells, and combined heat and power, have not been significantly modified.

1.6 IEC 61850-7-420 versus IEC 61850-7-520

In this document, Clause 1 covers the concepts and constructs for managing DERs that are needed to understand the IEC 61850 DER information model structure and methods. Subclause 4.3.1 and Clause 6 cover discussions of the DER resource components and the DER operational functions, while Annex A includes all of the detailed models for these two clauses. The remaining annexes cover additional modelling issues, modelling examples, a list of potential additional operational functions, and a bibliography.

The companion document, IEC 61850-7-520, will be updated to Edition 2 and will include additional supportive information such as use cases, system configuration language constructs for DER, example methods for implementing logical devices, various profiles of IEC 61850 data objects, and other implementation support.

1.7 Terminology due to historical usage of terms

Two types of terms used in this document have the same meaning but are derived from different types of DER for historical reasons.

- Generation and discharging
- Consuming and charging

In general, "generation" is associated with DER that supply energy e.g. a PV device, while "consuming" is generally associated with DER that use energy, e.g. loads. Storage devices both generate and consume energy, but the terms discharging and charging are usually used for historical reasons. Rather than trying to change the usage of these terms, this document attempts to recognize these differences in historical understanding, while still noting that the terms have the same meanings.

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 61557-12:2018, *Electrical safety in low voltage distribution systems up to 1 000 V AC and 1 500 V DC – Equipment for testing, measuring or monitoring of protective measures – Part 12: Power metering and monitoring devices (PMD)*

IEC TS 61850-2, *Communication networks and systems for power utility automation – Part 2: Glossary*

IEC 61850-7-2:2010, *Communication networks and systems for power utility automation – Part 7-2: Basic information and communication structure – Abstract communication service intervanse (ACSI)*

IEC 61850-7-2:2010/AMD1:2020

IEC 61850-7-3:2010, *Communication networks and systems for power utility automation – Part 7-3: Basic communication structure – Common data classes*

IEC 61850-7-3:2010/AMD1:2020

IEC 61850-7-4:2010, *Communication networks and systems for power utility automation – Part 7-4: Basic communication structure – Compatible logical node classes and data object classes*

IEC 61850-7-4:2010/AMD1:2020

IEC TS 62786, *Distributed energy resources connection with the grid*

IEEE 1547:2018 (all parts), *IEEE Standard for Interconnection and Interoperability of Distributed Energy Resources with Associated Electric Power Systems Interfaces*

ISO 4217, *Codes for the representation of currencies and funds*

EN 50549 series, *Requirements for generating plants to be connected in parallel with distribution networks*