

# **Communication networks and systems for power utility automation**

---

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

## National foreword

This British Standard is the UK implementation of EN IEC 61850-7-420:2021. It is identical to IEC 61850-7-420:2021. It supersedes BS EN 61850-7-420:2009, which is withdrawn.

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

A list of organizations represented on this committee can be obtained on request to its committee manager.

### Contractual and legal considerations

This publication has been prepared in good faith, however no representation, warranty, assurance or undertaking (express or implied) is or will be made, and no responsibility or liability is or will be accepted by BSI in relation to the adequacy, accuracy, completeness or reasonableness of this publication. All and any such responsibility and liability is expressly disclaimed to the full extent permitted by the law.

This publication is provided as is, and is to be used at the recipient's own risk.

The recipient is advised to consider seeking professional guidance with respect to its use of this publication.

This publication is not intended to constitute a contract. Users are responsible for its correct application.

© The British Standards Institution 2021  
Published by BSI Standards Limited 2021

ISBN 978 0 580 93226 7

ICS 33.200

**Compliance with a British Standard cannot confer immunity from legal obligations.**

This British Standard was published under the authority of the Standards Policy and Strategy Committee on 30 November 2021.

### Amendments/corrigenda issued since publication

| Date | Text affected |
|------|---------------|
|------|---------------|

---

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

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- latest date by which the national standards conflicting with the document have to be withdrawn (dow) 2024-11-17

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](http://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 <sup>1</sup> | 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                                                                                                                                                                | -                           | -           |

---

<sup>1</sup> 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 |

## 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.....                                                                          | 104 |

|        |                                                                                                    |     |
|--------|----------------------------------------------------------------------------------------------------|-----|
| 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<br>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<br>and other rules.....                | 178 |
| A.3                   | Namespace data model .....                                                                                       | 179 |
| A.3.1                 | Logical node classes for distributed energy resources<br>(LogicalNodes_7_420_DER).....                           | 179 |
| A.3.2                 | DER Operational functions<br>(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<br>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<br>single plant.....                               | 513 |
| B.2.3                 | Global DER modelling applying to shared DER (30 %PV + 30 %BAT)<br>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 DEResources .....                                                                                                 | 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 DFPP .....                                        | 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 ACSysKind .....                                       | 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<br>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](http://www.iec.ch/members_experts/refdocs). The main document types developed by IEC are described in greater detail at [www.iec.ch/standardsdev/publications](http://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                                                                                                                                                                                                                                                                                                                                         |
|-------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Namespace IEC specific information</b>                               |                                                                                                                                                                                                                                                                                                                                                 |
| 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)                                                                                                                                                                                                                                                             |
| <b>Namespace Changes</b>                                                |                                                                                                                                                                                                                                                                                                                                                 |
| 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 |
| <b>Namespace History</b>                                                |                                                                                                                                                                                                                                                                                                                                                 |
| 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](http://webstore.iec.ch) in the data related to the specific document. At this date, the document will be

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

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

## INTRODUCTION

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 2<sup>1</sup> 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.

---

<sup>1</sup> 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<br>(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                                     |
|-------------------------------|---------------------------------------------|
| <b>Namespace nameplate</b>    |                                             |
| 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                                      |
| <b>Namespace dependencies</b> |                                             |
| 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*

## 3 Terms, definitions and abbreviated terms and acronyms

### 3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC TS 61850-2 and IEC 61850-7-2 and the following apply.

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

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

NOTE Definition 3.1.17 related to electrical energy storage systems may have to be aligned further with the IEC 62933 series<sup>2</sup>.

---

<sup>2</sup> Under preparation.

### 3.1.1

#### **actual power capability (includes emergency mode)**

value of power at a given time considering as a result of temperature or other factors

### 3.1.2

#### **ambient temperature**

temperature of the medium in the immediate vicinity of a device

[SOURCE: IEC TS 62257-8-1:2007, 3.15 (modified – "battery" replaced by "device")]

### 3.1.3

#### **area electric power system (area EPS)**

EPS that serves local EPSs

[SOURCE: IEEE 1547:2018]

### 3.1.4

#### **authorized**

permitted by the appropriate authority, such as by the transmission or distribution operator

### 3.1.5

#### **available energy**

maximum electrical energy that can be extracted from the EESS from the current state of charge of the EESS system

Note 1 to entry: Joule (J) is the base unit, other units may be chosen for convenience as well (kWh, MWh).

Note 2 to entry: Depending on the technology used, the available energy can differ by ambient temperature, self-discharge, power conversion losses, c-rate (for batteries) and other factors.

[SOURCE: IEC 62933-1:2018]

### 3.1.6

#### **cease-to-energize**

cessation of active power delivery under steady-state and transient conditions and limitation of reactive power exchange

Note 1 to entry: This may lead to momentary cessation or trip.

Note 2 to entry: This does not necessarily imply, nor exclude disconnection, isolation, or a trip.

Note 3 to entry: Limited reactive power exchange may continue as specified, e.g., through filter banks.

Note 4 to entry: Energy storage systems are allowed to continue charging but are allowed to cease from actively charging when the maximum state of charge (maximum stored energy) has been achieved.

[SOURCE: IEEE 1547:2018]

### 3.1.7

#### **combined heat and power (CHP) co-generation**

production of heat which is used for non-electrical purposes and also for the generation of electric energy

Note 1 to entry: Conventional power plants emit the heat produced as a useless by-product of the generation of electric energy into the environment. With combined heat and power, the excess heat is captured for domestic or industrial heating purposes or – in form of steam – is used for driving a steam turbine connected to an air-conditioner compressor. Alternatively, the production of heat may be the primary purpose of combined heat and power, whereas excess heat is used for the generation of electric energy.

[SOURCE: IEC 60050-602:1983, 602-01-24, modified (replacement of "also for electricity" with "also for the generation of electric energy" and addition of Note 1 to entry)]

**3.1.8****common data class****CDC**

class of commonly used data structures defined in IEC 61850-7-3

**3.1.9****component**

instance of defined LN class

**3.1.10****controllable load**

load whose energy consumption may be increased or decreased (including turned on and off) through control actions by other entities

Note 1 to entry: "Controllable load" and "load" are considered equivalent in this document.

**3.1.11****deprecated element**

element marked still maintained in this edition of the standard, for backwards compatibility purposes, but intended to be phased out in the future

Note 1 to entry: A deprecated element by definition indicates what should be used instead.

**3.1.12****device**

material element or assembly of such elements intended to perform a required function

Note 1 to entry: A device may form part of a larger device.

[SOURCE: IEC 60050-151:2001, 151-11-20]

**3.1.13****distributed energy resource****DER**

energy resource comprised of generation and/or storage and/or controllable load connected at the low or medium voltage distribution level

Note 1 to entry: DER may include associated protection, control, and monitoring capabilities, and may consist of aggregated DER units.

Note 2 to entry: DER may interact with the area and/or local electric power systems (EPS) by providing energy through the EPSs, by adapting their behaviour based on EPS conditions, and/or by providing other EPS-related services for regulatory, contractual, or market reasons.

**3.1.14****distributed energy resource (DER) unit****DER unit**

individual physical DER device inside a group of DER that collectively form a system

[SOURCE: IEEE 1547:2018]

**3.1.15****distributed energy resource (DER) system****DER system**

collection of DER Units. This collection may also be called a DER plant or a DER facility

[SOURCE: IEEE 1547:2018]

**3.1.16****effective actual energy capacity**

EES energy capacity at a given time as a result of a degraded state of health and other factors

### **3.1.17** **electrical connection point** **ECP**

point of electrical connection between the DER and any electric power system (EPS)

Note 1 to entry: Each DER (generation or storage) unit has an ECP connecting it to its local power system; groups of DER units have an ECP where they interconnect to the power system at a specific site or plant; a group of DER units plus local loads have an ECP where they are interconnected to the utility power system.

Note 2 to entry: For those ECPs between a utility EPS and a plant or site EPS, this point is identical to the point of common coupling (PCC) in IEEE 1547, "*Standard for Interconnecting Distributed Resources with Electric Power Systems*".

### **3.1.18** **electric power system** **EPS**

all installations and plant provided for the purpose of generating, transmitting and distributing electricity

[SOURCE: IEC 60050-601:1985, 601-01-01]

### **3.1.19** **emergency energy capacity**

EESS energy capacity at a given time which can be used under emergency condition with potential risk to the asset (health)

### **3.1.20** **emergency power capability** to be defined

### **3.1.21** **energy resource** something which can provide usable energy

### **3.1.22** **energy storage** capture of energy produced at one time for use at a later time

[SOURCE: Wikipedia]

### **3.1.23** **event** **event information**

- a) something that happens in time [IEC 60050-111:1996, 111-16-04]
- b) monitored information on the change of state of operational equipment

Note 1 to entry: In power system operations, an event is typically state information and/or state transition (status, alarm, or command) reflecting power system conditions.

[SOURCE: IEC 60050-371:1984, 371-02-04]

### **3.1.24** **fuel cell**

- a) generator of electricity using chemical energy directly by ionisation and oxidation of the fuel [IEC 60050-602:1983, 602-01-33];
- b) cell that can change chemical energy from continuously supplied reactants to electric energy by an electrochemical process [IEC 60050-482:2004, 482-01-05]

**3.1.25****fuel cell stack**

individual fuel cells connected in series

Note 1 to entry: Fuel cells are stacked to increase voltage.

[SOURCE: US DOE]

**3.1.26****generator**

a) energy transducer that transforms non-electric energy into electric energy [IEC 60050-151:2001, 151-13-35];

b) device that converts kinetic energy to electrical energy, generally using electromagnetic induction

Note 1 to entry: The reverse conversion of electrical energy into mechanical energy is done by an electric motor, and motors and generators have many similarities. The prime mover source of mechanical energy may be a reciprocating or turbine steam engine, water falling through a hydropower turbine or waterwheel, an internal combustion engine, a wind turbine, a hand crank, or any other source of mechanical energy.

[SOURCE: Wikipedia 2007-12]

**3.1.27****grid code**

technical specification which defines the parameters that a facility connected to a public electric grid has to meet to ensure safe, secure and economic proper functioning of the electric system

Note 1 to entry: The facility can be an electricity generating plant, a consumer, or another network.

[SOURCE: Wikipedia]

**3.1.28****information**

a) intelligence or knowledge capable of being represented in forms suitable for communication, storage or processing [IEC 60050-701:1998, 701-01-01];

b) knowledge concerning objects, such as facts, events, things, processes, or ideas, including concepts, that within a certain context has a particular meaning [ISO/IEC 2382-1:1993, definition 01.01.01]

Note 1 to entry: Information may be represented for example by signs, symbols, pictures, or sounds.

**3.1.29****information exchange**

communication process between two or more computer-based systems in order to transmit and receive information

Note 1 to entry: The exchange of information between systems requires interoperable communication services.

**3.1.30****insolation**

solar radiation that has been received

[SOURCE: Merriam-Webster dictionary]

**3.1.31****inverter**

a) static power converter (SPC);

b) device that converts DC electricity into AC electricity, equipment that converts direct current from the array field to alternating current, the electric equipment used to convert electrical

power into a form or forms of electrical power suitable for subsequent use by the electric utility

Note 1 to entry: Any static power converter with control, protection, and filtering functions used to interface an electric energy source with an electric utility system. Sometimes referred to as power conditioning subsystems, power conversion systems, solid-state converters, or power conditioning units.

[SOURCE: IEC 61727:2004, definition 3.8]

### 3.1.32

#### **irradiance**

density of radiation incident on a given surface usually expressed in watts per square centimetre or square meter

Note 1 to entry: "Irradiance" is used when the electromagnetic radiation is incident on the surface. "Radiant excitance" or "radiant emittance" is used when the radiation is emerging from the surface. The SI units for all of these quantities are watts per square metre ( $\text{W}\cdot\text{m}^{-2}$ ), while the cgs units are ergs per square centimetre per second ( $\text{erg}\cdot\text{cm}^{-2}\cdot\text{s}^{-1}$ , often used in astronomy). These quantities are sometimes called intensity, but this usage leads to confusion with radiant intensity, which has different units.

[SOURCE: Merriam-Webster dictionary]

### 3.1.33

#### **load**

device intended to absorb power supplied by another device or an electric power system

[SOURCE: IEC 60050-151:2001, 151-15-15]

### 3.1.34

#### **local electric power system (local EPS):**

EPS contained entirely within a single premises or group of premises

[SOURCE: IEEE 1547:2018]

### 3.1.35

#### **measured value**

physical or electrical quantity, property or condition that is to be measured

Note 1 to entry: Measured values are usually monitored, but may be calculated from other values. They are also usually considered to be analogue values.

Note 2 to entry: The result of a sampling of an analogue magnitude of a particular quantity.

[SOURCE: IEC 61850-7-4:2010]

### 3.1.36

#### **membrane**

separating layer in a fuel cell that acts as electrolyte (an ion-exchanger) as well as a barrier film separating the gases in the anode and cathode compartments of the fuel cell

[SOURCE: US DoE]

### 3.1.37

#### **mixed DER**

a DER which consists of generation or storage or load, or any combinations of these

### 3.1.38

#### **monitor**

check at regular intervals selected values regarding their compliance to specified values, ranges of values or switching conditions

[SOURCE: IEC 60050-351:2013, 351-22-03]

### 3.1.39

#### **percentage**

quantity of percent of a given value, represented by a number between -100 and +100

### 3.1.40

#### **photovoltaic cell**

device in which the photovoltaic effect is utilized

[SOURCE: IEC 60050-521:2002, 521-04-34]

### 3.1.41

#### **photovoltaic system**

- a) complete set of components for converting sunlight into electricity by the photovoltaic process, including the array and balance of system components [US DoE];
- b) system comprises all inverters (one or multiple) and associated BOS (balance-of-system components) and arrays with one point of common coupling, described in IEC 61836 as PV power plant [IEC 61727:2004, 3.7]

Note 1 to entry: The component list and system configuration of a photovoltaic system varies according to the application, and can also include the following sub-systems: power conditioning, energy storage, system monitoring and control and utility grid interface.

### 3.1.42

#### **photovoltaics**

#### **PV**

generation of a voltage when radiant energy falls on the boundary between dissimilar substances (as two different semiconductors)

[SOURCE: Merriam-Webster dictionary]

### 3.1.43

#### **Point of Common Coupling**

#### **PCC**

electrical point (ECP) in an electric power system, electrically nearest to a particular load or generator, at which other loads or generators are, or may be, connected

Note 1 to entry: These loads can be either devices, equipment or systems, or distinct network users' installations.

Note 2 to entry: The point where a local EPS is connected to an area EPS [IEEE 1547]. The local EPS may include distributed energy resources.

[SOURCE: IEC 60050-614:2016, 614-01-12 – modified (addition of "or generator")]

### 3.1.44

#### **Point of Connection**

#### **PoC**

electrical point (ECP) of the connection of a DER to its local electrical network

### 3.1.45

#### **power conversion**

power conversion is the process of converting power from one form into another

Note 1 to entry: This could include electromechanical or electrochemical processes.

Note 2 to entry: In electrical engineering, power conversion has a more specific meaning, namely converting electric power from one form to another. This could be as simple as a transformer to change the voltage of AC power, but

also includes far more complex systems. The term can also refer to a class of electrical machinery that is used to convert one frequency of electrical power into another frequency.

One way of classifying power conversion systems is according to whether the input and output are alternating current (AC) or direct current (DC), thus:

#### DC to DC

- DC to DC converter
- Voltage stabiliser
- Linear regulator

#### AC to DC

- Rectifier
- Mains power supply unit (PSU)
- Switched-mode power supply

#### DC to AC

- Inverter

#### AC to AC

- Transformer/autotransformer
- Voltage regulator

[SOURCE: Wikipedia 2007-12]

### 3.1.46

#### **prime mover**

equipment acting as the energy source for the generation of electricity

Note 1 to entry: Examples include diesel engine, solar panels, gas turbines, wind turbines, hydro turbines, battery storage, water storage, air storage, etc.

### 3.1.47

#### **PV array**

- a) a mechanically integrated assembly of modules or panels and support structure that forms a DC electricity-producing unit

An array does not include foundation, tracking apparatus, thermal control, and other such components.

- b) a mechanically and electrically integrated assembly of PV modules, and other necessary components, to form a DC power supply unit [IEC 60364-7-712:2002, 712.3.4]

Note 1 to entry: A PV array may consist of a single PV module, a single PV string, or several parallel-connected strings, or several parallel-connected PV sub-arrays and their associated electrical components. For the purposes of this standard the boundary of a PV array is the output side of the PV array disconnecting device. Two or more PV arrays, which are not interconnected in parallel on the generation side of the power conditioning unit, shall be considered as independent PV arrays.

### 3.1.48

#### **PV module**

the smallest complete environmentally protected assembly of interconnected cells

Note 1 to entry: Colloquially referred to as a "solar module".

[SOURCE: IEC TS 62257-7-1:2006, 3.34]

### 3.1.49

#### **PV string**

a circuit of series-connected modules

[SOURCE: IEC TS 62257-7-1:2006, 3.36]

**3.1.50****rated energy capacity****nameplate energy capacity**

designed value of the energy content of the EESS in continuous operating conditions, starting from a full state of charge and discharging continuously at rated active power, measured at the primary PoC

**3.1.51****rated power capability****nameplate power capability**

designed value of the power in operating conditions measured at the primary PCC

**3.1.52****reciprocating engine****piston engine**

engine in which the to-and-fro motion of one or more pistons is transformed into the rotary motion of a crankshaft

Note 1 to entry: The most common form of reciprocating engines is the internal combustion engine using the burning of gasoline, diesel fuel, oil or natural gas to provide pressure. In DERs, the most common form is the diesel engine.

[SOURCE: Merriam-Webster dictionary]

**3.1.53****reformat**

hydrocarbon fuel that has been processed into hydrogen and other products for use in fuel cells

[SOURCE: US DoE]

**3.1.54****set point**

level or point at which a variable physiological state (as body temperature or weight) tends to stabilize

[SOURCE: Merriam-Webster Dictionary]

**3.1.55****set point command**

command in which the value for the required state of operational equipment is transmitted to a controlled station where it is stored

Note 1 to entry: A setpoint is usually an analogue value which sets the controllable target for a process or sets limits or other parameters used for managing the process.

[SOURCE: IEC 60050-371:1984, 371-03-11]

**3.1.56****standard test conditions****STC**

standard set of reference conditions used for the testing and rating of photovoltaic cells and modules

Note 1 to entry: The standard test conditions are:

- a) PV cell temperature of 25 °C;
- b) irradiance in the plane of the PV cell or module of 1 000 W/m<sup>2</sup>;
- c) light spectrum corresponding to an atmospheric air mass of 1,5.

[SOURCE: IEC TS 62257-7-1:2006, 3.46]

### **3.1.57**

#### **state of charge of an EESS**

#### **actual state of charge of an EESS**

#### **state of actual charge of an EESS**

relation between the available energy from an EESS and the actual energy capacity, typically expressed as a percentage of the actual energy capacity

### **3.1.58**

#### **state of total usable charge of an EESS**

relation between the available energy from an EESS and the total usable energy capacity, expressed as a percentage of the total usable energy capacity

### **3.1.59**

#### **state of usable charge of an EESS**

#### **usable state of charge of an EESS**

(per user) relation between the available energy from an EESS and the usable energy capacity, expressed as a percentage of the usable energy capacity

### **3.1.60**

#### **total usable energy capacity**

what all users are permitted to have access to, computed (in the simplest case just summing up) usable energy capacity out of those of the corresponding group of EESSs, based on the decisions of EESS manufacturers or EESS owner/operators

### **3.1.61**

#### **turbine**

machine for generating rotary mechanical power from the energy in a stream of fluid

Note 1 to entry: The energy, originally in the form of head or pressure energy, is converted to velocity energy by passing through a system of stationary and moving blades in the turbine.

[SOURCE: US DOE]

### **3.1.62**

#### **usable energy capacity (split)**

Is what each user is permitted to have access to, which is based on the decisions of EESS manufacturers or EESS owner/operators

### **3.1.63**

#### **usable power capability**

user is permitted to set, which is based on the decisions of EESS manufacturers or EESS owner/operators

## **3.2 Generic abbreviations**

Table 4 presents generic acronyms and abbreviations used throughout this document.

**Table 4 – Generic acronyms and abbreviations**

|                 |                                                                                                                                                   |
|-----------------|---------------------------------------------------------------------------------------------------------------------------------------------------|
| DCC             | European Union Commission Regulation (EU) 2016/1388 of 17 August 2016 establishing a Network Code on Demand Connection                            |
| DER             | Distributed Energy Resource                                                                                                                       |
| DERMS           | DER Management System                                                                                                                             |
| DERCtl          | DER Unit Controller                                                                                                                               |
| ds              | derived statistics (as specified in Table 3 of IEC 61850-7-4:2010+AMD1:2020)                                                                      |
| DSO             | Distribution System Operator                                                                                                                      |
| ECP             | Electrical Connection Point                                                                                                                       |
| EPS             | Electrical Power System                                                                                                                           |
| EESS            | Electrical Energy Storage System                                                                                                                  |
| ESS             | Energy Storage System                                                                                                                             |
| facility DER MS | Facility DER Management System                                                                                                                    |
| IED             | Intelligent Electronic Device                                                                                                                     |
| nds             | non-derived statistic (as specified in Table 3 of IEC 61850-7-4:2010+AMD1:2020)                                                                   |
| PCC             | Point of Common Coupling                                                                                                                          |
| PoC             | Point of Connection                                                                                                                               |
| RfG             | European Union Commission Regulation (EU) 2016/631 of 14 April 2016 establishing a network code on requirements for grid connection of generators |
| SoC             | State of Charge                                                                                                                                   |
| T               | Transient (as specified in Table 3 of IEC 61850-7-4:2010+AMD1:2020)                                                                               |
| TSO             | Transmission System Operator                                                                                                                      |
| VPP             | Virtual Power Plant                                                                                                                               |

### 3.3 Abbreviated terms

The following additional abbreviated terms are expected to be added to the 61850-7-4 list of abbreviations.

Table 5 shows normative terms that are combined to create data object names.

**Table 5 – Normative abbreviations for data object names**

| Term | Description                    |
|------|--------------------------------|
| Add  | addition, additional           |
| Ava  | Absorbing apparent power       |
| Avar | Absorbing reactive power (Var) |
| Cea  | Cease                          |
| Cnst | constraining, constrained      |
| Ctb  | Controllable                   |
| Eff  | Effective                      |
| Egz  | Energize                       |
| Elc  | Electric, Electrical           |
| Eps  | Electric Power System          |
| Esp  | Effective setpoint             |
| Expc | Expected                       |
| Fct  | Function, functional           |
| Frm  | Frame                          |
| Iva  | Injecting apparent power       |
| Ivar | Injecting reactive power (Var) |
| Mn   | Minimum                        |
| Ms   | Measure, measurement           |
| Mx   | Maximum                        |
| Opl  | Open Loop                      |
| Ple  | Pole                           |
| Poa  | Plane of array                 |
| Ren  | Renewable (energy)             |
| Rnt  | Round trip                     |
| Rpd  | Ramp Down                      |
| Rpu  | Ramp Up                        |
| Rsp  | Response                       |
| Rtn  | Return                         |
| Sink | Sink                           |
| Snpt | snapshot                       |
| Soe  | State of energy                |
| Soh  | state of health                |
| Susc | Susceptance ( in siemens)      |
| Thr  | Threshold                      |
| Unit | Unit                           |
| Wst  | Waste                          |

Following is the abbreviations list contained in IEC 61850-7-4:2010+AMD1:2020 and partly used in this document.

Table 6 shows normative terms that are combined to create data object names.

**Table 6 – Normative abbreviations for data object names**

| Term  | Description                                              |
|-------|----------------------------------------------------------|
| A     | Current; phase A (L1)                                    |
| AC    | AC, alternating current                                  |
| AGC   | Automatic generation control                             |
| ASG   | Analogue setting CDC                                     |
| AWatt | Wattmetric component of current                          |
| Abr   | Abrasion                                                 |
| Abs   | Absolute                                                 |
| Absb  | Absorbing                                                |
| Acc   | Accuracy;<br>acceleration (deprecated: use Accl instead) |
| Accl  | Acceleration                                             |
| Accm  | Accumulated                                              |
| Ack   | Acknowledgement, acknowledge                             |
| Acs   | Access                                                   |
| Act   | Action, activity, active, activate                       |
| Actr  | Actuator                                                 |
| Acu   | Acoustic                                                 |
| Addr  | Address                                                  |
| Adj   | Adjustment                                               |
| Admin | Administrative                                           |
| Adp   | Adapter, adaptation                                      |
| Aff   | Affected                                                 |
| Age   | Ageing                                                   |
| Ahr   | Ampere hours                                             |
| Air   | Air                                                      |
| Alg   | Algorithm                                                |
| Alm   | Alarm, alarm trigger status                              |
| Als   | Alarm trigger status set                                 |
| Alt   | Altitude                                                 |
| Altn  | Alternate                                                |
| Amnt  | Amount                                                   |
| Amp   | Ampere, current DC or non-phase-related AC               |
| An    | Analogue                                                 |
| Anc   | Ancillary                                                |
| Ane   | Anemometer                                               |
| Ang   | Angle                                                    |
| Ap    | Access point                                             |
| Apc   | Analogue point control                                   |
| App   | Apparent                                                 |
| Ar    | Amperes reactive (reactive current)                      |

| Term | Description                      |
|------|----------------------------------|
| Arc  | Arc                              |
| Area | Area                             |
| Arr  | Array                            |
| Asyn | Asynchronous                     |
| At   | At                               |
| Auth | Authorisation                    |
| Auto | Automatic                        |
| Aux  | Auxiliary                        |
| Av   | Average                          |
| Avl  | Availability                     |
| Ax   | Axial                            |
| Azi  | Azimuth                          |
| B    | Bushing; phase B (L2)            |
| BG   | Before Gain                      |
| Bac  | Binary-controlled analogue value |
| Bar  | Barrier                          |
| Base | Base                             |
| Bat  | Battery                          |
| Bck  | Backup                           |
| Bec  | Beacon                           |
| Beh  | Behaviour                        |
| Ber  | Bit error rate                   |
| Bias | Bias                             |
| Bl   | Blade                            |
| Blb  | Bulb                             |
| Blk  | Block, blocked                   |
| Blow | Blowby                           |
| Bnd  | Band, bandwidth                  |
| Boil | Boiler                           |
| Bot  | Bottom                           |
| Brcb | Buffered report control block    |
| Brg  | Bearing                          |
| Brk  | Brake                            |
| Bsc  | Binary status control            |
| Bst  | Boost                            |
| Bt   | Heartbeat                        |
| Bub  | Bubbling                         |
| Bus  | Bus                              |
| Byp  | Bypass                           |
| C    | Carbon; phase C (L3)             |
| C2H2 | Acetylene                        |

| Term  | Description                                    |
|-------|------------------------------------------------|
| C2H4  | Ethylene                                       |
| C2H6  | Ethane                                         |
| CB    | Circuit breaker                                |
| CE    | Cooling equipment (see also CI)                |
| CG    | Core ground                                    |
| CH4   | Methane                                        |
| CHP   | Combined heat and power                        |
| CO    | Carbon monoxide                                |
| CO2   | Carbon dioxide                                 |
| Cab   | Cable                                          |
| Cal   | Calorie, caloric                               |
| Cam   | Cam, e.g. rotating non-circular disk           |
| Can   | Cancel                                         |
| Cap   | Capability, capacity                           |
| Capac | Capacitance                                    |
| Car   | Carrier                                        |
| Cbr   | Calibration                                    |
| Ccw   | Counter clockwise                              |
| Ccy   | Currency                                       |
| Cds   | Condensation                                   |
| Ceil  | Ceiling                                        |
| Cel   | Cell                                           |
| Cf    | Crest factor                                   |
| Cff   | Coefficient                                    |
| Cfg   | Configuration                                  |
| Cg    | Combusted Gas                                  |
| Ch    | Channel                                        |
| Cha   | Charger                                        |
| Chg   | Change                                         |
| Chk   | Check                                          |
| Chr   | Characteristic                                 |
| Chs   | Chassis                                        |
| Circ  | Circulating, circuit                           |
| CI    | Cooling, coolant, cooling system (see also CE) |
| Clc   | Calculate, calculated                          |
| Clip  | Clip                                           |
| Clk   | Clock                                          |
| Cloud | Cloud                                          |
| Clr   | Clear                                          |
| Cls   | Close, closed                                  |
| Cm    | Centimetres                                    |
| Cmbu  | Combustible, combustion                        |

| Term    | Description                                         |
|---------|-----------------------------------------------------|
| Cmd     | Command                                             |
| Cmpl    | Completed, completion, complete                     |
| Cmut    | Commute, commutator                                 |
| Cndct   | Conductivity, Conducting                            |
| Cnt     | Counter                                             |
| Cntt    | Contractual                                         |
| Cnv     | Converter                                           |
| Col     | Coil                                                |
| Comm    | Communication                                       |
| Comp    | Compensation                                        |
| Conf    | Configuration                                       |
| ConfRev | Configuration revision (confRev from IEC 61850-7-2) |
| Conn    | Connected, connections                              |
| Cons    | Constant (general)                                  |
| Cor     | Correction                                          |
| Core    | Core                                                |
| Cost    | Cost                                                |
| Crank   | Crank                                               |
| Crd     | Coordination                                        |
| Crit    | Critical                                            |
| CrI     | Correlation                                         |
| Crp     | Creeping, slow movement                             |
| Crv     | Curve                                               |
| Csmp    | Consumption, consumed                               |
| Ctl     | Control                                             |
| Ctr     | Center                                              |
| Cum     | Cumulative                                          |
| Cur     | Current                                             |
| Cut     | Cut, cut-out, cut-in                                |
| Cvr     | Cover, cover level                                  |
| Cw      | Clockwise                                           |
| Cwb     | Crowbar                                             |
| Cyc     | Cycle                                               |
| D       | Derivate                                            |
| DC      | DC, direct current                                  |
| DER     | Distributed energy resource                         |
| DExt    | De-excitation                                       |
| DPCSO   | Double point controllable status output             |
| DQ0     | Direct, quadrature, and zero axis quantities        |
| DS      | Device state                                        |
| DT      | Daylight saving time                                |
| Dam     | Dam                                                 |

| Term    | Description                         |
|---------|-------------------------------------|
| Damp    | Damping                             |
| Date    | Date, date and time of action       |
| Day     | Day                                 |
| Db      | Deadband                            |
| Dcl     | DC-link                             |
| Dct     | Direct                              |
| De      | De (prefix)                         |
| Dea     | Dead                                |
| Dec     | Decrease                            |
| Deg     | Degrees                             |
| Dehum   | De-humidifier                       |
| Del     | Delta                               |
| Den     | Density                             |
| Dep     | Dependent                           |
| Desc    | Description                         |
| Det     | Detected                            |
| Detun   | Detuning                            |
| Dev     | Device                              |
| Dew     | Dew                                 |
| Dff     | Diffuse                             |
| Dfl     | Deflector (used in Pelton turbines) |
| Dft     | Default                             |
| Dia     | Diaphragm                           |
| Diag    | Diagnostics                         |
| Dif     | Differential, difference            |
| Dig     | Digital                             |
| Dip     | Dip                                 |
| Dir     | Direction                           |
| Dis     | Distance                            |
| Dist    | Distribution                        |
| Dith    | Dither                              |
| DI      | Delay                               |
| Dlt     | Delete                              |
| Dlv     | Delivery                            |
| Dmd     | Demand                              |
| Dn      | Down, downstream                    |
| Dpc     | Double point control                |
| Dpt     | Departure                           |
| Drag    | Drag hand                           |
| Dropout | Dropout                             |
| Drp     | Droop                               |
| Drt     | Derate                              |
| Drtb    | Draft tube                          |

| Term  | Description                             |
|-------|-----------------------------------------|
| Drv   | Drive                                   |
| Dsa   | Disable, disabled                       |
| Dsc   | Discrepancy                             |
| Dsch  | Discharge                               |
| Dscon | Disconnected                            |
| Dsp   | Displacement                            |
| Dtc   | Detection                               |
| Dur   | Duration                                |
| Dust  | Dust                                    |
| Dv    | Deviation                               |
| Dw    | Delta Omega                             |
| Dyn   | Dynamic                                 |
| EE    | External equipment                      |
| EF    | Earth fault                             |
| EFN   | Earth-fault neutraliser (Petersen coil) |
| EMA   | E-mobility Account                      |
| ENG   | Enumerated status setting CDC           |
| ENS   | Enumerated status CDC                   |
| EPC   | Emergency Power Control                 |
| EV    | Electrical Vehicle                      |
| EVSE  | EV Supply Equipment                     |
| Echo  | Echo                                    |
| Ecp   | Electrical connection point             |
| Edt   | Edit, edited                            |
| Efc   | Efficiency                              |
| EI    | Elevation                               |
| Ela   | Elasticity                              |
| Em    | Emission                                |
| Emg   | Emergency                               |
| En    | Energy                                  |
| Ena   | Enabled, enable, allow operation        |
| Enc   | Enumerated control                      |
| Encl  | Enclosure                               |
| End   | End                                     |
| Eng   | Engine                                  |
| Ent   | Entity, entities                        |
| Entr  | Entry, entries                          |
| Env   | Environment                             |
| Eq    | Equalization, equal, equivalent         |
| Err   | Error                                   |
| Est   | Estimated                               |
| Ev    | Evaluation                              |
| Evn   | Even                                    |

| Term  | Description                         |
|-------|-------------------------------------|
| Evt   | Event                               |
| Ex    | External                            |
| ExIm  | Export/import                       |
| Exc   | Exceeded                            |
| Excl  | Exclusion                           |
| Exp   | Expired                             |
| Exps  | Expansion                           |
| Expt  | Export                              |
| Ext   | Excitation                          |
| F     | Float                               |
| FA    | Fault arc                           |
| FPM   | Fuel processing module              |
| Fa    | "Fire all" sequence (to thyristors) |
| Fact  | Factor                              |
| Fail  | Failure                             |
| Fan   | Fan                                 |
| Fbc   | Field breaker configuration         |
| Fer   | Frame error rate                    |
| Fil   | Filter, filtration system           |
| Fire  | Fire                                |
| Fish  | Fish                                |
| Fix   | Fixed                               |
| Fld   | Field                               |
| Flk   | Flicker                             |
| Fll   | Fall                                |
| Flm   | Flame                               |
| Flood | Flood                               |
| Flsh  | Flash, flashing                     |
| Flt   | Fault                               |
| Flush | Flush                               |
| Flw   | Flow, flowing                       |
| Fol   | Follower, following                 |
| Forc  | Forced                              |
| Fu    | Fuse                                |
| Fuel  | Fuel                                |
| Full  | Full                                |
| Fun   | Function                            |
| Fwd   | Forward                             |
| Gain  | Gain                                |
| Gas   | Gas                                 |
| Gbx   | Gearbox                             |
| Gdv   | Guide vane                          |
| Gen   | General                             |

| Term    | Description                                    |
|---------|------------------------------------------------|
| Glob    | Global                                         |
| Gm      | Grand master                                   |
| Gn      | Generator                                      |
| Gnd     | Ground                                         |
| GoCBRef | GOOSE control block reference                  |
| Gocb    | GOOSE control block                            |
| Gr      | Group                                          |
| Gra     | Gradient                                       |
| Grd     | Guard                                          |
| Gri     | Grid                                           |
| Gross   | Gross                                          |
| Gs      | Grease                                         |
| Gte     | Gate                                           |
| Gust    | Gust                                           |
| H       | Harmonics (phase-related)                      |
| H2      | Hydrogen                                       |
| H2O     | Water (chemical aspect: liquid, steam, etc.)   |
| HP      | Hot point                                      |
| HPh     | Harmonics phase                                |
| Ha      | Harmonics (non-phase-related AC)               |
| Har     | Harmonic                                       |
| Hb      | Harmonic bin                                   |
| Hd      | Head                                           |
| Health  | Health                                         |
| Heat    | Heater, heating, heat (see also Ht)            |
| Hello   | Hello signal, Live signal, "I am alive" signal |
| Hi      | High, highest                                  |
| Hlf     | Half                                           |
| Hold    | Hold                                           |
| Hor     | Horizontal                                     |
| Horn    | Horn                                           |
| Ht      | Heating, heating system (see also Heat)        |
| Htex    | Heat-exchanger                                 |
| Hub     | Hub                                            |
| Hum     | Humidity                                       |
| Hy      | Hydraulic, hydraulic system                    |
| Hyd     | Hydrological, hydro, water                     |
| Hys     | Hysteresis                                     |
| Hz      | Frequency                                      |
| Hz1     | Frequency at side 1                            |
| Hz2     | Frequency at side 2                            |
| I       | Integral, integration                          |

| Term      | Description                                                                     |
|-----------|---------------------------------------------------------------------------------|
| ING       | Integer status setting CDC                                                      |
| INS       | Integer status CDC                                                              |
| ISCSO     | Integer status controllable status output                                       |
| Ia        | Information available                                                           |
| Iafm      | Information available force majeure                                             |
| Iano      | Information available non-operative                                             |
| Ianofo    | Information available non-operative forced outage                               |
| Ianopca   | Information available non-operative planned corrective action                   |
| Ianos     | Information available non-operative suspended                                   |
| Ianosm    | Information available non-operative scheduled maintenance                       |
| Iao       | Information available operative                                                 |
| Iaog      | Information available operative generating                                      |
| Iaogfp    | Information available operative generating with full performance                |
| Iaogpp    | Information available operative generating with partial performance             |
| Iaong     | Information available operative non-generating                                  |
| Iaongel   | Information available operative non-generating out of electrical specification  |
| Iaongen   | Information available operative non-generating out of environment specification |
| Iaongrs   | Information available operative non-generating requested shutdown               |
| Iaongts   | Information available operative non-generating technical standby                |
| Ice       | Ice                                                                             |
| Id        | Identity, identifier                                                            |
| Ieee      | IEEE definition                                                                 |
| IeeeKH    | Proportional gain HF (High Frequency). Defined in IEEE 421.5                    |
| IeeeKH1   | Proportional gain HF positive. Defined in IEEE 421.5                            |
| IeeeKH1 1 | Lead gain HF positive. Defined in IEEE 421.5                                    |
| IeeeKH1 7 | Lead gain HF negative. Defined in IEEE 421.5                                    |
| IeeeKH2   | Proportional gain HF negative. Defined in IEEE 421.5                            |
| IeeeKI    | Proportional gain IF (Intermediate Frequency). Defined in IEEE 421.5            |
| IeeeKI1   | Proportional gain IF positive. Defined in IEEE 421.5                            |
| IeeeKI1 1 | Lead gain IF positive. Defined in IEEE 421.5                                    |

| Term      | Description                                                         |
|-----------|---------------------------------------------------------------------|
| IeeeKI1 7 | Lead gain IF negative. Defined in IEEE 421.5                        |
| IeeeKI2   | Proportional gain IF negative. Defined in IEEE 421.5                |
| IeeeKL    | Proportional gain LF (Low Frequency). Defined in IEEE 421.5         |
| IeeeKL1   | Proportional gain LF positive. Defined in IEEE 421.5                |
| IeeeKL1 1 | Lead gain LF positive. Defined in IEEE 421.5                        |
| IeeeKL1 7 | Lead gain LF negative. Defined in IEEE 421.5                        |
| IeeeKL2   | Proportional gain LF negative. Defined in IEEE 421.5                |
| IeeeKs1   | Gain Ks1. Defined in IEEE 421.5                                     |
| IeeeKs2   | Gain Ks2. Defined in IEEE 421.5                                     |
| IeeeKs3   | Gain Ks3. Defined in IEEE 421.5                                     |
| IeeeM     | Ramptrack lowpass degree M. Defined in IEEE 421.R                   |
| IeeeN     | Ramptrack overall degree N. Defined in IEEE 421.5                   |
| IeeeT1    | Time constant T1. Defined in IEEE 421.5                             |
| IeeeT10   | Time constant T10. Defined in IEEE 421.5                            |
| IeeeT11   | Time constant T11. Defined in IEEE 421.5                            |
| IeeeT2    | Time constant T2. Defined in IEEE 421.5                             |
| IeeeT3    | Time constant T3. Defined in IEEE 421.5                             |
| IeeeT4    | Time constant T4. Defined in IEEE 421.5                             |
| IeeeT7    | Time constant T7. Defined in IEEE 421.5                             |
| IeeeT8    | Time constant T8. Defined in IEEE 421.5                             |
| IeeeT9    | Time constant T9. Defined in IEEE 421.5                             |
| IeeeTH1   | Time constant TH1 (High frequency positive). Defined in IEEE 421.5  |
| IeeeTH1 0 | Time constant TH10 (High frequency negative). Defined in IEEE 421.5 |
| IeeeTH1 1 | Time constant TH11 (High frequency negative). Defined in IEEE 421.5 |
| IeeeTH1 2 | Time constant TH12 (High frequency negative). Defined in IEEE 421.5 |
| IeeeTH2   | Time constant TH2 (High frequency positive). Defined in IEEE 421.5  |
| IeeeTH3   | Time constant TH3 (High frequency positive). Defined in IEEE 421.5  |
| IeeeTH4   | Time constant TH4 (High frequency positive). Defined in IEEE 421.5  |
| IeeeTH5   | Time constant TH5 (High frequency positive). Defined in IEEE 421.5  |
| IeeeTH6   | Time constant TH6 (High frequency positive). Defined in IEEE 421.5  |
| IeeeTH7   | Time constant TH7 (High frequency negative). Defined in IEEE 421.5  |

| Term     | Description                                                                 |
|----------|-----------------------------------------------------------------------------|
| IeeeTH8  | Time constant TH8 (High frequency negative). Defined in IEEE 421.5          |
| IeeeTH9  | Time constant TH9 (High frequency negative). Defined in IEEE 421.5          |
| IeeeTI1  | Time constant TI1 (Intermediate frequency positive). Defined in IEEE 421.5  |
| IeeeTI10 | Time constant TI10 (Intermediate frequency negative). Defined in IEEE 421.5 |
| IeeeTI11 | Time constant TI11 (Intermediate frequency negative). Defined in IEEE 421.5 |
| IeeeTI12 | Time constant TI12 (Intermediate frequency negative). Defined in IEEE 421.5 |
| IeeeTI2  | Time constant TI2 (Intermediate frequency positive). Defined in IEEE 421.5  |
| IeeeTI3  | Time constant TI3 (Intermediate frequency positive). Defined in IEEE 421.5  |
| IeeeTI4  | Time constant TI4 (Intermediate frequency positive). Defined in IEEE 421.5  |
| IeeeTI5  | Time constant TI5 (Intermediate frequency positive). Defined in IEEE 421.5  |
| IeeeTI6  | Time constant TI6 (Intermediate frequency positive). Defined in IEEE 421.5  |
| IeeeTI7  | Time constant TI7 (Intermediate frequency negative). Defined in IEEE 421.5  |
| IeeeTI8  | Time constant TI8 (Intermediate frequency negative). Defined in IEEE 421.5  |
| IeeeTI9  | Time constant TI9 (Intermediate frequency negative). Defined in IEEE 421.5  |
| IeeeTL1  | Time constant TL1 (Low frequency positive). Defined in IEEE 421.5           |
| IeeeTL10 | Time constant TL10 (Low frequency negative). Defined in IEEE 421.5          |
| IeeeTL11 | Time constant TL11 (Low frequency negative). Defined in IEEE 421.5          |
| IeeeTL12 | Time constant TL12 (Low frequency negative). Defined in IEEE 421.5          |
| IeeeTL2  | Time constant TL2 (Low frequency positive). Defined in IEEE 421.5           |
| IeeeTL3  | Time constant TL3 (Low frequency positive). Defined in IEEE 421.5           |
| IeeeTL4  | Time constant TL4 (Low frequency positive). Defined in IEEE 421.5           |
| IeeeTL5  | Time constant TL5 (Low frequency positive). Defined in IEEE 421.5           |
| IeeeTL6  | Time constant TL6 (Low frequency positive). Defined in IEEE 421.5           |
| IeeeTL7  | Time constant TL7 (Low frequency negative). Defined in IEEE 421.5           |

| Term         | Description                                                       |
|--------------|-------------------------------------------------------------------|
| IeeeTL8      | Time constant TL8 (Low frequency negative). Defined in IEEE 421.5 |
| IeeeTL9      | Time constant TL9 (Low frequency negative). Defined in IEEE 421.5 |
| IeeeTw1      | Time constant wash out Tw1. Defined in IEEE 421.5                 |
| IeeeTw2      | Time constant wash out Tw2. Defined in IEEE 421.5                 |
| IeeeTw3      | Time constant wash out Tw3. Defined in IEEE 421.5                 |
| IeeeTw4      | Time constant wash out Tw4. Defined in IEEE 421.5                 |
| IeeeVH Max   | Maximum limit set-point HF. Defined in IEEE 421.5                 |
| IeeeVH Min   | Minimum limit set-point HF. Defined in IEEE 421.5                 |
| IeeeVIM ax   | Maximum limit set-point IF. Defined in IEEE 421.5                 |
| IeeeVIMi n   | Minimum limit set-point IF. Defined in IEEE 421.5                 |
| IeeeVLM ax   | Maximum limit set-point LF. Defined in IEEE 421.5                 |
| IeeeVLM in   | Minimum limit set-point LF. Defined in IEEE 421.5                 |
| IeeeVsi1 Max | Input High Limit 1. Defined in IEEE 421.5                         |
| IeeeVsi1 Min | Input Low Limit 1. Defined in IEEE 421.5                          |
| IeeeVsi2 Max | Input High Limit 2. Defined in IEEE 421.5                         |
| IeeeVsi2 Min | Input Low Limit 2. Defined in IEEE 421.5                          |
| IeeeVst Max  | Output High Limit. Defined in IEEE 421.5                          |
| IeeeVst Min  | Output Low Limit. Defined in IEEE 421.5                           |
| Imb          | Imbalance                                                         |
| Imp          | Impedance non-phase-related AC                                    |
| Impact       | Impact                                                            |
| Impt         | Import                                                            |
| In           | Input                                                             |
| Ina          | Inactivity                                                        |
| Inc          | Integer control                                                   |
| Incl         | Inclination                                                       |
| Incr         | Increment, increase                                               |
| Ind          | Indication                                                        |
| Indp         | Independent                                                       |
| Iner         | Inertia                                                           |
| Inh          | Inhibit                                                           |
| Inl          | Inline                                                            |

| Term   | Description                                  |
|--------|----------------------------------------------|
| Inlet  | Inlet                                        |
| Inn    | Inner                                        |
| Ins    | Insulation                                   |
| Insol  | Insolation                                   |
| Inst   | Instantaneous                                |
| Int    | Integer                                      |
| Intm   | Intermediate                                 |
| Intn   | Internal                                     |
| Intr   | Interrupt, interruption                      |
| Intv   | Interval                                     |
| Inv    | Inverter, inverted, inverse                  |
| Isc    | Integer status control                       |
| Isld   | Islanded                                     |
| Iso    | Isolation                                    |
| Iu     | Information unavailable                      |
| Ix     | Index                                        |
| Jmp    | Jump                                         |
| Jnt    | Joint                                        |
| K      | Constant (regulation)                        |
| K0Fact | Zero-sequence (residual) compensation factor |
| KFact  | K factor (harmonics)                         |
| Kck    | Kicker                                       |
| Key    | Key, physical control device                 |
| L      | Lower (action)                               |
| LDC    | Line drop compensation                       |
| LDCR   | Line drop compensation resistance            |
| LDCX   | Line drop compensation reactance             |
| LDCZ   | Line drop compensation impedance             |
| LED    | Light-emitting diode                         |
| LTC    | Load tap changer                             |
| Last   | Last                                         |
| Ld     | Lead                                         |
| Ldp    | Link discovery protocol                      |
| Leap   | Leap (second)                                |
| Len    | Length                                       |
| Lev    | Level                                        |
| Lft    | Lifting, lift                                |
| Lg     | Lag                                          |
| Life   | Lifetime                                     |
| Lim    | Limit                                        |
| Lin    | Line                                         |
| Liv    | Live                                         |

| Term  | Description                            |
|-------|----------------------------------------|
| Lkd   | Locked                                 |
| Lkg   | Leakage                                |
| LI    | Last long (interval)                   |
| Lo    | Low (state or value)                   |
| Loc   | Local                                  |
| Locb  | Log control block                      |
| Lod   | Load, loading                          |
| Log   | Log                                    |
| Lok   | (use Lkd instead) Locked               |
| Loop  | Loop                                   |
| Los   | Loss                                   |
| Ls    | Last short (interval)                  |
| Lst   | List                                   |
| Lub   | Lubrication                            |
| Lum   | Luminosity                             |
| M     | Minutes                                |
| MV    | Measured value CDC                     |
| Mac   | Media access control, MAC-address      |
| Made  | Made                                   |
| Mag   | Magnetic, magnitude                    |
| Maint | Maintenance                            |
| Man   | Manual                                 |
| Mat   | Material                               |
| Mau   | Medium access unit                     |
| Max   | Maximum                                |
| Mbr   | Membrane                               |
| Md    | Motor drive                            |
| Mdul  | Module                                 |
| Meas  | Measurement                            |
| Mech  | Mechanical                             |
| Media | Media                                  |
| Mem   | Memory                                 |
| Min   | Minimum                                |
| Mir   | Mirror                                 |
| Mlt   | Multiple                               |
| Mns   | Mains                                  |
| Mod   | Mode                                   |
| Mot   | Motor                                  |
| Mrg   | Margin                                 |
| Mrk   | Market                                 |
| Mst   | Moisture                               |
| Msv   | Main signaling voltage                 |
| Msvcb | Multicast sampled values control block |

| Term    | Description                                                    |
|---------|----------------------------------------------------------------|
| Mth     | Method                                                         |
| Mult    | Multiplier                                                     |
| Mvm     | Movement, moving                                               |
| N2      | Nitrogen                                                       |
| NOx     | Nitrogen oxide                                                 |
| NQS     | Average partial discharge current                              |
| Nam     | Name                                                           |
| Name    | Name (reserved for use in data objects EEName and LNName only) |
| Ndl     | Needle (used in Pelton turbines)                               |
| NdsCom  | Needs commissioning                                            |
| Neut    | Neutral                                                        |
| Ng      | Negative                                                       |
| Ngt     | Negotiation                                                    |
| Nhd     | Net head                                                       |
| Night   | Night                                                          |
| No      | No, not                                                        |
| Nom     | Nominal, normalising                                           |
| Num     | Number                                                         |
| Nxt     | Next                                                           |
| O2      | Oxygen                                                         |
| O3      | Ozon, trioxygen                                                |
| Obl     | Obligation                                                     |
| Oc      | Open circuit                                                   |
| Odd     | Odd                                                            |
| Of      | Offline                                                        |
| Off     | Off, device disengaged, not running                            |
| Ofs     | Offset                                                         |
| Oil     | Oil                                                            |
| On      | On, device applied, running                                    |
| Oo      | Out of                                                         |
| Op      | Operate, operating, operation                                  |
| Operate | Operate order to any device                                    |
| Opn     | Open, opened                                                   |
| Ord     | Order                                                          |
| Out     | Output                                                         |
| Ov      | Over, override, overflow                                       |
| Ovl     | Overload                                                       |
| Ox      | Oxidant                                                        |
| P       | Proportional                                                   |
| PF      | Power factor                                                   |
| PH      | Acidity, value of pH                                           |
| PNV     | Phase-to-neutral voltage                                       |

| Term   | Description                           |
|--------|---------------------------------------|
| POW    | Point on wave switching               |
| PP     | Phase to phase                        |
| PPV    | Phase to phase voltage                |
| PT1    | Low-pass exponential time rate filter |
| Pa     | Partial                               |
| Pair   | Pair, paired                          |
| Pap    | Paper                                 |
| Par    | Parallel                              |
| Pas    | Passive                               |
| Path   | Path                                  |
| Pcb    | Power quality classifier bin          |
| Pct    | Percent, percentage                   |
| Pdm    | Power quality demodulation            |
| Pe     | Electric Power                        |
| Per    | Periodic, period                      |
| Ph     | Phase to reference                    |
| Phs    | Phase                                 |
| Phy    | Physical                              |
| Pi     | Instantaneous real power              |
| Pin    | Pin                                   |
| Pipe   | Pipe                                  |
| Pk     | Peak                                  |
| Pl     | Plant                                 |
| Plg    | Plug                                  |
| Pls    | Pulse                                 |
| Plt    | Plate; long-term flicker severity     |
| Pmp    | Pump                                  |
| Po     | Polar                                 |
| Pol    | Polarizing                            |
| Polytr | Polytropic                            |
| Port   | Port                                  |
| Pos    | Position                              |
| Pot    | Potentiometer                         |
| Prc    | Price, pricing                        |
| Pre    | Pre-                                  |
| Prec   | Precondition, initial status          |
| Pres   | Pressure                              |
| Prg    | Progress, in progress                 |
| Prim   | Primary                               |
| Prio   | priority                              |
| Prm    | Permissive                            |
| Pro    | Protection                            |
| Proc   | Process                               |

| Term  | Description                               |
|-------|-------------------------------------------|
| Proxy | Proxy                                     |
| Prs   | Presence                                  |
| Prt   | Parts, part                               |
| Ps    | Positive                                  |
| Psk   | Penstock                                  |
| Pss   | PSS, power system stabiliser function     |
| Pst   | Post, short-term flicker severity         |
| Pt    | Point                                     |
| Pth   | Pitch                                     |
| Pwr   | Power                                     |
| Qty   | Quantity                                  |
| Qu    | Queue                                     |
| Qud   | Quad                                      |
| R     | Raise, increase                           |
| Rad   | Radiation                                 |
| Ral   | Rail                                      |
| Ramp  | Ramp                                      |
| Rat   | Ratio                                     |
| Rb    | Runner blade                              |
| Rcd   | Record, recording                         |
| Rch   | Reach                                     |
| Rcl   | Reclaim                                   |
| Rct   | Reaction                                  |
| Rdy   | Ready                                     |
| Re    | Retry                                     |
| React | Reactance, reactive                       |
| Rec   | Reclose                                   |
| Rec1  | Reclose after single phase fault          |
| Rec13 | Reclose after evolving fault              |
| Rec3  | Reclose after three phase fault           |
| Recha | Recharge, recharging                      |
| Rect  | Rectifier                                 |
| Red   | Redundant; (deprecated meaning) reduction |
| Ref   | Reference                                 |
| Reg   | Regulation                                |
| Rel   | Release                                   |
| Req   | Requested                                 |
| Res   | Residual                                  |
| Reso  | Resonance                                 |
| Reuse | Reuse                                     |
| Rev   | Revision                                  |
| Rf    | Refreshment                               |

| Term  | Description                                 |
|-------|---------------------------------------------|
| Rin   | Reinsertion                                 |
| Ris   | Resistance                                  |
| RI    | Relation, relative                          |
| Rm    | Mutual resistance                           |
| Rmp   | Ramping, ramp                               |
| Rms   | Root mean square                            |
| Rn    | Rain                                        |
| Rnbk  | Runback                                     |
| Rng   | Range                                       |
| Rod   | Rod                                         |
| Root  | Root                                        |
| Rot   | Rotation, rotor                             |
| Rpt   | Repeat, repetition                          |
| Rs    | Reset, resettable                           |
| Rsl   | Result                                      |
| Rst   | Restraint, restriction                      |
| Rsv   | Reserve                                     |
| Rt    | Ride-through                                |
| Rte   | Rate                                        |
| Rtg   | Rating                                      |
| Rub   | Run-up/back                                 |
| Run   | Run                                         |
| Rv    | Reverse                                     |
| Rvc   | Rapid voltage change                        |
| Rvrt  | Revert                                      |
| Rwy   | Runaway, e.g. in runaway speed              |
| Rx    | Receive, received                           |
| S10   | Coefficient S1.0                            |
| S12   | Coefficient S1.2                            |
| SM    | Servo, servo-motor                          |
| SNL   | Speed-no-load, connected but not generating |
| SOx   | Sulphur oxide                               |
| SPCSO | Single point controllable status output     |
| SPG   | Single point setting CDC                    |
| SPS   | Single point status CDC                     |
| SPI   | Single pole/phase                           |
| ST    | Standard time                               |
| Saf   | Safety                                      |
| Sag   | Sag                                         |
| Sar   | Surge arrestor                              |
| Sat   | Saturation                                  |
| Sc    | Short circuit                               |

| Term  | Description                      |
|-------|----------------------------------|
| Scale | Scale                            |
| Schd  | Schedule                         |
| Scnd  | Secondary                        |
| Sco   | Supply change over               |
| Sec   | Security                         |
| Sel   | Select                           |
| Self  | Self                             |
| Seq   | Sequence                         |
| Ser   | Series, serial                   |
| Set   | Setting                          |
| Sgcb  | Setting group control block      |
| Sh    | Shunt                            |
| Shar  | Shared                           |
| Shft  | Shaft                            |
| Shld  | Shielded                         |
| Sig   | Signal                           |
| Sign  | Sign                             |
| Sim   | Simulation, simulated            |
| Sld   | Solidity                         |
| SInt  | Salinity, saline content         |
| Slp   | Sleep; slip                      |
| Smok  | Smoke                            |
| Smp   | Sampling                         |
| Snd   | Sound pressure                   |
| Snpt  | Snapshot                         |
| Snr   | Signal to noise ratio            |
| Snw   | Snow                             |
| Soc   | State of charge                  |
| Sof   | Switch on to fault               |
| Spc   | Single point control             |
| Spcf  | Specific                         |
| Spd   | Speed                            |
| Spec  | Spectra                          |
| Spir  | Spiral                           |
| Spt   | Setpoint                         |
| Sq    | Square                           |
| Src   | Source                           |
| Srfc  | Surface                          |
| St    | Status, state                    |
| Sta   | Station, function at plant level |
| Stab  | Stabilizer                       |
| Stat  | Statistics                       |
| Stc   | Stack                            |

| Term    | Description                                             |
|---------|---------------------------------------------------------|
| Std     | Standard                                                |
| Stdby   | Standby                                                 |
| Step    | Step                                                    |
| Stk     | Stroke                                                  |
| Stl     | Still, not moving                                       |
| Stnd    | Stand, standing                                         |
| Sto     | Storage, e.g. activity of storing data                  |
| Stop    | Stop                                                    |
| Storm   | Storm                                                   |
| Stow    | Stow                                                    |
| Str     | Start                                                   |
| Strg    | String                                                  |
| Stt     | Stator                                                  |
| Stuck   | Stuck, cannot move                                      |
| Sub     | Sub                                                     |
| Sum     | Sum                                                     |
| Sup     | Supply                                                  |
| Sv      | Sampled value                                           |
| SvCBRef | SV control block reference                              |
| Svc     | Service                                                 |
| Sw      | Switch, switched                                        |
| Swg     | Swing                                                   |
| Swl     | Power quality event swell                               |
| Syn     | Synchronisation, synchronous, synchronism, synchrocheck |
| Sys     | System                                                  |
| TP      | Three pole/phase                                        |
| Ta      | Armature time constant                                  |
| Tag     | Tag (maintenance work in progress)                      |
| Tap     | Tap                                                     |
| Task    | Task                                                    |
| Td      | Transformer derating                                    |
| Td0p    | Td0'                                                    |
| Td0s    | Td0''                                                   |
| Tdd     | Total demand distortion                                 |
| Tdf     | Transformer derating factor                             |
| Tdp     | Td'                                                     |
| Tds     | Td''                                                    |
| Tech    | Technology                                              |
| Term    | Termination                                             |
| Test    | Test                                                    |
| Tgt     | Target                                                  |
| Thd     | Total harmonic distortion                               |

| Term  | Description                           |
|-------|---------------------------------------|
| Thm   | Thermal                               |
| Ti    | Telephone influence                   |
| Tilt  | Tilt                                  |
| Tm    | Time                                  |
| Tm1   | Time constant 1                       |
| Tm2   | Time constant 2                       |
| Tm3   | Time constant 3                       |
| Tmh   | Time in h                             |
| Tmm   | Time in min                           |
| Tmms  | Time in ms                            |
| Tmp   | Temperature (°C)                      |
| Tms   | Time in s                             |
| Tnk   | Tank                                  |
| Tns   | Tension (stress)                      |
| Top   | Top (position)                        |
| Topo  | Topology                              |
| Torq  | Torque                                |
| Tot   | Total                                 |
| Tow   | Tower                                 |
| Tp    | Test Point                            |
| Tpc   | Teleprotection                        |
| Tpy   | Temporarily                           |
| Tq0p  | Tq0'                                  |
| Tq0s  | Tq0''                                 |
| Tqp   | Tq'                                   |
| Tqs   | Tq''                                  |
| Tr    | Trip (electrical protection function) |
| Trf   | Transformer                           |
| Trg   | Trigger                               |
| Trip  | Trip (non-electrical function)        |
| Trk   | Track, tracking                       |
| Trp   | Transient Performance Class           |
| Trs   | Transient                             |
| Trunk | Trunk                                 |
| Ts    | Total signed                          |
| Tu    | Total unsigned                        |
| Tun   | Tuning                                |
| Tur   | Turbine                               |
| Tx    | Transmit, transmitted                 |
| Typ   | Type                                  |
| UPS   | Uninterruptible power supply          |
| UTC   | Coordinated Universal Time            |
| Udp   | User Datagram Protocol                |

| Term    | Description                            |
|---------|----------------------------------------|
| Uhf     | Ultra-high-frequency                   |
| Un      | Un-; under                             |
| Unav    | Unavailable                            |
| Unb     | Unbalanced                             |
| Unld    | Unload                                 |
| Unt     | Unit, production unit                  |
| Up      | Up, upstream                           |
| Ups     | Uninterruptible Power Supply           |
| Urcb    | Unbuffered report control block        |
| Use     | Use                                    |
| Used    | Used                                   |
| Usvcb   | Unicast sampled values control block   |
| Util    | Utility                                |
| V       | Voltage                                |
| V1      | Voltage at side 1                      |
| V2      | Voltage at side 2                      |
| VA      | Apparent power (volt amperes)          |
| VAh     | Apparent energy                        |
| VAR     | Reactive power (volt amperes reactive) |
| VARh    | Reactive energy                        |
| Va      | Variation                              |
| Vac     | Vacuum                                 |
| Val     | Value                                  |
| Vbr     | Vibration                              |
| Ver     | Vertical                               |
| Viol    | Violation                              |
| Vis     | Visibility                             |
| Visc    | Viscosity                              |
| Vlan    | VLAN                                   |
| Vld     | Valid, validate, validated             |
| Vlm     | Volume                                 |
| Vlv     | Valve                                  |
| Vol     | Voltage DC or non-phase-related AC     |
| VolAmpr | Non-phase-related AC reactive power    |
| Vss     | Steady state voltage                   |
| W       | Active power                           |
| W200    | Watts peak at 200 W/m2                 |
| Wac     | Watchdog                               |
| Wash    | Washout                                |
| Watt    | Active power non-phase-related AC      |
| Wav     | Wave, waveform                         |
| Wd      | Wind                                   |
| Week    | Week                                   |