IEC 61850-7-420

Edition 2.0 2021-10

INTERNATIONAL STANDARD

NORME INTERNATIONALE

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

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

IEC 61850-7-420:2021-10(en-fr)

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COMMUNICATION NETWORKS AND SYSTEMS FOR POWER UTILITY AUTOMATION –

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

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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.

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

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

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

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

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/standardsdev/publications.

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

Such content is any text found in Annex A.

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

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

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

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

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The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under webstore.iec.ch in the data related to the specific document. At this date, the document will be

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

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

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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.

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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[1] should provide some additional examples of case of use of these specific LNs.

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

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

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

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COMMUNICATION NETWORKS AND SYSTEMS FOR POWER UTILITY AUTOMATION –

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

1 Scope

1.1 General

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

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

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

1.2 Published versions of this standard and related namespace name

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

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

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

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

1.3 Data model Namespace name and version

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

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

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

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

1.4 Data model Namespace Code Component distribution

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

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

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

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

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

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

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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.

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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 intervance (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[2].

[2] Under preparation.

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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 EEES 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)]

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

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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]

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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

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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 ($W \cdot m^{-2}$), while the cgs units are ergs per square centimetre per second ($erg \cdot cm^{-2} \cdot s^{-1}$, 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

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[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

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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]

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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
reformate
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^2;

c) light spectrum corresponding to an atmospheric air mass of 1,5.

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

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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.

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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.

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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.

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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; 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

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Term	Description
C2H4	Ethylene
C2H6	Ethane
CB	Circuit breaker
CE	Cooling equipment (see also Cl)
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
Cl	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
Crl	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

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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
Dl	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
El	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

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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

Documents
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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
IeeeKH11	Lead gain HF positive. Defined in IEEE 421.5
IeeeKH17	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
IeeeKI11	Lead gain IF positive. Defined in IEEE 421.5
IeeeKI17	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
IeeeKL11	Lead gain LF positive. Defined in IEEE 421.5
IeeeKL17	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
IeeeTH10	Time constant TH10 (High frequency negative). Defined in IEEE 421.5
IeeeTH11	Time constant TH11 (High frequency negative). Defined in IEEE 421.5
IeeeTH12	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

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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
IeeeVHMax	Maximum limit set-point HF. Defined in IEEE 421.5
IeeeVHMin	Minimum limit set-point HF. Defined in IEEE 421.5
IeeeVIMax	Maximum limit set-point IF. Defined in IEEE 421.5
IeeeVIMin	Minimum limit set-point IF. Defined in IEEE 421.5
IeeeVLMax	Maximum limit set-point LF. Defined in IEEE 421.5
IeeeVLMin	Minimum limit set-point LF. Defined in IEEE 421.5
IeeeVsi1Max	Input High Limit 1. Defined in IEEE 421.5
IeeeVsi1Min	Input Low Limit 1. Defined in IEEE 421.5
IeeeVsi2Max	Input High Limit 2. Defined in IEEE 421.5
IeeeVsi2Min	Input Low Limit 2. Defined in IEEE 421.5
IeeeVstMax	Output High Limit. Defined in IEEE 421.5
IeeeVstMin	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

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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
Ll	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

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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	Nogotiation
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

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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
Rl	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
SPl	Single pole/phase
ST	Standard time
Saf	Safety
Sag	Sag
Sar	Surge arrestor
Sat	Saturation
Sc	Short circuit

Documents
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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
Slnt	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

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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

Documents
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Term	Description
Wei	Weak end infeed
Wet	Wet
Wgt	Weight
Wh	Watt hours
Wid	Width
Win	Window
Wkup	Wake up
Wld	Welding
Wnd	Winding
Wrm	Warm
Wrn	Warning, warning trigger status
Wrs	Warning trigger status set
Wtr	Water (physical aspect: river, cooling, etc.)
Wup	Windup
X	Reactance (imaginary part of impedance)
X0	Zero sequence reactance
X1	Positive sequence reactance
X2	Negative sequence reactance X2
Xd	Synchronous reactance Xd
Xdir	X-direction

Term	Description
Xdp	Transient synchronous reactance Xd'
Xds	Subtransient reactance Xd''
Xm	Mutual reactance
Xq	Synchronous reactance Xq
Xqp	Transient synchronous reactance Xq'
Xqs	Subtransient reactance Xq''
Xsec	Cross-section
Ydir	Y-direction
Yw	Yaw
Z	Impedance
Zer	Zero
Zero	(use 'Zer' instead) Zero
Zm	Mutual impedance
Zn	Zone
Zro	Zero sequence
km	Kilometre
ppm	Parts per million

4 Concepts and constructs for managing DERs

4.1 Hierarchical concepts for DER facilities and plants

4.1.1 DER stakeholders

The future "smart energy" power system will be radically changed with the introduction of high penetrations of DERs which will not only require different power system structures but also greatly expanded communication capabilities.

Direct control of these DERs by distribution system operators (DSOs) is neither technically feasible nor contractually acceptable for the thousands if not millions of DERs interconnected with the distribution power system. At the same time, utilities are responsible for meeting the reliability and electrical requirements within their distribution systems and therefore require information on the locations, capabilities, and operational status of these DERs. In addition, these DERs can greatly assist in meeting these utility requirements effectively and efficiently, thus making them proactive stakeholders in managing the electric power system.

Information exchange is critical to accommodate these complex and dynamic power system requirements, and management of these information exchanges needs to be organized and interoperable. Specifically, a hierarchical approach is necessary for the various stakeholders (utilities, aggregators, facilities, markets, and DERs) to exchange information.

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There are many different types of stakeholders in managing the power system with high penetrations of DER. Each of these stakeholders have different business requirements and drivers which must be coordinated and managed to ensure the operation of the power grid as safe, reliable, efficient, environmentally sensitive, and least cost. Although the basic IEC 61850 information models focus on the interactions with the central green area (as shown in Figure 1) of DER "systems" (units and plants), often the types of information that should be modelled stem from the requirements of the other, more "distant" stakeholders and their applications. For instance, DER facilities, such as a university campus, shopping centre, or industrial site, may need to have their overall energy management capabilities modelled, not just the individual DERs.

4.1.2 Conceptual DER hierarchical architecture

At the local level, DERs can generally manage their own generation, storage, and load activities autonomously based on local conditions, pre-established settings, and DER owner preferences. However, DERs can also be active participants in power system operations and should be coordinated with other DERs and distribution equipment. In addition, the DSOs must interact with transmission system operators (TSOs), also known as regional transmission organizations (RTOs) and/or independent system operators (ISOs), for reliability and market purposes. In some regions, retail energy providers, aggregators, or other energy service providers are responsible for managing groups of DERs either through operational actions or market actions.

This hierarchical approach can be described as hybrid combinations of five levels across multiple domains, as illustrated in the five-level hierarchical DER architecture (using Domains and Zones from the Smart Grid Architecture Model (SGAM as stated in IEC TS 63200[3]), sliced through at the Information Layer) shown in Figure 1 and described below. The circled numbers (from 1 to 13) identify the various different types of logical information exchanges.

3 Under preparation. Stage at the time of publication: IEC PRVDTS 63200:2021.

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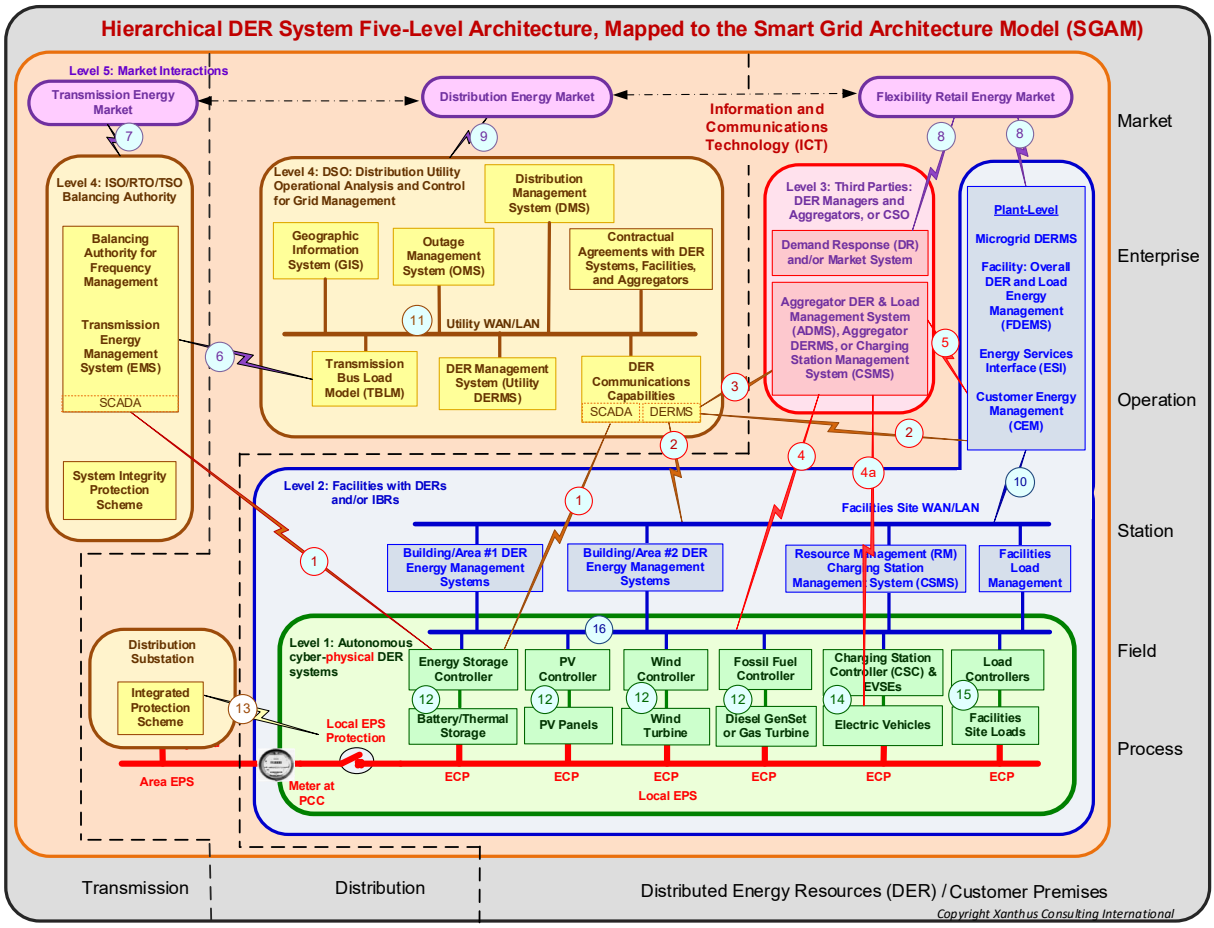


Figure 1 – Conceptual hierarchical architecture of DER information interactions with other entities

Level 1 DERs (green in Figure 1) is the lowest level and includes the actual cyber-physical DERs themselves. These DERs will be interconnected to local grids at Electrical Connection Points (ECPs) and to the utility grid through the Point of Common Coupling (PCC) (the ECP and the PCC may be the same if the DER is directly grid-connected). These DERs will usually be operated autonomously. In other words, these DERs will be running based on local conditions, such as photovoltaic systems operating when the sun is shining, wind turbines operating when the wind is blowing, electric vehicles charging when plugged in by the owner, and diesel generators operating when started up by the customer. This autonomous operation can be modified by DER owner preferences, pre-set parameter, and commands issued by utilities and aggregators. This standard IEC 61850-7-420 mostly focuses on any interactions crossing the border of this green rectangle (typically 1, 4, 13 and 16 circled numbers).

Level 2 Facility DER Management (blue in Figure 1) is the next higher level in which a facility DER management system (facility DER MS) manages the operation of the Level 1 DERs. This facility DER MS may be managing one or two DERs in a residential home, but more likely will be managing multiple DERs in commercial and industrial sites, such as university campuses and shopping malls. Utilities may also use a facility DER MS to handle DERs located at utility sites such as substations or power plant sites. For utilities, facility DER MS are viewed as field systems and shown at the Station level of the SGAM; however, from a facility's point of view, they may be seen as enterprises in their own right, and they could then be shown at the Enterprise and Operations levels. By extension and because of the aggregation capabilities of DER, this document also addresses the technical interactions between the DER energy management system and other energy related stakeholders (typically 2, 3, 5, and 10 circled numbers).

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