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Kommunikationsnetze und -systeme für die Automatisierung in der elektrischen Energieversorgung –**Teil 7-420: Grundlegende Kommunikationsstruktur –
Logische Knoten für die dezentrale Energieversorgung
(IEC 61850-7-420:2009);
Englische Fassung EN 61850-7-420:2009**

Communication networks and systems for power utility automation –
Part 7-420: Basic communication structure –
Distributed energy resources logical nodes (IEC 61850-7-420:2009);
English version EN 61850-7-420:2009

Systèmes et réseaux de communication pour l'automatisation des services de distribution d'énergie –
Partie 7-420: Structure de communication de base –
Noeuds logiques de ressources d'énergie distribuées (CEI 61850-7-420:2009);
Version anglaise EN 61850-7-420:2009

Gesamtumfang 101 Seiten

DKE Deutsche Kommission Elektrotechnik Elektronik Informationstechnik im DIN und VDE

Beginn der Gültigkeit

Die von CENELEC am 2009-05-01 angenommene EN 61850-7-420 gilt als DIN-Norm ab 2009-10-01.

Nationales Vorwort

Vorausgegangener Norm-Entwurf: E DIN EN 61850-7-420:2006-09.

Für diese Norm ist das nationale Arbeitsgremium K 952 „Netzleittechnik“ der DKE Deutsche Kommission Elektrotechnik Elektronik Informationstechnik im DIN und VDE (www.dke.de) zuständig.

Die enthaltene IEC-Publikation wurde vom TC 57 „Power systems management and associated information exchange“ erarbeitet.

Das IEC-Komitee hat entschieden, dass der Inhalt dieser Publikation bis zu dem Datum (maintenance result date) unverändert bleiben soll, das auf der IEC-Website unter „<http://webstore.iec.ch>“ zu dieser Publikation angegeben ist. Zu diesem Zeitpunkt wird entsprechend der Entscheidung des Komitees die Publikation

- bestätigt,
- zurückgezogen,
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- geändert.

Für den Fall einer undatierten Verweisung im normativen Text (Verweisung auf eine Norm ohne Angabe des Ausgabedatums und ohne Hinweis auf eine Abschnittsnummer, eine Tabelle, ein Bild usw.) bezieht sich die Verweisung auf die jeweils neueste gültige Ausgabe der in Bezug genommenen Norm.

Für den Fall einer datierten Verweisung im normativen Text bezieht sich die Verweisung immer auf die in Bezug genommene Ausgabe der Norm.

Der Zusammenhang der zitierten Normen mit den entsprechenden Deutschen Normen ergibt sich, soweit ein Zusammenhang besteht, grundsätzlich über die Nummer der entsprechenden IEC-Publikation. Beispiel: IEC 60068 ist als EN 60068 als Europäische Norm durch CENELEC übernommen und als DIN EN 60068 ins Deutsche Normenwerk aufgenommen.

Da sich die Benutzer der vorliegenden Norm der englischen Sprache als Fachsprache bedienen, wird die Englische Fassung der EN 61850-7-420 veröffentlicht. Für die meisten der verwendeten Begriffe existieren keine gebräuchlichen deutschen Benennungen, da sich die deutschen Anwender in der Regel ebenfalls der englischen Benennungen bedienen. Diese Norm steht nicht in unmittelbarem Zusammenhang mit Rechtsvorschriften und ist nicht als Sicherheitsnorm anzusehen.

Das Präsidium des DIN hat mit Präsidialbeschluss 1/2004 festgelegt, dass DIN-Normen, deren Inhalt sich auf internationale Arbeitsergebnisse der Informationsverarbeitung gründet, unter bestimmten Bedingungen allein in englischer Sprache veröffentlicht werden dürfen. Diese Bedingungen sind für die vorliegende Norm erfüllt.

**Communication networks and systems for power utility automation -
Part 7-420: Basic communication structure -
Distributed energy resources logical nodes
(IEC 61850-7-420:2009)**

Systèmes et réseaux de communication
pour l'automatisation des services
de distribution d'énergie -
Partie 7-420: Structure
de communication de base -
Nœuds logiques de ressources
d'énergie distribuées
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Kommunikationsnetze und -systeme
für die Automatisierung
in der elektrischen Energieversorgung -
Teil 7-420: Grundlegende
Kommunikationsstruktur -
Logische Knoten für die
dezentrale Energieversorgung
(IEC 61850-7-420:2009)

This European Standard was approved by CENELEC on 2009-05-01. 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 Central Secretariat 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 Central Secretariat has the same status as the official versions.

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

CENELEC

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

Central Secretariat: Avenue Marnix 17, B - 1000 Brussels

Foreword

The text of document 57/981/FDIS, future edition 1 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 was approved by CENELEC as EN 61850-7-420 on 2009-05-01.

The following dates were fixed:

- latest date by which the EN has to be implemented
at national level by publication of an identical
national standard or by endorsement (dop) 2010-02-01
- latest date by which the national standards conflicting
with the EN have to be withdrawn (dow) 2012-05-01

Annex ZA has been added by CENELEC.

Endorsement notice

The text of the International Standard IEC 61850-7-420:2009 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 60364-7-712	NOTE Harmonized as HD 60364-7-712:2005 (not modified).
IEC 60870-5-101	NOTE Harmonized as EN 60870-5-101:2003 (not modified).
IEC 60870-5-104	NOTE Harmonized as EN 60870-5-104:2006 (not modified).
IEC 61800-4	NOTE Harmonized as EN 61800-4:2003 (not modified).
IEC 61850	NOTE Harmonized in EN 61850 series (not modified).
IEC 61850-6	NOTE Harmonized as EN 61850-6:2004 (not modified).
IEC 61850-7-1	NOTE Harmonized as EN 61850-7-1:2003 (not modified).
IEC 61850-8	NOTE Harmonized in EN 61850-8 series (not modified).
IEC 61850-9	NOTE Harmonized in EN 61850-9 series (not modified).
IEC 61850-10	NOTE Harmonized as EN 61850-10:2005 (not modified).
IEC 61968	NOTE Harmonized in EN 61968 series (not modified).
IEC 61970-301	NOTE Harmonized as EN 61970-301:2004 (not modified).
IEC 62056	NOTE Harmonized in EN 62056 series (not modified).
ISO/IEC 7498-1	NOTE Harmonized as EN ISO/IEC 7498-1:1995 (not modified).

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INTRODUCTION

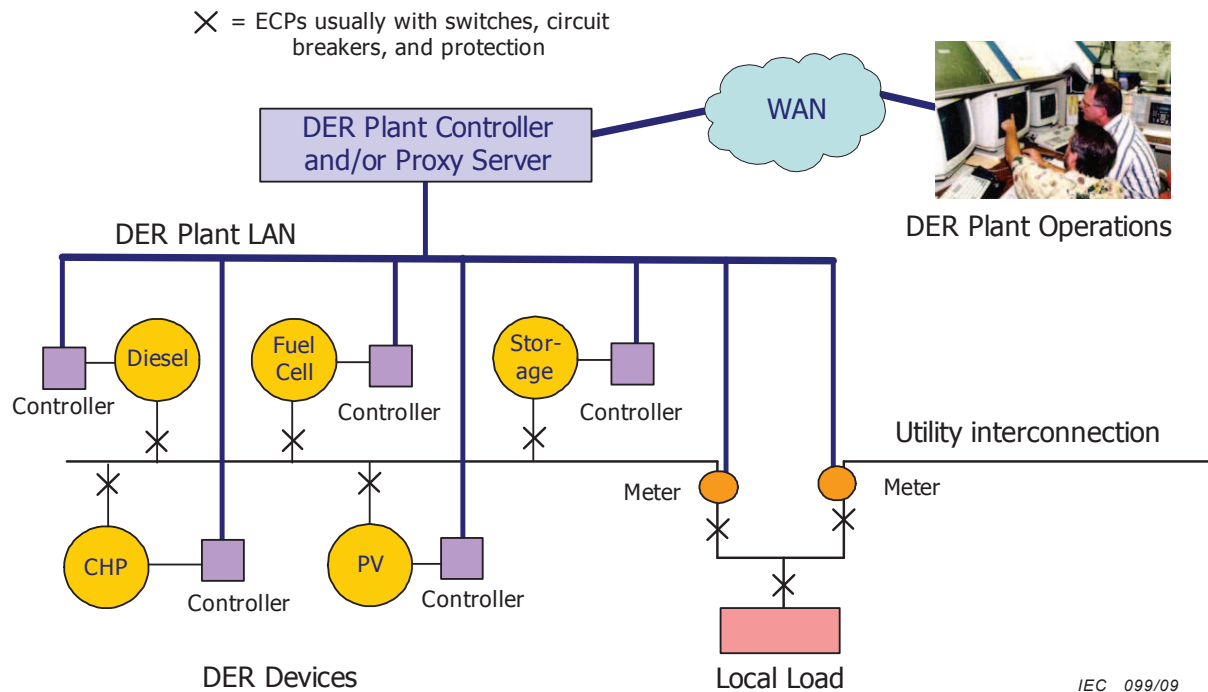
Increasing numbers of DER (distributed energy resources) systems are being interconnected to electric power systems throughout the world. As DER technology evolves and as the impact of dispersed generation on distribution power systems becomes a growing challenge - and opportunity, nations worldwide 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 utility system. In the past, DER manufacturers developed their own proprietary communication technology. However, as utilities, aggregators, and other energy service providers start to manage DER devices which are interconnected with the utility power system, they are finding that coping with these different communication technologies present major technical difficulties, implementation costs, and maintenance costs. Therefore, utilities 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 logical nodes in this document are intended for use with DER, 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 represented by the DER logical nodes 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. This is illustrated in Figure 1.

Example of a Communications Configuration for a DER Plant



Key

- CHP combined heat and power
- WAN wide area network
- DER distributed energy resources
- PV photovoltaics
- LAN local area network

Figure 1 – Example of a communications configuration for a DER plant

In basic terms, “communications” can be separated into four 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).

This document addresses only the IEC 61850 information modelling for DER. Other IEC 61850 documents address the services modelling (IEC 61850-7-2) and the mapping to communication protocols (IEC 61850-8-x). In addition, a systems configuration language (SCL) for DER (IEC 61850-6-x) would address the configuration of DER plants.

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 within substations have become International Standard. Many of the components of this standard can be reused for information models of other types of devices.

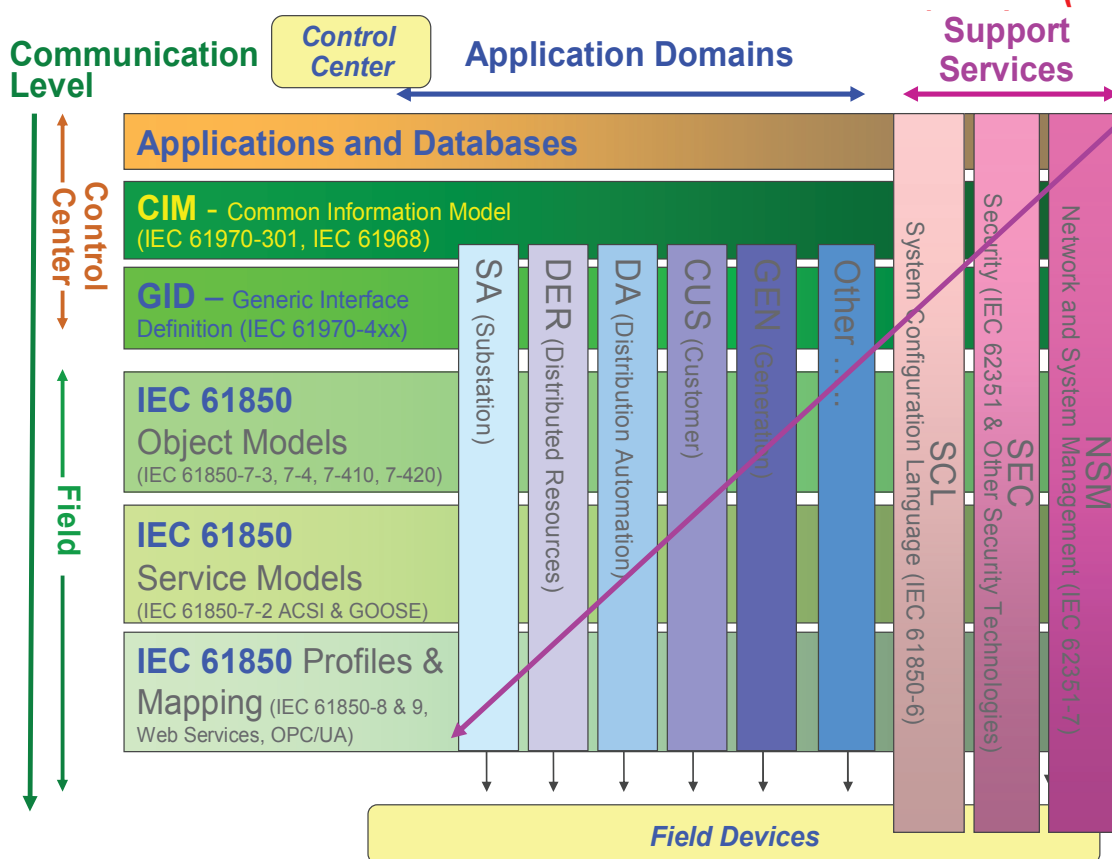
In addition to the IEC 61850 standards, IEC TC 57 has developed the common information model (CIM) that models the relationships among power system elements and other information elements

so that these relationships can be communicated across systems. Although this standard does not address these CIM relationships for DER, it is fully compatible with the CIM concepts.

The interrelationship between IEC TC 57 modelling standards is illustrated in Figure 2. This illustration shows as horizontal layers the three components to an information exchange model for retrieving data from the field, namely, the communication protocol profiles, the service models, and the information models. Above these layers is the information model of utility-specific data, termed the common information model (CIM), as well as all the applications and databases needed in utility operations. Vertically, different information models are shown:

- substation automation (IEC 61850-7-4),
- large hydro plants (IEC 61850-7-410),
- distributed energy resources (DER) (IEC 61850-7-420),
- distribution automation (under development),
- advanced metering infrastructure (as pertinent to utility operations) (pending).

IEC 61850 Models and the Common Information Model (CIM)



IEC 100/09

Figure 2 – IEC 61850 modelling and connections with CIM and other IEC TC 57 models

COMMUNICATION NETWORKS AND SYSTEMS FOR POWER UTILITY AUTOMATION –

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

1 Scope

This International Standard defines the IEC 61850 information models to be used in the exchange of information with distributed energy resources (DER), which comprise dispersed generation devices and dispersed storage devices, including reciprocating engines, fuel cells, microturbines, photovoltaics, combined heat and power, and energy storage.

The IEC 61850 DER information model standard utilizes existing IEC 61850-7-4 logical nodes where possible, but also defines DER-specific logical nodes where needed.

2 Normative references

The following referenced documents are indispensable for the application 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 61850-7-2:2003, *Communication networks and systems in substations – Part 7-2: Basic communication structure for substations and feeder equipment – Abstract communication service interface (ACSI)* ¹⁾

IEC 61850-7-3:2003, *Communication networks and systems in substations – Part 7-3: Basic communication structure for substations and feeder equipment – Common data classes* ¹⁾

IEC 61850-7-4:2003, *Communication networks and systems in substations – Part 7-4: Basic communication structure for substations and feeder equipment – Compatible logical node classes and data classes* ¹⁾

IEC 61850-7-410, *Communication networks and systems for power utility automation – Part 7-410: Hydroelectric power plants – Communication for monitoring and control*

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

¹⁾ A new edition of this document is in preparation.

3 Terms, definitions and abbreviations

For the purposes of this document, the following terms, definitions and abbreviations apply.

3.1 Terms and definitions

3.1.1

ambient temperature

temperature of the medium in the immediate vicinity of a device

[IEC/TS 62257-8-1:2007, definition 3.15 modified]

3.1.2

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

[IEV 602-01-24, modified]

NOTE Conventional power plants emit the heat produced as a useless byproduct 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.

3.1.3

common data class

CDC

classes of commonly used data structures which are defined in IEC 61850-7-3

3.1.4

device

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

[IEV 151-11-20]

NOTE A device may form part of a larger device.

3.1.5

electrical connection point

ECP

point of electrical connection between the DER source of energy (generation or storage) and any electric power system (EPS)

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 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 the IEEE 1547 “*Standard for Interconnecting Distributed Resources with Electric Power Systems*”.

3.1.6

electric power system

EPS

facilities that deliver electric power to a load

[IEEE 1547]

3.1.7

event

event information

- a) something that happens in time [IEV 111-16-04]
- b) monitored information on the change of state of operational equipment [IEV 371-02-04]

NOTE In power system operations, an event is typically state information and/or state transition (status, alarm, or command) reflecting power system conditions.

3.1.8

fuel cell

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

3.1.9

fuel cell stack

individual fuel cells connected in series

NOTE Fuel cells are stacked to increase voltage.

[US DOE]

3.1.10

function

a computer subroutine; specifically: one that performs a calculation with variables provided by a program and supplies the program with a single result

[Merriam-Webster dictionary]

NOTE This term is very general and can often be used to mean different ideas in different contexts. However, in the context of computer-based technologies, it is used to imply software or computer hardware tasks.

3.1.11

generator

- a) energy transducer that transforms non-electric energy into electric energy [IEV 151-13-35];
- b) device that converts kinetic energy to electrical energy, generally using electromagnetic induction

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. [WIKI 2007-12]

3.1.12

information

- a) intelligence or knowledge capable of being represented in forms suitable for communication, storage or processing [IEV 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, definition 01.01.01]

NOTE Information may be represented for example by signs, symbols, pictures, or sounds.

3.1.13

information exchange

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

NOTE The exchange of information between systems requires interoperable communication services.

3.1.14

insolation

solar radiation that has been received

[Merriam-Webster dictionary]

3.1.15

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

[IEC 61727:2004, definition 3.8]

NOTE 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.

3.1.16

irradiance

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

[Merriam-Webster dictionary]

NOTE "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 centimeter 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.

3.1.17

measured value

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

[IEC 61850-7-4]

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

NOTE 2 The result of a sampling of an analogue magnitude of a particular quantity.

3.1.18

membrane

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

[US DOE]

3.1.19

monitor

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

[IEV 351-22-03]

3.1.20

photovoltaic cell

device in which the photovoltaic effect is utilized

[IEV 521-04-34]

3.1.21

photovoltaic system

- a) 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) a 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, definition 3.7]

NOTE 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.

3.1.22

photovoltaics PV

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

[Merriam-Webster dictionary]

3.1.23

point of common coupling PCC

point of a power supply network, electrically nearest to a particular load, at which other loads are, or may be, connected [IEV 161-07-15]

NOTE 1 These loads can be either devices, equipment or systems, or distinct customer's installations.

NOTE 2 In some applications, the term "point of common coupling" is restricted to public networks.

NOTE 3 The point where a local EPS is connected to an area EPS [IEEE 1547]. The local EPS may include distributed energy resources as well as load (see IEC definition which only includes load).

3.1.24

power conversion

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

This could include electromechanical or electrochemical processes.

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

[WIKI 2007-12]

3.1.25

prime mover

equipment acting as the energy source for the generation of electricity

NOTE Examples include diesel engine, solar panels, gas turbines, wind turbines, hydro turbines, battery storage, water storage, air storage, etc.

3.1.26

PV array

a) a mechanically integrated assembly of modules or panels and support structure that forms a d.c. 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, definition 712.3.4]

NOTE 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.

3.1.27

PV module

the smallest complete environmentally protected assembly of interconnected cells

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

NOTE Colloquially referred to as a "solar module".

3.1.28

PV string

a circuit of series-connected modules

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

3.1.29

reciprocating engine

piston engine

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

[Merriam-Webster dictionary]

NOTE 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 DER systems, the most common form is the diesel engine.

3.1.30

reformat

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

[US DOE]

3.1.31

set point

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

[Merriam-Webster Dictionary]

3.1.32

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

[IEV 371-03-11]

NOTE 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.

3.1.33

standard test conditions

STC

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

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/m²;
- c) light spectrum corresponding to an atmospheric air mass of 1,5

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

3.1.34

turbine

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

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.

[US DOE]

3.2 DER abbreviated terms

Clause 4 of IEC 61850-7-4 defines abbreviated terms for building concatenated data names. The following DER abbreviated terms are proposed as additional terms for building concatenated data names.

Term	Description	Term	Description
Abs	Absorbing	El	Elevation
Acc	Accumulated	Em	Emission
Act	Active, activated	Emg	Emergency
Algn	Alignment	Encl	Enclosure
Alt	Altitude	Eng	Engine
Amb	Ambient	Est	Estimated
Arr	Array	ExIm	Export/import
Aval	Available	Exp	Export
Azi	Azimuth	Forc	Forced
Bas	Base	Fuel	Fuel
Bck	Backup	Fx	Fixed
Bnd	Band	Gov	Governor
Cal	Calorie, caloric	Heat	Heat
Cct	Circuit	Hor	Horizontal
Cmpl	Complete, completed	Hr	Hour
Cmut	Commute, commutator	Hyd	Hydrogen (suggested in addition to H ₂)
Cnfg	Configuration	Id	Identity
Cntt	Contractual	Imp	Import
Con	Constant	Ind	Independent
Conn	Connected, connections	Inert	Inertia
Conv	Conversion, converted	Inf	Information
Cool	Coolant	Insol	Insolation
Cost	Cost	Isld	Islanded
Csmp	Consumption, consumed	Iso	Isolation
Day	Day	Maint	Maintenance
Db	Deadband	Man	Manual
Dc	Direct current	Mat	Material
Dct	Direct	Mdul	Module
DCV	DC voltage	Mgt	Management
Deg	Degrees	Mrk	Market
Dep	Dependent	Obl	Obligation
DER	Distributed energy resource	Off	Off
Dff	Diffuse	On	On
Drt	Derate	Ox	Oxidant
Drv	Drive	Oxy	Oxygen
ECP	Electrical connection point	Pan	Panel
Efc	Efficiency		

Term	Description	Term	Description
PCC	Point of common coupling	Snw	Snow
Perm	Permission	Srt	Short
Pk	Peak	Stab	Stabilizer
Plnt	Plant, facility	Stp	Step
Proc	Process	Thrm	Thermal
Pv	Photovoltaics	Tilt	Tilt
Qud	Quad	Tm	Time
Rad	Radiation	Trk	Track
Ramp	Ramp	Tur	Turbine
Rdy	Ready	Unld	Unload
Reg	Regulation	Util	Utility
Rng	Range	Vbr	Vibration
Rsv	Reserve	Ver	Vertical
Schd	Schedule	Volm	Volume
Self	Self	Wtr	Water (suggested in addition to H ₂ O)
Ser	Series, serial	Wup	Wake up
Slp	Sleep	Xsec	Cross-section

4 Conformance

Claiming conformance to this specification shall require the provision of a model implementation conformance statement (MICS) document identifying the standard data object model elements supported by the system or device, as specified in IEC 61850-10.

5 Logical nodes for DER management systems

5.1 Overview of information modelling (informative)

5.1.1 Data information modelling constructs

Data information models provide standardized names and structures to the data that is exchanged among different devices and systems. Figure 3 illustrates the object hierarchy used for developing IEC 61850 information models.

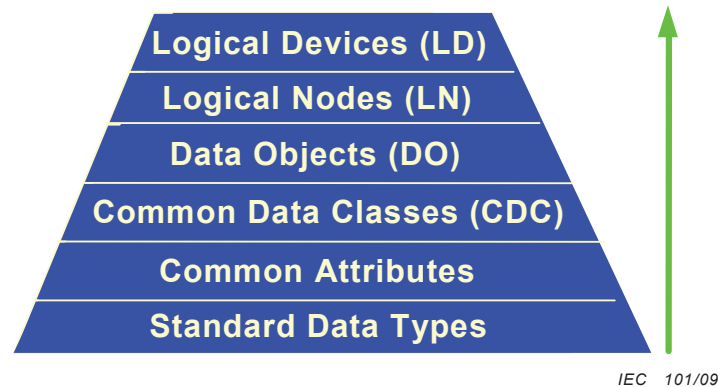


Figure 3 – Information model hierarchy

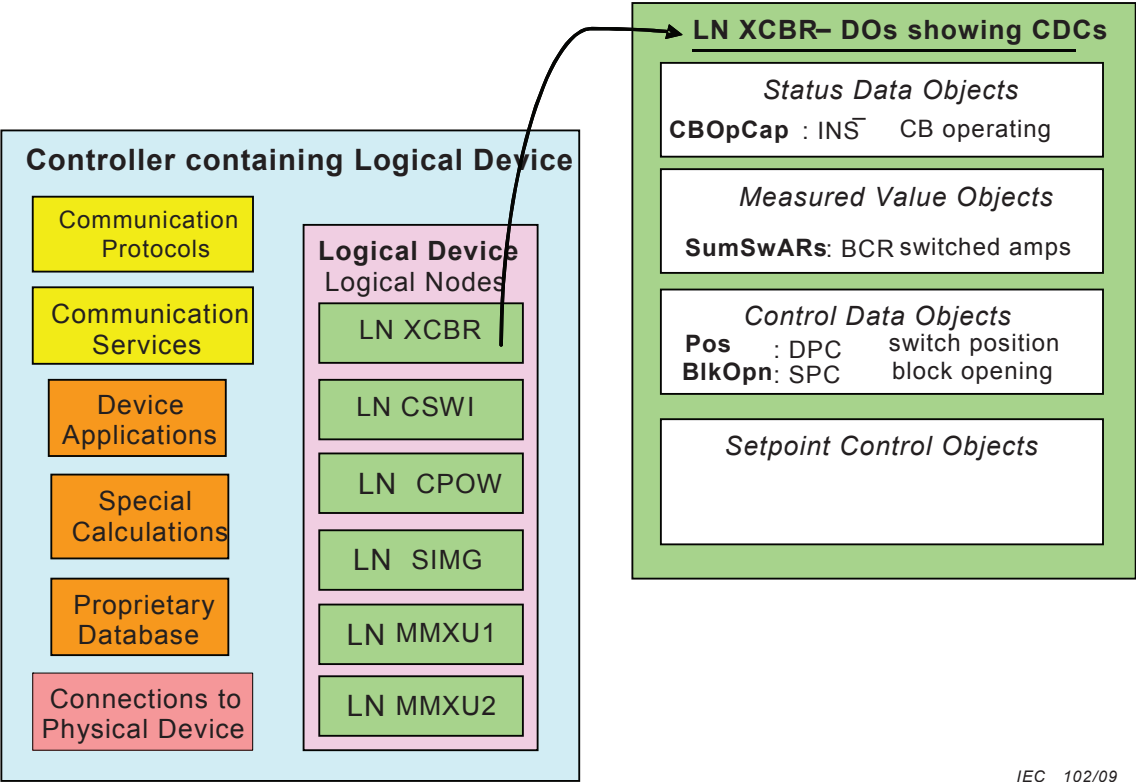
The process from the bottom up is described below:

- a) Standard data types: common digital formats such as Boolean, integer, and floating point.
- b) Common attributes: predefined common attributes that can be reused by many different objects, such as the quality attribute. These common attributes are defined in Clause 6 of IEC 61850-7-3.
- c) Common data classes (CDCs): predefined groupings building on the standard data types and predefined common attributes, such as the single point status (SPS), the measured value (MV), and the controllable double point (DPC). In essence, these CDCs are used to define the type or format of data objects. These CDCs are defined in IEC 61850-7-3 or in Clause 9 of this document. All units defined in the CDCs shall conform to the SI units (international system of units) listed in IEC 61850-7-3.
- d) Data objects (DO): predefined names of objects associated with one or more logical nodes. Their type or format is defined by one of the CDCs. They are listed only within the logical nodes. An example of a DO is “Auto” defined as CDC type SPS. It can be found in a number of logical nodes. Another example of a DO is “RHz” defined as a SPC (controllable single point), which is found only in the RSYN logical node.
- e) Logical nodes (LN): predefined groupings of data objects that serve specific functions and can be used as “bricks” to build the complete device. Examples of LNs include MMXU which provides all electrical measurements in 3-phase systems (voltage, current, watts, vars, power factor, etc.); PTUV for the model of the voltage portion of under voltage protection; and XCBR for the short circuit breaking capability of a circuit breaker. These LNs are described in Clause 5 of IEC 61850-7-4.
- f) Logical devices (LD): the device model composed of the relevant logical nodes for providing the information needed for a particular device. For instance, a circuit breaker could be composed of the logical nodes: XCBR, XSWI, CPOW, CSWI, and SMIG. Logical devices are not directly defined in any of the documents, since different products and different implementations can use different combinations of logical nodes for the same logical device.

5.1.2 Logical devices concepts

Controllers or servers contain the IEC 61850 logical device models needed for managing the associated device. These logical device models consist of one or more physical device models as well as all of the logical nodes needed for the device.

Therefore a logical device server can be diagrammed as shown in Figure 4.



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Figure 4 – Example of relationship of logical device, logical nodes, data objects, and common data classes

5.1.3 Logical nodes structure

The logical nodes (LNs) for DER devices are defined in the tables found in Clauses 5 to 8. For each LN implemented, all mandatory items shall be included (those indicated as an M in the M/O/C column). For clarity, these LNs are organized by typical logical devices that they may be a part of, but they may be used or not used as needed. The organization of IEC 61850 DER information models is illustrated in Figure 5. This illustration does not include all LNs that might be implemented, nor all possible configurations, but exemplifies the approach taken to create information models.

5.1.4 Naming structure

NOTE This is extracted from IEC 61850-7-2 Edition 2 (to be published) for informative purposes only – if any conflict is found, the original must be considered the definitive source.

The ObjectReference the various paths through a data object shall be:

LDName/LNName.
DataObjectName[.SubDataObjectName[. ...]].
DataAttributeName[(NumArrayElement)][.SubDataAttributeName[. ...]]

The following naming conventions (structure, lengths and character set) for object names and object references shall apply:

- LDName ≤ 64 characters, application specific
- LNName = [LN-Prefix] LN class name [LN-Instance-ID]
 - LN-Prefix = m characters (application specific); it may start with any character
 - LN class name = 4 characters (for example, compatible logical node name as defined in IEC 61850-7-4)
 - LN-Instance-ID = n numeric characters (application specific),
 - o m+n ≤ 7 characters

- DataObjectClassName $\leq$ 10 characters (as, for example, used in IEC 61850-7-4);
no DataObjectClassName shall end with a numeric character
- DataObjectName = DataObjectClassName[Data-Instance-ID]
- Data-Instance-ID = n numeric characters, optional; n shall be equal for all instances of the same data class
- FCD $\leq$ 61 characters including all separators "." (without the value of the FC)
- FCDA $\leq$ 61 characters including all separators "." (without the value of the FC)
- DataSetName $\leq$ 52 characters
- CBName = [CB-Prefix] CB class name [CB-Instance-ID]
 - CB-Prefix = m characters (application specific)
 - CB class name = 4 characters (as defined in this part of the standard)
 - CB-Instance-ID = n numeric characters (application specific)
 - m+n $\leq$ 7 characters

5.1.5 Interpretation of logical node tables

NOTE This is extracted from IEC 61850-7-4 Edition 2 (to be published) for informative purposes only – if any conflict is found, the original must be considered the definitive source.

The interpretation of the headings for the logical node tables is presented in Table 1.

Table 1 – Interpretation of logical node tables

Column heading	Description
Data object name	Name of the data object
Common data class	Common data class that defines the structure of the data object. See IEC 61850-7-3. For common data classes regarding the service tracking logical node (LTRK), see IEC 61850-7-2.
Explanation	Short explanation of the data object and how it is used.
T	<p>Transient data objects – the status of data objects with this designation is momentary and must be logged or reported to provide evidence of their momentary state. Some T may be only valid on a modelling level. The TRANSIENT property of DATA OBJECTS only applies to BOOLEAN process data attributes (FC=ST) of that DATA OBJECTS. Transient DATA OBJECT is identical to normal DATA OBJECT, except that for the process state change from TRUE to FALSE no event may be generated for reporting and for logging.</p> <p>For transient data objects, the falling edge shall not be reported if the transient attribute is set to true in the SCL-ICD file.</p> <p>It is recommended to report both states (TRUE to FALSE, and FALSE to TRUE), i.e. not to set the transient attribute in the SCL-ICD file for those DOs, and that the client filter the transitions that are not "desired".</p>
M/O/C	<p>This column defines whether data objects are mandatory (M) or optional (O) or conditional (C) for the instantiation of a specific logical node.</p> <p>NOTE The attributes for data objects that are instantiated may also be mandatory or optional based on the CDC (attribute type) definition in IEC 61850-7-3.</p> <p>The entry C is an indication that a condition exists for this data object, given in a note under the LN table. The condition decides what conditional data objects get mandatory. C may have an index to handle multiple conditions.</p>

The LN type and the LNName attribute are inherited from logical-node class (see IEC 61850-7-2). The LN class names are individually given in the logical node tables. The LN instance name shall be composed of the class name, the LN-Prefix and LN-Instance-ID according to Clause 19 of IEC 61850-7-2.

All data object names are listed alphabetically in Clause 6 [*applies to IEC 61850-7 only*]. Despite some overlapping, the data objects in the logical nodes classes are grouped for the convenience of the reader into some of the following categories.

a) Data objects without category (Common information)

Data objects without category (Common information) is information independent of the dedicated function represented by the LN class. Mandatory data objects (M) are common to all LN classes i.e. shall be used for all LN classes dedicated for functions. Optional data objects (O) may be used for all LN classes dedicated for functions. These dedicated LN classes show if optional data objects of the common logical node class are mandatory in the LN.

b) Measured values

Measured values are analogue data objects measured from the process or calculated in the functions such as currents, voltages, power, etc. This information is produced locally and cannot be changed remotely unless substitution is applicable.

c) Controls

Controls are data objects which are changed by commands such as switchgear state (ON/OFF), tap changer position or resettable counters. They are typically changed remotely, and are changed during operation much more often than settings.

d) Metered values

Metered values are analogue data objects representing quantities measured over time, e.g. energy. This information is produced locally and cannot be changed remotely unless substitution is applicable.

e) Status information

Status information is a data object, which shows either the status of the process or of the function allocated to the LN class. This information is produced locally and cannot be changed remotely unless substitution is applicable. Data objects such as “start” or “trip” are listed in this category. Most of these data objects are mandatory.

f) Settings

Settings are data objects which are needed for the function to operate. Since many settings are dependent on the implementation of the function, only a commonly agreed minimum is standardised. They may be changed remotely, but normally not very often.

5.1.6 System logical nodes LN Group: L (informative)

NOTE This is extracted from IEC 61850-7-4 Edition 2 (to be published) for informative purposes only – if any conflict is found, the original must be considered the definitive source.

5.1.6.1 General

In this subclause, the system specific information is defined. This includes system logical node data (for example logical node behaviour, nameplate information, operation counters) as well as information related to the physical device (LPHD) implementing the logical devices and logical nodes. These logical nodes (LPHD and common LN) are independent of the application domain. All other logical nodes are domain specific, but inherit mandatory and optional data from the common logical node.

5.1.6.2 LN: Physical device information Name: LPHD

This LN is introduced in this part to model common issues for physical devices. See Table 2.

Table 2 – LPHD class

LPHD Class				
Data object name	Common data class	Explanation	T	M/O/C
LNName		Shall be inherited from logical-node class (see IEC 61850-7-2)		
Data				
PhyNam	DPL	Physical device name plate		M
PhyHealth	ENS	Physical device health		M
OutOv	SPS	Output communications buffer overflow		O
Proxy	SPS	Indicates if this LN is a proxy		M
InOv	SPS	Input communications buffer overflow		O
NumPwrUp	INS	Number of power ups		O
WrmStr	INS	Number of warm starts		O
WacTrg	INS	Number of watchdog device resets detected		O
PwrUp	SPS	Power up detected		O
PwrDn	SPS	Power down detected		O
PwrSupAlm	SPS	External power supply alarm		O
RsStat	SPC	Reset device statistics		O
Data sets (see IEC 61850-7-2)				
Control blocks (see IEC 61850-7-2)				
Services (see IEC 61850-7-2)				

5.1.6.3 LN: Common logical node Name: Common LN

The common logical node class provides data which are mandatory or conditional to all dedicated LN classes. It also contains data which may be used in all dedicated logical node classes like input references and data for the statistical calculation methods. See Table 3.

Table 3 – Common LN class

Common LN Class				
Data object name	Common data class	Explanation	T	M/O/C
LNNName		Shall be inherited from logical-node class (see IEC 61850-7-2)		
Data				
Mandatory logical node information (Shall be inherited by ALL LN except LPHD)				
Mod	ENC	Mode		C
Beh	ENS	Behaviour		M
Health	ENS	Health		C1
NamPlt	LPL	Name plate		C1
Optional logical node information (May be inherited)				
InRef1	ORG	General input		O
BlkRef1	ORG	Block reference show the receiving of dynamically blocking signal		O
Blk	SPS	Dynamically blocking of function described by the LN		O
CmdBlk	SPC	Blocking of control sequences of controllable data objects		C2
ClcExp	SPS	Calculation period expired	T	O
ClcStr	SPC	Start calculation at time operTmh (if set) or immediately		O
ClcMth	ENG	Calculation Method of statistical data. Allowed values PRES MIN MAX AVG SDV TREND RATE		C3
CICMod	ENG	Calculation mode. Allowed values: TOTAL PERIOD SLIDING		O
CLCIntvTyp	ENG	Calculation interval type. Allowed values: ANYTIME CYCLE PER_CYCLE HOUR DAY WEEK		O
ClcPerms	ING	Calculation period in milliseconds. If ClcIntvTyp is equal ANYTIME Calculation Period shall be defined.		O
ClcSrc	ORG	Object reference to source logical node		O
ClcTyp	ENS	Calculation type		C
GrRef	ORG	Reference to a higher level logical device		O
Data sets (see IEC 61850-7-2)				
Control blocks (see IEC 61850-7-2)				
Services (see IEC 61850-7-2)				

5.1.6.4 LN: Logical node zero Name: LLN0

This LN shall be used to address common issues for Logical Devices. See Table 4.

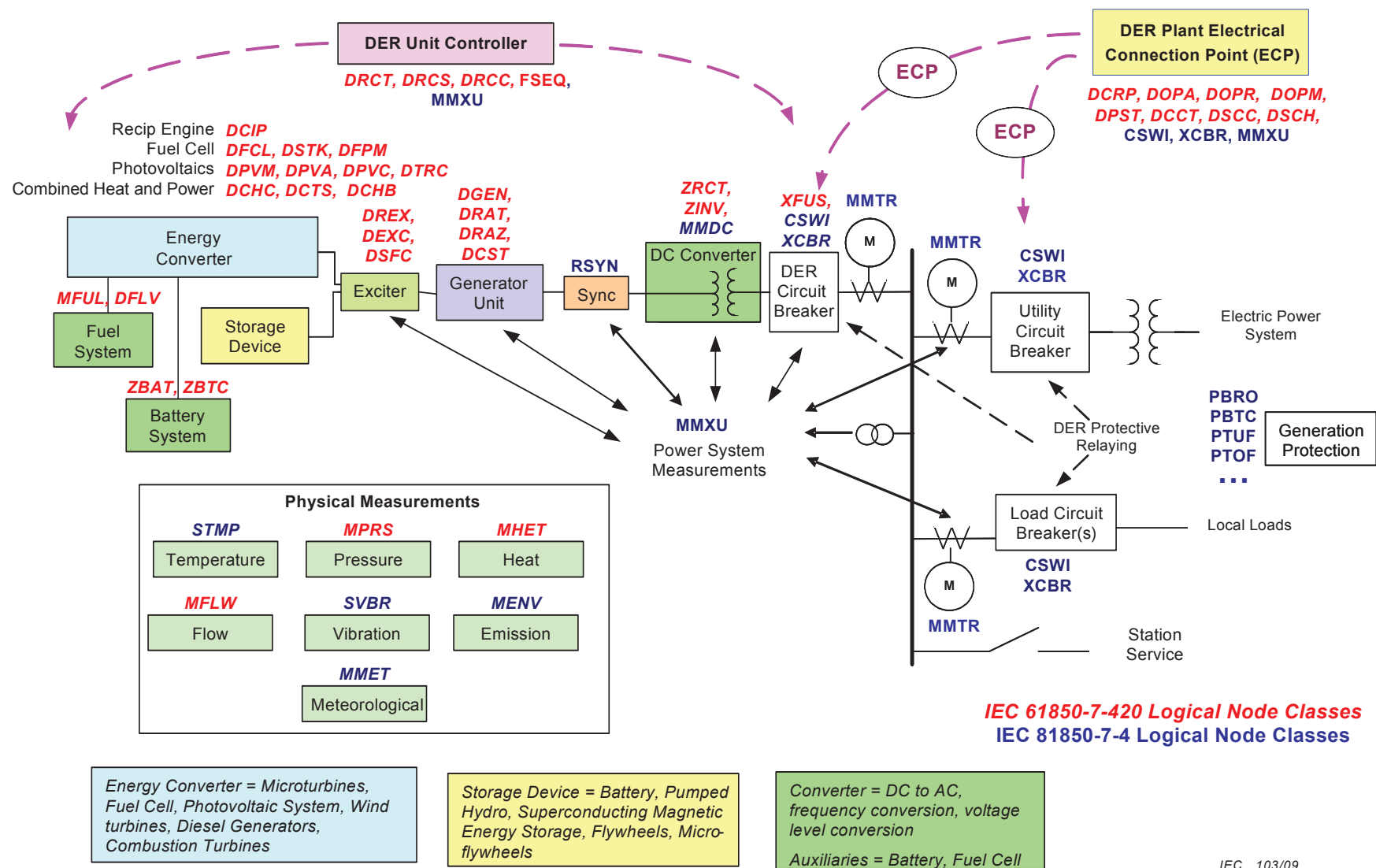
Table 4 – LLN0 class

LLN0 Class				
Data object name	Common data class	Explanation	T	M/O/C
LNName		Shall be inherited from logical-node class (see IEC 61850-7-2)		
Data				
LocKey	SPS	Local operation for complete logical device		O
RemCtlBlk	SPC	SPC remote control blocked		O
LocCtlBeh	SPS	SPS Local control behaviour		O
OpTmh	INS	Operation time		O
Controls				
Diag	SPC	Run diagnostics		O
LEDRs	SPC	LED reset	T	O
Settings				
MitLev	SPG	Select mode of authority for local control (True – control from multiple levels above the selected one is allowed, False – no other control level above allowed)		O

5.1.7 Overview of DER management system LNs

Figure 5 shows a conceptual view of the logical nodes which could be used for different parts of DER management systems.

Overview: Logical Devices and Logical Nodes for Distributed Energy Resource (DER) Systems



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Figure 5 – Overview: Conceptual organization of DER logical devices and logical nodes

5.2 Logical nodes for the DER plant ECP logical device

5.2.1 DER plant electrical connection point (ECP) logical device (informative)

The DER plant electrical connection point (ECP) logical device defines the characteristics of the DER plant at the point of electrical connection between one or more DER units and any electric power system (EPS), including isolated loads, microgrids, and the utility power system. Usually there is a switch or circuit breaker at this point of connection.

ECPs can be hierarchical. 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.

In a simple DER configuration, there is one ECP between a single DER unit and the utility power system. However, as shown in Figure 6, there may be more ECPs in a more complex DER plant installation. In this figure, ECPs exist between:

- each single DER unit and the local bus;
- each group of DER units and a local power system (with load);
- multiple groups of DER units and the utility power system.

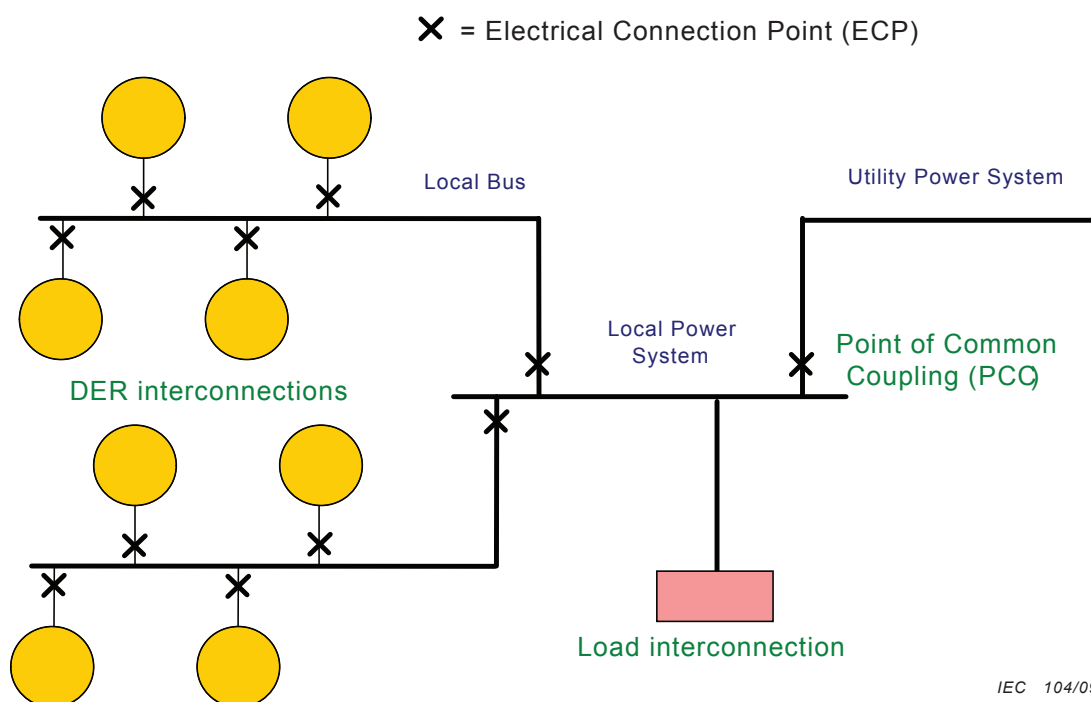


Figure 6 – Illustration of electrical connection points (ECP) in a DER plant

The ECP between a local DER power system and a utility power system is defined as the point of common coupling (PCC) in the IEEE 1547 “*Standard for Interconnecting Distributed Resources with Electric Power Systems*”. Although typically the PCC is the electrical connection between a utility and a non-utility DER plant, this is not always true: the DER plant may be owned/operated by a utility, and/or the EPS may be owned/operated by a non-utility entity, such as a campus power system or building complex.

DER systems have economic dispatch parameters related to their operations which are important for efficient operations, and will increasingly be used directly or indirectly in market operations, including demand response, real-time pricing, advanced distribution automation, and bidding into the auxiliary services energy marketplace.

Examples of installations with multiple ECPs include the following.

- One DER device is connected only to a local load through a switch. The connection point is the ECP.
- Groups of similar DER devices are connected to a bus which feeds a local load. If the group is always going to be treated as a single generator, then just one ECP is needed where the group is connected to the bus. If there is a switch between the bus and the load, then the bus has an ECP at that connection point.
- Multiple DER devices (or groups of similar DER devices) are each connected to a bus. That bus is connected to a local load. In this case, each DER device/group has an ECP at its connection to the bus. If there is a switch between the bus and the load, then the bus has an ECP at that connection point.
- Multiple DER devices are each connected to a bus. That bus is connected to a local load. It is also connected to the utility power system. In this case, each DER device has an ECP at its connection to the bus. The bus has an ECP at its connection to the local load. The bus also has an ECP at its connection to the utility power system. This last ECP is identical to the IEEE 1547 PCC.

ECP logical devices would include the following logical nodes as necessary for a particular installation. These LNs may or may not actually be implemented in an ECP logical device, depending upon the unique needs and conditions of the implementation. However, these LNs handle the ECP issues:

- DCRP: DER plant corporate characteristics at each ECP, including ownership, operating authority, contractual obligations and permissions, location, and identities of all DER devices connected directly or indirectly at the ECP.
- DOPR: DER plant operational characteristics at each ECP, including types of DER devices, types of connection, modes of operation, combined ratings of all DERs at the ECP, power system operating limits at the ECP.
- DOPA: DER operational control authorities at each ECP, including the authority to open the ECP switch, close the ECP switch, change operating modes, start DER units, stop DER units. This LN could also be used to indicate what permissions are currently in effect.
- DOPM: DER operating mode at each ECP. This LN can be used to set available operating modes as well as actual operating modes.
- DPST: Actual status at each ECP, including DER plant connection status, alarms.
- DCCT: Economic dispatch parameters for DER operations.
- DSCC: Control of energy and ancillary services schedules.
- DSCH: Schedule for DER plant to provide energy and/or ancillary services.
- XFUS, XCBR, CSWI: Switch or breaker at each ECP and/or at the load connection point (see IEC 61850-7-4).
- MMXU: Actual power system measurements at each ECP, including (as options) active power, reactive power, frequency, voltages, amps, power factor, and impedance as total and per phase (see IEC 61850-7-4).
- MMTR: Interval metering information at each ECP (as needed), including interval lengths, readings per interval (see IEC 61850-7-4, including statistical and historical statistical values).

5.2.2 LN: DER plant corporate characteristics at the ECP Name: DCRP

This logical node defines the corporate and contractual characteristics of a DER plant. A DER plant in this context is defined as one DER unit and/or a group of DER units which are connected at an electrical connection point (ECP). The DCRP LN can be associated with each ECP (e.g. with each DER unit and a group of DER units) or just those ECPs where it is appropriate.

The DCRP LN includes the DPL (device nameplate) information of ownership, operating authorities, and location of the ECP, and also provides contractual information about the ECP: plant purpose, contractual obligations, and contractual permissions. It is expected that only yes/no contractual information needed for operations will be available in this LN. See Table 5.

Table 5 – DER plant corporate characteristics at the ECP, LN (DCRP)

DCRP class				
Data object name	Common data class	Explanation	T	M/O/C
LNName		Shall be inherited from logical-node class (see IEC 61850-7-2)		
Data				
<i>System logical node data</i>				
		LN shall inherit all mandatory data from common logical node class		M
		The data from LLN0 may optionally be used		O
Settings				
PlntOblSelf	SPG	Plant purpose/obligations at the ECP – True = run passively or whenever possible (e.g. photovoltaics, wind)		O
PlntOblBck	SPG	Plant purpose/obligations at the ECP – True = for backup		O
PlntOblMan	SPG	Plant purpose/obligations at the ECP – True = manual operations		O
PlntOblMrk	SPG	Plant purpose/obligations at the ECP – True = market-driven		O
PlntOblUtil	SPG	Plant purpose/obligations at the ECP – True = utility operated		O
PlntOblEm	SPG	Plant purpose/obligations at the ECP – True = emission-limited		O

5.2.3 LN: Operational characteristics at ECP Name: DOPR

This logical node contains the operational characteristics of the combined group of DER units connected at the ECP, including the list of physically connected DER units, the status of their electrical connectivity at this ECP, the type of ECP, the modes of ECP operation, combined ratings of all DERs at ECP, and power system operating limits at ECP. See Table 6.