

High-voltage switchgear and controlgear —

Part 3: Digital interfaces based on IEC 61850

The European Standard EN 62271-3:2006 has the status of a
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National foreword

This British Standard was published by BSI. It is the UK implementation of EN 62271-3:2006. It is identical with IEC 62271-3:2006.

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A list of organizations represented on PEL/17/1 can be obtained on request to its secretary.

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**High-voltage switchgear and controlgear
Part 3: Digital interfaces based on IEC 61850
(IEC 62271-3:2006)**

Appareillage à haute tension
Partie 3: Interfaces numériques
basées sur la CEI 61850
(CEI 62271-3:2006)

Hochspannungs-Schaltgeräte
und -Schaltanlagen
Teil 3: Digitale Schnittstellen
nach IEC 61850
(IEC 62271-3:2006)

This European Standard was approved by CENELEC on 2006-09-01. 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.

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CENELEC

European Committee for Electrotechnical Standardization
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Europäisches Komitee für Elektrotechnische Normung

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Foreword

The text of document 17C/369/FDIS, future edition 1 of IEC 62271-3, prepared by SC 17C, High-voltage switchgear and controlgear assemblies, of IEC TC 17, Switchgear and controlgear, was submitted to the IEC-CENELEC parallel vote and was approved by CENELEC as EN 62271-3 on 2006-09-01.

This standard has the status of a product family standard and may be used as a normative reference in a dedicated product standard for highvoltage switchgear and controlgear.

This standard is to be read in conjunction with the following documents:

- EN 61850 series "Communication networks and systems in substations"
- EN 62271 series "High-voltage switchgear and controlgear".

The following dates were fixed:

- | | | |
|--|-------|------------|
| – latest date by which the EN has to be implemented
at national level by publication of an identical
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Annex ZA has been added by CENELEC.

Endorsement notice

The text of the International Standard IEC 62271-3:2006 was approved by CENELEC as a European Standard without any modification.

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0 Introduction

0.1 General

This standard is a product family standard for high-voltage switchgear and controlgear and assemblies thereof. It provides an application of the horizontal standard series IEC 61850 which details a layered substation communication architecture, in the world of high-voltage switchgear and controlgear.

By providing tutorial material such as examples and explanations, it also gives an access for switchgear experts to concepts and methods applied in the IEC 61850 series.

Compared to switchgear equipment, digital communication technology is subject to ongoing changes which are expected to continue in the future. Profound experience with electronics integrated directly into switchgear has yet to be gathered on a broader basis, as this type of equipment is not widely spread in the industry and a change of metabolism has not yet occurred.

This situation is taken into account in this standard by setting an appropriate validity date and by specifying several options to most of the communication-related requirements, such as connectors or fibres.

0.2 Position of this standard in relation to the IEC 61850 series

The IEC 61850 series is a horizontal standard intended to be used for communication and systems in the substation. The most important parts of this series define:

1. Information models for the substation automation system.
These information models include both the models of the switchgear (like circuit-breakers and disconnectors) and other process equipment (like instrument transformers), and the models of the substation automation system (like protection relays).
2. The communication between intelligent electronic devices (IEDs) of the substation automation system.
3. A configuration language used to describe the configuration aspects of the substation automation system.
4. Conformance testing of the communication interfaces of the IEDs of the substation automation system including their data models.

Typically, IEDs like bay level controllers interface to switchgear. In that case, the data models of the switchgear are implemented in these devices. However, this is not the only realization. In the case where electronics are integrated direct into switchgear, the above-mentioned data models should be implemented within the switchgear and the switchgear needs to support a communication interface.

IEC 61850, being a horizontal standard series, leaves many options open in order to support present and future requirements of all sizes of substations at all voltage levels.

HIGH-VOLTAGE SWITCHGEAR AND CONTROLGEAR –

Part 3: Digital interfaces based on IEC 61850

1 Scope

This International Standard is applicable to high-voltage switchgear and controlgear (scope of IEC SC 17A) and assemblies thereof (scope of IEC SC 17C) and specifies equipment for digital communication with other parts of the substation and its impact on testing. This equipment for digital communication, replacing metal parallel wiring, can be integrated into the high-voltage switchgear, controlgear, and assemblies thereof, or can be an external equipment in order to provide compliance for existing switchgear and controlgear and assemblies thereof with the standards of the IEC 61850 series.

This International Standard is a product standard based on the IEC 61850 series. It deals with all relevant aspects of switchgear and controlgear, and assemblies thereof with a serial communication interface according to the IEC 61850 series. In particular it defines:

- a) A selection of the information models from the IEC 61850 series that shall be supported by such switchgear and controlgear, and assemblies thereof.
- b) Conformance classes for the set of communication services that shall be supported by the switchgear and controlgear, and assemblies thereof.
- c) Modifications and extensions to type and routine tests of switchgear and controlgear, and assemblies thereof that are required due to the serial communication interface.
- d) An extension of the IEC 61850 series' object model for switchgear monitoring.

NOTE 1 It is intended to integrate the extension of the IEC 61850 series' object model for switchgear monitoring into a further revision of the IEC 61850 series. Once this integration is completed, the relevant parts will be removed from this standard.

The document is based on the IEC 61850 series, the horizontal standard series for communication, and specifies the requirements for digital communication equipment used within high-voltage switchgear, controlgear, and assemblies thereof, as well as the relevant testing requirements.

The relevant switchgear standards of the IEC 62271 series are applicable in general, with the additional specifications described in this standard.

NOTE 2 There is a limited activity today concerning switchgear with digital interface for rated voltage levels less than, or equal to, 52 kV. Such switchgear usually does not have integrated digital communication interfaces. If such products are to be developed, this should be done in accordance with the present standard.

NOTE 3 This standard intends to promote interoperability of communication interfaces. Interchangeability is outside the scope of this standard, as there is no requirement for it. Interchangeability is also outside the scope of the IEC 61850 series.

NOTE 4 For an introduction to substation communication and the related terms, definitions and models, refer to IEC 61850-1 which provides an overview of the objectives and requirements of the IEC 61850 series in general. IEC 61850-7-1 provides an overview of modelling techniques.

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 60050-191:1990, *International Electrotechnical Vocabulary, Chapter 191: Dependability and quality of service*

IEC 60265-2, *High-voltage switches – Part 2: High-voltage switches for rated voltages of 52 kV and above*

IEC 60694, *Common specifications for high-voltage switchgear and controlgear standards*

IEC 60794:2001, *Optical fibre cables*

IEC 60870-4:1990, *Telecontrol equipment and systems – Part 4: Performance requirements*

IEC 60874-10-3: 1998, *Connectors for optical fibres and cables – Detail specification for fibre optic adaptor type BFOC/2,5 for single and multimode fibre*

IEC 61850-1:2003, *Communication networks and systems in substations – Part 1: Concept and principles*

IEC 61850-2:2003, *Communication networks and systems in substations – Part 2: Glossary*

IEC 61850-3:2002, *Communication networks and systems in substations – Part 3: General requirements*

IEC 61850-4:2002, *Communication networks and systems in substations – Part 4: System and project management*

IEC 61850-5:2003, *Communication networks and systems in substations – Part 5: Communication requirements for functions and device models*

IEC 61850-6:2004, *Communication networks and systems in substations – Part 5: Configuration description language for communication in electrical substations related to IEDs*

IEC 61850-7-1:2003, *Communication networks and systems in substations – Part 7-1: Basic communication structure for substation and feeder equipment – Principles and models*

IEC 61850-7-2:2003, *Communication networks and systems in substations – Part 7-2: Basic communication structure for substation and feeder equipment – Abstract communication service interface (ACSI)*

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

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

IEC 61850-8-1:2004, *Communication networks and systems in substations – Part 8-1: Specific communication service mapping (SCSM) – Mappings to MMS (ISO 9506-1 and ISO 9506-2) and to ISO/IEC 8802-3*

IEC 61850-9-1:2003, *Communication networks and systems in substations – Part 9-1: Specific communication service mapping (SCSM) – Sampled values over serial unidirectional multidrop point to point link 2*

IEC 61850-9-2:2004, *Communication networks and systems in substations – Part 9-2: Specific communication service mapping (SCSM) – Sampled values over ISO/IEC 8802-3*

IEC 61850-10:2004, *Communication networks and systems in substations – Part 10: Conformance testing*

IEC 62271-102, *High-voltage switchgear and controlgear – Part 102: Alternating current disconnectors and earthing switches*

ISO/IEC 7498:1994, *Information technology – Open Systems Interconnection – Basic Reference Model: The Basic Model*

ISO/IEC 8802-3:2001, *Information technology – Telecommunications and information exchange between systems – Local and metropolitan area networks – Specific requirements – Part 3: Carrier sense multiple access with collision detection (CSMA/CD) access method and physical layer specifications*

ITU-T V.24:2000, *List of definitions for interchange circuits between data terminal equipment (DTE) and data circuit-terminating equipment (DCE)*

3 Terms and definitions

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

3.1

time requirement

maximum acceptable time delay between source and sink

3.2

mandatory data

data where coding is specified and the information always present

NOTE Mandatory data ensures interoperability in a substation.

3.3

optional data

data where the coding is specified but the information not necessarily present

3.4

data integrity

ability of a communication system to deliver data from its originator to its destinations with an acceptable residual error rate

NOTE In the case of switchgear with a digital interface, data integrity concerns the probability of undetected errors resulting in wrong information about actual process states in the monitoring direction or unintended actions in the control direction of the system.

3.5

interoperability

ability of two or more IEDs from the same vendor, or from different vendors, to exchange information and use that information for correct execution of specified functions

[IEC 61850-1, definition 3.1.8]

3.6

logical node (LN)

smallest part of a function that exchanges data. A logical node is an object defined by its data and methods

[IEC 61850-1, definition 3.1.9]

3.7

ACSI (abstract communication service interface)

virtual interface to an IED providing abstract communication services, for example, connection, variable access, unsolicited data transfer, device control and file transfer services, independent of the actual communication stack and profiles used

[IEC 61850-1, definition 3.1.1]

3.8

IED (intelligent electronic device)

any device incorporating one or more processors with the capability to receive or send data/control from or to an external source (for example, electronic multifunction meters, digital relays, controllers)

[IEC 61850-1, definition 3.1.6]

3.9

PICS (protocol implementation conformance statements)

summary of the capabilities of the system to be tested

[ISO/IEC 8823-2]

NOTE PICS contain information regarding the ACSI. This information could typically be optional parts, specific restrictions, or add-ons (see IEC 61850-7-2).

3.10

MICS (model implementation conformance statement)

document which details the standard data object model elements supported by the system or device

[IEC 61850-10]

3.11

service

functional capability of a resource which can be modelled by a sequence of service primitives

[IEC 61850-2, definition 2.121]

NOTE A resource in the context of this standard is an IED. A service primitive is an abstract, implementation independent representation of an interaction between the service user and the service provider.

3.12**configuration (of a system or device)**

step in system design, for example, selecting functional units, assigning their locations and defining their interconnections

[IEC 61850-2, definition 2.14]

3.13**data security**

data security of a switchgear with a digital communication interface can be defined as its ability to avoid placing the controlled system in a potentially dangerous or unstable situation by an undetected error

3.14**reliability**

measure of a system or equipment to perform its intended function under specified conditions for a specified period of time. It is a probability figure, based on failure data and length of operating time

[IEC 60271, IEC 60271A, IEC 60300]

3.15**availability**

ability of a device to perform its required function at any given moment

3.16**maintainability**

ability of a switchgear with a digital communication interface under given conditions of use, after detection of a fault, to be restored to full working order and to be maintained during normal working operation

3.17**dependability**

collective term used to describe the availability performance and its influencing factors: reliability performance, maintainability performance, and maintenance support performance

[IEC 60050-191]

3.18**communication conformance test**

check of data flow on communication channels in accordance with the standard conditions concerning access organization, formats and bit sequences, time synchronization, timing, signal form and level and reaction to errors. The conformance test can be carried out and certified to the standard or to specifically described parts of the standard

[IEC 61850-10]

NOTE The term "communication" has been added to "conformance test" in order to state that this test refers to communication conformance.

3.19**performance test**

test on complete intelligent switchgear system to characterize it under operating conditions

3.20

SAS (substation automation system)

substation automation system

[IEC 61850-2]

NOTE See IEC 61850-1 for an introduction to substation automation systems.

3.21

intelligent switchgear

switchgear composed of its primary part, its mechanism, and its secondary part (for example, auxiliary relays).

Intelligent switchgear is switchgear whose secondary part comprises a switchgear controller

3.22

switchgear controller

IED with an interface according to IEC 61850-8-1 (or proprietary). It is part of the secondary part of switchgear. It provides for application functionality

NOTE A switchgear controller can be:

- a circuit-breaker controller (abbreviated as CBC in this standard);
- disconnector controller (abbreviated as CC in this standard);
- earthing switch controller (abbreviated as ESC in this standard);
- controller of another type of switchgear.

3.23

intelligent sensor

sensor with an interface according to IEC 61850 is an intelligent sensor (for example, used to measure gas quality)

3.24

communication device

a communication device (such as a hub or a communication switch or a communication gateway) is equipment used for interconnection of several IEDs. It does not provide for application functionality

NOTE 1 The term “communication switch” is used in this standard in order to distinguish this type of equipment from switches as defined in IEC 60265. Such a communication switch is used in local area communication networks to combine communication network segments with different communication hardware, such as copper-based and fibre optic serial communication networks. The defined data rate is available on every network segment in parallel. A communication switch is a device which implements layers 1 and 2 of the ISO/OSI reference model according to ISO/IEC 7498.

NOTE 2 A hub is used in local area communication networks to combine communication network segments based on the same communication hardware. It is used to extend the communication network. The defined data rate is available on all network segments in common. A hub is a device which implements layers 1 and 2 of the ISO/OSI reference model according to ISO/IEC 7498.

NOTE 3 A communication gateway is a communication device used for interconnection of several IEDs which may use completely different communication methods (for example, one IED with proprietary communication and another IED with communication according to IEC 61850). A communication gateway is a device which implements all 7 layers of the ISO/OSI communication reference model according to ISO/IEC 7498.

4 Normal and special service conditions

Clause 2 of IEC 60694, giving environmental conditions (such as climatic, mechanical, electrical) is applicable.

5 Ratings and classifications

5.1 LNs on the process level of a high-voltage substation

According to the number of functions integrated in the switchgear, a choice of LNs, among those given in IEC 61850-5, can be implemented. This standard describes a minimum requirement if the relevant functions are present.

NOTE 1 LNs are one of the basic concepts of the IEC 61850 series. They can be seen as containers of data within an IED. LNs are compatibly defined in IEC 61850-7-4 in order to achieve interoperability between IEDs. For further information, IEC 61850-7-1 should be referred to.

NOTE 2 For example, a circuit-breaker controller of an intelligent circuit-breaker implements the LN XCBR. Should that circuit-breaker controller also implement a synchrocheck function, the LN RSYN would also be included.

The following LNs shall be used to model the communication interface of the relevant switchgear functions; they are mandatory in the case where the function is present and it has a serial communication interface:

NOTE 3 The following LNs are taken from IEC 61850-7-4. The column "Purpose and explanation" gives requirements and explanations to fit into the context of this standard.

Table 1 – LNs on process level

Logical node	Name	Purpose and explanation
Alarm handling (creation of group alarms and group events)	CALH	This LN shall be used to handle alarms and events
LN zero (mandatory for every logical device)	LLN0	This LN shall be used to address common data for logical devices NOTE 1 According to IEC 61850-7-2, a logical device can be seen as a composition of LNs and communication services. A logical device is not a switching device. NOTE 2 Communication services are the means to access the data which reside in LNs.
LN physical device (mandatory for every physical device)	LPHD	This LN shall be used to model common data for physical devices NOTE A physical device according to IEC 61850-7-2 is an IED (such as a circuit-breaker controller), not a switching device.
Circuit-breaker	XCBR	This LN shall be used for modelling circuit-breakers NOTE If there is a single-phase circuit-breaker, this LN has an instance per phase. These three instances may be allocated to multiple physical devices.
All kinds of switchgear except circuit-breakers, such as: Switch-disconnectors Disconnectors Earthing switches High-speed earthing switches	XSWI	This LN shall be used for modelling all kinds of switchgear except circuit-breakers NOTE If there is a single-phase switchgear (not a circuit-breaker), this LN has an instance per phase. These three instances may be allocated to multiple physical devices.
Insulation medium supervision (gas)	SIMG	This LN shall be used to supervise the gas volumes of GIS (gas-insulated switchgear) regarding density, pressure, temperature, etc.
Monitoring and diagnostics for arcs	SARC	This LN shall be used to supervise the gas volumes of GIS regarding switching faults or fault arcs
Monitoring and diagnostics for partial discharge	SPDC	This LN shall be used to supervise the gas volumes of GIS regarding signatures of partial discharges
Test generator	GTES	This LN shall be used for testing purposes by using process signals but avoiding any impact on the process (blocking of process outputs)

5.2 Additional data and LNs for switchgear monitoring

NOTE These LNs are described here until their integration into IEC 61850-7-4, edition 2 (or amendment).

As described in 5.1, the standards of the IEC 61850 series contain a number of LNs that allow the control and monitoring of switchgear.

Where these LNs do not provide sufficient information to monitor specific switchgear, the LNs specified in the following table, which are additional to those specified in the IEC 61850 series, shall be used.

Table 2 – Additional LNs on process level

Logical node	Name	Purpose and explanation
Circuit-breaker monitoring	SCBR	Additional LN, not specified in the IEC 61850 series, to be used specifically for circuit-breaker monitoring See Annex B for further details of logical node formation
Monitoring of all kinds of switchgear except circuit-breakers, such as: Switch-disconnectors Disconnectors Earthing switches High-speed earthing switches	SSWI	Additional LN, not specified in the IEC 61850 series, to be used specifically for circuit switch monitoring of all kinds of switchgear except circuit-breakers See Annex B for further details of logical node formation

These supplemental LNs shall be used in conjunction with, and not in place of, those specified in the IEC 61850 series, to correctly represent the item of equipment.

The use of these LNs shall be considered when monitoring the following:

- energy of the operating mechanism (for example, spring energy, hydraulic pressure);
- component failure (for example, trip circuit failure, position sensor failure);
- environmental conditions;
- performance capability (for example, travel curves);
- ageing (for example, electrical wear).

The details of the LNs SCBR and SSWI are given in Annex B.

The use of these nodes should also be considered for situations where the monitoring equipment is located remotely from the switchgear being monitored and for the communication of manufacturer-specific data.

Where additional data above that specified in the IEC 61850 series is required for the monitoring of insulation, acs and partial discharge, this shall be achieved by the extension of the LNs SIMS, SARC and SPDC as specified in IEC 61850-7-4

5.3 Communication services

5.3.1 Conformance classes

The standards of the IEC 61850 series specify a large set of communication services. Not all of these services are used to operate switchgear; many of these services support additional capabilities such as configuration and supervision of an IED.

NOTE Communication services are used to access and exchange data residing in logical nodes via a serial communication network according to the IEC 61850 series.

Therefore, not all of the services defined in the IEC 61850 series need to be implemented in an IED. The services that are required to be implemented are defined in terms of conformance classes within this clause. The conformance classes are defined using the ACSI conformance statements specified in IEC 61850-7-2, Annex A. The following conformance classes are defined:

- class a: the minimal set of services required to operate switchgear;
- class b: the services required to implement the complete IEC 61850 series' data model with self-descriptive capabilities;
- class c: the implementation of all services that are applicable for the specific LN. This includes configuration capabilities, file transfer and log.

There is no requirement for a switchgear controller of a given conformance class to implement a certain LN or not.

NOTE 1 The services within the IEC 61850 series are defined using an abstract object-modelling technique. Abstract means that this definition is focused on the description of what the services provide.

NOTE 2 Logical nodes and services within the IEC 61850 series provide means to retrieve comprehensive information about the information model and the services that operate on the information models, i.e. about themselves. This capability is called self-description.

NOTE 3 File transfer can be used to transmit information such as travel curves or configuration information via the communication network.

NOTE 4 Logging is a communication facility within the IEC 61850 series which can be used for the transmission of, for example, a sequence of events, from an IED to a human machine interface for the purpose of maintenance of a substation.

5.3.2 ACSI basic conformance statement

NOTE 1 ACSI is the abstract communication service interface for IEDs as defined in IEC 61850-7-2. It is defined in an abstract way and thus independent of the underlying communication architecture.

NOTE 2 ACSI conformance statements are used to provide an overview and details about IEDs claiming conformance with ACSI.

NOTE 3 The mapping to the communication protocol defined by the ISO/IEC 8802-3 (Ethernet)/TCP/IP/MMS standard is called SCMS (specific communication service mapping) and is defined in IEC 61850-8-1, IEC 61850-9-1, and IEC 61850-9-2, where IEC 61850-9-1 and IEC 61850-9-2 consider the exchange of sampled values which is outside the scope of this standard.

TCP/IP means transport control protocol/internet protocol. MMS means manufacturing message specification.

NOTE 4 The client-server model as mentioned in Table 3 is one of the basic concepts for data exchange according to the IEC 61850 series. A client is defined as a requester of communication services and a server is defined as the provider of communication services. The client-server model is most commonly used for the exchange of alarms and events.

NOTE 5 The GSE or generic substation event model is another basic concept of data exchange according to the IEC 61850 series. It provides fast and reliable distribution of data between IEDs. It can be used for the exchange of, for example, binary status information used for interlocking purpose, or trip signals. Data is made available to the communication network by a publisher; subscribers receive this data without further request. The generic substation event provides the peer-to-peer information exchange between the input data values of one IED to the output data of many other IEDs (multicast, peer-to-peer communication).