BS EN 62271-3:2015

BSI Standards Publication

High-voltage switchgear and controlgear

Part 3: Digital interfaces based on IEC 61850

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National foreword

This British Standard is the UK implementation of EN 62271-3:2015. It is identical to IEC 62271-3:2015. It supersedes BS EN 62271-3:2006 which is withdrawn.

The UK participation in its preparation was entrusted by Technical Committee PEL/17, Switchgear, controlgear, and HV-LV co-ordination, to Subcommittee PEL/17/1, High-voltage switchgear and controlgear.

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

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Appareillage à haute tension - Partie 3: Interfaces numériques basées sur l'IEC 61850 (IEC 62271-3:2015)

Hochspannungs-Schaltgeräte und -Schaltanlagen - Teil 3: Digitale Schnittstellen nach IEC 61850 (IEC 62271-3:2015)

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Foreword

The text of document 17C/617/FDIS, future edition 2 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 approved by CENELEC as EN 62271-3:2015.

The following dates are fixed:

• latest date by which the document has to be implemented at national level by publication of an identical national standard or by endorsement	(dop)	2016-01-14
• latest date by which the national standards conflicting with the document have to be withdrawn	(dow)	2018-04-14

This document supersedes EN 62271-3:2006.

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

Endorsement notice

The text of the International Standard IEC 62271-3:2015 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 60265 Series	NOTE	Harmonized as EN 60265 Series [1)].
IEC 60794 Series	NOTE	Harmonized as EN 60794 Series.
IEC 61754-20:2012	NOTE	Harmonized as EN 61754-20:2012 (not modified).
IEC 61850-6:2009	NOTE	Harmonized as EN 61850-6:2010 (not modified).
IEC 61850-7-1:2011	NOTE	Harmonized as EN 61850-7-1:2011 (not modified).
IEC 61850-7-410:2012	NOTE	Harmonized as EN 61850-7-410:2013 (not modified).
IEC 61850-7-420:2009	NOTE	Harmonized as EN 61850-7-420:2009 (not modified).
IEC 61869-9 [2)]	NOTE	Harmonized as EN 61869-9 [2)] (not modified).
IEC 62271-102:2001	NOTE	Harmonized as EN 62271-102:2002 (not modified).
IEC 62271-102:2001/A1:2011	NOTE	Harmonized as EN 62271-102:2002/A1:2011 (not modified).
IEC 62271-102:2001/A2:2013	NOTE	Harmonized as EN 62271-102:2002/ A2:2013 (not modified).
IEC 62271-103	NOTE	Harmonized as EN 62271-103.
IEC 62271-104	NOTE	Harmonized as EN 62271-104.
IEC 62271-202	NOTE	Harmonized as EN 62271-202.
ISO/IEC 7498-1:1994	NOTE	Harmonized as EN ISO/IEC 7498-1:1994 [3)] (not modified).

[1)] Superseded by EN 62271 Series.

[2)] At draft stage.

[3)] Withdrawn publication.

Annex ZA
(normative)

Normative references to international publications with their corresponding European publications

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

NOTE 1 When an International Publication has been modified by common modifications, indicated by (mod), the relevant EN/HD applies.

NOTE 2 Up-to-date information on the latest versions of the European Standards listed in this annex is available here: www.cenelec.eu

Publication	Year	Title	EN/HD	Year
IEC 60870-4	1990	Telecontrol equipment and systems - Part 4: Performance requirements	HD 546.4 S1	1992
IEC 61850-3	2013	Communication networks and systems for power utility automation - Part 3: General requirements	EN 61850-3	2014
IEC 61850-4	2011	Communication networks and systems for power utility automation - Part 4: System and project management	EN 61850-4	2011
IEC 61850-5	2013	Communication networks and systems for power utility automation - Part 5: Communication requirements for functions and device models	EN 61850-5	2013
IEC 61850-7-2	2010	Communication networks and systems for power utility automation - Part 7-2: Basic information and communication structure - Abstract communication service interface (ACSI)	EN 61850-7-2	2010
IEC 61850-7-3	2010	Communication networks and systems for power utility automation - Part 7-3: Basic communication structure - Common data classes	EN 61850-7-3	2011
IEC 61850-7-4	2010	Communication networks and systems for power utility automation - Part 7-4: Basic communication structure - Compatible logical node classes and data object classes	EN 61850-7-4	2010
IEC 61850-8-1	2011	Communication networks and systems for power utility automation - Part 8-1: Specific Communication Service Mapping (SCSM) - Mappings to MMS (ISO 9506-1 and ISO 9506-2) and to ISO/IEC 8802-3	EN 61850-8-1	2011

Publication	Year	Title	EN/HD	Year
IEC 61850-9-2	2011	Communication networks and systems for power utility automation - Part 9-2: Specific Communication Service Mapping (SCSM) - Sampled values over ISO/IEC 8802-3	EN 61850-9-2	2011
IEC 61850-10	2012	Communication networks and systems for power utility automation - Part 10: Conformance testing	EN 61850-10	2013
IEC/TR 61850-90-4	2013	Communication networks and systems for power utility automation - Part 90-4: Network engineering guidelines	-	-
IEC 62271-1	2007	High-voltage switchgear and controlgear - Part 1: Common specifications	EN 62271-1	2008
A1	2011		A1	2011
IEC 62271-100	2008	High-voltage switchgear and controlgear - Part 100: Alternating current circuit-breakers	EN 62271-100	2009
A1 + corr. December 2012	2012		A1	2012

CONTENTS

INTERNATIONAL ELECTROTECHNICAL COMMISSION

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HIGH-VOLTAGE SWITCHGEAR AND CONTROLGEAR –

Part 3: Digital interfaces based on IEC 61850

FOREWORD

1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
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International Standard IEC 62271-3 has been prepared by subcommittee 17C: High-voltage switchgear and controlgear assemblies, of IEC technical committee 17: Switchgear and controlgear.

This second edition cancels and replaces the first edition published in 2006. This edition constitutes a technical revision.

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

a) an update to the latest edition(s) of IEC 61850 series;

   (e.g. Annex B "LNs for sensors and monitoring" of edition 1 has been deleted since these LNs are now covered by standard IEC 61850-7-4:2010)

b) an update of normative references;

c) the minimum voltage range this standard refers to, was changed from 72,5 kV to above 1 kV;

d) the description of performance tests and conformance tests became more specific;

e) the new – informative – Annex C gives an example for performance type testing;

f) 6.2.3 “transmission systems” as well as appropriate subclauses have been superseded by standard IEC TR 61850-90-4:2013;

g) fibre optical connector type LC becomes only recommended type of fibre optic connector in accordance with IEC TR 61850-90-4:2013;

h) electronic nameplates have been redefined as extension of LN XCBR and LN XSWI with data objects, reflecting required additional name plate information.

NOTE A new common data class Visible String Description (VSD) will be added to the IEC 61850-7-3 to support these new data objects.

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.

The text of this standard is based on the following documents:

FDIS	Report on voting
17C/617/FDIS	17C/623/RVD

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

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

A list of all parts in the IEC 62271 series, published under the general title *High voltage switchgear and controlgear*, can be found on the IEC website.

The committee has decided that the contents of this publication will remain unchanged until the stability date indicated on the IEC web site under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

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

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

INTRODUCTION

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 layered power utility 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 power utility. The most important parts of this series define:

1) information models for the power utility 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 power utility automation system (like protection relays);
2) the communication between intelligent electronic devices (IEDs) of the power utility automation system;
3) a configuration language used to describe the configuration aspects of the power utility automation system;
4) conformance testing of the communication interfaces of the IEDs of the power utility 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 supports 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 power utility automation system at all voltage levels.

HIGH-VOLTAGE SWITCHGEAR AND CONTROLGEAR –

Part 3: Digital interfaces based on IEC 61850

1 Scope

This part of IEC 62271 is applicable to high-voltage switchgear and controlgear for all rated voltage levels above 1 kV and assemblies thereof and specifies equipment for digital communication with other parts of the power utility automation 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 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 are supported by such switchgear and controlgear, and assemblies thereof;

b) conformance classes for the set of communication services that are 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.

The standard 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 1 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 2 For an introduction to power utility automation 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 documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

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

IEC 61850-3:2013, *Communication networks and systems for power utility automation – Part 3: General requirements*

IEC 61850-4:2011, *Communication networks and systems for power utility automation – Part 4: System and project management*

IEC 61850-5:2013, *Communication networks and systems for power utility automation – Part 5: Communication requirements for functions and device models*

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

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

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

IEC 61850-8-1:2011, *Communication networks and systems for power utility automation – 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 61850-9-2:2011, *Communication networks and systems for power utility automation – Part 9-2: Specific communication service mapping (SCSM) – Sampled values over ISO/IEC 8802-3*

IEC 61850-10:2012, *Communication networks and systems for power utility automations – Part 10: Conformance testing*

IEC TR 61850-90-4:2013, *Communication networks and systems for power utility automation – Part 90-4: Network engineering guidelines*

IEC 62271-1:2007, *High-voltage switchgear and controlgear – Part 1: Common specifications*
IEC 62271-1:2007/AMD1:2011

IEC 62271-100:2008, *High-voltage switchgear and controlgear – Part 100: Alternating current circuit-breakers*
IEC 62271-100:2008/AMD1:2012

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 1 to entry: Mandatory data ensures interoperability in power utility automation.

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 1 to entry: 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

[SOURCE: IEC TR 61850-1:2013, 3.1.8]

3.6
logical node
LN
smallest part of a function that exchanges data

Note 1 to entry: A logical node is an object defined by its data and methods.

[SOURCE: IEC TR 61850-1:2013, 3.1.9]

3.7
abstract communication service interface
ACSI
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

[SOURCE: IEC TR 61850-1:2013, 3.1.1]

3.8
intelligent electronic device
IED
any device incorporating one or more processors with the capability to receive or send data/controls from or to an external source (for example, electronic multifunction meters, digital relays, controllers)

[SOURCE: IEC TR 61850-1:2013, 3.1.6]

3.9
protocol implementation conformance statements
PICS
summary of the capabilities of the system to be tested

Note 1 to entry: PICS contain information regarding the ACSI. This information could typically be optional parts, specific restrictions, or add-ons (see IEC 61850-7-2:2010).

[SOURCE: adapted from ISO/IEC 8823-2:1997]

3.10
model implementation conformance statement
MICS
statement which details the standard data object model elements supported by the system or device

[SOURCE: IEC 61850-10:2012, 3.4]

3.11
service
functional capability of a resource which can be modelled by a sequence of service primitives

Note 1 to entry: 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.

[SOURCE: IEC TS 61850-2:2003, 2.121, modified – addition of a new note to entry]

3.12
configuration (of a system or device)
step in system design, for example, selecting functional units, assigning their locations and defining their interconnections

[SOURCE: IEC TS 61850-2:2003, 2.14]

3.13
data security
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

Note 1 to entry: It is a probability figure, based on failure data and length of operating time.

[SOURCE: adapted from IEC 60050-191:1990, 191-02-06]

3.15
availability
the ability of an item to be in a state to perform a required function under given conditions at a given instant of time or over a given time interval, assuming that the required external resources are provided

Note 1 to entry: This ability depends on the combined aspects of the reliability performance, the maintainability performance and the maintenance support performance.

Note 2 to entry: Required external resources, other than maintenance resources do not affect the availability performance of the item.

Note 3 to entry: In French the term "disponibilité" is also used in the sense of "instantaneous availability".

3.16
maintainability
the ability of an item under given conditions of use, to be retained in, or restored to, a state in which it can perform a required function, when maintenance is performed under given conditions and using stated procedures and resources

Note 1 to entry: The term "maintainability" is also used as a measure of maintainability performance.

3.17
dependability
collective term used to describe the availability performance and its influencing factors: reliability performance, maintainability performance, and maintenance support performance

[SOURCE: IEC 60050-191:1990, 191-02-03]

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

Note 1 to entry: The conformance test can be carried out and certified to the standard or to specifically described parts of the standard.

Note 2 to entry: 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
intelligent switchgear
switchgear composed of its primary part, its mechanism and one or more switchgear controllers containing at a minimum set of logical nodes according to the IEC 61850 series

Note 1 to entry: Minimum set of logical nodes are as per 5.1. of this standard.

3.21
switchgear controller
IED with an interface according to IEC 61850-8-1:2011

Note 1 to entry: A switchgear controller can be:

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

3.22
intelligent sensor
sensor with a processor and communications interface according to the IEC 61850 series

EXAMPLE An interface according to IEC 61850-9-2:2011, used for current and voltage measurement via a merging unit as specified within IEC 61869-9.[1]

3.23
communication device
equipment used for interconnection of several IEDs

Note 1 to entry: The term “communication switch” is used in this standard in order to distinguish this type of equipment from switches as defined in IEC 62271-103:2011. 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 series.

Note 2 to entry: 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 series). A communication gateway is a device which implements all 7 layers of the ISO/OSI communication reference model according to ISO/IEC 7498 series.

Note 3 to entry: The communication device does not provide for application functionality.

3.24
test device
equipment used for generation of test signals and/or test functions

3.25
test object
device under test

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[1] To be published.

4 Normal and special service conditions

Clause 2 of IEC 62271-1:2007/AMD 1:2011 giving service conditions, such as ambient air temperature, altitude 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 61850-5:2013, 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 61850-7-4:2010 in order to achieve interoperability between IEDs. For further information, IEC 61850-7-1:2011 is 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. Apart from that, sampled values are subject to IEC 61850-9-2:2011.

The LNs as given in Table 1 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 LNs given in Table 1 are taken from IEC 61850-7-4:2010. 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 61850-7-2:2010, 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 61850-7-2:2010 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
Circuit-breaker monitoring	SCBR	This LN shall be used specifically for circuit-breaker monitoring
Monitoring of all kinds of switchgear except circuit-breakers, such as: Switch-disconnectors Disconnectors Earthing switches High-speed earthing switches	SSWI	This LN shall be used specifically for circuit switch monitoring of all kinds of switchgear except circuit-breakers

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, arcs and partial discharge, this shall be achieved by the extension of the LNs SIMG, SARC and SPDC as specified in IEC 61850-7-4:2010.

5.2 Communication services

5.2.1 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 1 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 61850-7-2:2010, Annex A. The following conformance classes are defined:

- class a: the minimal set of services required to operate switchgear;

NOTE 2 The intention of conformance class “a” is to allow very simple devices; i.e. “GOOSE-only-devices”.

- 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 3 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 4 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 5 File transfer can be used to transmit information such as travel curves or configuration information via the communication network.

NOTE 6 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.

5.2.2 ACSI basic conformance statement

The ACSI is described within IEC 61850-7-2:2010 in detail. The conformance classes related to intelligent switchgears are given in Table 2.

NOTE 1 ACSI is the abstract communication service interface for IEDs as defined in IEC 61850-7-2:2010. 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 8802-3:2000 (Ethernet)/TCP/IP/MMS standard is called SCSM (specific communication service mapping) and is defined in IEC 61850-8-1:2011, and IEC 61850-9-2:2011, where IEC 61850-9-2:2011 considers the exchange of sampled values. Therefore, sampled values are outside the scope of this standard.

NOTE 4 TCP/IP means transport control protocol/internet protocol. MMS means manufacturing message specification.

NOTE 5 The client-server model as mentioned in Table 2 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 6 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).

NOTE 7 The SVC or sampled value control model is used for the fast exchange of measurands, for example, between a non-conventional current sensor and a protection device. This type of data exchange is outside the scope of this standard.

NOTE 8 The first two columns in Table 2 are taken from IEC 61850-7-2:2010. The first column is used to enumerate the different basic conformance requirements. B stands for “basic” as used in “ACSI basic conformance statement”.

NOTE 9 For further details, see IEC 61850-7-2:2010, A.2.

Table 2 – ACSI basic conformance statement

		Conformance class		
Client-server roles		a	b	c
B11	Server side (of TWO-PARTY-APPLICATION-ASSOCIATION)	-	M1	M1
B12	Client side (of TWO-PARTY-APPLICATION-ASSOCIATION)	-	-	-
SCSMs supported				
B21	SCSM: IEC 61850-8-1 used	O	O	O
B23	SCSM: IEC 61850-9-2 used	O	O	O
B24	SCSM: other	-	-	-
Generic substation event model (GSE)				
B31	Publisher side	M	M	M
B32	Subscriber side	M	M	M
Transmission of sampled value model (SVC)				
B41	Publisher side	O	O	O
B42	Subscriber side	O	O	O
M – mandatory M1 – mandatory, if support for logical device model has been declared O – optional / – – not required				

5.2.3 ACSI models conformance statement

The ACSI models conformance statement is described within Annex A of IEC 61850-7-2:2010 in detail. The conformance statement related to intelligent switchgears are given in Table 3.

NOTE 1 ACSI is the abstract communication service interface for IEDs as defined in IEC 61850-7-2:2010. 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 first two columns in Table 3 are taken from IEC 61850-7-2:2010. The first column (M1 to M17) is used to enumerate the different models conformance requirements. M stands for “models” as used in “ACSI models conformance statement”.

NOTE 4 A report can be used to transmit events or alarms from an IED via the communication system to an HMI. The specific characteristic of the buffered report control is basically that it buffers the event data as they occur until their transmission over the communication network is completed. Unbuffered report control does not provide this functionality. In case of, for example, a communication interruption, the event data would be lost.

NOTE 5 GOOSE (generic object oriented substation event) is the way to realize GSE (see Note 6 to 5.2.2).

NOTE 6 The other model requirements cannot be described here in an exhaustive way. For further information, IEC 61850-7-1:2011 is referred to.

NOTE 7 For further details about the models conformance statement, see IEC 61850-7-2:2010, A.3.

Table 3 – ACSI models conformance statement

		Conformance class		
If server side (B11) is supported		**a**	**b**	**c**
M1	**Logical device**	C1	M	M
M2	**Logical node**	C1	M	M
M3	**Data**	-	M	M
M4	**Data set**	-	M	M
M5	**Substitution**	-	O	O
M6	**Setting group control**	O	O	O
	Reporting			
M7	**Buffered report control**		O	O
M7-1	sequence-number	-	O	O
M7-2	report-time-stamp	-	O	C2
M7-3	reason-for-inclusion	-	O	O
M7-4	data-set-name	-	O	O
M7-5	data-reference	-	O	O
M7-6	buffer-overflow	-	O	O
M7-7	entryID	-	O	O
M7-8	BufTim	-	O	O
M7-9	IntgPd	-	O	O
M7-10	GI	-	O	O
M7-11	conf-revision		O	O
M8	**Unbuffered report control**	-	O	O
M8-1	sequence-number	-	O	O
M8-2	report-time-stamp	-	O	C3
M8-3	reason-for-inclusion	-	O	O
M8-4	data-set-name	-	O	O
Table is continued on following page				
		a	**b**	**c**
M8-5	data-reference	-	O	O
M8-6	BufTim	-	O	O
M8-7	IntgPd	-	O	O
M8-8	GI	-	O	O
M8-9	conf-revision		O	O
	Logging			
M9	**Log control**	-	O	O
M9-1	IntgPd		O	O
M10	**Log**	-	O	O
M11	**Control**	-	M	M
If **GSE** (B31/32) is supported				
M12	GOOSE	M	M	M
If **SVC** (B41/42) is supported				
M14	Multicast SVC	O	O	O
M15	Unicast SVC	O	O	O
For all IED's				
M16	Time	M	M	M
M17	File transfer	-	O	O

M – mandatory
O – optional
- – not required
C1 – shall be M, if support for **M6 "setting group control"** is declared
C2 – shall be M, if support for **M7 "buffered report control"** is declared
C3 – shall be M, if support for **M8 "unbuffered report control"** is declared

The following applies to all switchgear controllers of a given conformance class: If the switchgear controller implements information in the LNs in the column “LN” of Table 4 then the data mentioned in the column “Data that is mandatory to be included in the GOOSE message” of Table 4 shall be included in the data set which is the basis for the GOOSE message / messages of this switchgear controller.

Table 4 – Additional restrictions for GOOSE

LN		Data that is mandatory to be included in the GOOSE message
CALH	LN group control: Alarm handling	Beh, Health, GrAlm
LLN0	LN group system: Logical node zero	Beh, Health
LPHD	LN group system: Physical device information	PhyHealth
XCBR	LN group for switchgear: Circuit breaker	Beh, Health, EEHealth, Loc, Pos, BlkOpn, BlkCls, CBOpCap
XSWI	LN group for switchgear: Circuit switch	Beh, Health, EEHealth, Loc, Pos, BlkOpn, BlkCls, SwOpCap
SIMG	LN group for supervision and monitoring: Insulation medium supervision (gas)	Beh, Health, InsAlm, PresAlm[a], DenAlm[a], TmpAlm[a]
[a] Depends on the supervised properties of the insulation gas, at least one alarm shall be present.		

NOTE 8 In the following, a short description of the data to be included in a GOOSE message is given. For a more detailed description, see IEC 61850-7-4:2010. Enumerated items are sorted by order of appearance in Table 4.

1. Beh: behaviour of the LN
2. Health: health information reflecting the state of the LN related hardware and software (i.e., red-yellow-green indication)
3. GrAlm: grouped alarm, assigned via configuration
4. PhyHealth: health information reflecting the state of the IED
5. EEHealth: external equipment health (in this standard: health, for example, of circuit-breaker controlled via LN XCBR)
6. Loc: control authority = local
7. Pos: position of switchgear (for example, open-close for a circuit-breaker)
8. BlkOpn: block open operation
9. BlkCls. block close operation
10. MechHealth: mechanical behaviour alarm
11. CBOpCap: circuit-breaker operation capability
12. SwOpCap: operation capability for switchgear (not circuit-breaker)
13. InsAlm: insulation alarm
14. PresAlm: pressure alarm
15. DenAlm: density alarm
16. TmpAlm: temperature alarm

For all data objects mentioned above, both stVal and q at a minimum shall be included in the GOOSE message.

NOTE 9 The stVal attribute describes the status value of the data (for example, open/close for circuit-breaker position). The q.validity is part of the quality attribute describing the validity of the data: data becomes invalid, for example, in the case of an oscillating input or a failure of the input contact. More detailed information on attributes can be found in IEC 61850-7-3:2010.

5.2.4 ACSI service conformance statement

NOTE 1 ACSI is the abstract communication service interface for IEDs as defined in IEC 61850-7-2:2010. It is defined in an abstract way and is 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 first two columns in Table 5 are taken out of IEC 61850-7-2:2010. The first column (S35 to S39) is used to enumerate the different service conformance requirements. S stands for “service” as used in “ACSI service conformance statement”.

If an ACSI model as described in 5.2.3 is supported, the service conformance shall be as defined in A.4 of IEC 61850-7-2:2010.

For a class ‘a’ device, the ACSI service conformance statement shall be as follows.

Table 5 – ACSI service conformance statement

	Services	Conformance class ‘a’
S35	SendGOOSEMessage	Mandatory
S36	GetGoReference	Optional
S37	GetGOOSEElementNumber	Optional
S38	GetGoCBValues	Optional
S39	SetGoCBValues	Optional

For class ‘b’ and class ‘c’ devices, the details of the ACSI service conformance statement shall be specified by the manufacturer.

5.3 Timing requirements

5.3.1 General

The manufacturer shall specify the time performance of the intelligent switchgear. For this, the manufacturer shall declare where the interface point A (connection point for an external connection according to Figure 1 and following figures) is located. Communication devices may be from different manufacturer. All timing performances shall be specified with reference to this interface point. See 6.1 for further explanation.

The time performance, identified as t_3 (intelligent switchgear total operating time) in Figure 1 or Figure 2, shall include t_1 (total processing delay of the communication device [if applicable], and the switchgear controller), and t_2 (switchgear operating time). For these time delays, see Figure 1 or Figure 2. For calculation of the overall operation time the timing performance of external IED’s and the network shall be considered in addition. IED- and switchgear controller performance classes as specified in IEC 61850-5:2013, Clause 11, need to be considered. The time performance is calculated from the reception of the first message (of GOOSE-message containing trip command) at interface point A (see Figure 1, Figure 2, Figure 3), until the operation of the switchgear. The operation time of the switchgear is opening time according Figure 5 and closing time as specified in Figure 6.

For communication devices or switchgear controllers that are supplied independent of the switchgear, for example for use on retrofitting projects, the system integrator shall specify the total processing delay t_1 including the processing delay of the communication device and if applicable any controlgear.

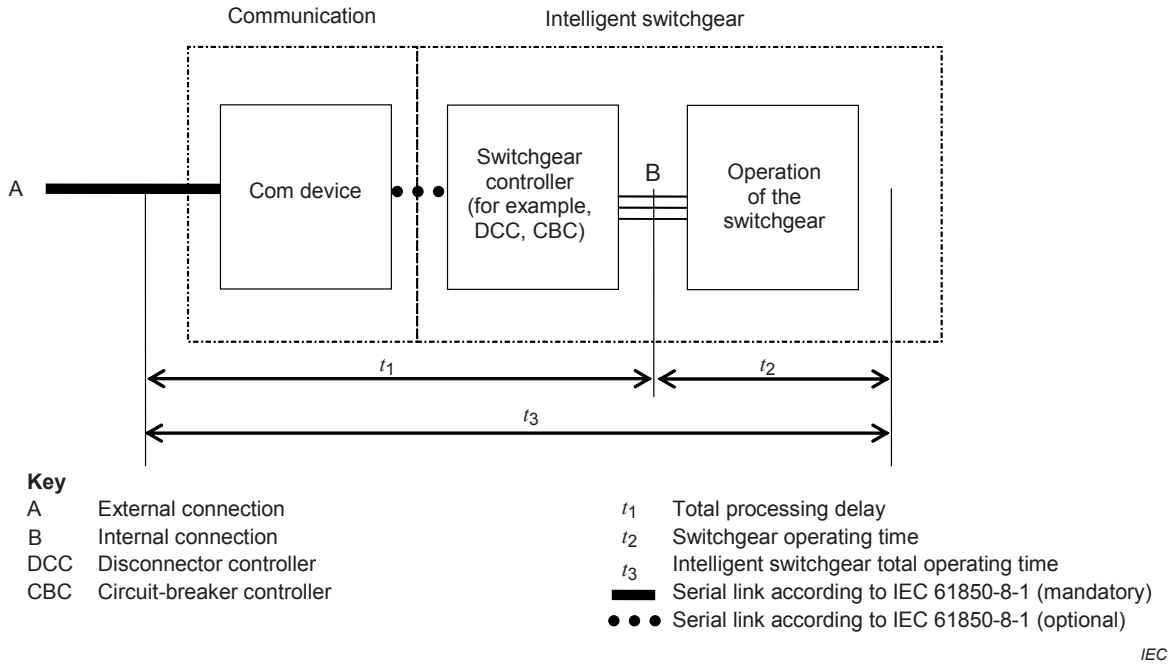


Figure 1 – Calculation of intelligent switchgear operating times (example 1)

Figure 1 shows a timing calculation example for the case of a GIS (gas-insulated switchgear) bay as shown in Figure 11 or an AIS (air-insulated switchgear) bay as shown in Figure 14.

NOTE 1 In Figure 1, the abbreviation “com device” is short for communication device. See 3.23 for a definition.

NOTE 2 Switchgear equipment and communication device can be from different suppliers.

Figure 2 shows a timing calculation example for the case of a GIS bay as shown in Figure 12 or an AIS bay as shown in Figure 13.

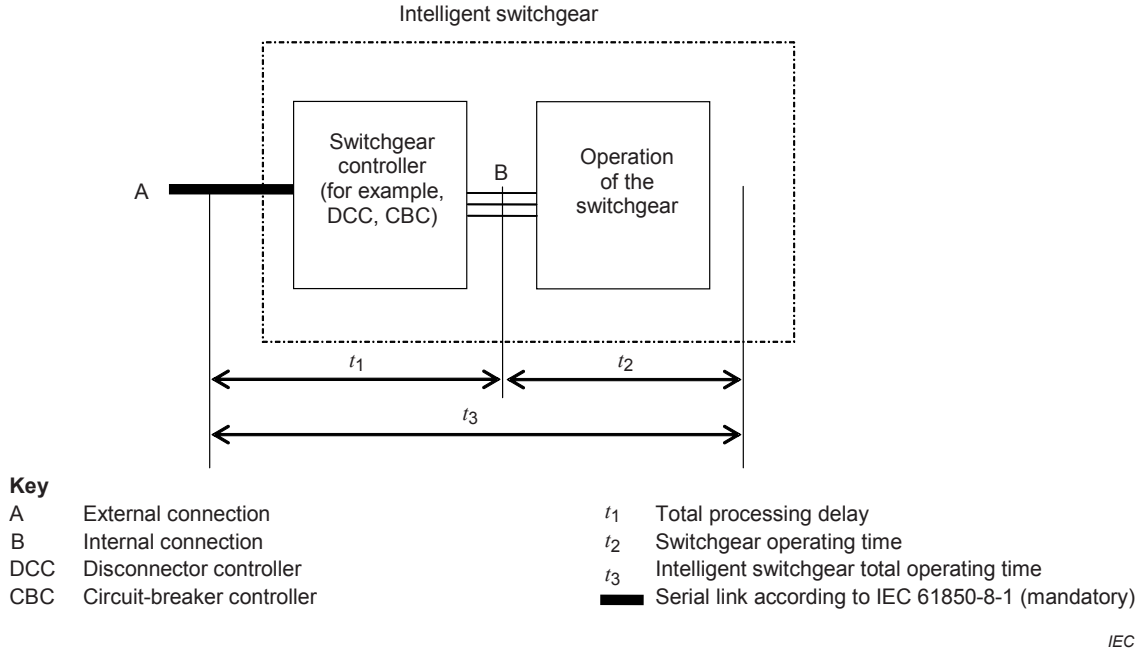
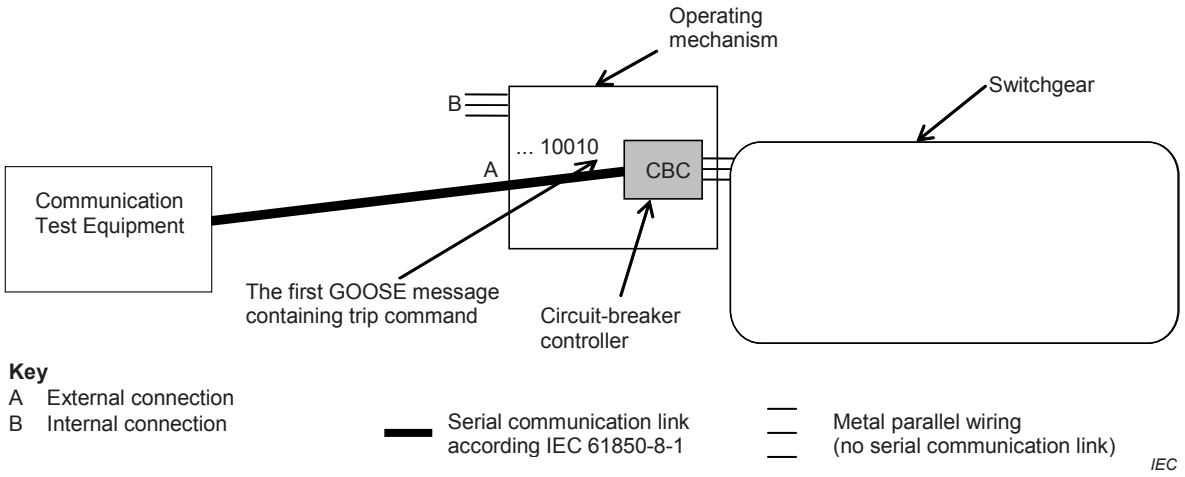


Figure 2 – Calculation of intelligent switchgear operating times (example 2)

5.3.2 Opening and closing times for circuit-breakers

This subclause describes how opening and closing times are defined. Opening and closing times are both examples for intelligent switchgear total operating times as explained in 5.3.1.



NOTE 1 The bit sequence "...10010" as shown in Figure 3 is an example in order to demonstrate the principle. It does not necessarily comply with the real message transmitted via the communication interface of an opening or closing command.

NOTE 2 For an explanation of GOOSE, see the notes in 5.2.2 and 5.2.3.

Figure 3 – Opening/closing command to intelligent switchgear

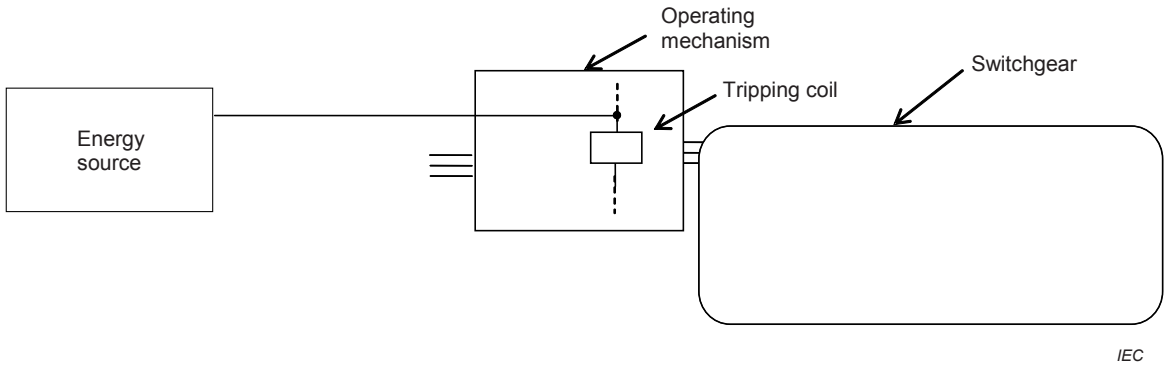


Figure 4 – Opening/closing command to switchgear

Figure 4 shows a test scenario for non-intelligent switchgear where the tripping coil is energized. For intelligent switchgear, this energization of the tripping coil is replaced by the reception of the trip command via the serial interface according to the IEC 61850 series as shown in Figure 3.

The reception of the message containing the trip command can be measured by using a test environment as shown in Figure 15.

For circuit-breakers, the definitions of opening and closing times given in IEC 62271-100:2008/AMD1:2012 are applicable, with the following additions.

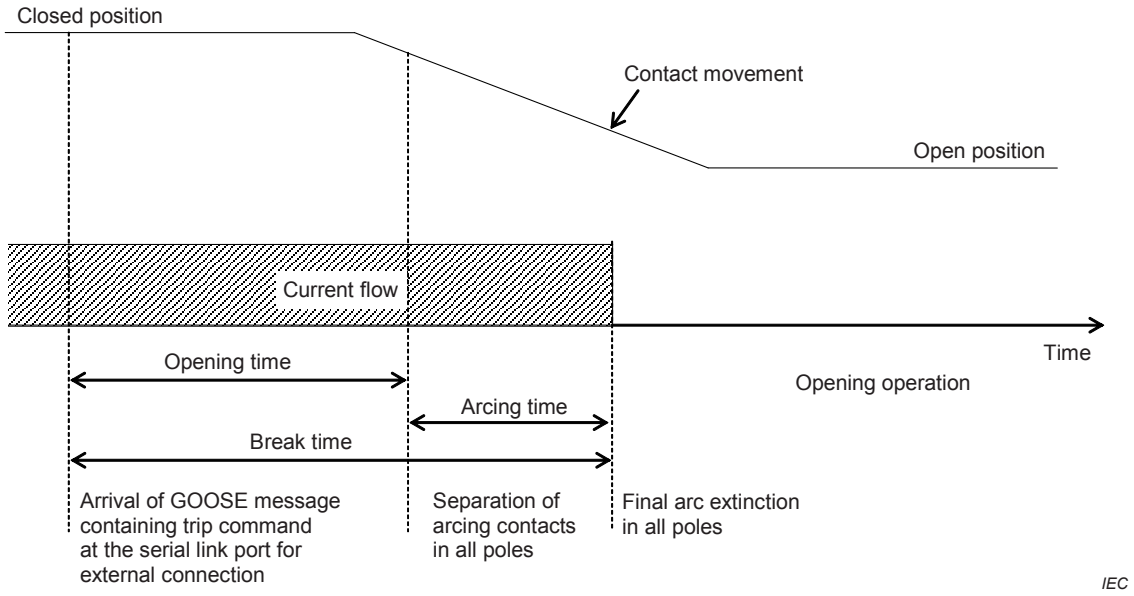


Figure 5 – Opening operation of an intelligent circuit-breaker

For intelligent switchgear, the opening time shall be the time from the reception of the first message containing the trip command via the interface according to the IEC 61850 series (GOOSE message according to 5.2.3, see Figure 3), the circuit-breaker being in the closed position, to the instant when the arcing contacts have separated in all poles (see Figure 5).

For intelligent switchgear, the closing time shall be the time from the reception of the first message containing the close command via the interface according to the IEC 61850 series (GOOSE message according to5.2.3, see Figure 3), the circuit-breaker being in the open position, to the instant when the contacts touch in all poles (see Figure 6).

In the case of time measurements, coherence shall be checked between the position indication via the serial interface (see Figure 6) in the secondary system and the real position of the intelligent switchgear.

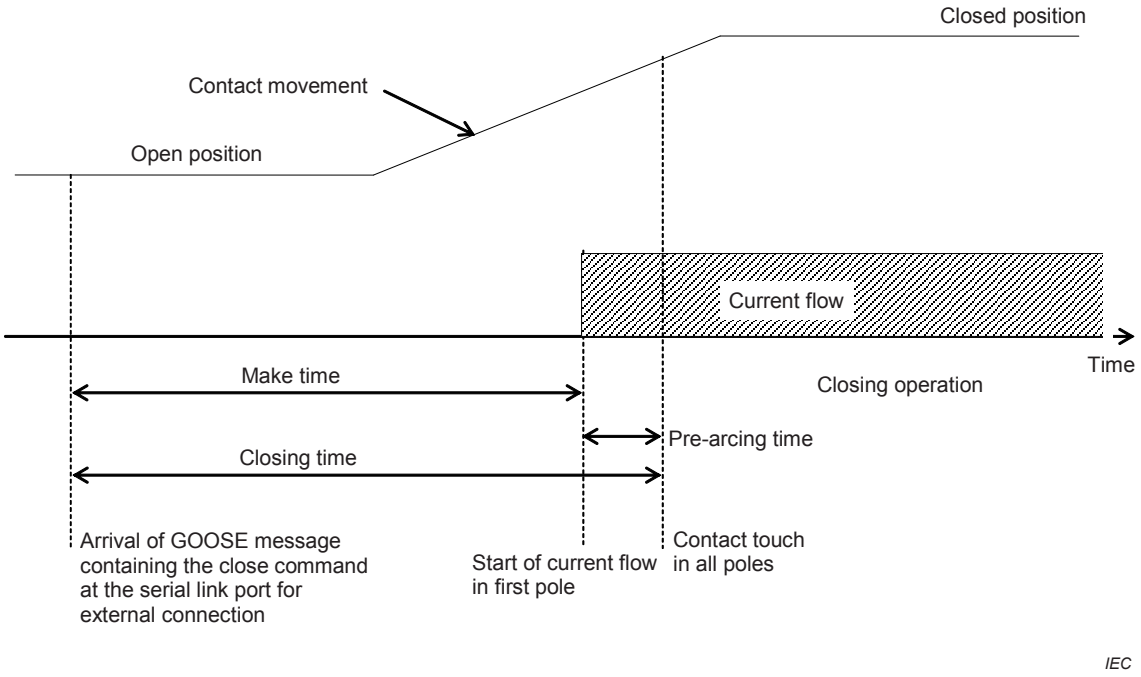


Figure 6 – Closing operation of an intelligent circuit-breaker

5.4 Data security

IEC 60870-4:1990 is applicable.

5.5 Data integrity

IEC 60870-4:1990 is applicable.

5.6 Performance requirements

5.6.1 Performance classes for reliability

IEC 61850-3:2013 is applicable with the following addition: The preferred reliability class of switchgear with digital interface is reliability class R3 as defined in IEC 60870-4:1990.

5.6.2 Performance classes for availability

IEC 61850-3:2013 is applicable.

5.6.3 Performance classes for maintainability

IEC 61850-3:2013 is applicable with the following addition: The preferred maintainability class is M3 as defined in IEC 60870-4:1990.

In addition, any switchgear controller shall be provided with functions for self-supervision and for error detection of the controlled switchgear.

NOTE Self-supervision is the capability of a digital device to monitor its own health state.

5.6.4 Dependability

A failure of any switchgear controller or communication device shall not result in loss of functions except those for which the switchgear controller or communication device is directly needed. In particular, because communication is concerned with monitoring and control of

widespread processes, failure of a switchgear controller or communication device at one location shall not cause loss of functions at different locations.

A failure of any switchgear controller or communication device shall not result in an undetected loss of functions or multiple or cascading failures.

A failure of any switchgear controller or communication device shall not cause any spurious operation.

NOTE Further information regarding “dependability” is given in IEC 61850-3:2013 and IEC TR 61850-90-4:2013.

5.6.5 Maximum expansion of the network

IEC TR 61850-90-4:2013 is applicable.

6 Design and construction

6.1 General

6.1.1 Typical location of switchgear controllers and communication devices

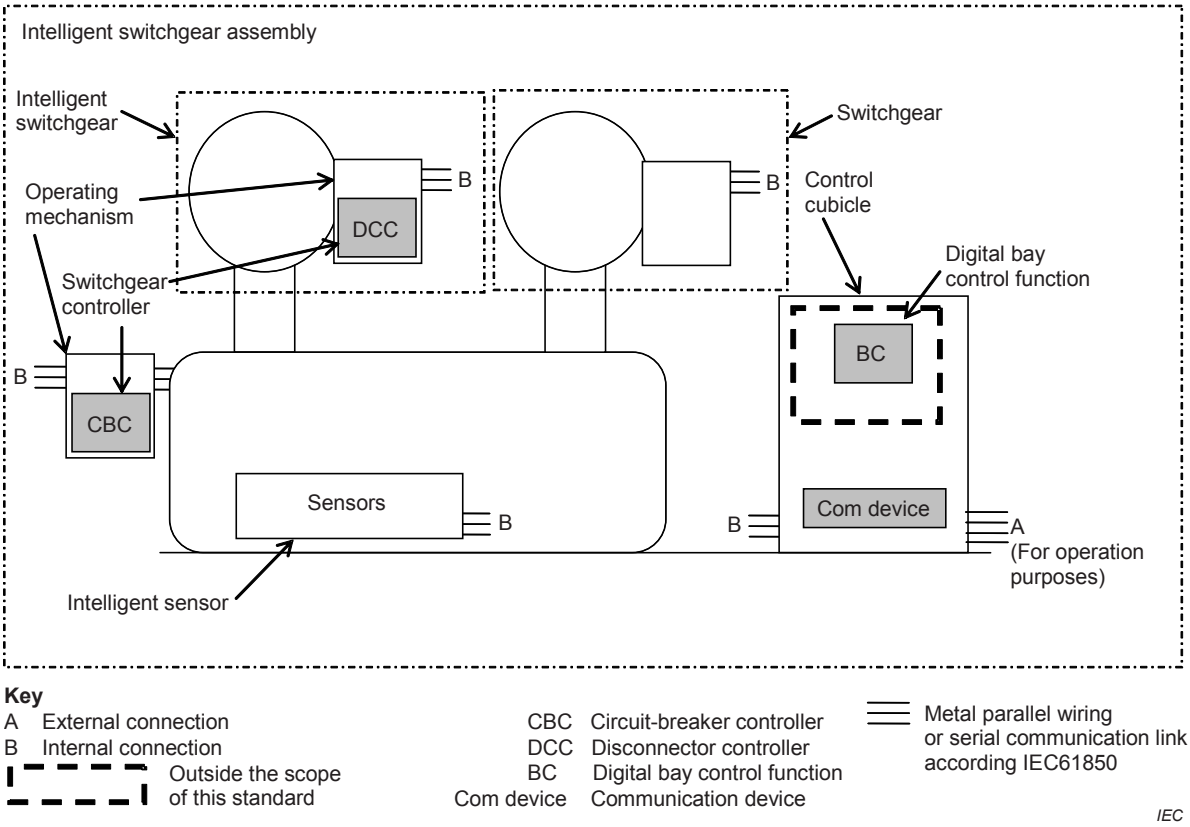


Figure 7 – GIS (example 1)

A typical configuration of GIS with switchgear controllers and communication devices is shown in Figure 7. The CBC controls all three poles of the circuit-breaker; the DCC controls all three poles of the disconnector in this example. A typical configuration of medium voltage cubicles with switchgear controllers and communication devices is shown in Figure 8.

A CBC typically implements the LNs XCBR for the circuit-breaker it controls. A DCC typically implements the LNs XSWI for the disconnector it controls.

An ESC (not shown in Figure 7) typically implements the LNs XSWI for the earthing switch it controls.

An intelligent sensor typically implements one or several of the LNs SIMG (insulation medium supervision), SARC (monitoring and diagnostic for arcs), or SPDC (monitoring and diagnostic for partial discharge).

NOTE 1 A bay control function (for example, bay interlocking, local human machine interface, etc.) can also be located inside the control cubicle. IEDs implementing such bay control functions and their communication links, for example, to the station level, are outside the scope of this standard.

NOTE 2 Bay control function, communication device, and switchgear controller can be further integrated into physical devices.

NOTE 3 For examples concerning the serial communication links between switchgear controllers and communication devices, refer to 6.1.2.

NOTE 4 CBC (circuit-breaker controller) and SC (switch controller) are both switchgear controllers.

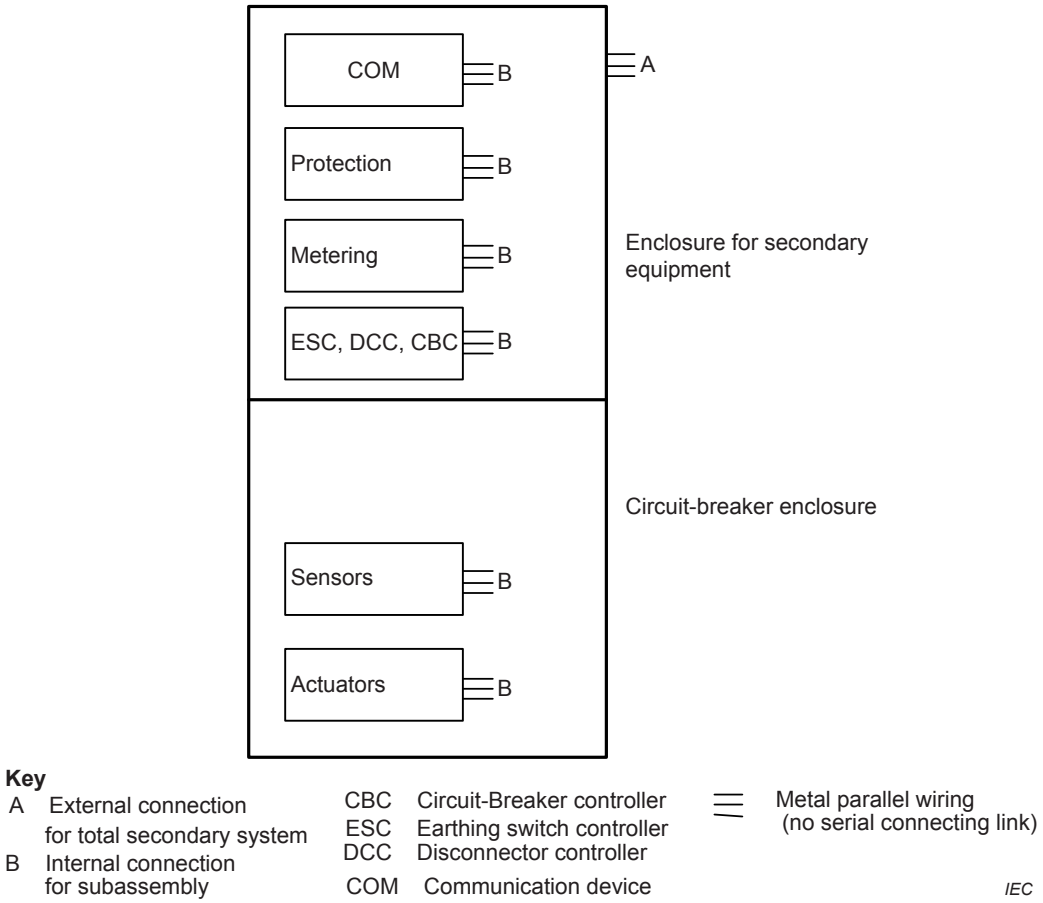


Figure 8 – Secondary system in medium voltage cubicle (example 2)

Figure 9 and Figure 10 show examples for circuit-breakers in intelligent AIS: in Figure 9, the switchgear controller controls all three poles of the circuit-breaker via phase segregated operating mechanism. In Figure 10, the switchgear controller controls all three poles of the circuit breaker via common operating mechanism.

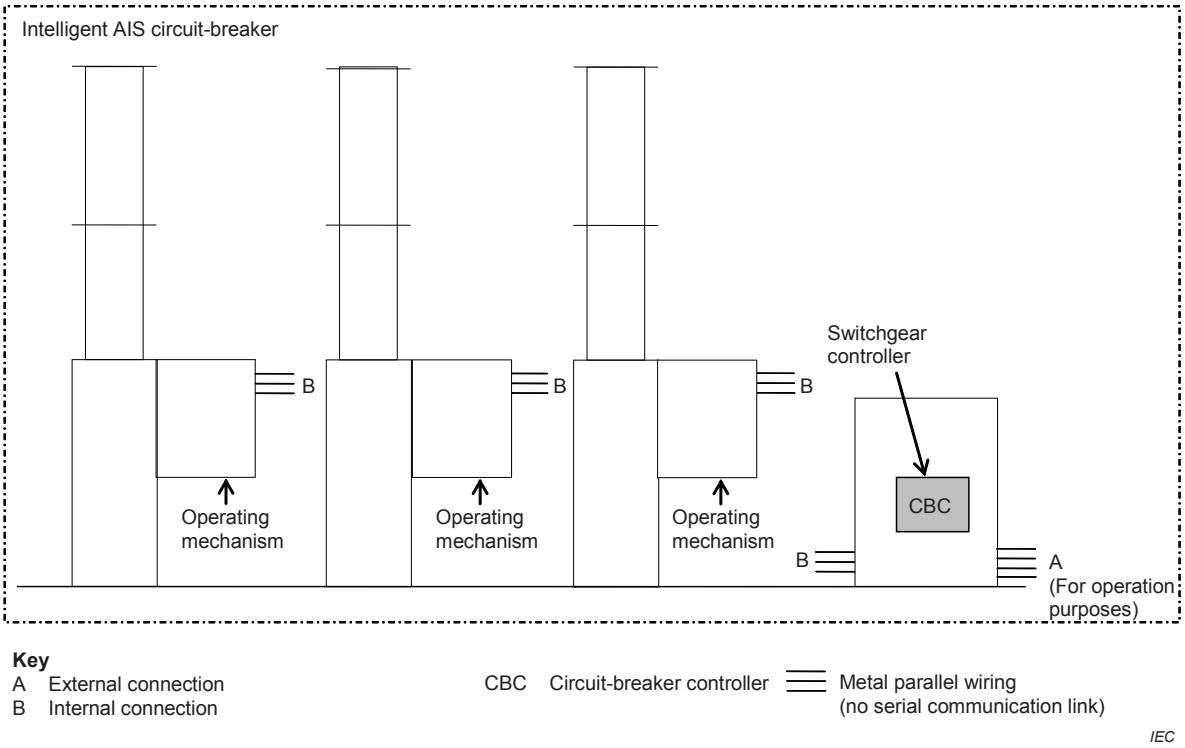


Figure 9 – AIS circuit-breaker (example 3)

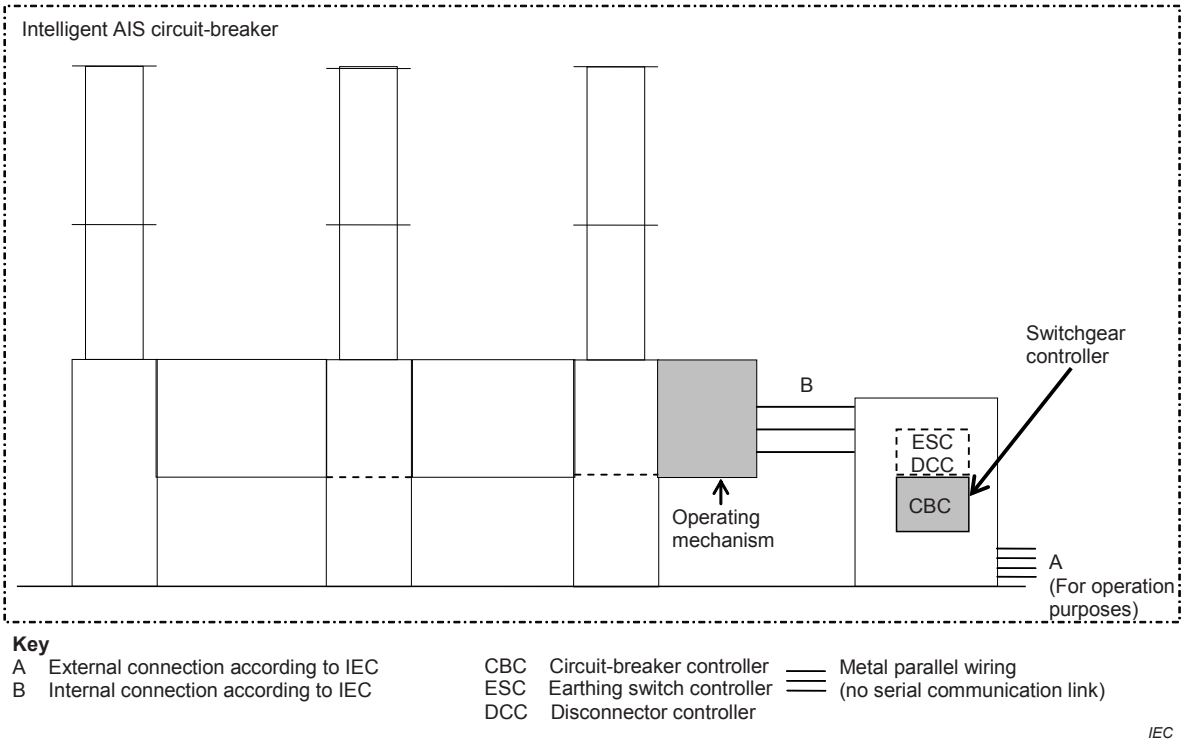


Figure 10 – AIS circuit-breaker (example 4)

6.1.2 Typical system topology

The interconnection between switchgear controllers and other power utility automation equipment is done via serial communication links. The following figures show examples of how these communication networks may be realized.

NOTE 1 As the communication device as shown, for example in Figure 11, can also be a gateway, compliance for existing equipment with the IEC 61850 series is provided.

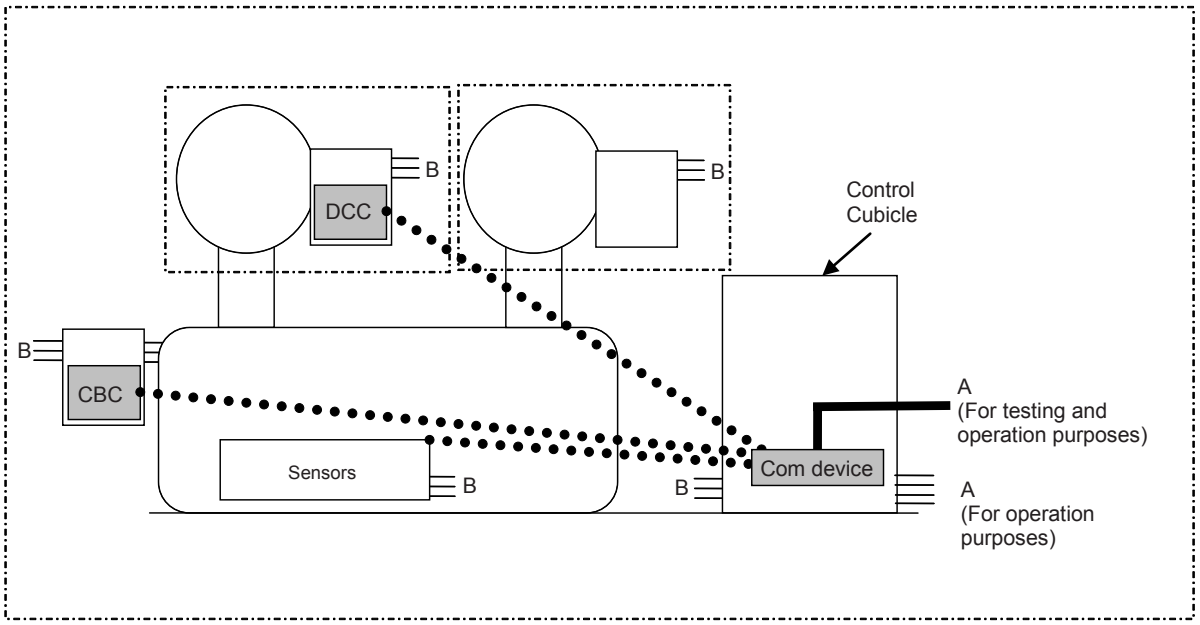
A switchgear controller may have external (type "A") or internal (type "B") connections. In intelligent switchgear, the interface point "A" can be located on a port of the relevant communication equipment (see Figure 11) or directly at the switchgear controller (see Figure 12).

An external connection (type "A") of a switchgear controller shall be according to IEC 61850-8-1:2011.

An internal connection (type "B") of a switchgear controller may be according to IEC 61850-8-1:2011. In that case, the external connection shall be available by means of a communication device.

For an example of GIS with internal and external serial communication interfaces, see Figure 12.

NOTE 2 The communication device shown in Figure 11 is as defined in 3.23 in the case where the communication link represented by a dotted line is different to the communication links specified in the IEC 61850 series.



Key

A	External connection
B	Internal connection
DCC	Disconnector controller
CBC	Circuit-breaker controller
Com device	Communication device

Metal parallel wiring (no ethernet link)

ethernet link according to IEC 61850-8-1 (mandatory)

ethernet link according to IEC 61850-8-1 (optional)

IEC

Figure 11 – GIS (example 1) with serial communication network

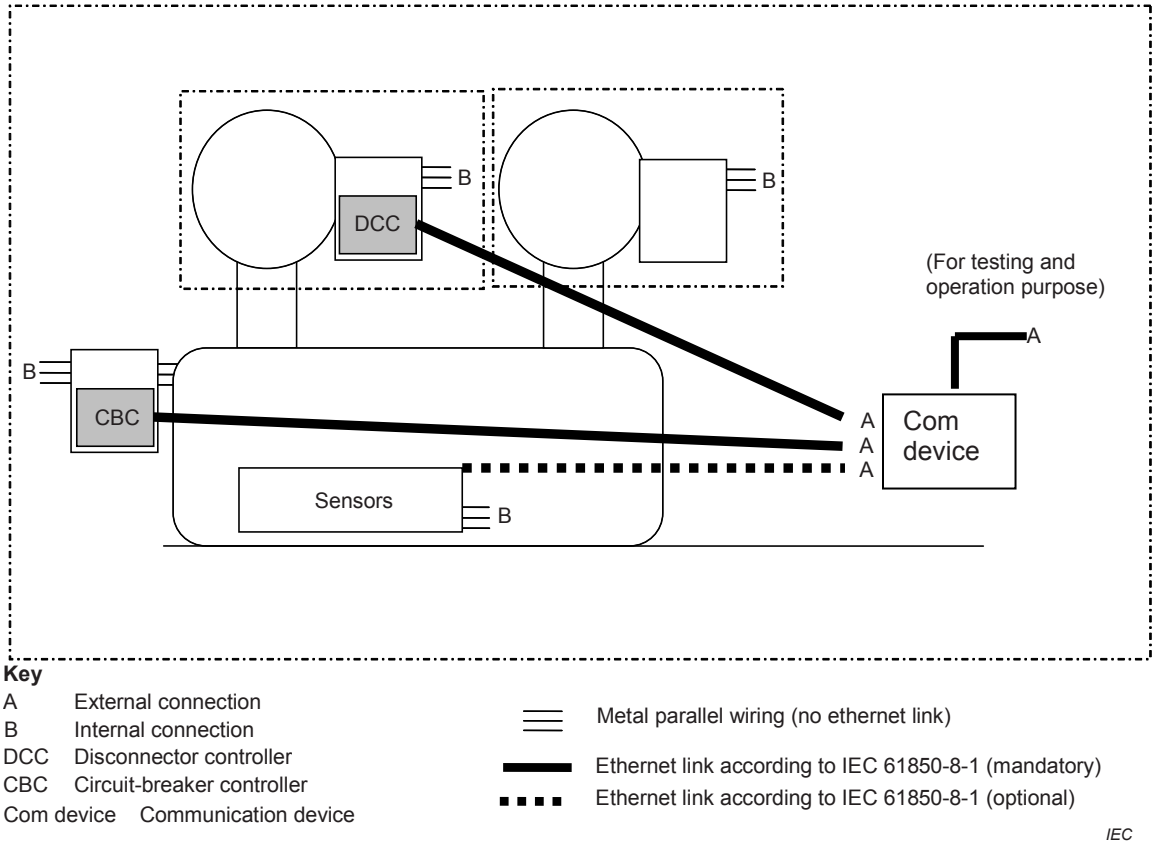


Figure 12 – GIS (example 2) with serial communication network

Another configuration example is shown in Figure 12 where the switchgear controllers are located within the operating mechanism. In this configuration, the interfaces of the switchgear controllers are interfaces of type A (external interfaces).

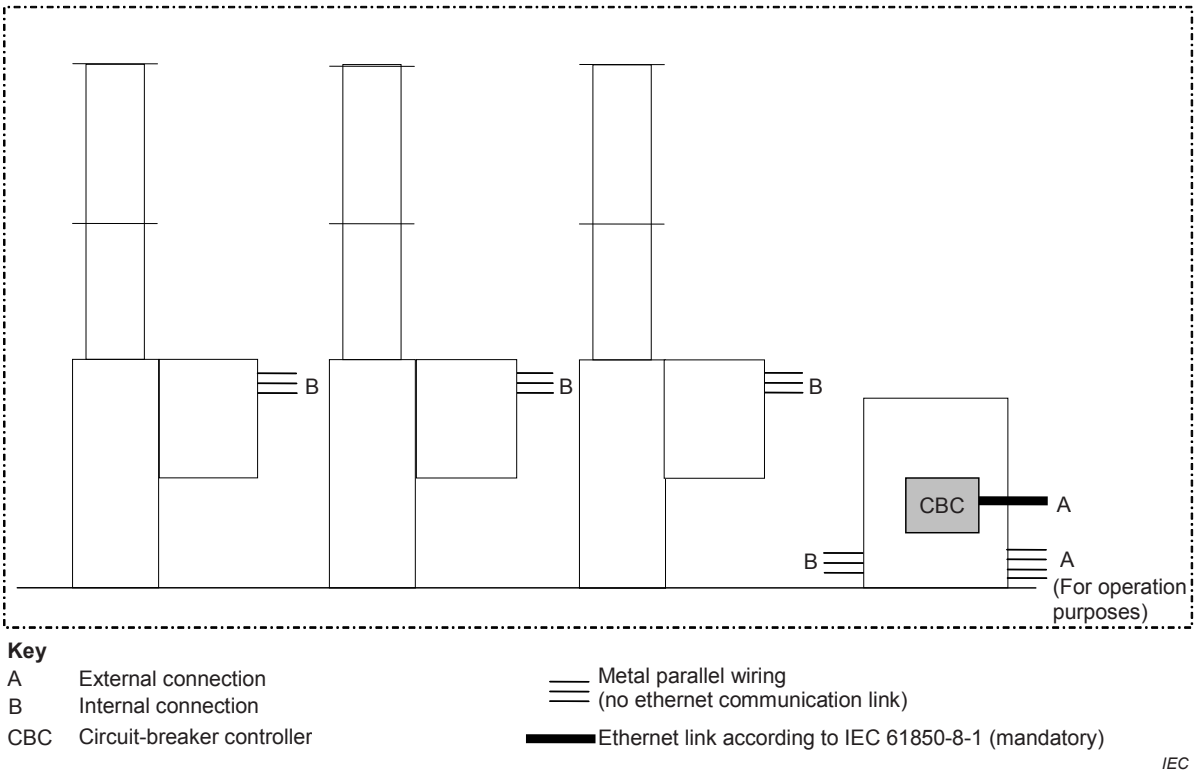


Figure 13 – AIS circuit-breaker (example 3) with serial communication network

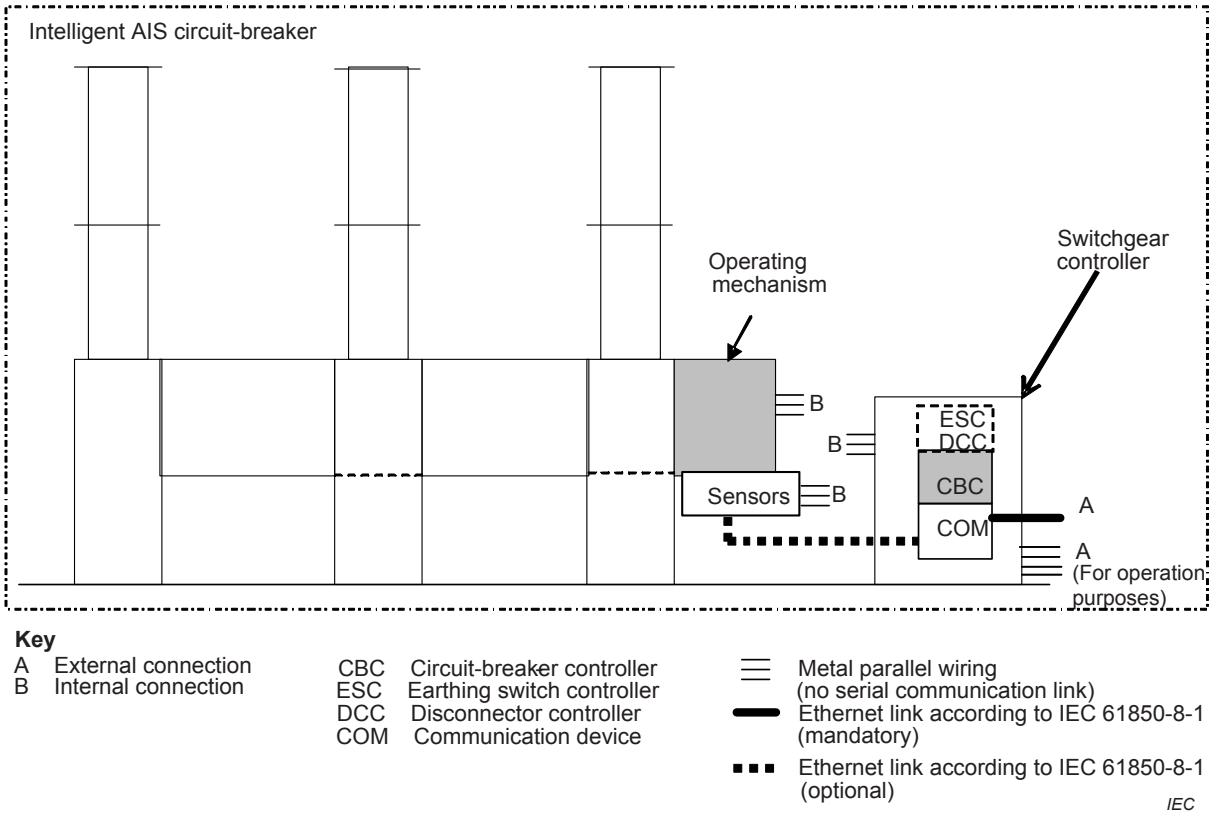


Figure 14 – AIS circuit-breaker (example 4) with serial communication network

Figure 13 and Figure 14 show examples of intelligent AIS with serial communication networks. In Figure 13 the interface point "A" is placed directly on the serial communication interface of the one existing circuit-breaker controller.

In Figure 14 the external interface point "A" is located on a serial communication port of the communication device linking together the three circuit-breaker controllers (one per phase).

For the requirement to specify the interface point "A", refer to 6.2.2.

6.1.3 Typical controller system redundancy

For circuit breakers with multiple trip coils, redundancy in communication / controllers is required. In order to avoid loss of functions, communication devices as well as controllers shall be duplicated to be in line with circuit breaker tripping scheme. This applies to switchgears in single- and/or three-pole operating schemes. Within IEC TR 61850-90-4:2013 details to this subject are already given.

6.2 Technological boundaries

6.2.1 General

The serial communication link that shall connect all switchgear and controlgear covered by this standard to the substation automation system (SAS) shall be realized using a fibre optic or copper-based transmission system for serial communication. The use of a transmission system formed by other than fibre optic or copper-based material may be permitted if equivalent performance is demonstrated.

NOTE Further recommendations regarding the transmission system for serial communication are given in IEC TR 61850-90-4:2013.

The serial communication link implements the external connection of the switchgear.

6.2.2 Interface point

The interface point to the switchgear shall be realized by the connector, either fibre optic or electrical, fitted to the switchgear controller or communication device. Preferably, this should also define the split of responsibility between the switchgear manufacturer and the system integrator.

The switchgear manufacturer should preferably supply all cables and connections that are internal to the switchgear assembly, including if necessary any interphase cables. The system integrator should preferably supply all cables and connections that form part of the connection to the SAS. Where any cables or connections are run external to switchgear enclosures, they should preferably be supplied with suitable mechanical protection. Ambient conditions should be defined.

The switchgear manufacturer should preferably supply all necessary termination boxes, either fibre optic or electrical, and make suitable provision for all SAS cable connections. Such termination boxes should preferably be directly accessible for inspection from ground level, and, where they are not mounted internal to the switchgear enclosure, they shall be provided with protection to at least IP44 for indoor applications and at least IP65 for outdoor.

6.2.3 Transmission systems

In order to stay in line with IEC 61850-series, the entire 6.2.3, as well as its sub-clauses have been superseded by IEC TR 61850-90-4:2013.

6.2.4 Human machine interface

The switchgear shall either incorporate a human machine interface (HMI) or include provision for an externally connected service device.

NOTE The connection of the HMI, the protocol applied and the link to service tools are outside the scope of this standard.

6.3 Mechanical requirements

6.3.1 Mechanical stresses

The communication equipment shall be designed to be able to withstand all the mechanical stresses likely to occur during the operation of the switchgear for its complete life. Clauses 2 and 5 of IEC 62271-1:2007/AMD 1:2011 are applicable.

6.3.2 Degree of protection provided by enclosures

The degree of protection provided by enclosures shall be in accordance with 5.13 of IEC 62271-1:2007/AMD 1:2011.

The recommended protection class is IP 44.

6.3.3 Degree of protection for connectors

The degree of protection shall apply for all types of connectors. It shall be at least:

- IP44 for outdoors,
- IP41 for indoors,
- IP20 for a connector within a proper enclosure.

Precautions against dust and condensation shall be taken during handling.

6.3.4 Accessibility

The communication equipment shall be designed in such a way that no special tools are required for the at site installation except the necessary equipment required for installing optical fibres and their associated connectors.

6.4 Electrical requirements

The communication equipment shall comply with 4.8 and 4.9 of IEC 62271-1:2007/AMD 1:2011 regarding electrical requirements.

6.5 EMC

The communication equipment shall comply with 5.18 of IEC 62271-1:2007/AMD 1:2011 and 6.7 of IEC 61850-3:2013 regarding EMC requirements.

6.6 Electronic nameplates

The provision of an electronic nameplate that can be read out via the serial interface of the switchgear controller is optional. If such a nameplate is implemented, its contents shall be in accordance with the relevant switchgear product standards.

The specification of nameplates for switchgears is given in Annex B.

7 Type tests

7.1 General

The tests described in this clause require the involvement of experts familiar with the testing of switchgear, especially the time measurement of circuit-breakers, and of experts familiar with serial communication in power utility automations, especially the standards of the IEC 61850 series.

See test overview table in Annex A.

Type tests on a switchgear controller only (i.e., without the switchgear it controls) may be required for retrofitting purposes. Tests of such a switchgear controller shall be executed by a simulation tool. The test result of such a tool shall ensure the required functions of the switchgear controller.

The relevant switchgear product standards of the IEC 62271 series are applicable in general. Digital interfaces shall be taken into account where applicable.

Subclauses 7.2 and 7.3 are applicable.

7.2 Switchgear communication interface conformance tests

Clause 6 of IEC 61850-10:2012, dealing with conformance and performance tests, is applicable.

This test is carried out in order to verify the correct behaviour of an IED by the use of system tested software under the environmental test conditions corresponding with the technical data of the equipment under test [IEC 61850-10:2012].

NOTE This test can be conducted on the switchgear controller(s) only (i.e., without the switchgear it/they control(s)) if the switchgear manufacturer supplies a means to simulate this switchgear (for example, for retrofitting purposes). This test can also be conducted on the switchgear controller together with the switchgear it controls.

7.3 Time measurement of switchgear

7.3.1 Circuit-breakers

7.3.1.1 General

The purpose of the tests described in this clause is to demonstrate that the opening and closing times are within the rated limits specified in 5.3.

NOTE 1 The tests described in this clause are harmonized with IEC 62271-100:2008/AMD1:2012.

For this purpose, two test configurations are described in 7.3.1.2 and 7.3.1.3. Due to the use of serial communication connections, measured opening and closing times are dependent on the load on the communication network. The loads that shall be used are defined in 7.3.1.4. Each test shall be performed minimum 5 times so that the effect of various load conditions is eliminated. It is recommended to repeat each test minimum five times for each combination of circuit breaker and circuit breaker controller.

NOTE 2 Load on the communication network is transmitted data volume. It is not a power system load.

When synchronous switching is applicable, refer to IEC TR 62271-302:2010 for extended requirements on time measurements. Additionally, digital interface is taken into account, as explained in 5.3.2.

7.3.1.2 Performance test with command going direct to the switchgear controller

This testing configuration according to Figure 15 refers to Figure 12 (GIS) or Figure 13 (AIS).

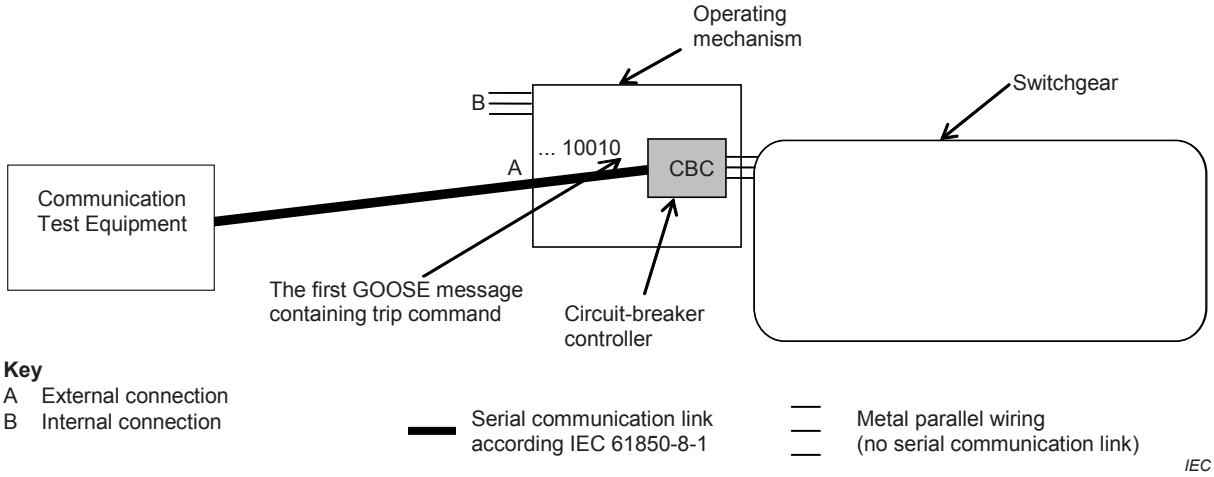


Figure 15 – Performance test of an intelligent switchgear (configuration 1)

The closing time shall be the time from the reception of the first message containing the close command via GOOSE message, to the instant when the contacts touch in all poles (see Figure 6).

The opening time shall be the time from the reception of the first message containing the trip command via GOOSE message, to the instant when the arcing contacts have separated in all poles (see Figure 5).

Additionally, tester shall provide for a way to accurately synchronize the switchgear main contacts operation time measurement with the test device, in order to precisely measure t_3 value (t_3 is described in Figure 1 and Figure 2). For example, if an oscilloscope is used to measure the main contact operating time, it shall be synchronized with the test device.

As the start signal for measuring time t_1 and t_3 in Figure 1 and Figure 2, the first payload databit of first GOOSE message is applicable (see Annex C).

Additional performance testing of the circuit breaker controller shall be based on IEC 61850-10:2012.

The test consists of the following parts:

a) Comparison of the opening time rated by the manufacturer against the measured opening times. The test is passed if the following three conditions are fulfilled:
   - the measured opening time is within the tolerances of the manufacturer's specification;
   - the status transmitted in the captured return indication shows that the switchgear is in open position (XCBR.pos.stval = off);
   - the time between the sending of the command and the capturing of the return indication is within the tolerances of the manufacturer's specification.

   The test shall be repeated minimum 5 times and above mentioned conditions shall be fulfilled for all the test repetitions.
b) Comparison of the closing time rated by the manufacturer against the measured closing times. The test is passed if the following three conditions are fulfilled:
   - the measured closing time is within the tolerances of the manufacturer's specification;

– the status transmitted in the captured return indication shows that the switchgear is in closed position (XCBR.pos.stval = on);

– the time between the sending of the command and the capturing of the return indication is within the tolerances of the manufacturer's specification.

The test shall be repeated minimum 5 times and above mentioned conditions shall be fulfilled for all the test repetitions.

For both cases (opening and closing), the complete set of test results have to be documented.

7.3.1.3 Performance test with communication equipment as part of the tested intelligent switchgear

This testing configuration according to Figure 16 refers to Figure 11 (GIS with Com device) or Figure 14 (AIS with Com device).

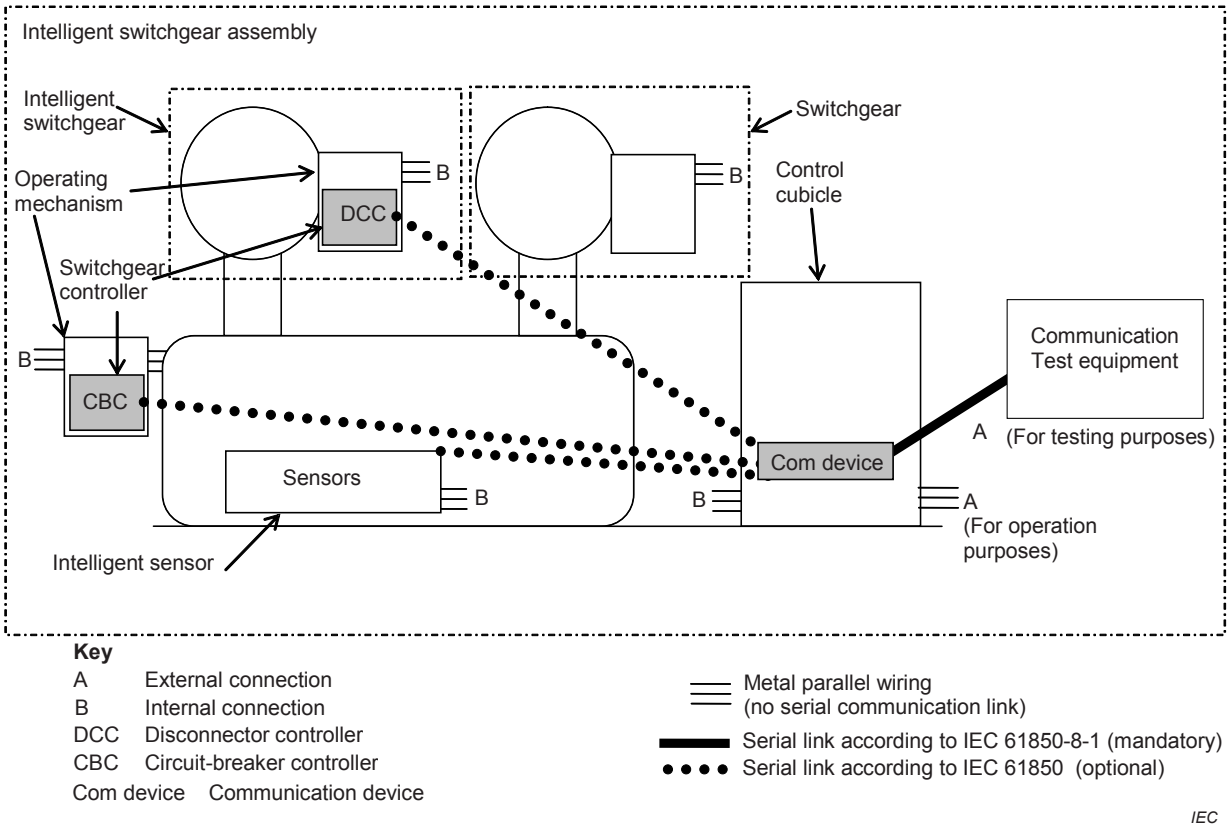


Figure 16 – Performance test of an intelligent switchgear (configuration 2)

The closing time shall be the time from the reception of the first message containing the close command via GOOSE message, to the instant when the contacts touch in all poles (see Figure 6).

The opening time shall be the time from the reception of the first message containing the trip command via GOOSE message, to the instant when the arcing contacts have separated in all poles (see Figure 5).

Additionally, tester shall provide for a way to accurately synchronize the switchgear main contacts operation time measurement with the test device, in order to precisely measure t_3 value (t_3 is described in Figure 1 and Figure 2). For example, if an oscilloscope is used to measure the main contact operating time, it shall be synchronized with the test device.

Additional performance testing of the circuit breaker controller shall be based on IEC 61850-10:2012.

Care shall be taken in this scenario that the test device has no effect on the timing behaviour of the communication interface.

NOTE This test is applicable to a situation where the switchgear controller interfaces are proprietary (thus, not accessible for standardization).

The test consists of the following parts:

a) Comparison of the opening time rated by the manufacturer against the measured opening times. The test is passed if the following three conditions are fulfilled:
   – the measured opening time is within the tolerances of the manufacturer's specification;
   – the status transmitted in the captured return indication shows that the switchgear is in open position (XCBR.pos.stval = off);
   – the time between the sending of the command and the capturing of the return indication is within the tolerances of the manufacturer's specification.

   The test shall be repeated minimum 5 times and above mentioned conditions shall be fulfilled for all the test repetitions.
b) Comparison of the closing time rated by the manufacturer against the measured closing times. The test is passed if the following three conditions are fulfilled:
   – the measured closing time is within the tolerances of the manufacturer's specification;
   – the status transmitted in the captured return indication shows that the switchgear is in closed position (XCBR.pos.stval = on);
   – the time between the sending of the command and the capturing of the return indication is within the tolerances of the manufacturer's specification.

   The test shall be repeated minimum 5 times and above mentioned conditions shall be fulfilled for all the test repetitions.

For both cases (opening and closing), the complete set of test results have to be documented.

7.3.1.4 Load patterns for tests

The details of test messages with regard to “conformance testing of communication networks and systems for power utility automation” are given in IEC 61850-10:2012, Clause 8.

7.3.2 Other switchgear

For other switchgear, the relevant product standards are applicable, taking into account digital interfaces where applicable.

8 Routine tests

8.1 General

See test overview table in Annex A.

Routine tests on a switchgear controller only (without the switchgear it controls) may be required for retrofitting purposes. Tests of such a switchgear controller will be covered by a further extension of this standard. Should such testing be required today, it should be subject to agreement between manufacturer and customer.

NOTE For a definition of switchgear controller, refer to 3.21.

Routine tests are for the purpose of revealing faults in material or construction. They do not impair the properties and reliability of a test object. The routine tests shall be made wherever reasonably practicable at the manufacturer's works on each apparatus manufactured, to ensure that the product is in accordance with the equipment on which the type tests have been passed. By agreement, any routine test may be made on site (IEC 62271-1:2007/AMD1:2008).

The relevant switchgear product standards of the IEC 62271 series are applicable in general. Digital interfaces shall be taken into account where applicable.

Subclauses 8.2 and 8.3 are applicable.

8.2 Time measurement on switchgear

Subclause 7.3 is applicable with the following modifications:

The test as described in 7.3.1.2 shall be done once for opening and once for closing.

The test as described in 7.3.1.3 shall be done once for opening and once for closing.

9 Information to be given with enquiries, tenders and orders

The minimum included information the supplier shall give with tenders and orders, shall be as specified in the relevant IEC standards for switchgear and controlgear, with the following additional information specifically for the communication interface:

- conformance class according to 5.2.1;
- provide PICS, MICS, TICS and PIXIT according to IEC 61850-10:2012;
- number of redundant communication links;
- timing performance according to 7.3;
- availability class;
- the switchgear controller shall be able to subscribe to a minimum of two protection IED's; the maximum amount of protection IED's the controller can subscribe to shall be given.

For enquiries, the same information as mentioned above are recommended to be included as a minimum.

10 Rules for transport, storage, installation, operation and maintenance

Clause 10 of IEC 62271-1:2007/AMD 1:2011 is applicable.

11 Safety

Clause 11 of IEC 62271-1:2007/AMD 1:2011 is applicable.

Annex A
(normative)

Test overview table

Table A.1 – Test overview table

	Type test (switchgear)	Routine test (switchgear)	System related test (factory or site acceptance test)
Communication conformance testing according to IEC 61850	yes 7.2		
Interoperability testing according to IEC 61850			yes
System and IED configuration according to IEC 61850			yes (only applicable to switchgear assemblies)
Timing performance according to this standard	yes 7.3	yes 8.2	
System performance according to IEC 61850			yes
Switchgear test according to this standard and relevant product standards	yes 7.1	yes 8.1	

NOTE The type test verifies the development of the switchgear; the routine test verifies the correct manufacturing of the switchgear; the system related test verifies the engineering and commissioning of the switchgear assembly.

With this standard, the existing standards on switchgear, and IEC 61850-4:2011 and IEC 61850-10:2012, a complete test of the switchgear can be performed as shown in Table A.1. The testing shall consider the switchgear as a self-contained unit, testing only the reaction to inputs at the switchgear interface ("black-box test").

The basis for the tests is the existing standards of the IEC 62271 series. Due to the fact that the metal parallel wired interface is not implemented because of the use of digital technology and/or digital communication, changes may apply to the existing test specifications. Those changes are described in this standard.

In the case of the use of a switchgear controller and metal parallel wiring to the bay level devices, the existing standards on switchgear are applicable. This case is not described here.

System-related testing is outside the scope of this standard, as those tests are project-specific and are, thus, dependent on an agreement between customer and manufacturer. If a system-related test should be required, refer to 7.1.2.2 of IEC 61850-4:2011.

Annex B
(normative)

Electronic nameplates

B.1 General

The electronic nameplate is defined as extensions to the data model defined in IEC 61850-7-4:2010. The name space as defined in IEC 61850-7-1 for that extension is:

IEC 62271-3:2014A

As a consequence, for all the new data object below, the data attribute **dataNs** shall be present and shall have the value "IEC 62271-3:2014A".

The extensions are using the common data class VSD Visible string description information that will be added to the future amendment of IEC 61850-7-3:2010. The definition of that CDC is provided here for information purpose.

Table B.1 – Common data class VSD

VSD class					
Data attribute name	**Type**	**FC**	**TrgOp**	**Value/Value range**	**M/O/C**
DataName	Inherited from GenDataObject Class or from GenSubDataObject Class (see IEC 61850-7-2:2010)				
DataAttribute					
Configuration, description and extension					
val	VISIBLE STRING255	DC			M
d	VISIBLE STRING255	DC		Text	O
dU	UNICODE STRING255	DC			O
cdcNs	VISIBLE STRING255	EX			AC_DLNDA_M
cdcName	VISIBLE STRING255	EX			AC_DLNDA_M
dataNs	VISIBLE STRING255	EX			AC_DLN_M
Services					
As defined in Table 60 of IEC 61850-7-3:2010					
Key M: Mandatory O: Optional					

NOTE Presence conditions AC_DLNDA_M and AC_DLN_M are specified in IEC 61850-7-3:2010 and deal with the IEC 61850 series' name-space concept. This name space concept is intended to make the interpretations of the names used in this standard unique for all IEC 61850 installations and all further extensions.

B.2 Electronic nameplate for circuit breaker

Based on the name plate definition of a circuit breaker in IEC 62271-100:2008/AMD:2012, an electronic nameplate is defined as an extension of the logical node XCBR.

The following table shows the new data objects added to the LN XCBR.

Table B.2 – New Data Objects added to LN XCBR

XCBR class				
Data object name	**Common data class**	**Explanation**	**T**	**M/O/C**
LNName		The name shall be composed of the class name, the LN-Prefix and LN-Instance-ID according to IEC 61850-7-2:2010, Clause 22.		
Data objects				
Descriptions				
EEName	DPL	External equipment name plate (Common data class DPL as per IEC 61850-7-3:2010; 7.8.2)		O
NamUr	VSD			M
NamUp	VSD			M
NamUs	VSD			EC_1
Namfr	VSD			EC_2
NamIr	VSD			M
Namtk	VSD			EC_3
NamIsc	VSD			M
NamIscDC	VSD			EC_4
NamTauDC	VSD			EC_16
Namkpp	VSD			EC_5
NamId	VSD			O
NamIl	VSD			EC_6
NamIc	VSD			O
NamIsb	VSD			O
NamIbb	VSD			O
NamIbi	VSD			O
Namprm	VSD			O
Nampre	VSD			O
NamUop	VSD			O
Namfop	VSD			O
NamUa	VSD			O
Namfa	VSD			O
NamM	VSD			EC_9
NamMfl	VSD			EC_10
NamOpSeq	VSD			M
NamYear	VSD			M
NamTC	VSD			EC_11
NamCl	VSD			EC_12
NamStd	VSD			M
Status information				
....		Data objects as specified within IEC 61850-7-4:2010; 5.16.2		
Measured and metered values				
....		Data objects as specified within IEC 61850-7-4:2010; 5.16.2		
Controls				
....		Data objects as specified within IEC 61850-7-4:2010; 5.16.2		
Settings				
....		Data objects as specified within IEC 61850-7-4:2010; 5.16.2		

Key
M: Mandatory
O: Optional
C: Conditional (with conditions given in B.4)

NOTE The most left and most right information is taken from IEC 62271-100 using comprehensive abbreviations.

B.3 Electronic nameplate for switchgear other than circuit breakers

Based on the name plate definition in IEC 62271-102:2001/AMD1:2011/AMD2:2013, an electronic nameplate is defined as an extension of the logical node XSWI.

The following table shows the new data objects added to the LN XSWI.

Table B.3 – New data objects added to LN XSWI

XSWI class				
Data object name	**Common data class**	**Explanation**	**T**	**M/O/C**
LNName		The name shall be composed of the class name, the LN-Prefix and LN-Instance-ID according to IEC 61850-7-2:2010, Clause 22.		
Data objects				
Descriptions				
EEName	DPL	External equipment name plate (Common data class DPL as per IEC 61850-7-3:2010; 7.8.2)		O
NamUr	VSD			M
NamUp	VSD			M
NamUs	VSD			M
NamIr	VSD			EC_13
NamIk	VSD			M
Namtk	VSD			EC_3
NamPre	VSD			M
NamF	VSD			O
NamMr	VSD			EC_14
NamEr	VSD			EC_15
Namm	VSD			O
Status information				
....		Data objects as specified within IEC 61850-7-4:2010 5.16.3		
Controls				
....		Data objects as specified within IEC 61850-7-4:2010; 5.16.3		

Key

M: Mandatory
O: Optional
C: Conditional (with conditions given in B.4)

NOTE The most left and most right information is taken from IEC 62271-100 using comprehensive abbreviations.

B.4 Presence conditions

The abbreviations used for indicating the presence conditions for data objects as given in Table B.2 and Table B.3 are explained in detail with the following Table B.4.

Table B.4 – Conditions for application of new data objects

Abbreviation	Condition
EC_1	Required if rated voltage 300 kV and above
EC_2	Required if rating is not applicable at both 50 Hz and 60 Hz
EC_3	Required if different from 1 s
EC_4	Required if more than 20 %
EC_5	Required if different from 1,3 for rated voltages 100 kV to 170 kV
EC_6	Required if rated voltage equal to or greater than 72,5 kV
EC_9	Required if more than 300 kg
EC_10	Required if contains fluid
EC_11	Required if different from – 5 °C for indoor or –25 °C for outdoor
EC_12	Required if different from E1, M1, S1 for rated voltages less than 100kV Required if different from E1, M1 for rated voltages 100 kV and above
EC_13	Required for disconnector
EC_14	Required for disconnector if different from M0 or E0
EC_15	Required for earthing switch if different from M0 or E0
EC_16	Required if different from 45 ms

Table B.5 below provides the explanations of data attributes used in Tables B.2 and B.3.

Table B.5 – Explanations for objects *(1 of 2)*

source: IEC 62271-100:2008/AMD1:2012

Data object	Explanation and abbreviation	Unit	Conditions
NamUr	Rated voltage U_r	kV	
NamUp	Rated lightning impulse withstand voltage U_p	kV	
NamUs	Rated switching impulse withstand voltage U_s	kV	Rated voltage 300 kV and above
Namfr	Rated frequency f_r	Hz	Rating is not applicable at both 50 Hz and 60 Hz
NamIr	Rated normal current I_r	A	
Namtk	Rated duration of short circuit t_k	s	Different from 1 s
NamIsc	Rated short-circuit breaking current I_{SC}	kA	
NamTauDC	D.C. time constant of the rated shortcircuit breaking current τ	ms	Different from 45 ms
NamIscDC	D.C. component of the rated short-circuit breaking current at contact separation corresponding to the d.c. time constant of the rated short-circuit breaking current p_{CS}	%	More than 20 %
Namkpp	First pole-to-clear factor k_{pp}		Different from 1,3 for rated voltages 100 kV to 170 kV
NamId	Rated out-of-phase breaking current I_d	kA	
NamIl	Rated line-charging breaking current I_l	A	Rated voltage equal to or greater than 72,5 kV
NamIc	Rated cable-charging breaking current I_C	A	
NamIsb	Rated single capacitor bank-breaking current I_{Sb}	A	
NamIbb	Rated back-to-back capacitor bankbreaking current I_{bb}	A	
NamIbi	Rated back-to-back capacitor bank inrush making current I_{bi}	kA	
Namprm	Rated filling pressure for operation p_{rm}	MPa	
Nampre	Rated filling pressure for interruption p_{re}	MPa	

Table B.5 *(2 of 2)*

Data object	Explanation and abbreviation	Unit	Conditions
NamUop	Rated supply voltage of closing and opening devices U_{op}	V	
NamUa	Rated supply voltage of auxiliary circuits U_a	V	
Namfa	Rated supply frequency of auxiliary circuits U_a	Hz	
NamM	Mass (including oil for oil circuitbreakers) M	kg	
NamMfl	Mass of fluid m	kg	If contains fluid
NamOpSeq	Rated operating sequence		
NamYear	Year of manufacture		
NamTC	Temperature class		Different from – 5 °C indoor – 25 °C outdoor
NamCl	Classification		If different from E1, M1, S1 for rated voltages less than 100 kV If different from E1, M1 for rated voltages 100 kV and above
NamStd	Relevant standard with date of issue		

Annex C
(informative)

Test procedures – Performance type testing

One example of how to test the performance of an intelligent switchgear according to Figure 11 would be as shown in Figure C.1.

Here, the communication test equipment issues a GOOSE-message containing the trip command as an electrical signal. This signal is sent via the media converter and the circuit breaker controller to the circuit breaker. The (electrical) signals between communication test equipment and circuit breaker controller are monitored by an oscilloscope or ethernet analyzer. The first payload databit of first GOOSE message containing the trip command will be used as start signal for testing the operating time of the Circuit Breaker Controller (=CBC).

The electrical signal output of the CBC; i.e. the trip command; is then used to stop time measurement. Assuming that delay time on electrical to optical media converter is neglectable, the delay time between the communication test equipment issues a GOOSE-message and the trip command output of the CBC corresponds to CBC operating time.

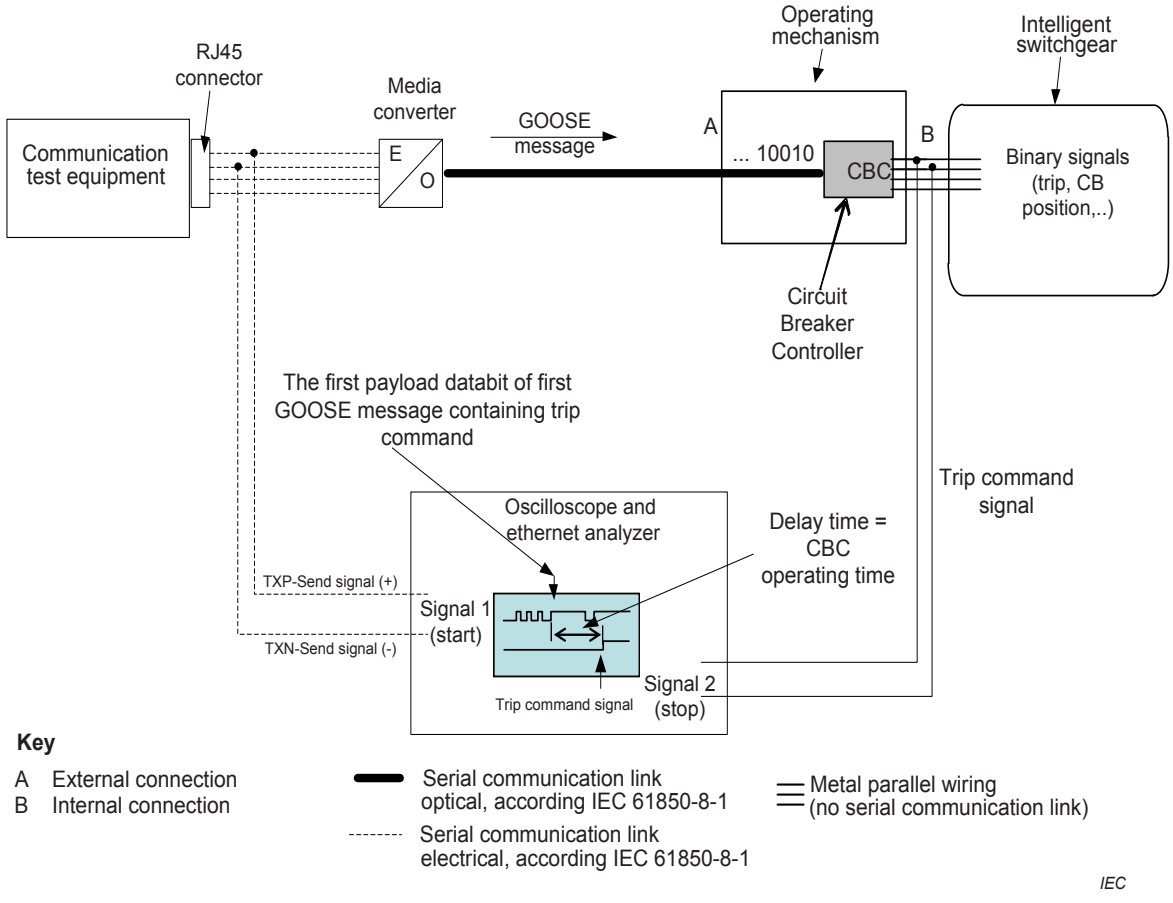


Figure C.1 – Performance test of an intelligent switchgear – CBC operating time

Once the CBC operating time is known, the circuit breaker operating times can be measured in a similar way. An example is given in Figure C.2 below:

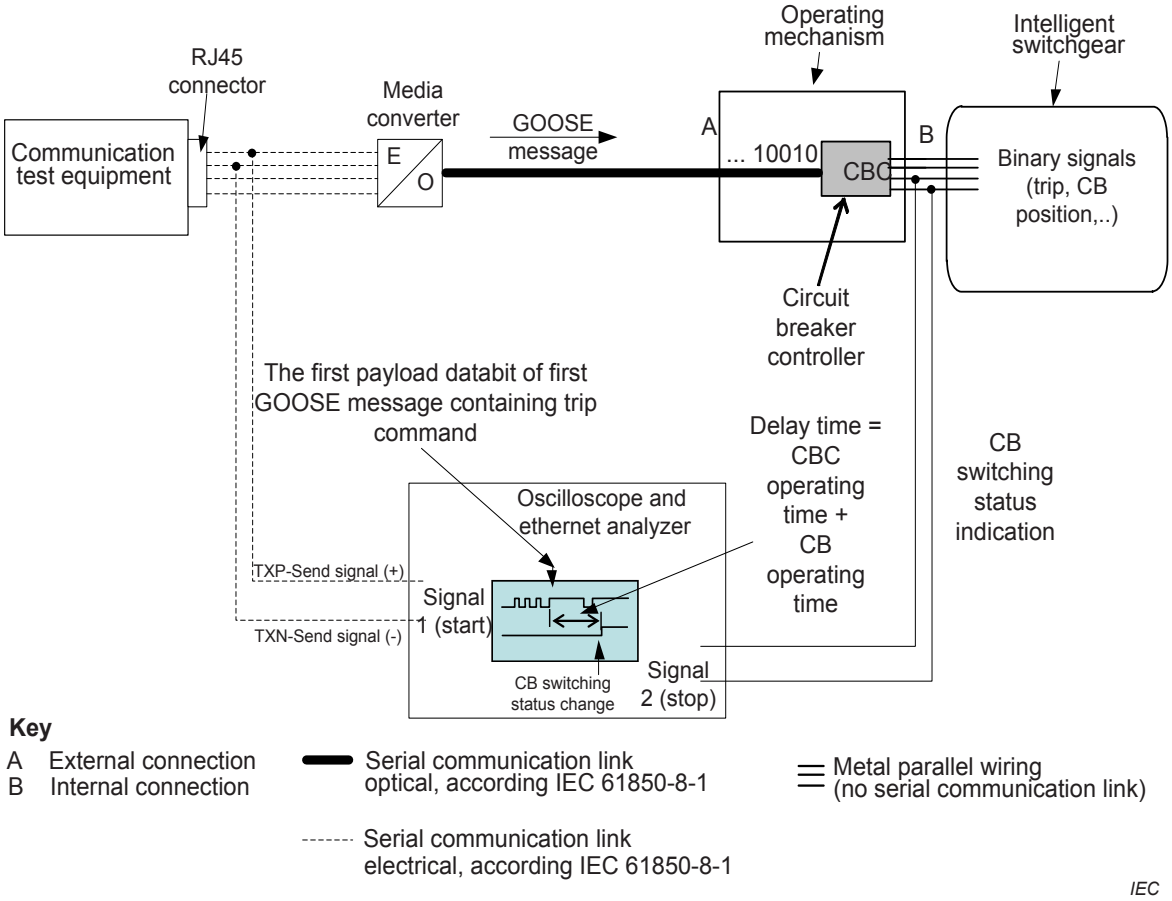


Figure C.2 – Performance test of an intelligent switchgear – CB operating time

The measuring scheme is almost identical to that explained for CBC operating time measuring, except that for stopping the delay time measuring, an auxiliary contact of the circuit breaker will be used to indicate the change of switching status. As an alternative, current flow at CB main contacts might be used to indicate the change of switching status.

As indicated in Figure C.2, the measured time delay has to be reduced by the CBC operating time to get the correct CB operating time.

Since the intention of these tests is to check the performance of the switchgear only, the connection between communication test equipment and circuit breaker controller will be a peer-to-peer connection. There will be neither any ethernet switch nor any background traffic considered. This would be subject to a network performance test.

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2 This publication was withdrawn and replaced by IEC 62271-103.

3 To be published.

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