



BSI Standards Publication

Communication networks and systems for power utility automation

Part 10: Conformance testing

National foreword

This British Standard is the UK implementation of EN 61850-10:2013+A1:2025. It is identical to IEC 61850-10:2012, incorporating amendment 1:2025. It supersedes BS EN 61850-10:2013, which will be withdrawn on 30 September 2028

The start and finish of text introduced or altered by amendment is indicated in the text by tags. Tags indicating changes to IEC text carry the number of the IEC amendment. For example, text altered by IEC amendment 1 is indicated by A1 A1.

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

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

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Date	Text affected
30 September 2025	Implementation of IEC amendment 1:2025 with CENELEC endorsement A1:2025

**Communication networks and systems for power utility automation -
Part 10: Conformance testing
(IEC 61850-10:2012)**

Réseaux et systèmes de communication
pour l'automatisation des systèmes
électriques -
Partie 10: Essais de conformité
(CEI 61850-10:2012)

Kommunikationsnetze und -systeme in
Stationen -
Teil 10: Konformitätsprüfung
(IEC 61850-10:2012)

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Comité Européen de Normalisation Electrotechnique
Europäisches Komitee für Elektrotechnische Normung

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Foreword

The text of document 57/1284/FDIS, future edition 2 of IEC 61850-10, prepared by IEC TC 57 "Power systems management and associated information exchange" was submitted to the IEC-CENELEC parallel vote and approved by CENELEC as EN 61850-10:2013.

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) 2014-01-05
- latest date by which the national standards conflicting with the document have to be withdrawn (dow) 2016-01-18

This document supersedes EN 61850-10:2005.

EN 61850-10:2013 includes the following significant technical changes with respect to EN 61850-10:2005:

- server device conformance test procedures have been updated;
- client device conformance test procedures have been added;
- sampled values device conformance test procedures have been added;
- (engineering) tool related conformance test procedures have been added;
- GOOSE performance test procedures have been added.

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 61850-10:2013 was approved by CENELEC as a European Standard without any modification.

European foreword to amendment A1

The text of document 57/2769/FDIS, future edition 2 of IEC 61850-10/AMD1, prepared by TC 57 "Power systems management and associated information exchange" was submitted to the IEC-CENELEC parallel vote and approved by CENELEC as EN 61850-10:2013/A1:2025.

The following dates are fixed:

- latest date by which the document has to be implemented at national (dop) 2026-09-30 level by publication of an identical national standard or by endorsement
- latest date by which the national standards conflicting with the (dow) 2028-09-30 document have to be withdrawn

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The text of the International Standard IEC 61850-10:2012/AMD1:2025 was approved by CENELEC as a European Standard without any modification.

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 When an international publication has been modified by common modifications, indicated by (mod), the relevant EN/HD applies.

<u>Publication</u>	<u>Year</u>	<u>Title</u>	<u>EN/HD</u>	<u>Year</u>
IEC/TS 61850-2	-	Communication networks and systems in substations - Part 2: Glossary	-	-
IEC 61850-3	-	Communication networks and systems for power utility automation - Part 3: General requirements	EN 61850-3	-
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	2003	Communication networks and systems in substations - Part 5: Communication requirements for functions and device models	EN 61850-5 ¹⁾	2003
IEC 61850-6	2009	Communication networks and systems for power utility automation - Part 6: Configuration description language for communication in electrical substations related to IEDs	EN 61850-6	2010
IEC 61850-7-1	2011	Communication networks and systems for power utility automation - Part 7-1: Basic communication structure - Principles and models	EN 61850-7-1	2011
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

¹⁾ EN 61850-5 is superseded by EN 61850-5:2013, which is based on IEC 61850-5:2013.

<u>Publication</u>	<u>Year</u>	<u>Title</u>	<u>EN/HD</u>	<u>Year</u>
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
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/IEEE 61850-9-3	2016	Communication networks and systems for power utility automation - Part 9-3: Precision time protocol profile for power utility automation	-	-
IEC 61869-9	2016	Instrument transformers - Part 9: Digital interface for instrument transformers	EN IEC 61869-9	2019
ISO 9001	-	Quality management systems - Requirements	EN ISO 9001	-
ISO 9506	Series	Industrial automation systems - Manufacturing Message Specification	-	-
ISO/IEC 9646	Series	Information technology - Open Systems Interconnection - Conformance testing methodology and framework	EN ISO/IEC 9646	-
IEEE 1588	2008	IEEE Standard for a Precision Clock Synchronization Protocol for Networked Measurement and Control Systems	-	-

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

**Communication networks and systems for power utility automation -
Part 10: Conformance testing**

FOREWORD

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This consolidated version of the official IEC Standard and its amendment has been prepared for user convenience.

IEC 61850-10 edition 2.1 contains the second edition (2012-12) [documents 57/1284/FDIS and 57/1303/RVD] and its amendment 1 (2025-07) [documents 57/2769/FDIS and 57/2797/RVD].

This Final version does not show where the technical content is modified by amendment 1. A separate Redline version with all changes highlighted is available in this publication.

International Standard IEC 61850-10 has been prepared by IEC technical committee 57: Power systems management and associated information exchange.

This second edition cancels and replaces the first edition published in 2005. It constitutes a technical revision.

The major technical changes with regard to the previous edition are as follows:

- server device conformance test procedures have been updated;
- client device conformance test procedures have been added;
- sampled values device conformance test procedures have been added;
- (engineering) tool related conformance test procedures have been added;
- GOOSE performance test procedures have been added.

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

FDIS	Report on voting
57/1284/FDIS	57/1303/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 of IEC 61850 series, under the general title *Communication networks and systems for power utility automation*, can be found on the IEC website.

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

- reconfirmed,
- withdrawn, or
- revised.

INTRODUCTION

This part of IEC 61850 is part of a set of specifications which details a layered power utility communication architecture.

This part of IEC 61850 defines:

- the methods and abstract test cases for conformance testing of client, server and sampled values devices used in power utility automation systems, and
- the methods and abstract test cases for conformance testing of engineering tools used in power utility automation systems, and
- the metrics to be measured within devices according to the requirements defined in IEC 61850-5.

The intended readers are IEC 61850 developers, test engineers and test system developers.

NOTE 1 Tests regarding EMC requirements and environmental conditions are subject to IEC 61850-3 and not included in this part of IEC 61850.

It is recommended that IEC 61850-5 and IEC 61850-7-1 be read first in conjunction with IEC 61850-7-2, IEC 61850-7-3, and IEC 61850-7-4.

NOTE 2 Abbreviations used in IEC 61850-10 are listed in Clause 4 or may be found in other parts of IEC 61850 that are relevant for conformance testing.

1 Scope

This part of IEC 61850 specifies standard techniques for testing of conformance of client, server and sampled value devices and engineering tools, as well as specific measurement techniques to be applied when declaring performance parameters. The use of these techniques will enhance the ability of the system integrator to integrate IEDs easily, operate IEDs correctly, and support the applications as intended.

A1 Cyber security extensions provided by IEC 62351 are conformance tested against the IEC 62351-100-4 and IEC 62351-100-6. **A1**

NOTE The role of the test facilities for conformance testing and certifying the results is beyond the scope of this part of IEC 61850.

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 61850-2, *Communication networks and systems for power utility automation – Part 2: Glossary*

IEC 61850-3, *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 61850-5:2003, *Communication networks and systems for power utility automation – Part 5: Communication requirements for functions and devices models*

IEC 61850-6:2009, *Communication networks and systems for power utility automation – Part 6: Configuration description language for communication in electrical substations related to IEDs*

IEC 61850-7-1:2011, *Communication networks and systems for power utility automation – Part 7-1: Basic communication structure – Principles and 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 61850-7-4:2011, *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/IEC 9506-1 and ISO/IEC 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 61869-9:2016, *Instrument transformers – Part 9: Digital interface for instrument transformers*

Text deleted

ISO/IEC 9646 (all parts), *Information technology – Open Systems Interconnection – Conformance testing methodology and framework*

ISO 9001 (all parts), *Quality management systems*

ISO 9506 (all parts), *Industrial automation systems – Manufacturing Message Specification*

IEC/IEEE 61850-9-3:2016, *Communication networks and systems for power utility automation – Part 9-3: Precision time protocol profile for power utility*

IEEE 1588:2008, *Standard for a precision clock synchronization protocol for networked measurement and control systems*

3 Terms and definitions

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

3.1

factory acceptance test

FAT

customer-agreed functional tests of the specifically manufactured power utility automation system or its parts using the parameter set for the planned application as specified in a specific customer specification

Note 1 to entry: The FAT will be carried out in the factory of the manufacturer or other agreed-upon location by the use of process simulating test equipment.

3.2

hold point

point, defined in the appropriate document beyond which an activity shall not proceed without the approval of the initiator of the conformance test

Note 1 to entry: The test facility shall provide a written notice to the initiator at an agreed time prior to the hold point. The initiator or his representative is obligated to verify the hold point and approve the proceeding of the activity.

3.3

interoperability

ability of two or more IEDs from the same vendor (or different vendors) to exchange information and use that information for correct co-operation.

Set of values having defined correspondence with the quantities or values of another set

3.4

model implementation conformance statement

MICS

statement that details the standard data object model elements supported by the system or device

3.5

negative test

test to verify the correct response of a system or a device when subjected to:

- IEC 61850 series conformant information and services which are not implemented in the system or device under test;
- non IEC 61850 series conformant information and services sent to the system or device under test

3.6

protocol implementation conformance statement

PICS

statement with the summary of the communication capabilities of the system or device to be tested

3.7

protocol implementation extra Information for testing

PIXIT

statement with system or device specific information regarding the communication capabilities of the system or device to be tested and which are outside the scope of the IEC 61850 series. The PIXIT is not subject to standardisation.

3.8

routine test

performed by the manufacturer in order to ensure device operation and safety

3.9

site acceptance test

SAT

verification of each data and control point and the correct functionality within the PUAS and between the PUAS and its operating environment at the whole installed plant by use of the final parameter set as specified in a specific customer specification

Note 1 to entry: The SAT is the precondition for the power utility automation system (PUAS) being put into operation.

3.10

SCL implementation conformance statement

SICS

statement with the summary of the capabilities of the SCL engineering tool

3.11

system related test

verification of correct behaviour of the IEDs and of the overall PUAS under specific application conditions

Note 1 to entry: The system related test is part of the final stage of the development of IEDs as belonging to a PUAS-product family.

3.12

test equipment

all tools and instruments which simulate and verify the input/outputs of the operating environment of the PUAS such as switchgear, transformers, network control centres or connected telecommunication units on the one side, and the serial links between the IEDs of the PUAS on the other

3.13

test facility

organisation able to provide appropriate test equipment and trained staff for conformance testing

Note 1 to entry: The management of conformance tests and the resulting information should follow a quality system.

3.14 **technical issues conformance statement** **TICS**

statement with device specific information regarding the implemented technical issues detected after publication of the standard. The TICS is not subject to standardisation.

3.15 **type test**

verification of correct behaviour of the IEDs of the PUAS by use of the system tested software under the test conditions corresponding with the technical data

Note 1 to entry: The type test marks the final stage of the hardware development and is the precondition for the start of the production. This test is carried out with IEDs, which have been manufactured through the normal production cycle.

3.16 **witness point**

point, defined in the appropriate document, at which an inspection will take place on an activity

Note 1 to entry: The activity may proceed without the approval of the initiator of the conformance test. The test facility provides a written notice to the initiator at an agreed time prior to the witness point. The initiator or his representative has the right, but is not obligated, to verify the witness point.

4 Abbreviated terms

ACSI	abstract communication service interface
BRCB	buffered report control block
CDC	common data class
DUT	device under test
FAT	factory acceptance test
GI	general interrogation
GoCB	GOOSE control block
GOOSE	generic object oriented substation events
HMI	human machine interface
HSR	high availability seamless ring
ICD	IED capability description
IED	intelligent electronic device
IID	instantiated IED description
IP	internet protocol
LCB	log control block
LD	logical device
LN	logical node
MICS	model implementation conformance statement
MMS	manufacturing message specification (ISO 9506 series)
MSVCB	multicast sampled value control block
PICS	protocol implementation conformance statement
PIXIT	protocol implementation extra information for testing
PPS	pulse per second

PRP	parallel redundancy protocol
 PTP	Precision Time Protocol 
PUAS	power utility automation system
SAT	site acceptance test
SAV	sampled analogue values (IEC 61850-9-2)
SCD	substation configuration description
SCL	substation configuration language
SCSM	specific communication service mapping
SGCB	setting group control block
SICS	SCL implementation conformance statement
SNTP	simple network time protocol
SSD	system specification description
SV	sampled values
SVCB	sampled values control block
TCP	transport control protocol
TICS	technical issues conformance statement
TPAA	two party application association
TUT	tool under test
URCB	unbuffered report control block
USVCB	unicast sampled values control block
UTC	coordinated universal time
XML	extensible markup language

5 Introduction to conformance testing

5.1 General

There are many steps involved from the development and production of a device to the proper running of a complete system designed according the specific needs of a customer. Suitable test steps are incorporated in this process.

The quality system of the producer/supplier forms the basis of reliable testing in development and production activities.

Many internal tests during the development of a device (or a system kit) result in a type test (unit level test) performed at least by the provider and – if required by applicable standards – by an independent test authority. In the context of this standard, the term type test is restricted to the functional behaviour of the device.

Continuing routine tests in the production chain are necessary to ensure a constant quality of delivered devices in accordance with the quality procedures of the producer.

A conformance test is the type test for communication and – since communication establishes a system – the system related test of the incorporated IEDs. As a global communications standard, the IEC 61850 series includes standardised conformance tests to ensure that all suppliers comply with applicable requirements.

Type tests and conformance tests do not completely guarantee that all functional and performance requirements are met. However, when properly performed, such tests

significantly reduce the risk of costly problems occurring during system integration in the factory and on-site.

Conformance testing does not replace project specific system related tests such as the FAT and SAT. The FAT and SAT are based on specific customer requirements for a dedicated power utility automation system and are done by the system integrator and normally witnessed by the customer. These tests increase the confidence level that all potential problems in the system have been identified and solved. These tests establish that the delivered power utility automation system is performing as specified.

5.2 Conformance test procedures

In general, conformance testing of the communication behaviour of an IED should address the functional requirements and performance requirements of typical applications supported by these devices in a PUAS. IEC 61850-4 defines a general classification of quality tests, which are used within this part.

Conformance testing demonstrates the capability of the DUT to operate with other IEDs in a specified way according to the IEC 61850 series.

Conformance testing requires consideration of the following issues:

- The problem of all testing is the completeness of the tests. The number of all possible situations can be very large. It may be possible to cover all normal operating cases, but this may not be true for all failure cases.
- It is impossible to test all system configurations using IEDs from different world-wide suppliers. Therefore, a standardized test architecture with device simulators should be used. The use of such a test architecture implies agreement about its configuration and the test procedures applied in order to achieve compatible and reproducible results.
- A communication standard does not standardise the functions of the communicating equipment. Therefore, the failure modes of the functions are outside the scope of this part of the IEC 61850 series. But both, the existence of distributed functions and the impact of function response in devices on the data flow create some interdependence.
- Depending on the definition range of the standard, some properties of the device may be proven by information and documents provided with the DUT for the conformance testing instead of the conformance test itself.

The conformance test establishes that the communication of the DUT works according the IEC 61850 series. The IEC 61850 series is focussed on interoperability using data, function and device models including all services above or at the application level (ACSI). In addition, performance classes are addressed.

Since the IEC 61850 series defines no new communication stacks, the conformance to all seven ISO/OSI layers may be proven by documentation that communication stack software compliant with the corresponding specifications is implemented and may have been pre-tested and optionally certified. In the standard conformance test, only the application according to ACSI can be tested.

5.3 Quality assurance and testing

5.3.1 General

In order to ensure the quality during conformance testing, a quality assurance system has to be in place. This shall be clearly demonstrated by the test facility. This applies to the quality systems of all sub-suppliers.

In general, quality surveillance is used to monitor and verify the status of components during all phases of the conformance tests. For this purpose, inspections are carried out, based on hold and witness points that are indicated by the initiator or its representative in the test and

the inspection plan that is supplied by the test facility. These inspections are process-related and will provide information and confidence on the quality of the tests. Quality surveillance will reduce the risks of failure during the FAT and SAT.

5.3.2 Quality plan

5.3.2.1 Conformance test quality plan

The test facility will supply, for evaluation, a quality plan for the conformance test.

The conformance test quality plan shall meet the requirements of ISO 9001. The plan shall describe all measures for the scope of work and/or deliveries in the areas of budget, organisation, time, information and quality. There is only one plan for the test facility and its sub-suppliers.

The conformance test quality plan shall also contain the following:

- A complete and detailed description of the work methods. This will help ensure that all verifiable activities will fulfil all applicable requirements and conditions as stated in the scope of work during the time allowed.
- A detailed description of all tasks to be performed, including references to the schedule, an overview of the involved staff, materials and work methods as well as relevant methods and procedures.
- A detailed description of the organisation, including the assignments, tasks and responsibilities of mentioned staff during the different stages of the test programs. The description shall include all tests, inspections, research and audits during the various stages of the tests and the dates on which they will take place. These descriptions will be part of the test and inspection plan.
- A method for handling deviations, changes and modifications during all stages of the test.
- A sign off procedure and a description of the documentation to be supplied.

5.3.2.2 Test and inspection plan

The conformance test quality plan shall contain a test and inspection plan. In this plan, the test facility specifies, for all phases of the tests:

- what will be inspected, tested and registered;
- the purpose of the inspections and tests;
- the procedures and standards to which inspections, tests and registrations will be performed;
- the expected results of the inspections and tests;
- by whom the inspections, tests and registrations will be performed.

The test facility is responsible for the correct and timely performance of all activities mentioned in the test and inspection plan.

The test facility shall provide a proposal for so-called hold, witness and review points in the test and inspection plan.

There are several methods to perform a hold or witness point. The initiator of the conformance test or a representative can be present during the execution of a test or inspection. It is also possible to review the associated quality documents, e.g. checklists, verification and validation documents. This review can take place at the test facility's site during the execution of a test or inspection can be made at the initiator's site in which case the test facility shall provide all relevant documentation to the initiator.

All hold and witness points will be announced by the test facility at least a predefined time before they take place. A period of at least one week is recommended, depending on the time needed for making travel arrangements and the availability of the needed resources.

5.3.2.3 Audits requested by initiator

The initiator of a conformance test has the right to conduct audits on the quality system of the test facility and its sub-suppliers. The test facility shall co-operate and provide access to all locations applicable for the conformance test. The initiator's right to check the quality of the conformance test does not dismiss the test facility from its responsibilities.

Inspections and tests by the initiator of a conformance test shall be possible at mutually agreeable times at the locations, offices and factories of the test facility and all applicable third parties and sub-suppliers.

5.4 Testing

5.4.1 General

Conformance testing shall be customised for each device under test based on the capabilities identified in the PICS, PIXIT, TICS and MICS provided by the vendor. When submitting devices for testing, the following shall be provided:

- device ready for testing;
- protocol implementation conformance statement (PICS). A standard PICS, also known as PICS proforma shall be supplied (see IEC 61850-7-2, Annex A);
- protocol implementation extra information for testing (PIXIT) statement;
- model implementation conformance statement (MICS);
- technical issues conformance statement (TICS);
- instruction manuals detailing the installation and operation of the device.

The requirements for conformance testing fall into two categories:

- a) static conformance requirements (define the requirements the implementation shall fulfil);
- b) dynamic conformance requirements (define the requirements that arise from the protocol used for a certain implementation).

The static and dynamic conformance requirements shall be defined in a protocol implementation conformance statement or PICS. The PICS serves three purposes:

- 1) selection of the appropriate set of tests;
- 2) ensure that the tests appropriate to a claim of conformance are performed;
- 3) provide the basis for the review of the static conformance.

A standard PICS shall be supplied.

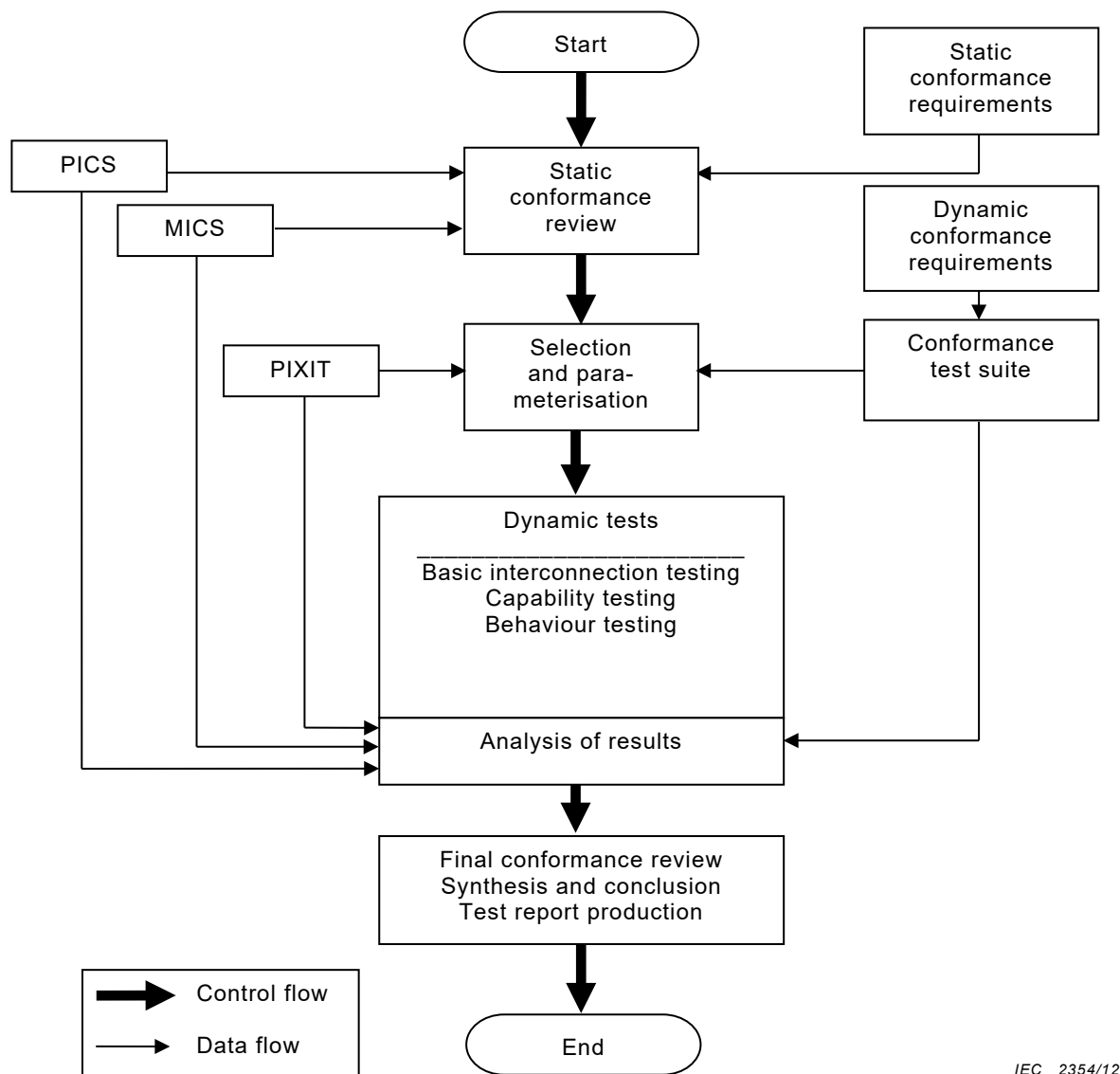
Concrete PICS shall be as defined for the SCSMs.

A model implementation conformance statement or MICS shall be provided detailing the data object model elements supported by the system or device. The MICS is implemented in the ICD or IID file according to IEC 61850-6.

A technical issues conformance statement or TICS shall be provided detailing the implemented technical issues detected after publication of the standard.

In addition to the PICS, a protocol implementation extra information for testing or PIXIT document shall be provided.

The process of assessing the conformance is shown in Figure 1.



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Figure 1 – Conceptual conformance assessment process

5.4.2 Use of SCL files

The DUT shall be delivered with an ICD file.

The test entity shall generate from the ICD file the corresponding SCD file based on the configuration of the test system. If the test entity requires that the initiator of a conformance test also provides the SCD file, then the test entity shall provide the SSD file and the SCD/SED file of the test system.

5.4.3 Device testing

A single device shall be conformance tested against a test device.

The device-specific conformance tests contain the positive and negative testing of the following, as appropriate:

- inspection of the documentation and version control of the device (IEC 61850-4);
- test of device configuration file against standardised syntax (schema) (IEC 61850-6);
- test of device configuration file against the device related object model (IEC 61850-7-4, IEC 61850-7-3);
- test of communication stack implementation against applicable SCSM (IEC 61850-8-1, IEC 61850-9-2);
- test of implemented ACSI services against ACSI definition (IEC 61850-7-2);
- test of device specific extensions according to rules given by the IEC 61850 series in general.

5.5 Documentation of conformance test report

A conformance test report shall include the following information:

- A reference list of all documents that describe or specify any qualifying tests that have been performed. These documents may include the vendor's standard operating and testing procedures, and local, national and international standards. International standards shall be cited by document number, date, clause and subclauses. References to other documents shall include a complete source address and document identification. A complete and contextually accurate summary or extract of the document may be included for convenience.
- A list of any specialised test equipment or computer programs used for performing the conformance tests.
- Name and address of the vendor.
- Name and address of the initiator of the conformance test (if different from vendor name).
- Name of the tested device.
- All of the variants (hardware, firmware, etc.) of the tested device.
- Name and address of the test facility.
- Date of issue of the test report.
- Name and signature of the tester.
- Unique reference number.
- A list of test items performed to verify conformance.
- Comments and problems found.
- For each test item, the following subjects shall be documented:
 - description of the test item with the objective of the test, the procedure how to perform the test and the expected result;
 - reference to the IEC 61850 series part, clause and subclause;
 - unique identifier per test item;
 - test result: passed, failed, inconclusive, not applicable or <empty> = not tested;
 - comparison of the test result to the expected result.

Changes or alterations to the device made at any point in the test, particularly those made to correct a test deficiency, shall be completely described. The consequences and requirements of re-testing of a server device – if required – shall be specified in corresponding test plans and test reports.

Conformance test documentation shall be supplied to the initiator.

6 Device related conformance testing

6.1 Test methodology

A1) Communication testing needs at least two devices to communicate with each other. Comprehensive interoperability testing of all possible products is not feasible. Therefore, the test concept shall include test devices, test configurations, and test scenarios. The dynamic behaviour should be tested properly by using well-defined test cases.

Messages are generated to test the communication capabilities. Hardwired stimuli (contacts, voltages, currents, etc.) and stimuli coming over a serial link if applicable should be used if applicable.

Special attention shall be given to communication equipment such as star-couplers, switches, etc. which shall support all requested features of the standard but not introduce additional contingencies and limitations. The impact of the communication method (client-server, GOOSE, SV, etc.) used by the DUT shall be considered properly in the test procedures. Verification of functional applications (use of GOOSE messages) is not part of a conformance test even if advanced tools may offer such analysis.

6.2 Conformance test procedures

6.2.1 General

This subclause describes the test procedure requirements, test structure, the abstract test cases (what is to be tested). The format and a few examples of detailed test procedures (how to perform the test) are given in Annex A.

6.2.2 Test procedure requirements

The test procedure requirements are:

- The abstract test cases describe what shall be tested, the detailed test procedures describe how a test engineer, or a test system shall perform the test.
- Test cases include a reference to the applicable paragraph(s) in the referenced document(s).
- The test results shall be reproducible in the same test lab and in other test labs.
- Support automated testing with minimal human intervention, as far as reasonably possible.
- The tests shall focus on situations that cannot easily be tested during, for example, a factory or site acceptance test, and prevent inter-operability risks, for example:
 - check behaviour of the device on delayed, lost, double and out of order packets,
 - configuration, implementation, operation risks,
 - mismatching names, parameters, settings, or data types,
 - exceeding certain limits, ranges or timeouts,
 - force situations to test negative responses,
 - check all (control) state machine paths, and
 - force simultaneous control operations from multiple clients.
- The ACSI tests focus on the application layer (mapping).
- The device under test (DUT) is considered as a black box. The I/O and the communication interface are used for testing.
- The test includes testing the versions, data model and configuration file, and the use of applicable ISO/IEC 9646 series terminology.

The test procedures shall be formatted as outlined in Figure 2. With this format, the test procedures document can also be used as test report. A few test procedure examples are depicted in Annex A.

The diagram illustrates the format of a test procedure document, which can also serve as a test report. It consists of several sections with specific fields and callouts:

- Test reference:** A box containing the format: <type><ACSI-model><[N][p/s]><number>, with the example "e.g. sRp3".
- Test purpose:** A box containing the example: "Test purpose, e.g. test if association is set up correctly".
- Test result:** A box containing the options: ☐ Passed, ☐ Failed, and ☐ Inconclusive.
- Test reference:** A field in the document header.
- Test purpose:** A field in the document header.
- Ref. Part Clause and Subclause of IEC 61850:** A field in the document header.
- References to the IEC 61850 part Clause and Subclause, PIXIT or TISSUE:** A box pointing to the reference field.
- Expected result:** A field in the document header.
- Definition of the expected behavior of the DUT after a step:** A box pointing to the expected result field.
- Test description:** A field in the document header.
- Step by step description of how to perform the test:** A box pointing to the test description field.
- Comment:** A field in the document header.
- Area for comments during testing, e.g. identified problems and comments:** A box pointing to the comment field.

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Figure 2 – Test procedure format

6.2.3 Test structure

The test cases are structured as follows:

- documentation and version control (IEC 61850-4);
- configuration file (IEC 61850-6);
- data model (IEC 61850-7-3 and IEC 61850-7-4);
- mapping of ACSI models and services (IEC 61850-7-2 and applicable SCSM).

6.2.4 Test cases to test a server device

6.2.4.1 General

This part of the IEC 61850 series specifies the test system architecture and abstract test cases for server devices. The abstract test cases shall be used for the definition of test procedures to run in tests.

NOTE The SCSM specific test procedures are provided by test facilities agreed upon by the market participants.

6.2.4.2 Test system architecture to test a server device

In order to be able to perform a server device test, a minimum test set-up is necessary. The test architecture contains (see Figure 3):

- DUT;
- client simulator to initiate and generate TPAA messages;
- GOOSE simulator to send correct and incorrect GOOSE messages;
- SV simulator to send correct and incorrect SV messages;
- test master to start/stop test cases, start/stop the analyzer and archive test results;
- time master;
- engineering tool to configure the DUT;
- protocol analyzer to store all the network traffic for each test case;
- signal generator to force binary and analogue events, controlled by the test master or test engineer.

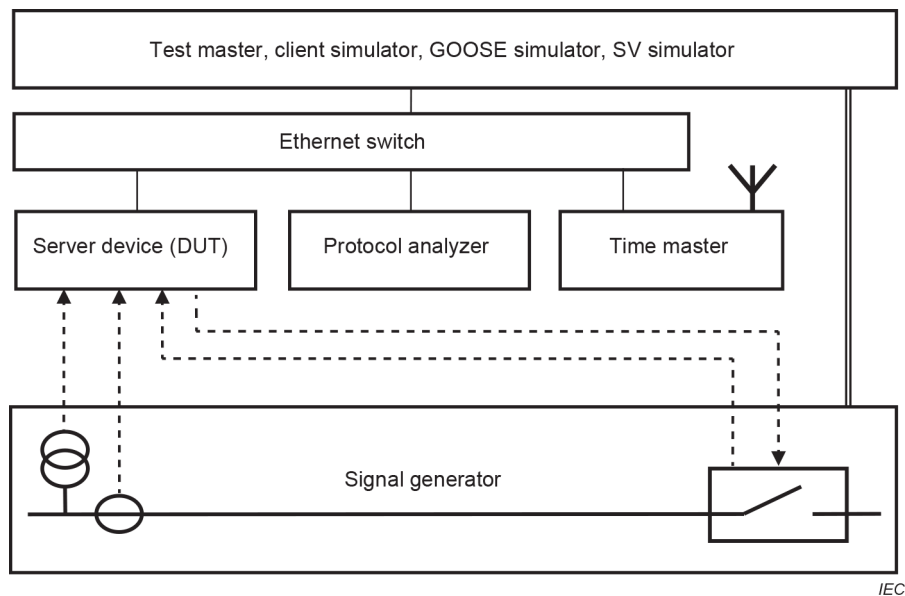


Figure 3 – Test system architecture to test a server device

The test system shall include documentation regarding test system hardware and test system software.

6.2.4.3 Documentation and version control test procedure overview

The test cases listed in Table 1 shall apply.

Table 1 – Server documentation test cases

Test case	Test case description
sDoc1	Check if the major/minor software version in the PICS documentation and the DUT do match (IEC 61850-4). PICS shall contain: • ACSI conformance statement according to IEC 61850-7-2:2010, Annex A • IEC 61850-9-3 PICS (when supported) • IEC 61869-9 conformance class a, b, c or d (when supported)
sDoc2	Check if the major/minor software version in the PIXIT documentation and software version of the DUT does match (IEC 61850-4). PIXIT shall indicate the required information as requested in the test cases
sDoc3	Check if the major/minor software version in the MICS documentation and software version of the DUT does match (IEC 61850-4). MICS shall indicate the semantics of all non-standard Logical Nodes, Data Objects, Data Attributes and enumeration. MICS may contain other items in additional sections of the MICS.
sDoc4	Check if the major/minor software version in the TICS documentation and software version of the DUT does match (IEC 61850-4). TICS shall indicate that the mandatory and applicable technical issues are implemented.
sDoc5	Check the ICD if the server capabilities in the IED "services" section(s) do correspond with the ACSI services specified in the PICS

6.2.4.4 Configuration file test cases

The test cases listed in Table 2 shall apply.

Table 2 – Server configuration file test cases

Test case	Test case description
sCnf1	Verify the SCL version = "2007", revision = "B", release = "4"
sCnf2	Verify the XML encoding is UTF-8 or utf-8; <?xml version="1.0" encoding="UTF-8"?>
sCnf3	Verify that the ICD validates according to SCL schema: version 2007, revision B, release 4
sCnf4	Use the ICT tool to export an ICD file. When ICD is not supported export IID file. Use this file for the remaining tests. It is not allowed to change this SCL file with general purpose tools such as an XML editor. Condition: when the ICD is not fixed
sCnf5	Import the ICD or IID file from sCnf4 into SCT SIMULATOR and generate SCD file as follows: • update IED name • change IP/MAC address • change SubNetwork name • add DataSet's (when supported) • add ReportControl's (when supported) • add GSEControl's (when supported) • add SampledValueControl's (when supported) • add data flows (ExtRef's) from other IED's (when nolctBinding=F) Import the SCD file into the ICT tool and select the IED to be handled from IED's named in the SCD file by IED name
sCnf6	Complete the GOOSE and SV subscribe from sCnf5 and export the IID file. Verify that the ExtRef intAddr does not change when the external binding changes. The intAddr should not contain external data. Condition: when GOOSE and/or SV subscribe is supported

Test case	Test case description
sCnf10	Verify the ICD has at most one Substation or Line or Process exists at SCL level and the attribute "name" is "TEMPLATE". Condition: when Substation or Line or Process section is present
sCnf11	Verify the ICD has none of the LNode bound to an IED different from "TEMPLATE" or "none" Condition: when Substation section is present
sCnf20	Verify that the "Communication" element exists: - IED/Services/DynAssociation or IED/AccessPoint/Services/DynAssociation is declared) and IED/AccessPoint/ Server is declared or - LN0/GSEControl element exist or - LN0/SampledValueControl element exist
sCnf21	For each ConnectedAP/Address element: Verify that exactly one "P" element with attribute type="OSI-PSEL" with a valid value (non-empty, even number of characters, maximum 16 characters 0-9,A-F) Verify that exactly one "P" element with attribute type="OSI-SSEL" with a valid value (non-empty, even number of characters, maximum 16 characters 0-9,A-F) Verify that exactly one "P" element with attribute type="OSI-TSEL" with a valid value (non-empty, even number of characters, maximum 8 characters 0-9,A-F) (Note that if xsi:type mechanism is used then schema validator can automatically verify the type) Condition: IED/Services/DynAssociation is declared
sCnf22	Verify that for each accesspoint no more than one "P" element with attribute type="OSI-AP-Title" and "OSI-AE-Qualifier and "IP" and "IP-SUBNET", "IP-GATEWAY", OSI-NSAP, OSI-AP-Invoke, OSI-AE-Invoke and DNSName exists. For each of these that exist: Verify OSI-AP-Title value contains only decimal digits and non-repeating commas Verify OSI-AE-Qualifier value is decimal representation from 0-65535 Verify IP and IP-SUBNET and IP-GATEWAY contain a "standard dotted-decimal" for Ipv4 Verify Ipv6 and Ipv6-SUBNET and Ipv6-GATEWAY contain a RFC 4291 address with leading zeros for Ipv6 Verify OSI-AP-Invoke and OSI-AE-Invoke values are between 0 and 65535.
sCnf23	For each GSE element: Address/P[type=MAC-Address] right digit of first octet is odd (1,3,5,7,9,B,D,F) (multicast). Address/P[type=VLAN-ID] present Address/P[type=PRIORITY] present Address/P[type=APPID] = 0000-3FFF or 8000-BFFF Condition: when GSE element is present
sCnf24	For each SMV element referencing a SampledValueControl whose attribute multicast=true or missing, verify Address/P[type=MAC-Address] right digit of first octet is odd (1,3,5,7,9,B,D,F) (multicast) For each SMV element referencing a SampledValueControl whose attribute multicast=false, verify Address/P[type=MAC-Address] right digit of first octet is even (0,2,4,6,8,A,C,E) (unicast) For each SMV element in the ICD: - Address/P[type=VLAN-ID] present - Address/P[type=PRIORITY] = present - Address/P[type=APPID] = 4000-7FFF Condition: when SMV element is present
sCnf25	Verify the ICD that each Subnetwork/ConnectedAP@iedName is "TEMPLATE"
sCnf26	Verify each Subnetwork/ConnectedAP@apName matches one of IED/AccessPoint@name
sCnf27	Verify for each GSE element, the GSE@cbName points to a GSEControl within the AccessPoint pointed to by GSE//@apName and GSE@IdInst. Condition: when GSE element is present

Test case	Test case description
sCnf28	Verify for each SMV element, the SMV@cbName points to a SampledValueControl within the AccessPoint pointed to by SMV//@apName and SMV@IdInst. Condition: when SMV element is present
sCnf29	Verify that at least one SubNetwork type has value "8-MMS" when type is present or type is absent
sCnf40	Verify the ICD has exactly one IED element and that the attribute "name" of the element is "TEMPLATE"
sCnf41	Verify all FCDA elements reference existing data and that doName and (optional) daName contain correct references. (ref 61850-6:2010, 9.3.,7 Table 22). - Verify attributes IdInst, InClass, doName, and fc are declared. - Verify attribute InInst is declared if InClass is not "LLN0". - Verify first component of doName references a DO@name and second component (if any) references a SDO@name within DO referenced by first component - Verify first component of daName (if present) references a DA@name and other component (if any) references a BDA@name within structure hierarchy of the DA referenced by first component - Verify that at most one component of doName/daName contains an index and that ix attribute is identical to this index (see 61850-6:2010, Table 22). Valid example: <FCDA IdInst="LD0" InClass="MHA1" InInst="1" fc="MX" doName="HA.phsAHar(0)" daName="cVal.mag.f" ix="0" />
sCnf42	Verify DOI/SDI/DAI structures match DataTypeTemplates (DOI@name is valid DO in LD/LN and DAI@name is a leaf within that DO and SDI@name form hierarchy between DOI and DAI)
sCnf43	Verify that the ICD has none of the ExtRef references IEDs different from TEMPLATE or "@" Condition: when ExtRef iedName attribute is present
sCnf44	Verify that the ICD has no ClientLN elements exist within ReportControl and no IEDName elements within GSEControl and SampledValueControl
sCnf45	Verify all GSEControl/SampledValueControl/ReportControl have confRev>0 when datSet is not empty
sCnf46	Verify IED@originalSciVersion, IED@originalSciRevision and IED@originalSciRelease attributes match corresponding attributes of SCL element (SCL@version, SCL@revision and SCL@release)
sCnf47	Verify multiple identically named DOI/SDI/DAI elements at the same level differ by "ix" attribute (either different "ix" or "ix" attribute not present). Condition: when DOI/SDI/DAI ix attribute is present
sCnf48	Verify multiple LLN0.SGCB do not appear in the same logical device hierarchy (defined by LLN0.GrRef which references the parent logical device) Condition: when multiple SGCB are present
sCnf49	Verify element "Log" exists only in LLN0 Condition: when Log is present
sCnf50	Verify that the name length of IED, Logical Devices, Logical Nodes, data objects, data attributes, data sets and control blocks do not exceed the maximum length as specified in IEC 61850-7-2:2010, 22.2 and SCSM
sCnf51	Verify that logical node LPHD is present in each root logical device (IEC 61850-7-1:2010, 8.2.5)
sCnf52	Verify that DUT/tool can import file with GSEControl in multiple LN0 Add one GSEControl to first and last LN0 in the configuration of the device Condition: Services/GSESettings attribute cbName is not "fix" or absent and multiple Logical Devices exist and GOOSE max > 1
sCnf60	Verify that the attribute nameLength="64" exists in the IED/Services element