

Communication networks and systems in substations —

Part 10: Conformance testing

The European Standard EN 61850-10:2005 has the status of a British Standard

ICS 33.200

National foreword

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The UK participation in its preparation was entrusted to Technical Committee PEL/57, Power systems management and associated information exchange, which has the responsibility to:

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CENELEC

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Foreword

The text of document 57/742/FDIS, future edition 1 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 was approved by CENELEC as EN 61850-10 on 2005-05-01.

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The text of the International Standard IEC 61850-10:2005 was approved by CENELEC as a European Standard without any modification.

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INTRODUCTION

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

This part of IEC 61850 defines:

- the methods and abstract test cases for conformance testing of devices used in substation automation systems, and
- the metrics to be measured within devices according to the requirements defined in IEC 61850-5.

The intended readers are 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.

NOTE 2 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 3 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.

COMMUNICATION NETWORKS AND SYSTEMS IN SUBSTATIONS –

Part 10: Conformance testing

1 Scope

This part of IEC 61850 specifies standard techniques for testing of conformance of implementations, 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.

NOTE 1 The role of the test facilities for conformance testing and certifying the results are beyond the scope of this part of IEC 61850.

NOTE 2 The test approach and test system design to test a client device is likely to be different across the broad range of clients. There are many possibilities to test clients. The client tests are beyond the scope of this part of IEC 61850. It is intended to define client test requirements during the maintenance of this part.

2 Normative references

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

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

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

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

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

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

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

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

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

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

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

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

ISO/IEC 9646-1, *Information technology – Open Systems Interconnection – Conformance testing methodology and framework – Part 1: General concepts*

ISO/IEC 9646-2, *Information technology – Open Systems Interconnection – Conformance testing methodology and framework – Part 2: Abstract test suite specification*

ISO/IEC 9646-4, *Information technology – Open Systems Interconnection – Conformance testing methodology and framework – Part 4: Test realization*

ISO/IEC 9646-5, *Information technology – Open Systems Interconnection – Conformance testing methodology and framework – Part 5: Requirements on test laboratories and clients for the conformance assessment process*

ISO/IEC 9646-6, *Information technology – Open Systems Interconnection – Conformance testing methodology and framework – Part 6: Protocol profile test specification*

3 Terms and definitions

For the purpose of this document, the terms and definitions provided in IEC 61850-2 as well as the following definitions apply.

3.1

Factory Acceptance Test

FAT

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

A set of values having defined correspondence with the quantities or values of another set.

3.4

Model Implementation Conformance Statement

MICS

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

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

3.7

Protocol Implementation eXtra Information for Testing

PIXIT

the Protocol Implementation eXtra Information for Testing document contains 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 SAS and between the SAS and its operating environment at the whole installed plant by use of the final parameter set as specified in a specific customer specification. The SAT is the precondition for the SAS being put into operation.

3.10

system related test

verification of correct behaviour of the IEDs and of the overall SAS under specific application conditions. The system related test is part of the final stage of the development of IEDs as belonging to a SAS-product family.

3.11

test equipment

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

3.12

test facility

organisation able to provide appropriate test equipment and trained staff for conformance testing. The management of conformance tests and the resulting information should follow a quality system.

3.13

type test

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

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.

3.14

witness point

point, defined in the appropriate document at which an inspection will take place on an activity. 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
ASDU	Application Service Data Unit
BRCB	Buffered Report Control Block
CDC	Common Data Class
CT	Current Transducer
DTD	Document Type Definition
DUT	Device Under Test
FAT	Factory Acceptance Test
GI	General Interrogation
GoCB	GOOSE Control Block
GOOSE	Generic Object Oriented Substation Events
GSE	Generic Substation Event
GSSE	Generic Substation Status Event
GsCB	GSSE Control Block
HMI	Human Machine Interface
ICD	IED Capability Description
IED	Intelligent Electronic Device
IP	Internet Protocol
LCB	Log Control Block
LD	Logical Device
LN	Logical Node
MC	MultiCast
MCAA	Multicast Application Association
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
RTU	Remote Terminal Unit
SAS	Substation Automation System

SAT	Site Acceptance Test
SAV	Sampled Analogue Value (IEC 61850-9 series)
SCADA	Supervisory Control And Data Acquisition
SCD	Substation Configuration Description.
SCL	Substation Configuration Language
SCSM	Specific Communication Service Mapping
SGCB	Setting Group Control Block
SoE	Sequence-of-Events
SSD	System Specification Description
SUT	System Under Test
SV	Sampled Values
SVC	Sampled Value Control
TCP	Transport Control Protocol
TPAA	Two Party Application Association
URCB	Unbuffered Report Control Block
USVCB	Unicast Sampled Value Control Block
UTC	Coordinated Universal Time
VT	Voltage Transducer
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 document, 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 substation 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 substation 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 SAS. 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 standardised 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 to 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 assure 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.