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Power systems management and associated information exchange — Data and communication security

Part 100-6: Cybersecurity conformance testing for IEC 61850-8-1 and IEC 61850-9-2

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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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Part 100-6: Cybersecurity conformance testing for IEC 61850-8-1 and IEC 61850-9-2

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POWER SYSTEMS MANAGEMENT AND ASSOCIATED INFORMATION EXCHANGE – DATA AND COMMUNICATION SECURITY –

Part 100-6: Cybersecurity conformance testing for IEC 61850-8-1 and IEC 61850-9-2

FOREWORD

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IEC TS 62351-100-6 has been prepared by IEC technical committee 57: Power systems management and associated information exchange. It is a Technical Specification.

The text of this Technical Specification is based on the following documents:

Draft	Report on voting
57/2438/DTS	57/2484/RVDTS

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

The language used for the development of this Technical Specification is English.

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This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/standardsdev/publications.

A list of all parts in the IEC 62351 series, published under the general title *Power systems management and associated information exchange – Data and communication security*, can be found on the IEC website.

The committee has decided that the contents of this document 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- withdrawn,
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INTRODUCTION

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The quality system of a device producer forms the basis of reliable testing in development and production activities. Many internal tests during the development of a device result in a 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 behavior of the device.

Conformance testing does not replace project-specific system related tests such as the FAT (Factory acceptance Test) and SAT (Site Acceptance Test). 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. The conformance testing reduces the risks of failure during the FAT and SAT.

The purpose of this part of IEC 62351 is to cover all possible situations taking into consideration the normal operating test cases and also the failure test cases to demonstrate the capability of the DUT (Device Under Test) to operate with other devices in the specified way according to the IEC 62351-6.

Through this part of IEC 62351, a test facility can prove the IEC TS 62351-100-6:2022 (E), which is a technical specification, is part of the IEC 62351 suite of standards, which describes test cases for interoperability conformance testing of data and communication security for Substation Automation Systems [SAS] and telecontrol systems which implement IEC TS 62351-6. The tests described in this part do not evaluate the security of the implementation. Thus, citing conformance to this part does not imply that any particular security level has been achieved by the corresponding product, or by the system in which it is used.

The goal of this part of IEC 62351 is to enable interoperability by providing a standard method of testing protocol implementations, but it does not guarantee the full interoperability of devices. It is expected that using this specification during testing will minimize the risk of non-interoperability. Additional testing and assurance measures will be required to verify that a particular implementation of IEC TC 62351-6 has correctly implemented all the security functions and that they can be assured to be present in all delivered products. This topic is covered in other IEC standards, for example IEC 62443.

The scope of this document is to specify common available procedures and definitions for conformance and/or interoperability testing of IEC 62351-6, the IEC 61850-8-1, IEC 61850-9-2 and also their recommendations over IEC 62351-3 for profiles including TCP/IP and IEC 62351 4 for profiles including MMS. These are the security extensions for IEC 61850 and derivatives to enable unambiguous and standardized evaluation of IEC TS 62351-6 and its companion standards protocol implementations.

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The detailed test cases per companion standard, containing among others mandatory and optional mandatory test cases per Secure Communication Application Function, secure ASDU (Application Service Data Unit) and transmission procedures, will become available as technical specifications (TS). Other functionality may need additional test cases, but this is outside the scope of this part of IEC 62351. This document is such a technical specification for the mentioned companion standard.

This document deals mainly with data and communication security conformance testing; therefore, other requirements, such as safety or EMC (Electromagnetic compatibility) are not covered. These requirements are covered by other standards (if applicable) and the proof of compliance for these topics is done according to these standards. SMV at the DUT communication subsystem (or a part of it) conforms to IEC 62351-6.

The tests cases described in this specification do not guarantee full cybersecurity conformance testing. It should be complemented with other test suites.

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POWER SYSTEMS MANAGEMENT AND ASSOCIATED INFORMATION EXCHANGE – DATA AND COMMUNICATION SECURITY –

Part 100-6: Cybersecurity conformance testing for IEC 61850-8-1 and IEC 61850-9-2

1 Scope

IEC TS 62351-100-6, which is a technical specification, is part of the IEC 62351 suite of standards, which describes test cases for interoperability conformance testing of data and communication security for Substation Automation Systems [SAS] and telecontrol systems which implement IEC TS 62351-6. The tests described in this part do not evaluate the security of the implementation. Thus, citing conformance to this part does not imply that any particular security level has been achieved by the corresponding product, or by the system in which it is used.

The goal of this part of IEC 62351 is to enable interoperability by providing a standard method of testing protocol implementations, but it does not guarantee the full interoperability of devices. It is expected that using this specification during testing will minimize the risk of non-interoperability. Additional testing and assurance measures will be required to verify that a particular implementation of IEC TC 62351-6 has correctly implemented all the security functions and that they can be assured to be present in all delivered products. This topic is covered in other IEC standards, for example IEC 62443.

The scope of this document is to specify common available procedures and definitions for conformance and/or interoperability testing of IEC 62351-6, the IEC 61850-8-1, IEC 61850-9-2 and also their recommendations over IEC 62351-3 for profiles including TCP/IP and IEC 62351-4 for profiles including MMS. These are the security extensions for IEC 61850 and derivatives to enable unambiguous and standardized evaluation of IEC TS 62351-6 and its companion standards protocol implementations.

The detailed test cases per companion standard, containing among others mandatory and optional mandatory test cases per Secure Communication Application Function, secure ASDU (Application Service Data Unit) and transmission procedures, will become available as technical specifications (TS). Other functionality may need additional test cases, but this is outside the scope of this part of IEC 62351. This document is such a technical specification for the mentioned companion standard.

This document deals mainly with data and communication security conformance testing; therefore, other requirements, such as safety or EMC (Electromagnetic compatibility) are not covered. These requirements are covered by other standards (if applicable) and the proof of compliance for these topics is done according to these standards.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 62351-3, *Power systems management and associated information exchange – Data and communications security – Part 3: Communication network and system security – Profiles including TCP/IP*

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IEC 62351-4, *Power systems management and associated information exchange – Data and communications security – Part 4: Profiles including MMS and derivatives*

IEC 62351-6, *Power systems management and associated information exchange – Data and communications security – Part 6: Security for IEC 61850*

IEC 62351-9, *Power systems management and associated information exchange – Data and communications security – Part 9: Cyber security key management for power system equipment*

3 Terms and definitions

No terms and definitions are listed in this document.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at http://www.electropedia.org/
- ISO Online browsing platform: available at http://www.iso.org/obp

4 General

4.1 General guidelines

The test environment shall be as close as possible to the final environment. To perform the test, a specially designed testing device is used to test the DUT. Since the IED (Intelligent Electronic Device) can be tested in publisher or subscriber mode, there exist two versions of testing devices.

To realize the tests described in this document, a test equipment (TEQ) shall support the capability of analysis all the IEC 62351-6 requirements and be able to generate invalid messages to test the robustness of the DUT. The DUT shall provide means of reporting/displaying internal status (see 4.3.4) to provide to the test engineer enough information in order to validate the state machine status and the results of the tests.

The test facility will likely use a single publisher/subscriber simulator, but there is no restriction on using one publisher/subscriber which only supports certain communication services and using another to do the rest i.e. as long as the server(s)/client(s) simulators can cover the input requirements to the test case/DUT. Such test environment adaptions shall be documented in the test report.

A certificate authority is also required for the tests.

4.2 Test methodology

4.2.1 General

The tests are realized in a non-intrusive mode. The DUT has the same software and parameters as the production system. To realize the conformity testing, IED functions, at application level, are used to generate GOOSE or SV (Sampled Values) messages. When an operation fails, the DUT shall have the capability to provide an output to the tester to verify failing tests. The output may be through at least one of the following: DUT logs and security events (e.g. IEC 62351-14), internal data representation (e. g. if LGOS is supported, the data change in the application) and network management MIBs (e.g. IEC 62351-7). The tests are grouped in tables for each type of tests. In these tables, the test procedures have numeric references. If the test case needs more than one step, it will be enumerated as 1a), 1b), etc. If the test comprises different variants, it will be enumerated as 1-1, 1-2, etc. The test cases in this document should be referred as follows: "Table 1-1a)".

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The detailed test procedures are not part of this document and are left to the test labs. Test labs claiming the ability to perform conformance testing to these parts shall be accredited for quality and technical competency by an internationally recognized organization.

4.2.2 Normal procedure tests and resiliency tests

IEC 62351-6 specifies how each IED (client and server) shall execute the procedures in normal conditions (expected behavior) and how it shall behave when unexpected or fault events occur during their execution (negative behaviors).

Normal procedure tests and resiliency tests shall be performed at least once for one of the mandatory cipher suites required by the standard referencing IEC 62351-6.

4.3 Conformance testing requirements

4.3.1 Testing within the context of an application

The test cases listed in this document shall be executed within the context of an application. The DUT claiming conformance to IEC 62351-6 shall execute an application protocol defined in a standard requiring conformance to the IEC 62351-6.

4.3.2 Requirements for the device under test

Prior to the present conformity testing, the DUT should have successfully performed the conformity testing for the base protocol which may include IEC61850 MMS and/or GOOSE and/or SV. It is expected that the DUT submitted for these tests has the same firmware version as the one used in the base protocol testing.

Before the beginning of the testing, the PIDs (Protocol Implementation Documents) that includes all the required parameters, settings and options for a particular protocol implemented in the IED is required. The required PIDs documents include the PICS (Protocol Implementation Conformance Statement) and PIXIT (Protocol Implementation eXtra Information for Testing) that will be provided and referenced by the test lab during the tests.

The entity submitting the device for testing shall provide the following:

a) The DUT ready for testing;

b) PICS (Protocol Implementation Conformance Statement);

c) PIXIT (Protocol Implementation eXtra Information for Testing);

d) Instruction manuals detailing the installation and operation of the device or assistance for operating the DUT during the test.

A device is ready for testing when the following are satisfied:

a) The DUT is able to operate as a subscriber and/or publisher according to what has been stated in the PICS.

b) The DUT shall be configured with a similar configuration submitted for a Client/Server Conformance Test. The supported security features declared in the PICS shall all be configured to allow all applicable test cases to be executed.

c) The digital and/or analogue data that is in the configuration shall be verifiable in human readable way e.g., by an MMS client read of the data model, via the DUT HMI, LEDs, SNMP MIB Datapoint etc. as described in the DUT base protocol PIXIT. This verification can also include Syslog events according to IEC 62351-14 if supported.

d) The DUT has successfully passed the initial PIDs verification to ensure all supported features have been presented and detailed. This verification is expected to be in advance of the any test case commencement.

61850 DUT shall also include:

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