

TECHNICAL SPECIFICATION

**Telecontrol equipment and systems –
Part 5-604: Conformance test cases for the IEC 60870-5-104 companion standard**

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INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

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CONTENTS

FOREWORD.....	4
INTRODUCTION.....	6
1 Scope.....	7
2 Normative references.....	7
3 Terms and definitions.....	7
4 Abbreviated terms.....	7
5 Conformance testing for IEC 60870-5-104.....	8
5.1 Overview and legend.....	8
5.2 Configuration parameters IEC 60870-5-104.....	10
5.3 Verification IEC 60870-5-104 communication.....	11
5.4 Conformance test procedures.....	52
5.5 Test results chart.....	84
5.6 Test results of command transmission.....	91
5.6.1 Test results of single command transmission.....	91
5.6.2 Test results of double command transmission.....	94
5.6.3 Test results of regulating step command transmission.....	97
5.6.4 Test results of setpoint command transmission.....	100
Figure 1 – Test procedure.....	9
Table 1 – Tests on transport provider level.....	11
Table 2 – Tests on data unit identifier.....	16
Table 3 – Verification of ASDUs for process information in monitor (normal) direction.....	17
Table 4 – Verification of ASDUs for process information in control (normal) direction.....	35
Table 5 – Verification of ASDUs for system information in monitor (normal) direction.....	43
Table 6 – Verification of ASDUs for system information in control (normal) direction.....	43
Table 7 – Verification of ASDUs for parameters in control (normal) direction.....	46
Table 8 – Verification of ASDUs for file transfer (in monitor (normal) and control direction).....	48
Table 9 – Data unit identifier conformance test procedures.....	52
Table 10 – Information object address conformance test procedures.....	53
Table 11 – Station initialisation function (unbalanced systems) conformance test procedures.....	54
Table 12 – Redundant link conformance test procedures.....	57
Table 13 – Cyclic data transmission function conformance test procedures.....	60
Table 14 – Data acquisition through read function conformance test procedures.....	61
Table 15 – Acquisition of events function conformance test procedures.....	62
Table 16 – General interrogation function conformance test procedures.....	63
Table 17 – Clock synchronisation function conformance test procedures.....	67
Table 18 – Command transmission function conformance test procedures.....	68
Table 19 – Transmission of integrated totals (telecounting) function conformance test procedures.....	74
Table 20 – Parameter loading function conformance test procedures.....	77

Table 21 – Test procedure function conformance test procedures.....	78
Table 22 – File transfer procedure function conformance test procedures.....	79
Table 23 – Additional conformance test procedures.....	81
Table 24 – Negative conformance test procedures.....	82
Table 25 – PIXIT related conformance test procedures.....	83
Table 26 – Test results chart	84
Table 27 – Test results of single command transmission.....	91
Table 28 – Test results of double command transmission	94
Table 29 – Test results of regulating step command transmission.....	97
Table 30 – Test results of setpoint command transmission	100

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

TELECONTROL EQUIPMENT AND SYSTEMS –

**Part 5-604: Conformance test cases for
the IEC 60870-5-104 companion standard**

FOREWORD

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- The subject is still under technical development or where, for any other reason, there is the future but no immediate possibility of an agreement on an International Standard.

Technical specifications are subject to review within three years of publication to decide whether they can be transformed into International Standards.

IEC 60870-5-604, which is a technical specification, has been prepared by IEC technical committee 57: Power systems management and associated information exchange.

The text of this technical specification is based on the following documents:

Enquiry draft	Report on voting
57/856/DTS	57/898/RVC

Full information on the voting for the approval of this technical specification 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 60870 series, published under the general title *Telecontrol equipment and systems*, can be found on the IEC website.

The committee has decided that the contents of this publication will remain unchanged until the maintenance result 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

- transformed into an International standard,
- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

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INTRODUCTION

This technical specification (TS) describes test cases for conformance testing of telecontrol equipment or systems using the IEC 60870-5 companion standard 104 based on the IEC 60870-5-104 companion standard and IEC 60870-5-6, Guidelines for conformance testing for the IEC 60870-5 companion standards.

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TELECONTROL EQUIPMENT AND SYSTEMS –

Part 5-604: Conformance test cases for the IEC 60870-5-104 companion standard

1 Scope

This technical specification which is part of the IEC 60870-5 series describes test cases for conformance testing of telecontrol equipment, Substation Automation Systems [SAS] and telecontrol systems, including front-end functions of SCADA.

The use of this part of IEC 60870 facilitates interoperability by providing a standard method of testing protocol implementations, but it does not guarantee interoperability of devices. It is expected that using this specification during testing will minimize the risk of non-interoperability.

The goal of this part of IEC 60870 is to enable unambiguous and standardised evaluation of IEC 60870-5 companion standard protocol implementations. The guidelines and conditions for the testing environment are described in IEC 60870-5-6. The detailed test cases per companion standard, containing among others mandatory and optional mandatory test cases per Basic Application Function, ASDU and transmission procedure, will become available as a technical specification (TS). Other functionality may need additional test cases but this is outside the scope of this part of IEC 60870. For proper testing, it is recommended to define these additional test cases. This document is such a Technical Specification for the mentioned companion standard.

This part of IEC 60870 deals mainly with communication conformance testing; therefore other requirements, such as safety or EMC 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 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.¹

IEC 60870-5-6, *Telecontrol equipment and systems – Part 5-6: Guidelines for conformance testing for the IEC 60870-5 companion standards*

IETF RFC220, *Internet Official Protocol Standards*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 60870-5-6 apply.

4 Abbreviated terms

For the purposes of this document, the abbreviations given in IEC 60870-5-6 apply.

¹ The base standard always takes precedence. In case of ambiguity between this technical specification and the base standards (IEC 60870-5-1 to IEC 60870-5-5, IEC 60870-5-104), this part of IEC 60870 needs to be clarified or amended.

When testing, negative behaviour is not described in the base standard, the behaviour described in this document prevails and should be observed.

The conformance statement produced after testing indicates any lack of conformance to either the test plan or the base standard.

5 Conformance testing for IEC 60870-5-104

5.1 Overview and legend

An overview of tests is given in the tables below. Procedural and functional testing must always start with the Station Initialisation function and proceeds with the next Basic Application Functions. The procedure in each test case must be followed, which means that the DUT is able to function as described in the specific test case.

The test procedures in the tables 0 through 10 must be carried out with no errors detected during testing of all the Basic Application Functions in tables 11 through 25. These tests are preferably automatically performed by the used test platform.

In addition to the performance criteria listed in the test procedures, 5.3 lists the protocol specifications that must be verified automatically by the testing software or verified manually by review of the test history log after execution of the test procedures. The verification must result in no errors detected during the complete test procedure.

This test plan has a direct reference to the PICS and possibly a PIXIT. Without a reference to a PICS or PIXIT this test plan is obsolete.

Test case numbering syntax is subclause number + table number + test case number.

Test cases are mandatory depending on the description in the column 'Required'. The following situations are possible:

- | | | |
|-----------|---|--|
| M | = | Mandatory test case regardless if enabled in the PICS/PIXIT, not only in one situation but during execution of all the tests as in the PICS and/or PIXIT |
| PICS, x.x | = | Mandatory test case if the functionality is enabled in the PICS (by marking the applicable check box), with a reference to the section number of the PICS (x.x); note: PICS 8.x always refers to 60870-5-104, Clause 8 |
| PIXIT | = | Mandatory test case if the functionality is enabled/described in the PIXIT. Verification of these test cases by the user/owner of the PIXIT is required before the test is started. |

For each test case the test results need to be marked in the appropriate column of the test result chart in 5.5 and 5.6. Each test case can either pass the test (Passed), fail the test (Failed), not applicable, when the configuration value is not supported by the device (N.A.), or the test case was not performed (Empty). Ideally, there should be no empty boxes when testing is complete.

The test tables are divided into 5 subclauses:

- Subclause 5.2 Configuration parameters IEC 60870-5-104
- Subclause 5.3 Verification IEC 60870-5-104 communication
- Subclause 5.4 Conformance test procedures
- Subclause 5.5 Test result chart
- Subclause 5.6 Test results of command transmission

The procedure to perform all the mandatory test cases, according to the PID, is shown in Figure 1.

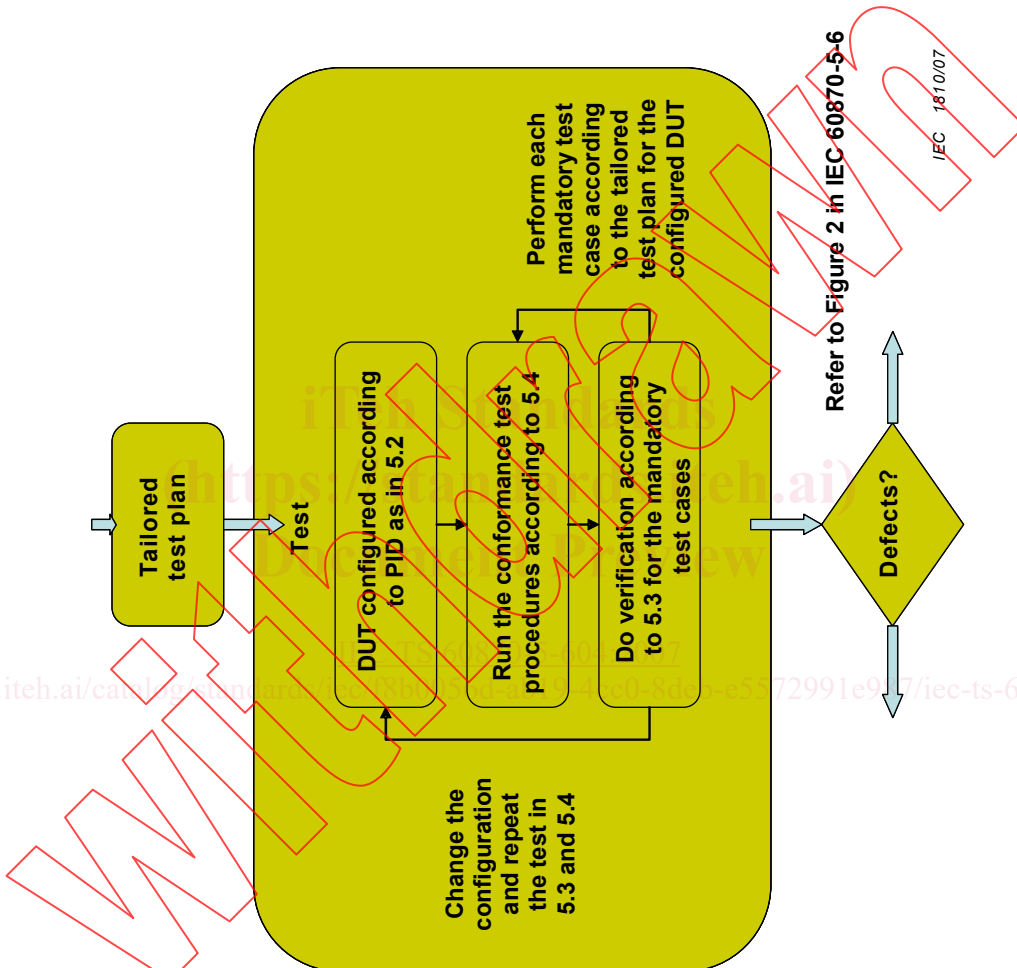


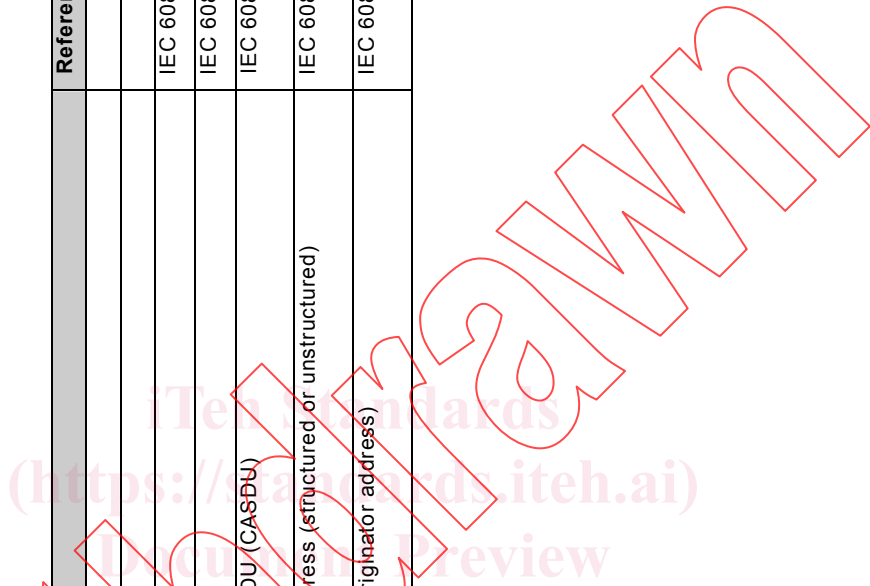
Figure 1 – Test procedure

5.2 Configuration parameters IEC 60870-5-104

Table 0 Run the Conformance Test Procedures for each of the following supported configuration parameter values

Since IEC 60870-5-104 contains a number of configuration parameters affecting protocol behaviour, the conformance test procedures in 5.4 and verification in 5.3 must be performed at least once for each supported value of the parameters listed in Table 0. Basically the DUT must be tested if the functionality in 5.3 and 5.4 behaviour is correct for the configuration(s) in this table.

No.	Test	Description	Reference	Required
5.2.0.1	System definition	Controlling station test (Master)		PICS, 9.1
5.2.0.2		Controlled station test (Slave)		PICS, 9.1
5.2.0.50	Frame length	Maximum length L (control direction)	IEC 60870-5-101, 6.2	PICS, 9.4
5.2.0.51		Maximum length L (monitor direction)	IEC 60870-5-101, 6.2	PICS, 9.4
5.2.0.70	COMMON ADDRESS of ASDU	Two (2) octets for Common Address of ASDU (CASDU)	IEC 60870-5-101, 7.2.4	PICS, 9.5
5.2.0.80	INFORMATION OBJECT ADDRESS	Three (3) octets for Information Object Address (structured or unstructured)	IEC 60870-5-101, 7.2.5	PICS, 9.5
5.2.0.90	CAUSE OF TRANSMISSION	Two (2) octets for COT field (2 nd octet is Originator address)	IEC 60870-5-101, 7.2.3	PICS, 9.5



5.3 Verification IEC 60870-5-104 communication

This subclause lists the protocol specifications that must be verified automatically by the testing software or verified manually by review of the test history log after execution of the test procedures. Every test case describes functionality that has passed the test if the functionality as in the description column was shown to be correct. Correct means: the functionality must be checked either automatically or manually, and also be checked by the test engineer in a human readable format log-file. For example to test the IV qualifier of some information elements, the ASDU containing this element must be sent with the IV=1. Every test case marked "Passed", has to be verifiable during testing and archived in log-files for post assessment.

To identify if a test case is mandatory, it is necessary to read 5.1 carefully.

Table 1 – Tests on transport provider level

No.	Test	Description	Reference	Required
5.3.1.1	IP FRAME	IP Header, IP Fragment Re-assembly	IETF RFC2200	M
5.3.1.2		Source Address, Destination address	IETF RFC2200	M
5.3.1.3	TCP FRAME	TCP Header, TCP Control field (specifically ACK, RST, SYN, FIN), TCP Sequencing	IETF RFC2200	M
5.3.1.4		[The server (controlled station) uses the] port number 2404 [(confirmed by IANA) in all cases, both for the listening port and established connections. The client (controlling station) is free to use ephemeral port number, e.g. as allocated by the client's TCP/IP implementation]	IEC 60870-5-104, 5.4 [MOM WG03 15 June 2001 4.2.2.4] (Especially marked because it is not yet in the standard!)	M
5.3.1.5		Actively opening a new TCP connection starts with a TCP frame containing (SYN) from the node that takes the initiative to establish the TCP connection. This is answered by the other node with (SYN, ACK), which in turn is answered by the initiating node with (ACK). Thereinafter the TCP connection is established	IETF RFC2200 IEC 60870-5-104, 7.1	M
5.3.1.6		Actively closing an established TCP connection starts with a TCP frame containing (FIN) from the node that takes the initiative to close the TCP connection. This is answered by the other node (ACK) followed by a TCP frame from this same other node containing also (FIN). This in turn is answered by the initiating node with (ACK). Thereinafter the TCP connection is closed	IETF RFC2200 IEC 60870-5-104, 7.1, Figure 19	M
5.3.1.7		TCP Data stream on an established TCP connection contains APDU's. APDU's are correctly assembled when divided over multiple TCP frames	IEC 60870-5-104, Clause 5	M
5.3.1.10	CS104 APDU FRAME	Start character of APDU: 68 _H	IEC 60870-5-104, Clause 5	M
5.3.1.11	LAYOUT	Configured number of octets L as the maximum number of Data octets (ASDU + Control field) in APDU: max. 253	IEC 60870-5-104, Clause 5	PICS, 9.4
5.3.1.12		4-octet Control field	IEC 60870-5-104, Clause 5	M

Table 1 (continued)

No.	Test	Description	Reference	Required
5.3.1.20	CS104 I-FORMAT APDU	Control field octet 1 bit 1 (LSB) = 0	IEC 60870-5-104, Clause 5	M
5.3.1.21	Information transfer frame	Control field octets 1-2, bit 2..16 contain end sequence number N(S) range 0..Maximum value 32767	IEC 60870-5-104, Clause 5	M
5.3.1.22		Control field octet 3 bit 1 (bit 17) = 0	IEC 60870-5-104, Clause 5	M
5.3.1.23		Control field octets 3-4, bit 18..32 contain Receive sequence number N(R) range 0..maximum value 32767	IEC 60870-5-104, Clause 5	M
5.3.1.24		I-format frame contains exactly one ASDU	IEC 60870-5-104, Clause 5	M
5.3.1.25	CS104 S-FORMAT APDU	Control field octet 1, bit 1-2 have value 01 _b	IEC 60870-5-104, Clause 5	M
5.3.1.26	Numbered Supervisory function frame	Control field octets 1-2, bit 3..16 all contain value 0	IEC 60870-5-104, Clause 5	M
5.3.1.27		Control field octet 3 bit 1 (bit 17) = 0	IEC 60870-5-104, Clause 5	M
5.3.1.28		Control field octets 3-4, bit 18..32 contain Receive sequence number N(R) range 0..maximum value 32767	IEC 60870-5-104, Clause 5	M
5.3.1.29		S-frame APDU only contains a single APCI field	IEC 60870-5-104, Clause 5	M
5.3.1.30	CS104 U-FORMAT APDU	Control field octet 1, bit 1-2 have value 11 _b	IEC 60870-5-104, Clause 5	M
5.3.1.31	Unnumbered Control function frame	Control field octet 1, bit 3 used for control function STARTDT Activation	IEC 60870-5-104, Clause 5	M
5.3.1.32		Control field octet 1, bit 4 used for control function STARTDT Confirmation	IEC 60870-5-104, Clause 5	M
5.3.1.33		Control field octet 1, bit 5 used for control function STOPDT Activation	IEC 60870-5-104, Clause 5	M
5.3.1.34		Control field octet 1, bit 6 used for control function STOPDT Confirmation	IEC 60870-5-104, Clause 5	M
5.3.1.35		Control field octet 1, bit 7 used for control function TESTFR Activation	IEC 60870-5-104, Clause 5	M
5.3.1.36		Control field octet 1, bit 8 used for control function TESTFR Confirmation	IEC 60870-5-104, Clause 5	M
5.3.1.37		Control field bit 3..8 contains exactly one active (bit with value 1) Control function (TESTFR, STARTDT, STOPDT, either Activation or Confirmation) per U-frame	IEC 60870-5-104, Clause 5	M
5.3.1.38		Control field octets 2-4, bit 9..32 all contain value 0	IEC 60870-5-104, Clause 5	M
5.3.1.39		U-frame APDU only contains a single APCI field	IEC 60870-5-104, Clause 5	M

