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Type conformance test report of the IEC60870-5-101 Unbalanced Slave protocol implementation in the IPCOMM IpConv

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1 INTRODUCTION

1.1 Background

The IEC 6080-5 Telecontrol Companion Standard 101 (TCS101) can be used as a communication protocol for exchanging information between Control Center(s) (controlling station) and their substations (controlled stations), such as control and data acquisition information like measurands, status messages and commands. IPCOMM, Erlangen, Germany has implemented the IEC 60870-5 Telecontrol Companion Standard 101 (Unbalanced) in the IpConv gateway for communications with a controlling system.

Figure 1 shows the configuration of the test environment for the IPCOMM IpConv and the scope of the conformance test.

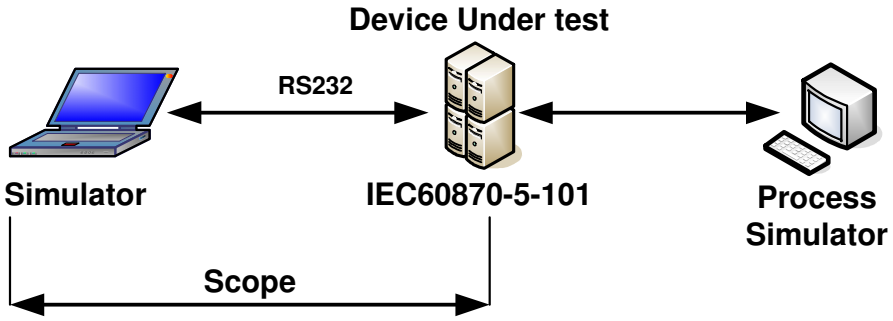

Figure 1: Configuration of the target environment

An overview and description of the actual test environment is given in Chapter 2.

KEMA's assignment was to answer the following question:

"*Does the IPCOMM IEC60870-5-101 Unbalanced Slave protocol implementation in the IpConv gateway (software version 3.2) conform to the IEC60870-5-101 Companion Standard in Standard and Reversed direction, and the IpConv IEC 60870-5-101 Controlled Station Interoperability document (edition April 2011, Version 3.2)* ?"

To answer this question, KEMA has performed a **type conformance test** of the IPCOMM IEC 60870-5-101 unbalanced slave protocol implementation in the IpConv gateway.

1.2 Testing Viewpoints

There are two viewpoints for testing: **Type conformance testing** and **Interoperability testing**.

The first testing viewpoint, **Type conformance testing**, is the process of verifying that an implementation performs in accordance with a particular standard. A manufacturer may claim: “my equipment is conformant to standard ISO/IEC xxx-x ”. Type testing enables such a claim to be investigated and assessed by an objective and independent institute, like KEMA, to establish its validity. The type test may result in certification by means of an Attestation of Conformity, guaranteed by KEMA, for the tested implementation version in that equipment. KEMA maintains a list of type-tested and approved equipment with IEC 870-5 implementations (see www.kema.com).

Type testing extends the normal conformance test process by adding negative and boundary test items to the testing process.

The second viewpoint, **Interoperability testing**, shows whether or not a protocol implementation, installed in one product, can be used to exchange information with another product which has implemented the same protocol. No direct attention is paid to the implementation of the protocol itself. After completion of the tests, there is no guarantee that the protocol implementation is in accordance with that particular standard. It is clear, however, whether or not the protocol functions required in order to exchange information can work together to accomplish the required task.

1.3 Purpose of this document

The purpose of this document is to describe the results of the type test of the IEC 870-5-101 implementation in the System Under Test [further called SUT]. The type test was executed at IPCOMM, Erlangen (Germany) from April 26 till April 28, 2011. The results will form the basis for an Attestation of Conformance. This Attestation is primarily of interest to product marketeers and customers, as a proof of independent verification of minimized interoperability risks.

This test is performed on basis of the relevant IEC 870-5 standards and the IPCOMM IpConv IEC 60870-5-101 Controlled Station Interoperability document-Edition April 2011, Version 3.2.

1.4 Contents of this document

Chapter 2 describes the various relevant components for the type test and their configuration as used in the type test, including the System Under Test. This chapter also gives an overview and introduction to the various test groups that together constitute the type-test. Chapter 3 gives an overview and summary of the test results, the conclusion(s) and recommendations based on the conclusions. The summary contains two **defect** categories for defects found during the type test: a **Major** category and a **Minor** category. Also a **Remarks** category is introduced. These categories are further explained in this chapter. Chapter 4 shows the interoperability list. Chapter 5 specifies the results of the test cases as specified in the IEC 60870-5-601 Conformance Test document.

1.5 Normative references

The tests defined in this document are based on the following IEC (International Electrotechnical Committee) documents in the IEC 870-5 range: Telecontrol equipment and systems part 5: Transmission protocols:

1. IEC 870-5-1: TELECONTROL EQUIPMENT AND SYSTEMS, PART 5, Transmission protocols: Transmission Frame Formats, IS (International Standard), 1990, further referred to as [IEC5-1]
2. IEC 870-5-2: TELECONTROL EQUIPMENT AND SYSTEMS, PART 5, Transmission protocols: Link Transmission Procedures, IS, 1992, further referred to as [IEC5-2]
3. IEC 870-5-3: TELECONTROL EQUIPMENT AND SYSTEMS, PART 5, Transmission protocols: General Structure of Application Data, IS, 1992, further referred to as [IEC5-3]
4. IEC 870-5-4: TELECONTROL EQUIPMENT AND SYSTEMS, PART 5, Transmission protocols: Definition and Coding of Application Information Elements, IS, 1993, further referred to as [IEC5-4]
5. IEC 870-5-5: TELECONTROL EQUIPMENT AND SYSTEMS, PART 5, Transmission protocols: Basic Application Functions, IS, 1995, further referred to as [IEC5-5]
6. IEC 870-5-101: TELECONTROL EQUIPMENT AND SYSTEMS, PART 5, Transmission protocols: Companion standard for basic telecontrol tasks, IS, first edition 1995-11, further referred to as [IEC5-101].
7. Addendum 1 to [IEC5-101], extension of time tags, further referred to as [IEC5-101 A1].
8. Addendum 2 to [IEC5-101], Supplementary Definitions to IEC 60870-5-101, revision 7, further referred to as [IEC5-101 A2].
9. IEC 60870-5-601: Conformance Test procedures for IEC 60870-5-101

1.6 Other References

1 IPCOMM IpConv IEC 60870-5-101 Controlled Station Interoperability document-Edition April 2011, Version 3.2.

2 THE TYPE TEST

2.1 Components in the test environment

The test environment consists of the following components:

- The System Under Test (SUT): the IPCOMM IpConv IEC 60870-5-101 protocol implementation version 3.2 (28-04-2011) acting as the unbalanced Slave.
- The UnIECim version 2.23.02 (March 2011) protocol test platform, which runs the Cs101Master-Interactive Version1_22.UTS simulator test suite and acts as a single-node Controlling station in unbalanced mode.
- One Connection cable sub-D 9pins from the test system to the IPCOMM IpConv based on RS232 communication.

Figure 2 shows the (simple) layout of the connected test components.

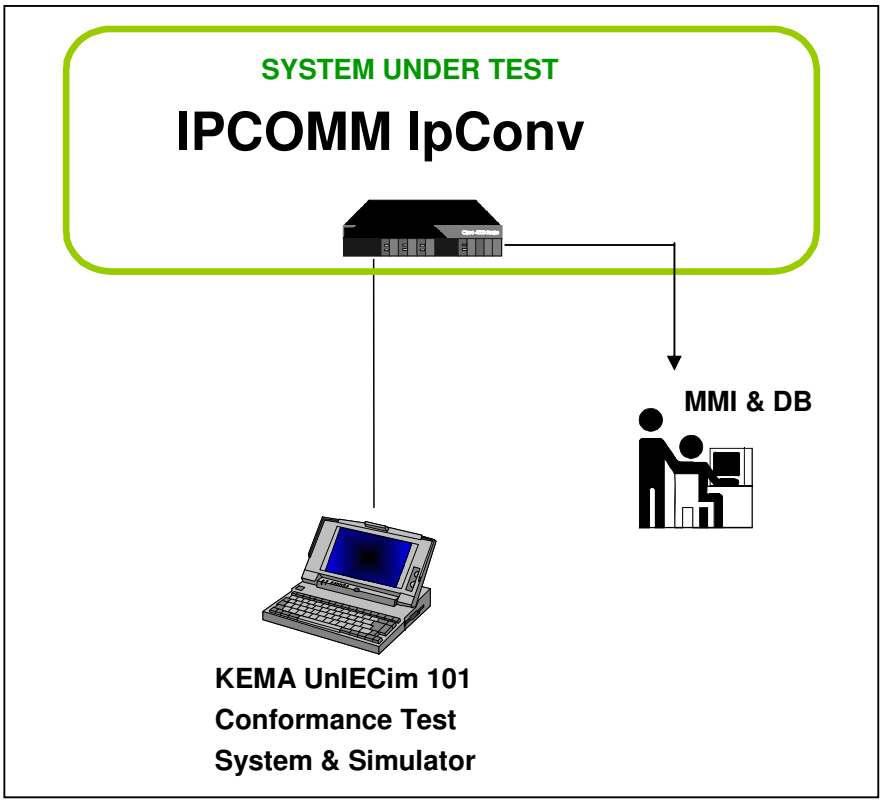

Figure 2: Test environment lay-out

5.6.1 SUT[1] requirements

Next to the CS101 communication capability specified in the PID, the System Under Test must support the following requirements for control and simulation purposes during testing, e.g. via additional test equipment attached to the SUT or one or more configured and running operator MMI stations:

- Display the current values of the Information Elements described in I/O list, mapped to visible MMI-elements
- Manually shut down and restart or equivalent
- Manually cut-off of the connection to the communication link
- Manually activate the supported Basic Application Functions
- Direct physical connection to the communication link.

5.6.2 SUT configuration

The configuration of the SUT is as follows:

- The telecontrol communication modes are unbalanced Master-Slave capable of using fixed (point-to-point) communication lines, and the UnIECim and the IPCOMM IpConv are respectively acting as the (simulated) Master and the Slave.
- FT1.2 frames at maximum 56000 bps[2], 8 data bits, even parity, and 1 stop bit.
- 1 or 2 octets for data link address.
- 1 or 2 octets for the Common address of ASDU (same address as link address).
- 1, 2 or 3 octets for the Information Object Addresses (see next section).
- Further details of the implemented protocol (interoperability sheet) subset can be found in Chapter 4, Protocol Implementation Conformance Statement (PICS). The PICS forms the basis for the applicable test cases performed as described in Chapter 5.

5.6.3 UnIECim test system requirements

The UnIECim IEC 870-5 protocol simulator is KEMA's test system for testing IEC 870-5 protocol implementations. The knowledge of the IEC 870-5 protocol is in the software. UnIECim 870-5 supports real-time data capturing, analysis and decoding, combined with construction of frames and real-time script execution for simulation of conforming (positive) as well as non-conforming (negative) communication functions. UnIECim automatically executes all scripts (test cases) in a so-called test suite.

---

[1] SUT= System Under Test

[2] Configurable as in the PID

UnIECim 870-5-***101*** is the test tool for testing Master, Slave and peer implementations based on the IEC 870-5 Telecontrol Companion Standard 101 (TCS 101) for basic telecontrol tasks. In this type test, UnIECim 870-5 is used in active mode and acts like a Master.

2.2 Overview of the test suite

5.6.4 Tests on physical level

For signal transmission between both end systems the V24/V28 (the well-known EIA232 standard) interface with interface connector (EIA DB9) is used. UnIECim checks constantly physical level failures. The SUT can send and receive octets after connecting the systems. The tests are passed if the physical connection doesn't fail permanently. Some of the additional tests defined in Chapter 5 are performed on physical level.

5.6.5 Tests on link level

The tests on link level are automatically performed by the UnIECim test system on each transmitted frame. The tests are passed if no error is reported during a test session. If relevant, redundant link tests are defined in Chapter 5.

5.6.6 Tests on application level

The Basic Application Functions (BAFs) tests defined in the tables of Chapter 5 are performed by a combination of automatic verification and manual expert analysis for each test case if applicable. The tests have passed if no defects are found during a test session.

5.6.7 Negative tests

The Negative tests defined in Chapter 5 are performed by a combination of automatic verification and manual expert analysis for each test case if applicable. The tests have passed if the SUT continues correct operation, that is: does not send corrupted frames and reacts in a correct and sensible manner.

The SUT may not fail permanently when receiving:
- Corrupted frames
- Illegal functions
- Not supported functions
- Not supported Basic Application Functions (BAF) or ASDU's.

3 TEST RESULTS

Table 1 in this Chapter gives a summary of the type test results. Numbers shown in the table columns refer to test numbers of individual test cases in Chapter 5 and as used in the IEC 60870-5-601 conformance test procedures.

Major defects are a **certain** cause for operational risks: these MUST be corrected before going into an operational situation! They imply the test is **failed.**

A **minor** defect is non-conformant behaviour, and can have a negative influence on the use of the product *in specific configurations*. Minor defects are a potential cause for operational problems. Therefore in a type test they also imply the test is **failed**.
In interoperability tests a minor defect **could pass** the test, depending on the severity of the defect. In configurations with different products and/or different manufacturers these minor defects in the implementation are a potential risk for the interoperability when not taken into account before going into an operational situation.

Finally, **remarks** introduce additional observations about the test case results, like limitations in the implementation.

The Protocol Implementation Conformance Statement (PICS) in Chapter 4 is the basis for the applicable test cases in Chapter 5. The PICS gives an overview of the tested protocol implementation, but this isn't a guarantee that the complete function or ASDU, as enabled in the PICS, is tested and supported. Partial testing is possible and the completeness of the tests for the specific function or ASDU should be consulted in Chapter 5.

Table 1 Summary of test results for the System Under Test

Test Group	Major	Minor	Remarks on test case number	Verdict
Table 1 Supported Configuration Parameter Values			-	Passed
Table 2 Verification of the Physical Level			-	Passed
Table 3 Verification of the Link Level			-	Passed
Table 4 Verification of the Data Unit Identifier			-	Passed
Table 5 Verification of the Object Address			-	Passed
Table 6 ASDUs for process information in monitor direction			-	Passed
Table 7 ASDUs for process information in control direction			-	Passed
Table 8 ASDUs for system information in monitor direction			-	Passed
Table 9 ASDUs for system information in control direction			-	Passed
Table 10 ASDUs for parameters in control direction			-	Passed
Table 11 ASDUs for file transfer in normal and control direction			-	Passed
Table 12 Link layer Conformance Test Procedure			-	Passed
Table 13 Data Unit Identifier Conformance Test Procedure			-	Passed
Table 14 Information Object Address Conformance Test Procedure			-	Passed
Table 15 Station Initialisation Unbalanced Systems			5.4.15.10	Passed
Table 16 Data Acquisition by Polling			-	Passed
Table 17 Station Initialisation Balanced Systems			N.A.	N.A.
Table 18 Redundant Links			N.A.	N.A.
Table 19 Cyclic Data Transmission			5.4.19.1	Passed
Table 20 Data Acquisition through Read			5.4.20.1	Passed
Table 21 Acquisition of Events			-	Passed
Table 22 General Interrogation			5.4.22.1	Passed
Table 23 Clock Synchronisation			-	Passed
Table 24 Command Transmissions			-	Passed
Table 25 Transmission of Integrated Totals			-	Passed
Table 26 Parameter Loading			5.4.26.1	Passed
Table 27 Test Command			-	Passed
Table 28 File Transfer Procedure			N.A.	N.A.
Table 29 Delay Acquisition Procedure			-	Passed
Table 30 Additional Conformance Tests			-	Passed
Table 31 Negative Conformance Test Procedure			-	Passed
Table 32 PIXIT Related Conformance Test			N.A.	N.A.
TOTALS	**0**	**0**	**4**	**Passed**

* N.A. = Not Applicable

3.1 Conformance Test Conclusion

The assignment was to give a well-founded answer on the question:

"Does the IEC60870-5-101 Unbalanced Slave protocol implementation in the IPCOMM IpConv (software version 3.2) conform to the IEC60870-5-101 Companion Standard in Standard and Reversed direction, and the IpConv IEC 60870-5-101 Controlled Station Interoperability document (edition April 2011, Version 3.2) ?"

Based on the test results described in this report, KEMA declares the tested unbalanced slave CS101 implementation in the IPCOMM IpConv **in conformance** with the IEC 870-5-101 standard, and the IPCOMM IpConv IEC 60870-5-101 Controlled Station Interoperability document (edition April 2011, Version 3.2).

3.2 Remarks & Recommendations following from the test

1. Due to the flexibility in the configuration of the functions in the IPCOMM IpConv it is necessary to maintain a good administration about the parameters per station and per system. A slight difference in the configuration might have a lot of impact on the behaviour of every particular station/system. Pure configuration and database settings are not mentioned as they are part of the normal set-up procedure and do not imply any code changes.

2. If the use of SQ=1 is configured then data with non consecutive IOA addresses are not grouped in one frame with SQ=0, but all send in separate frames with SQ=1. Therefore the use of SQ=1 is not efficient if the IOA addresses are not in consecutive order.

3. Read command to a data point without time tag (e.g. single point ASDU 1) is answered with the corresponding data point with a long time tag (ASDU 30).

4 PROTOCOL IMPLEMENTATION CONFORMANCE STATEMENT (PICS)

IMPORTANT

The Protocol Implementation Conformance Statement (PICS) in this paragraph is the basis for the applicable test cases in Chapter 5. This PICS gives an overview of the tested protocol implementation, but this isn't a guarantee that the complete function or ASDU, as enabled in the PICS, is tested and supported. Partial testing is possible and the completeness of the tests for the specific function or ASDU should be consulted in Chapter 5.

The selected parameters should be marked in the white boxes as follows:

☐ Function or ASDU is not used
☒ Function or ASDU is used as standardized (default)
R Function or ASDU is used in reverse mode
B Function or ASDU is used in standard and reverse mode

The possible selection (blank, X, R, or B) is specified for each specific clause or parameter.

NOTE: In addition, the full specification of a system may require individual selection of certain parameters for certain parts of the system, such as the individual selection of scaling factors for individually addressable measured values.

4.1 System or device

(System-specific parameter, indicate the definition of a system or a device by marking one of the following with '**X**').

☐ System definition
☐ Controlling station definition
☒ Controlled station definition

4.2 Network configuration

(Network-specific parameter, all configurations that are used are to be marked '**X**').

[X]	Point-to-point	[X]	Multipoint-partyline
[X]	Multiple point-to-point	[X]	Multipoint-star

4.3 **Physical layer**

(network-specific parameter, all interfaces and data rates that are used are to be marked '**X**').

Transmission speed (control direction)

Unbalanced interchange Circuit V.24/V.28 Standard	Unbalanced interchange Circuit V.24/V.28 Recommended if >1 200bit/s	Balanced interchange Circuit X.24/X.27	
[ ] 100 bit/s	[X] 2 400 bit/s	[X] 2 400 bit/s	[X] 56 000 bit/s
[ ] 200 bit/s	[X] 4 800 bit/s	[X] 4 800 bit/s	[X] 64 000 bit/s
[X] 300 bit/s	[X] 9 600 bit/s	[X] 9 600 bit/s	
[X] 600 bit/s	[X] 19 200 bit/s	[X] 19 200 bit/s	
[X] 1 200 bit/s		[X] 38 400 bit/s	

Transmission speed (monitor direction)

Unbalanced interchange Circuit V.24/V.28 Standard	Unbalanced interchange Circuit V.24/V.28 Recommended if >1 200bit/s	Balanced interchange Circuit X.24/X.27	
[ ] 100 bit/s	[X] 2 400 bit/s	[X] 2 400 bit/s	[X] 56 000 bit/s
[ ] 200 bit/s	[X] 4 800 bit/s	[X] 4 800 bit/s	[X] 64 000 bit/s
[X] 300 bit/s	[X] 9 600 bit/s	[X] 9 600 bit/s	
[X] 600 bit/s	[X] 19 200 bit/s	[X] 19 200 bit/s	
[X] 1 200 bit/s		[X] 38 400 bit/s	

4.4 Link layer

(network-specific parameter, all options that are used are to be marked 'X'. Specify the maximum frame length. If a non-standard assignment of class 2 messages is implemented for unbalanced transmission, indicate the type ID and COT of all messages assigned to class 2.)

Frame format FT 1.2, single character 1 and the fixed time out interval are used exclusively in this companion standard.

Link transmission procedure

- [X] Balanced
- [X] Unbalanced

Frame length

- [255] Maximum length L

Address field of the link

- [X] Not present (balanced transmission
- [X] One octet
- [X] Two octets
- [ ] Structured
- [X] Unstructured

4.5 Application layer

Transmission mode for application data

Mode 1 (least significant octet first), as defined in 4.10 of IEC 60870-5-4, is used exclusively in this companion standard.

Common address of ASDU

(system-specific parameter, all configurations that are used are to be marked '**X**').

- [X] One octet
- [X] Two octets

Information object address

(system-specific parameter, all configurations that are used are to be marked '**X**').

- [X] One octet
- [X] Two octets
- [X] Three octets
- [X] Structured
- [X] Unstructured

Cause of transmission
(system-specific parameter, all configurations that are used are to be marked '**X**').

[X] One octet	[X] Two octets (with originator address) Set to zero in case of no originator address

Selection of standard ASDUs
Process information in monitor direction
(station-specific parameter, mark each type ID '**X**' if it is only used in the standard direction, '**R**' if only used in the reverse direction, and '**B**' if used in both directions).

[B]	<1>	:=	Single-point information	M_SP_NA_1
[X]	<2>	:=	Single-point information with time tag	M_SP_TA_1
[B]	<3>	:=	Double-point information	M_DP_NA_1
[X]	<4>	:=	Double-point information with time tag	M_DP_TA_1
[B]	<5>	:=	Step position information	M_ST_NA_1
[X]	<6>	:=	Step position information with time tag	M_ST_TA_1
[B]	<7>	:=	Bitstring of 32 bit	M_BO_NA_1
[X]	<8>	:=	Bitstring of 32 bit with time tag	M_BO_TA_1
[B]	<9>	:=	Measured value, normalized value	M_ME_NA_1
[X]	<10>	:=	Measured value, normalized value with time tag	M_ME_TA_1
[B]	<11>	:=	Measured value, scaled value	M_ME_NB_1
[X]	<12>	:=	Measured value, scaled value with time tag	M_ME_TB_1
[B]	<13>	:=	Measured value, short floating point value	M_ME_NC_1
[X]	<14>	:=	Measured value, short floating point value with time tag	M_ME_TC_1
[B]	<15>	:=	Integrated totals	M_IT_NA_1
[X]	<16>	:=	Integrated totals with time tag	M_IT_TA_1
[X]	<17>	:=	Event of protection equipment with time tag	M_EP_TA_1
[X]	<18>	:=	Packed start events of protection equipment with time tag	M_EP_TB_1
[X]	<19>	:=	Packed output circuit information of protection equipment with time tag	M_EP_TC_1
[ ]	<20>	:=	Packed single-point information with status change detection	M_PS_NA_1
[X]	<21>	:=	Measured value, normalized value without quality descriptor	M_ME_ND_1

B	<30> :=	Single-point information with time tag CP56Time2a	M_SP_TB_1
B	<31> :=	Double-point information with time tag CP56Time2a	M_DP_TB_1
B	<32> :=	Step position information with time tag CP56Time2a	M_ST_TB_1
B	<33> :=	Bitstring of 32 bit with time tag CP56Time2a	M_BO_TB_1
B	<34> :=	Measured value, normalized value with time tag CP56Time2a	M_ME_TD_1
B	<35> :=	Measured value, scaled value with time tag CP56Time2a	M_ME_TE_1
B	<36> :=	Measured value, short floating point value with time tag CP56Time2a	M_ME_TF_1
B	<37> :=	Integrated totals with time tag CP56Time2a	M_IT_TB_1
X	<38> :=	Event of protection equipment with time tag CP56Time2a	M_EP_TD_1
X	<39> :=	Packed start events of protection equipment with time tag CP56Time2a	M_EP_TE_1
X	<40> :=	Packed output circuit information of protection equipment with time tag CP56Time2a	M_EP_TF_1

Either ASDUs of the set <2>, <4>, <6>, <8>, <10>, <12>, <14>, <16>, <17>, <18>, <19> or of the set <30 –40> are used.

Process information in control direction

(station-specific parameter, mark each type ID '**X**' if it is only used in the standard direction, '**R**' if only used in the reverse direction, and '**B**' if used in both directions).

B	<45> :=	Single command	C_SC_NA_1
B	<46> :=	Double command	C_DC_NA_1
B	<47> :=	Regulating step command	C_RC_NA_1
B	<48> :=	Set point command, normalized value	C_SE_NA_1
B	<49> :=	Set point command, scaled value	C_SE_NB_1
B	<50> :=	Set point command, short floating point value	C_SE_NC_1
B	<51> :=	Bitstring of 32 bit	C_BO_NA_1

System information in monitor direction

(station-specific parameter, mark '**X**' if it is only used in the standard direction, '**R**' if only used in the reverse direction, and '**B**' if used in both directions)

X	<70> :=	End of initialization	M_EI_NA_1

System information in control direction

(station-specific parameter, mark each type ID '**X**' if it is only used in the standard direction, '**R**' if only used in the reverse direction, and '**B**' if used in both directions)

B	<100>:=	Interrogation command	C_IC_NA_1
B	<101>:=	Counter interrogation command	C_CI_NA_1
X	<102>:=	Read command	C_RD_NA_1
X	<103>:=	Clock synchronization command	
X	<104>:=	Test command	C_TS_NA_1
X	<105>:=	Reset process command	C_RP_NA_1
X	<106>:=	Delay acquisition command	C_CD_NA_1

Parameter in control direction

(station-specific parameter, mark each type ID '**X**' if it is only used in the standard direction, '**R**' if only used in the reverse direction, and '**B**' if used in both directions)

X	<110>:=	Parameter of measured value, normalized value	P_ME_NA_1
X	<111>:=	Parameter of measured value, scaled value	P_ME_NB_1
X	<112>:=	Parameter of measured value, short floating point value	P_ME_NC_1
	<113>:=	Parameter activation	P_AC_NA_1

File Transfer

(station-specific parameter, mark each type ID '**X**' if it is only used in the standard direction, '**R**' if only used in the reverse direction, and '**B**' if used in both directions)

	<120>:=	File ready	F_FR_NA_1
	<121>:=	Section ready	F_SR_NA_1
	<122>:=	Call directory, select file, call file, call section	F_SC_NA_1
	<123>:=	Last section, last segment	F_LS_NA_1
	<124>:=	Ack file, ack section	F_AF_NA_1
	<125>:=	Segment	F_SG_NA_1
	<126>:=	Directory {blank or X, only available in monitor (standard) direction}	F_DR_TA_1

Type identifier and cause of transmission assignments

(station-specific parameters)

Shaded boxes are not required.

Blank = function or ASDU is not used.

Mark type identification/cause of transmission combinations:

'**X**' if used only in the standard direction.

Type identification		Cause of transmission																		
		1	2	3	4	5	6	7	8	9	10	11	12	13	20 to 36	37 to 41	44	45	46	47
<1>	M_SP_NA_1		X	B								B	B		B					
<2>	M_SP_TA_1			X								X	X							
<3>	M_DP_NA_1		X	B								B	B		B					
<4>	M_DP_TA_1			X								X	X							
<5>	M_ST_NA_1		X	B								B	B		B					
<6>	M_ST_TA_1			X								X	X							
<7>	M_BO_NA_1		X	B											B					
<8>	M_BO_TA_1			X																
<9>	M_ME_NA_1	X	X	B											B					
<10>	M_ME_TA_1			X																
<11>	M_ME_NB_1	X	X	B											B					
<12>	M_ME_TB_1			X																
<13>	M_ME_NC_1	X	X	B											B					
<14>	M_ME_TC_1			X																
<15>	M_IT_NA_1			B												B				
<16>	M_IT_TA_1			X												X				
<17>	M_EP_TA_1			X																
<18>	M_EP_TB_1			X																
<19>	M_EP_TC_1			X																
<20>	M_PS_NA_1																			
<21>	M_ME_ND_1	X	X	X											X					
<30>	M_SP_TB_1			B		X						B	B							
<31>	M_DP_TB_1			B		X						B	B							
<32>	M_ST_TB_1			B		X						B	B							
<33>	M_BO_TB_1			B		X														
<34>	M_ME_TD_1			B		X														
<35>	M_ME_TE_1			B		X														
<36>	M_ME_TF_1			B		X														
<37>	M_IT_TB_1			B												B				
<38>	M_EP_TD_1			X																
<39>	M_EP_TE_1			X																
<40>	M_EP_TF_1			X																
<45>	C_SC_NA_1						B	B	B	B	B						X	X	X	X
<46>	C_DC_NA_1						B	B	B	B	B						X	X	X	X

Type identification		Cause of transmission																		
		1	2	3	4	5	6	7	8	9	10	11	12	13	20 to 36	37 to 41	44	45	46	47
<47>	C_RC_NA_1						B	B	B	B	B						X	X	X	X
<48>	C_SE_NA_1						B	B	B	B	B						X	X	X	X
<49>	C_SE_NB_1						B	B	B	B	B						X	X	X	X
<50>	C_SE_NC_1						B	B	B	B	B						X	X	X	X
<51>	C_BO_NA_1						B	B	B	B	B						X	X	X	X
<70>	M_EI_NA_1				X															
<100>	C_IC_NA_1						B	B	X	X	B						B	B	B	B
<101>	C_CI_NA_1						B	B			B						B	B	B	B
<102>	C_RD_NA_1					X											X	X	X	X
<103>	C_CS_NA_1			X			X	X									X	X	X	
<104>	C_TS_NA_1						X	X									X	X	X	
<105>	C_RP_NA_1						X	X									X	X	X	
<106>	C_CD_NA_1			X			X	X									X		X	
<110>	P_ME_NA_1						X	X									X		X	X
<111>	P_ME_NB_1						X	X									X		X	X
<112>	P_ME_NC_1						X	X									X		X	X
<113>	P_AC_NA_1																			
<120>	F_FR_NA_1																			
<121>	F_SR_NA_1																			
<122>	F_SC_NA_1																			
<123>	F_LS_NA_1																			
<124>	F_AF_NA_1																			
<125>	F_SG_NA_1																			
<126>	F_DR_TA_1*																			

4.6 Basic application functions

Station initialization
(station-specific parameter, mark 'X' if function is used).

[X] Remote initialisation

Cyclic data transmission
(station-specific parameter, mark 'X' if function is used only in the standard direction, 'R' if used only in the reverse direction, and 'B' if used in both directions).

[X] Cyclic data transmission

Read procedure
(station-specific parameter, mark 'X' if function is used only in the standard direction, 'R' if used only in the reverse direction, and 'B' if used in both directions).

[X] Read procedure

Spontaneous transmission
(station-specific parameter, mark '**X**' if function is used only in the standard direction, '**R**' if used only in the reverse direction, and '**B**' if used in both directions).

[B] Spontaneous transmission

Double transmission of information objects with cause of transmission spontaneous
(station-specific parameter, mark each information type 'X' where both a type ID without time and corresponding type ID with time are issued in response to a single spontaneous change of a monitored object).

The following type identifications may be transmitted in succession caused by a single status change of an information object. The particular information object addresses for which double transmission is enabled are defined in a project-specific list.

[X] Single-point information M_SP_NA_1, M_SP_TA_1, M_SP_TB_1 and M_PS_NA_1
[X] Double-point information M_DP_NA_1, M_DP_TA_1 and M_DP_TB_1
[X] Step position information M_ST_NA_1, M_ST_TA_1 and M_ST_TB_1
[X] Bitstring of 32 bit M_BO_NA_1, M_BO_TA_1 and M_BO_TB_1 (if defined for a specific project,
[X] Measured value, normalized value M_ME_NA_1, M_ME_TA_1, M_ME_ND_1 and
[X] Measured value, scaled value M_ME_NB_1, M_ME_TB_1 and M_ME_TE_1
[X] Measured value, short floating point number M_ME_NC_1, M_ME_TC_1 and

Station interrogation
(station-specific parameter, mark '**X**' if function is used only in the standard direction, '**R**' if used only in the reverse direction, and '**B**' if used in both directions)

[B] global

[X] group 1
[X] group 2
[X] group 3
[X] group 4
[X] group 5
[X] group 6
[X] group 7
[X] group 8
[X] group 9
[X] group 10
[X] group 11
[X] group 12
[X] group 13
[X] group 14
[X] group 15
[X] group 16

Information object addresses assigned to each group must be shown in a separate table

Clock synchronization
(station-specific parameter, mark '**X**' if function is used only in the standard direction, '**R**' if used only in the reverse direction, and '**B**' if used in both directions)

[X] Clock synchronization
[ ] RES1, GEN (time tag substituted/not substituted used
[X] Day of week used
[X] SU-bit (summertime) used

Command transmission
(object-specific parameter, mark '**X**' if function is used only in the standard direction, '**R**' if used only in the reverse direction, and '**B**' if used in both directions)

[B] Direct command transmission
[B] Direct set-point command transmission
[B] Select and execute command
[B] Select and execute set-point command
[B] C_SE ACTTERM used

[B] No additional definition
[X] Short pulse duration (duration determined by a system parameter in the controlled station)
[X] Long pulse duration (duration determined by a system parameter in the controlled
[ ] Persistent output

Transmission of integrated totals
(station- or object-specific parameter, mark '**X**' if function is used only in the standard direction, '**R**' if used only in the reverse direction, and '**B**' if used in both directions)

[B] Mode A: local freeze with spontaneous
[B] Mode B: local freeze with counter
[X] Mode C: freeze and transmit by counter interrogation
[X] Mode D: freeze by counter interrogation command, frozen values reported

[B] Counter read
[X] Counter freeze without reset
[X] Counter freeze with reset
[X] Counter reset

[B] General request counter
[B] Request counter group 1
[B] Request counter group 2
[B] Request counter group 3
[B] Request counter group 4

Parameter loading
(object-specific parameter, mark '**X**' if function is used only in the standard direction, '**R**' if used only in the reverse direction, and '**B**' if used in both directions)

[X] Threshold value
[X] Smoothing factor
[ ] Low limit for transmission of measured value
[ ] High limit for transmission of measured value

Parameter activation
(object-specific parameter, mark '**X**' if function is used only in the standard direction, '**R**' if used only in the reverse direction, and '**B**' if used in both directions)

[ ] Act/deact of persistent cyclic or periodic transmission of the addressed object

Test procedure
(station-specific parameter, mark '**X**' if function is used only in the standard direction, '**R**' if used only in the reverse direction, and '**B**' if used in both directions)

[B] Test

File transfer
(station-specific parameter, mark '**X**' if function is used)

File transfer in monitor direction
[ ] Transparent file
[ ] Transmission of disturbance data of protection
[ ] Transmission of sequences of events
[ ] Transmission of sequences of recorded analogue values

File transfer in control direction
☐ Transparent file

Background scan
(station-specific parameter, mark '**X**' if function is used only in the standard direction, '**R**' if used only in the reverse direction, and '**B**' if used in both directions)

☒ Background scan

Acquisition of transmission delay
(station-specific parameter, mark '**X**' if function is used only in the standard direction, '**R**' if used only in the reverse direction, and '**B**' if used in both directions)

☒ Acquisition of transmission delay

5 TEST RESULTS CONFORMANCE TESTING IEC 60870-5-101

The test result charts described in this chapter are based upon the conformance test procedures as described in the IEC 60870-5-601 document. For a full description of the test cases is presented in that document.

5.1 Test Results Chart

	Record the conformance test procedure result for each of the supported configuration parameter values on the right	Station type		Transmission speed				Trans-mission type		Address field of the link			Assign-ment class 2		Common address of ASDU		Information object address			Cause of trans-mission	
	√ indicates the test procedure passed for that configuration value. FAIL indicates Test Procedure failed for at least one of the Test Cases. N.A. indicates that configuration value is not supported by the device. Empty indicates the Test Procedure was not performed. (There should be no empty boxes when testing is complete).	Controlling station test (Master)	Controlled station test (Slave)	Max. Transmission speed in control direction	Min. Transmission speed in control direction	Max. Transmission speed in monitor direction	Min. Transmission speed in monitor direction	Unbalanced transmission	Balanced transmission	Zero (0) octets for address field (balanced only)	One (1) octet for address field	Two (2) octets for address field	Standard assignment of class 2 messages	Special assignments of class 2 messages	One (1) octet for Common Address of ASDU (CASDU)	Two (2) octets for Common Address of ASDU (CASDU)	One (1) octet for Information Object Address (structured or unstructured)	Two (2) octets for Information Object Address (structured or unstructured)	Three (3) octets for Information Object Address (structured or unstructured)	One (1) octet for COT field	Two (2) octets for COT field (2^{nd} octet is Originator address)
Frame length	**5.2.1.50 Maximum length L (control direction)**	N.A	✓																		
	5.2.1.51 Maximum length L (monitor direction)	N.A	✓																		
Physical layer	**5.3.2.1 Byte frame**	N.A	✓																		
Verification of link level	**5.3.3.10 FT1.2 Frame Layout**	N.A	✓																		
	5.3.3.30 Byte lag	N.A	✓																		
	5.3.3.40 Control Field	N.A	✓																		
	5.3.3.60 Unbalanced Transmission Procedure	N.A	✓																		
	5.3.3.80 Balanced Transmission Procedure	N.A	N.A																		

	Record the conformance test procedure result for each of the supported configuration parameter values on the right	Station type		Transmission speed				Trans-mission type		Address field of the link			Assign-ment class 2		Common address of ASDU		Information object address			Cause of trans-mission	
	√ indicates the test procedure passed for that configuration value. FAIL indicates Test Procedure failed for at least one of the Test Cases. N.A. indicates that configuration value is not supported by the device. Empty indicates the Test Procedure was not performed. (There should be no empty boxes when testing is complete).	Controlling station test (Master)	Controlled station test (Slave)	Max. Transmission speed in control direction	Min. Transmission speed in control direction	Max. Transmission speed in monitor direction	Min. Transmission speed in monitor direction	Unbalanced transmission	Balanced transmission	Zero (0) octets for address field (balanced only)	One (1) octet for address field	Two (2) octets for address field	Standard assignment of class 2 messages	Special assignments of class 2 messages	One (1) octet for Common Address of ASDU (CASDU)	Two (2) octets for Common Address of ASDU (CASDU)	One (1) octet for Information Object Address (structured or unstructured)	Two (2) octets for Information Object Address (structured or unstructured)	Three (3) octets for Information Object Address (structured or unstructured)	One (1) octet for COT field	Two (2) octets for COT field (2nd octet is Originator address)
	5.3.3.100 Time Out Interval	N.A	✓																		
Verification of data unit identifier	**5.3.4.1 Type Identification**	N.A	✓																		
	5.3.4.10 Variable Structure Qualifier	N.A	✓																		
	5.3.4.20 Cause of Transmission	N.A	✓																		
Verification of ASDUs	**5.3.6.10 ASDU 1 Single-point Information**	N.A	✓																		
	5.3.6.30 ASDU 2 Single-point Information with Timetag	N.A	✓																		
	5.3.6.50 ASDU 3 Double-point Information	N.A	✓																		
	5.3.6.70 ASDU 4 Double-point Information with Timetag	N.A	✓																		
	5.3.6.90 ASDU 5 Step-position Information	N.A	✓																		
	5.3.6.110 ASDU 6 Step-position Information with Timetag	N.A	✓																		
	5.3.6.130 ASDU 7 Bitstring of 32 bit	N.A	✓																		
	5.3.6.150 ASDU 8 Bitstring of 32 bit with Timetag	N.A	✓																		
	5.3.6.170 ASDU 9 Measured value, normalised value	N.A	✓																		

	Record the conformance test procedure result for each of the supported configuration parameter values on the right	Station type		Transmission speed				Trans-mission type		Address field of the link			Assign-ment class 2		Common address of ASDU		Information object address			Cause of trans-mission	
	√ indicates the test procedure passed for that configuration value. FAIL indicates Test Procedure failed for at least one of the Test Cases. N.A. indicates that configuration value is not supported by the device. Empty indicates the Test Procedure was not performed. (There should be no empty boxes when testing is complete).	Controlling station test (Master)	Controlled station test (Slave)	Max. Transmission speed in control direction	Min. Transmission speed in control direction	Max. Transmission speed in monitor direction	Min. Transmission speed in monitor direction	Unbalanced transmission	Balanced transmission	Zero (0) octets for address field (balanced only)	One (1) octet for address field	Two (2) octets for address field	Standard assignment of class 2 messages	Special assignments of class 2 messages	One (1) octet for Common Address of ASDU (CASDU)	Two (2) octets for Common Address of ASDU (CASDU)	One (1) octet for Information Object Address (structured or unstructured)	Two (2) octets for Information Object Address (structured or unstructured)	Three (3) octets for Information Object Address (structured or unstructured)	One (1) octet for COT field	Two (2) octets for COT field (2nd octet is Originator address)
	5.3.6.190 ASDU 10 Measured value, normalised value with Timetag	N.A	✓																		
	5.3.6.210 ASDU 11 Measured value, scaled value	N.A	✓																		
	5.3.6.230 ASDU 12 Measured value, scaled value with Timetag	N.A	✓																		
	5.3.6.250 ASDU 13 Measured value, short floating point number	N.A	✓																		
	5.3.6.270 ASDU 14 Measured value, short floating point number with Timetag	N.A	✓																		
	5.3.6.300 ASDU 15 Integrated Totals	N.A	✓																		
	5.3.6.320 ASDU 16 Integrated Totals with Timetag	N.A	✓																		
	5.3.6.340 ASDU 17 Event of protection equipment with Timetag	N.A	✓																		
	5.3.6.360 ASDU 18 Packed start events of protection equipment with time-tag	N.A	✓																		
	5.3.6.390 ASDU 19 Packet output circuit information of protection equipment with time tag	N.A	✓																		
	5.3.6.420 ASDU 20 Packed single-point information with status change detection	N.A	N.A																		

	Record the conformance test procedure result for each of the supported configuration parameter values on the right	Station type		Transmission speed				Trans-mission type		Address field of the link			Assign-ment class 2		Common address of ASDU		Information object address			Cause of trans-mission	
	√ indicates the test procedure passed for that configuration value. FAIL indicates Test Procedure failed for at least one of the Test Cases. N.A. indicates that configuration value is not supported by the device. Empty indicates the Test Procedure was not performed. (There should be no empty boxes when testing is complete).	Controlling station test (Master)	Controlled station test (Slave)	Max. Transmission speed in control direction	Min. Transmission speed in control direction	Max. Transmission speed in monitor direction	Min. Transmission speed in monitor direction	Unbalanced transmission	Balanced transmission	Zero (0) octets for address field (balanced only)	One (1) octet for address field	Two (2) octets for address field	Standard assignment of class 2 messages	Special assignments of class 2 messages	One (1) octet for Common Address of ASDU (CASDU)	Two (2) octets for Common Address of ASDU (CASDU)	One (1) octet for Information Object Address (structured or unstructured)	Two (2) octets for Information Object Address (structured or unstructured)	Three (3) octets for Information Object Address (structured or unstructured)	One (1) octet for COT field	Two (2) octets for COT field (2^{nd} octet is Originator address)
	5.3.6.440 ASDU 21 Measured value, normalised value without quality descriptor	N.A	✓																		
	5.3.6.450 ASDU 30 Single-point information with time tag CP56Time2a	N.A	✓																		
	5.3.6.480 ASDU 31 Double-point information with time tag CP56Time2a	N.A	✓																		
	5.3.6.510 ASDU 32 Step-position information with time-tag CP56Time2a	N.A	✓																		
	5.3.6.540 ASDU 33 Bitstring of 32 bit with time-tag CP56Time2a	N.A	✓																		
	5.3.6.570 ASDU 34 Measured value, normalised value with time-tag CP56Time2a	N.A	✓																		
	5.3.6.600 ASDU 35 Measured value, scaled value with time-tag CP56Time2a	N.A	✓																		
	5.3.6.630 ASDU 36 Measured value, short floating point number with time-tag CP56Time2a	N.A	✓																		
	5.3.6.660 ASDU 37 Integrated totals with time tag CP56Time2a	N.A	✓																		
	5.3.6.690 ASDU 38 Event of protection equipment with time-tag CP56Time2a	N.A	✓																		

	Record the conformance test procedure result for each of the supported configuration parameter values on the right	Station type		Transmission speed				Trans-mission type		Address field of the link			Assign-ment class 2		Common address of ASDU		Information object address			Cause of trans-mission	
	√ indicates the test procedure passed for that configuration value. FAIL indicates Test Procedure failed for at least one of the Test Cases. N.A. indicates that configuration value is not supported by the device. Empty indicates the Test Procedure was not performed. (There should be no empty boxes when testing is complete).	Controlling station test (Master)	Controlled station test (Slave)	Max. Transmission speed in control direction	Min. Transmission speed in control direction	Max. Transmission speed in monitor direction	Min. Transmission speed in monitor direction	Unbalanced transmission	Balanced transmission	Zero (0) octets for address field (balanced only)	One (1) octet for address field	Two (2) octets for address field	Standard assignment of class 2 messages	Special assignments of class 2 messages	One (1) octet for Common Address of ASDU (CASDU)	Two (2) octets for Common Address of ASDU (CASDU)	One (1) octet for Information Object Address (structured or unstructured)	Two (2) octets for Information Object Address (structured or unstructured)	Three (3) octets for Information Object Address (structured or unstructured)	One (1) octet for COT field	Two (2) octets for COT field (2^{nd} octet is Originator address)
	5.3.6.720 ASDU 39 Packed start events of protection equipment with time-tag CP56Time2a	N.A	✓																		
	5.3.6.760 ASDU 40 Packet output circuit information of protection equipment with time tag CP56Time2a	N.A	✓																		
	5.3.7.1 ASDU 45 Single Command	N.A	✓																		
	5.3.7.10 ASDU 46 Double Command	N.A	✓																		
	5.3.7.20 ASDU 47 Regulating step command	N.A	✓																		
	5.3.7.30 ASDU 48 Set point command, normalised value	N.A	✓																		
	5.3.7.40 ASDU 49 Set point command, scaled value	N.A	✓																		
	5.3.7.50 ASDU 50 Set point command, short floating point value	N.A	✓																		
	5.3.7.60 ASDU 51 Bitstring of 32 bits	N.A	✓																		
	5.3.8.1 ASDU 70 End of Initialisation	N.A	✓																		
	5.3.9.1 ASDU 100 Interrogation command	N.A	✓																		
	5.3.9.10 ASDU 101 Counter interrogation command	N.A	✓																		

	Record the conformance test procedure result for each of the supported configuration parameter values on the right	Station type		Transmission speed				Trans-mission type		Address field of the link			Assign-ment class 2		Common address of ASDU		Information object address			Cause of trans-mission	
	√ indicates the test procedure passed for that configuration value. FAIL indicates Test Procedure failed for at least one of the Test Cases. N.A. indicates that configuration value is not supported by the device. Empty indicates the Test Procedure was not performed. (There should be no empty boxes when testing is complete).	Controlling station test (Master)	Controlled station test (Slave)	Max. Transmission speed in control direction	Min. Transmission speed in control direction	Max. Transmission speed in monitor direction	Min. Transmission speed in monitor direction	Unbalanced transmission	Balanced transmission	Zero (0) octets for address field (balanced only)	One (1) octet for address field	Two (2) octets for address field	Standard assignment of class 2 messages	Special assignments of class 2 messages	One (1) octet for Common Address of ASDU (CASDU)	Two (2) octets for Common Address of ASDU (CASDU)	One (1) octet for Information Object Address (structured or unstructured)	Two (2) octets for Information Object Address (structured or unstructured)	Three (3) octets for Information Object Address (structured or unstructured)	One (1) octet for COT field	Two (2) octets for COT field (2nd octet is Originator address)
	5.3.9.20 ASDU 102 Read command	N.A	✓																		
	5.3.9.30 ASDU 103 Clock synchronisation command	N.A	✓																		
	5.3.9.50 ASDU 104 Test command	N.A	✓																		
	5.3.9.60 ASDU 105 Reset process command	N.A	✓																		
	5.3.9.70 ASDU 106 Delay acquisition command	N.A	✓																		
	5.3.10.1 ASDU 110 Parameter of measured value, normalised value	N.A	✓																		
	5.3.10.10 ASDU 111 Parameter of measured values, scaled value	N.A	✓																		
	5.3.10.20 ASDU 112 Parameter of measured values, short floating point number	N.A	✓																		
	5.3.10.30 ASDU 113 Parameter activation	N.A	N.A																		
	5.3.11.1 ASDU 120 File ready	N.A	N.A																		
	5.3.11.10 ASDU 121 Section ready	N.A	N.A																		
	5.3.11.30 ASDU 122 Call directory, select file, call file, call section	N.A	N.A																		
	5.3.11.40 ASDU 123 Last section, last segment	N.A	N.A																		

	Record the conformance test procedure result for each of the supported configuration parameter values on the right	Station type		Transmission speed				Trans-mission type		Address field of the link			Assign-ment class 2		Common address of ASDU		Information object address			Cause of trans-mission	
	√ indicates the test procedure passed for that configuration value. FAIL indicates Test Procedure failed for at least one of the Test Cases. N.A. indicates that configuration value is not supported by the device. Empty indicates the Test Procedure was not performed. (There should be no empty boxes when testing is complete).	Controlling station test (Master)	Controlled station test (Slave)	Max. Transmission speed in control direction	Min. Transmission speed in control direction	Max. Transmission speed in monitor direction	Min. Transmission speed in monitor direction	Unbalanced transmission	Balanced transmission	Zero (0) octets for address field (balanced only)	One (1) octet for address field	Two (2) octets for address field	Standard assignment of class 2 messages	Special assignments of class 2 messages	One (1) octet for Common Address of ASDU (CASDU)	Two (2) octets for Common Address of ASDU (CASDU)	One (1) octet for Information Object Address (structured or unstructured)	Two (2) octets for Information Object Address (structured or unstructured)	Three (3) octets for Information Object Address (structured or unstructured)	One (1) octet for COT field	Two (2) octets for COT field (2nd octet is Originator address)
	5.3.11.50 ASDU 124 ACK file, ACK section	N.A	N.A																		
	5.3.11.60 ASDU 125 Segment	N.A	N.A																		
	5.3.11.70 ASDU 126 Directory	N.A	N.A																		
Link Layer	**5.4.12.1 Frame Count Bit**	N.A	✓																		
	5.4.12.2 Invalid Checksum	N.A	✓																		
	5.4.12.3 Time Out Interval	N.A	N.A																		
	5.4.12.4 Address Field	N.A	✓																		
Data Unit Identifier	**5.4.13.1 Type Identification**	N.A	✓																		
	5.4.13.5 Cause Of Transmission	N.A	✓																		
	5.4.13.10 Common Address of ASDU	N.A	✓																		
Information object address	**5.4.14.1 Object Address**	N.A	✓																		
Station	**5.4.15.1 Initialisation of the controlling station in unbalanced transmission systems: (re-)boot**	N.A		N.A	N.A	N.A	N.A	NA		N.A	N.A	N.A	N.A	NA	N.A	N.A	N.A	N.A	N.A	NA	N.A

	Record the conformance test procedure result for each of the supported configuration parameter values on the right	Station type		Transmission speed				Trans-mission type		Address field of the link			Assign-ment class 2		Common address of ASDU		Information object address			Cause of trans-mission	
	√ indicates the test procedure passed for that configuration value. FAIL indicates Test Procedure failed for at least one of the Test Cases. N.A. indicates that configuration value is not supported by the device. Empty indicates the Test Procedure was not performed. (There should be no empty boxes when testing is complete).	Controlling station test (Master)	Controlled station test (Slave)	Max. Transmission speed in control direction	Min. Transmission speed in control direction	Max. Transmission speed in monitor direction	Min. Transmission speed in monitor direction	Unbalanced transmission	Balanced transmission	Zero (0) octets for address field (balanced only)	One (1) octet for address field	Two (2) octets for address field	Standard assignment of class 2 messages	Special assignments of class 2 messages	One (1) octet for Common Address of ASDU (CASDU)	Two (2) octets for Common Address of ASDU (CASDU)	One (1) octet for Information Object Address (structured or unstructured)	Two (2) octets for Information Object Address (structured or unstructured)	Three (3) octets for Information Object Address (structured or unstructured)	One (1) octet for COT field	Two (2) octets for COT field (2^{nd} octet is Originator address)
initialisation function (unbalanced systems)	**5.4.15.10 Local initialisation of the controlled station in unbalanced transmission systems: (re-)boot[3]**		✓	✓	✓	✓	✓	✓		N.A	✓	✓	✓	NA	✓	✓	✓	✓	✓	✓	✓
	5.4.15.20 Remote initialisation of the controlled station in unbalanced transmission systems		✓	✓	✓	✓	✓	✓		N.A	✓	✓	✓	NA	✓	✓	✓	✓	✓	✓	✓
	5.4.15.30 Re-establishing a broken link between the Controlling and the Controlled station in unbalanced transmission systems	N.A	✓	✓	✓	✓	✓	✓		N.A	✓	✓	✓	NA	✓	✓	✓	✓	✓	✓	✓
	5.4.15.40 Compatibility With Other Test Cases	N.A	✓	✓	✓	✓	✓	✓		N.A	✓	✓	✓	NA	✓	✓	✓	✓	✓	✓	✓
Data acquisition by polling function (unbalanced systems)	**5.4.16.1 Data acquisition by polling in Unbalanced transmission systems – sequential procedure**	N.A	✓	✓	✓	✓	✓	✓		N.A	✓	✓	✓	NA	✓	✓	✓	✓	✓	✓	✓
	5.4.16.10 COM Compatibility With Other Test Cases	N.A	✓	✓	✓	✓	✓	✓		N.A	✓	✓	✓	NA	✓	✓	✓	✓	✓	✓	✓
Station	**5.4.17.1 Initialisation of the controlling station in BALanced transmission systems: (re-)boot**	N.A		N.A	N.A	N.A	N.A		NA	N.A	N.A	N.A	N.A	NA	N.A	N.A	N.A	N.A	N.A	NA	N.A

[3] For the End of Init (ASDU type 70), the SUT could only send COI = 0. Values 1 and 2 are not supported.

	Record the conformance test procedure result for each of the supported configuration parameter values on the right	Station type		Transmission speed				Trans-mission type		Address field of the link			Assign-ment class 2		Common address of ASDU		Information object address			Cause of trans-mission	
	√ indicates the test procedure passed for that configuration value. FAIL indicates Test Procedure failed for at least one of the Test Cases. N.A. indicates that configuration value is not supported by the device. Empty indicates the Test Procedure was not performed. (There should be no empty boxes when testing is complete).	Controlling station test (Master)	Controlled station test (Slave)	Max. Transmission speed in control direction	Min. Transmission speed in control direction	Max. Transmission speed in monitor direction	Min. Transmission speed in monitor direction	Unbalanced transmission	Balanced transmission	Zero (0) octets for address field (balanced only)	One (1) octet for address field	Two (2) octets for address field	Standard assignment of class 2 messages	Special assignments of class 2 messages	One (1) octet for Common Address of ASDU (CASDU)	Two (2) octets for Common Address of ASDU (CASDU)	One (1) octet for Information Object Address (structured or unstructured)	Two (2) octets for Information Object Address (structured or unstructured)	Three (3) octets for Information Object Address (structured or unstructured)	One (1) octet for COT field	Two (2) octets for COT field (2nd octet is Originator address)
initialisation function (balanced systems)	**5.4.17.10 Local initialisation of the controlled station in BALanced transmission systems: (re-)boot**		N.A	N.A	N.A	N.A	N.A		N.A	N.A	N.A	N.A	N.A	NA	N.A	N.A	N.A	N.A	N.A	NA	N.A
	5.4.17.20 Remote initialisation of the controlled station in BALanced transmission systems		N.A	N.A	N.A	N.A	N.A		N.A	N.A	N.A	N.A	N.A	NA	N.A	N.A	N.A	N.A	N.A	NA	N.A
	5.4.17.30 Re-establishing a broken link between the Controlling and the Controlled station in BALanced transmission systems	N.A	N.A	N.A	N.A	N.A	N.A		N.A	N.A	N.A	N.A	N.A	NA	N.A	N.A	N.A	N.A	N.A	NA	N.A
	5.4.17.40 Compatibility With Other Test Cases	N.A	N.A	N.A	N.A	N.A	N.A		N.A	N.A	N.A	N.A	N.A	NA	N.A	N.A	N.A	N.A	N.A	NA	N.A
Redundant link	5.4.18.1 Periodic check of ALL redundant connections	N.A	N.A	N.A	N.A	N.A	N.A	NA	N.A	N.A	N.A	N.A	N.A	NA	N.A	N.A	N.A	N.A	N.A	NA	N.A
	Both lines are fully initialized, on both lines Test function of Link are transmitted. On primary answered with Ack, on secondary answered with NACK	N.A	N.A	N.A	N.A	N.A	N.A	N.A	N.A	N.A	N.A	N.A	N.A	NA	N.A	N.A	N.A	N.A	N.A	NA	N.A
	Switch over it established bij sending a command (GI, Test command) on the secondary line. From then on test functions of link on secondary are answered with ACK and on primary with NACK	N.A	N.A	N.A	N.A	N.A	N.A	NA	N.A	N.A	N.A	N.A	N.A	NA	N.A	N.A	N.A	N.A	N.A	NA	N.A
	Switchback is performed accordingly	N.A	N.A	N.A	N.A	N.A	N.A	NA	N.A	N.A	N.A	N.A	N.A	NA	N.A	N.A	N.A	N.A	N.A	NA	N.A
Cyclic data transmission	**5.4.19.1 Cyclic data transmission and Background Scan – sequential procedure**[4]	N.A	✓	✓	✓	✓	✓	NA	✓	N.A	✓	✓	✓	NA	✓	✓	✓	✓	✓	✓	✓

[4] If the use of SQ=1 is configured then data with non consecutive IOA addresses are not grouped in one frame with SQ=0, but all send in separate frames with SQ=1. Therefore the use of SQ=1 is not efficient if the IOA addresses are not in consecutive order.

	Record the conformance test procedure result for each of the supported configuration parameter values on the right	Station type		Transmission speed				Trans-mission type		Address field of the link			Assign-ment class 2		Common address of ASDU		Information object address			Cause of trans-mission	
	√ indicates the test procedure passed for that configuration value. FAIL indicates Test Procedure failed for at least one of the Test Cases. N.A. indicates that configuration value is not supported by the device. Empty indicates the Test Procedure was not performed. (There should be no empty boxes when testing is complete).	Controlling station test (Master)	Controlled station test (Slave)	Max. Transmission speed in control direction	Min. Transmission speed in control direction	Max. Transmission speed in monitor direction	Min. Transmission speed in monitor direction	Unbalanced transmission	Balanced transmission	Zero (0) octets for address field (balanced only)	One (1) octet for address field	Two (2) octets for address field	Standard assignment of class 2 messages	Special assignments of class 2 messages	One (1) octet for Common Address of ASDU (CASDU)	Two (2) octets for Common Address of ASDU (CASDU)	One (1) octet for Information Object Address (structured or unstructured)	Two (2) octets for Information Object Address (structured or unstructured)	Three (3) octets for Information Object Address (structured or unstructured)	One (1) octet for COT field	Two (2) octets for COT field (2^{nd} octet is Originator address)
function	**5.4.19.10 Compatibility With Other Test Cases**	N.A	✓	✓	✓	✓	✓	NA	✓	N.A	✓	✓	✓	NA	✓	✓	✓	✓	✓	✓	✓
Data acquisition through Read function	**5.4.20.1 Data acquisition through Read – sequential procedure**[5]	N.A	✓	✓	✓	✓	✓	NA	✓	N.A	✓	✓	✓	NA	✓	✓	✓	✓	✓	✓	✓
	5.4.20.10 Compatibility With Other Test Cases	N.A	✓	✓	✓	✓	✓	NA	✓	N.A	✓	✓	✓	NA	✓	✓	✓	✓	✓	✓	✓
Acquisition of events function	**5.4.21.1 Acquisition of events -sequential procedure**	N.A	✓	✓	✓	✓	✓	NA	✓	N.A	✓	✓	✓	NA	✓	✓	✓	✓	✓	✓	✓
	5.4.21.10 Compatibility With Other Test Cases	N.A	✓	✓	✓	✓	✓	NA	✓	N.A	✓	✓	✓	NA	✓	✓	✓	✓	✓	✓	✓
General interrogation function	**5.4.22.1 Outstation interrogation – one Logical Remote Unit (LRU) available in the controlled station**[4]	N.A	✓	✓	✓	✓	✓	NA	✓	N.A	✓	✓	✓	NA	✓	✓	✓	✓	✓	✓	✓
	5.4.22.10 Outstation interrogation – more than one Logical Remote Unit (LRU) available in the controlled station -	N.A	N.A	N.A	N.A	N.A	N.A	NA	NA	N.A	N.A	N.A	N.A	NA	N.A	N.A	N.A	N.A	N.A	NA	N.A
	5.4.22.20 Re-activate a running Outstation interrogation – Option 1: the running GI continues.	N.A	N.A	N.A	N.A	N.A	N.A	NA	N.A	N.A	N.A	N.A	N.A	NA	N.A	N.A	N.A	N.A	N.A	NA	N.A
	5.4.22.30 Re-activate a running Outstation interrogation Option 2: the running GI is stopped and the second GI is started.	N.A	✓	✓	✓	✓	✓	NA	✓	N.A	✓	✓	✓	NA	✓	✓	✓	✓	✓	✓	✓

[5] Read command to data point without time tag is answered with the corresponding data point with long time tag.

	Record the conformance test procedure result for each of the supported configuration parameter values on the right	Station type		Transmission speed				Trans-mission type		Address field of the link			Assign-ment class 2		Common address of ASDU		Information object address			Cause of trans-mission	
	√ indicates the test procedure passed for that configuration value. FAIL indicates Test Procedure failed for at least one of the Test Cases. N.A. indicates that configuration value is not supported by the device. Empty indicates the Test Procedure was not performed. (There should be no empty boxes when testing is complete).	Controlling station test (Master)	Controlled station test (Slave)	Max. Transmission speed in control direction	Min. Transmission speed in control direction	Max. Transmission speed in monitor direction	Min. Transmission speed in monitor direction	Unbalanced transmission	Balanced transmission	Zero (0) octets for address field (balanced only)	One (1) octet for address field	Two (2) octets for address field	Standard assignment of class 2 messages	Special assignments of class 2 messages	One (1) octet for Common Address of ASDU (CASDU)	Two (2) octets for Common Address of ASDU (CASDU)	One (1) octet for Information Object Address (structured or unstructured)	Two (2) octets for Information Object Address (structured or unstructured)	Three (3) octets for Information Object Address (structured or unstructured)	One (1) octet for COT field	Two (2) octets for COT field (2^{nd} octet is Originator address)
	5.4.22.40 Re-activate a running Outstation interrogation Option 3: the running GI continues and after activation termination (COT=10) the second GI is started. (Option 3 can be described as undesirable behaviour!!)	N.A	N.A	N.A	N.A	N.A	N.A	NA	N.A	N.A	N.A	N.A	N.A	NA	N.A	N.A	N.A	N.A	N.A	NA	N.A
	5.4.22.50 Deactivate a running Outstation interrogation	N.A	✓	✓	✓	✓	✓	NA	✓	N.A	✓	✓	✓	NA	✓	✓	✓	✓	✓	✓	✓
	5.4.22.60 Compatibility With Other Test Cases	N.A	✓	✓	✓	✓	✓	NA	✓	N.A	✓	✓	✓	NA	✓	✓	✓	✓	✓	✓	✓
Clock synchronisation function	**5.4.23.1 Clock synchronisation -sequential procedure**	N.A	✓	✓	✓	✓	✓	NA	✓	N.A	✓	✓	✓	NA	✓	✓	✓	✓	✓	✓	✓
	5.4.23.10 Clock synchronisation – Change the clock	N.A	✓	✓	✓	✓	✓	NA	✓	N.A	✓	✓	✓	NA	✓	✓	✓	✓	✓	✓	✓
	5.4.23.20 Compatibility With Other Test Cases	N.A	✓	✓	✓	✓	✓	NA	✓	N.A	✓	✓	✓	NA	✓	✓	✓	✓	✓	✓	✓
Command transmission function	**5.4.24.1 Select and Execute**	N.A	✓	✓	✓	✓	✓	NA	✓	N.A	✓	✓	✓	NA	✓	✓	✓	✓	✓	✓	✓
	5.4.24.10 Select and Deactivation	N.A	✓	✓	✓	✓	✓	NA	✓	N.A	✓	✓	✓	NA	✓	✓	✓	✓	✓	✓	✓
	5.4.24.20 Direct Execute	N.A	✓	✓	✓	✓	✓	NA	✓	N.A	✓	✓	✓	NA	✓	✓	✓	✓	✓	✓	✓
	5.4.24.30 Select with Negative Confirmation by Controlled station (Abort)	N.A	✓	✓	✓	✓	✓	NA	✓	N.A	✓	✓	✓	NA	✓	✓	✓	✓	✓	✓	✓
	5.4.24.40 Select with Negative Execute Confirmation by Controlled station if Execute is received after configured delay in the controlling station	N.A	✓	✓	✓	✓	✓	NA	✓	N.A	✓	✓	✓	NA	✓	✓	✓	✓	✓	✓	✓

	Record the conformance test procedure result for each of the supported configuration parameter values on the right	Station type		Transmission speed				Trans-mission type		Address field of the link			Assign-ment class 2		Common address of ASDU		Information object address			Cause of trans-mission	
	√ indicates the test procedure passed for that configuration value. FAIL indicates Test Procedure failed for at least one of the Test Cases. N.A. indicates that configuration value is not supported by the device. Empty indicates the Test Procedure was not performed. (There should be no empty boxes when testing is complete).	Controlling station test (Master)	Controlled station test (Slave)	Max. Transmission speed in control direction	Min. Transmission speed in control direction	Max. Transmission speed in monitor direction	Min. Transmission speed in monitor direction	Unbalanced transmission	Balanced transmission	Zero (0) octets for address field (balanced only)	One (1) octet for address field	Two (2) octets for address field	Standard assignment of class 2 messages	Special assignments of class 2 messages	One (1) octet for Common Address of ASDU (CASDU)	Two (2) octets for Common Address of ASDU (CASDU)	One (1) octet for Information Object Address (structured or unstructured)	Two (2) octets for Information Object Address (structured or unstructured)	Three (3) octets for Information Object Address (structured or unstructured)	One (1) octet for COT field	Two (2) octets for COT field (2^{nd} octet is Originator address)
	5.4.24.50 Direct Execute with Negative Confirmation by Controlled station	N.A	✓	✓	✓	✓	✓	NA	✓	N.A	✓	✓	✓	NA	✓	✓	✓	✓	✓	✓	✓
	5.4.24.60 Test for all supported ASDU's	N.A	✓	✓	✓	✓	✓	NA	✓	N.A	✓	✓	✓	NA	✓	✓	✓	✓	✓	✓	✓
	5.4.24.70 Compatibility With Other Test Cases	N.A	✓	✓	✓	✓	✓	NA	✓	N.A	✓	✓	✓	NA	✓	✓	✓	✓	✓	✓	✓
Transmission of integrated totals (telecounting) function	**5.4.25.1 Mode A – Local freeze with spontaneous transmission**	N.A	✓	✓	✓	✓	✓	N.A	✓	N.A	✓	✓	✓	NA	✓	✓	✓	✓	✓	✓	✓
	5.4.25.10 Mode B – Local freeze with Counter Interrogation	N.A	✓	✓	✓	✓	✓	N.A	✓	N.A	✓	✓	✓	NA	✓	✓	✓	✓	✓	✓	✓
	5.4.25.20 Mode C – Remote initiated freeze with Counter Interrogation	N.A	✓	✓	✓	✓	✓	N.A	✓	N.A	✓	✓	✓	NA	✓	✓	✓	✓	✓	✓	✓
	5.4.25.30 Mode D – Remote initiated freeze with spontaneous transmission	N.A	✓	✓	✓	✓	✓	N.A	✓	N.A	✓	✓	✓	NA	✓	✓	✓	✓	✓	✓	✓
	5.4.25.40 Compatibility With Other Test Cases	N.A	✓	✓	✓	✓	✓	N.A	✓	N.A	✓	✓	✓	NA	✓	✓	✓	✓	✓	✓	✓
Parameter loading function	**5.4.26.1 Load and activate parameter**[6]	N.A	✓	✓	✓	✓	✓	N.A	✓	N.A	✓	✓	✓	NA	✓	✓	✓	✓	✓	✓	✓
	5.4.26.10 Load and activate parameter with Negative Confirmation by Controlled station	N.A	✓	✓	✓	✓	✓	N.A	✓	N.A	✓	✓	✓	NA	✓	✓	✓	✓	✓	✓	✓

[6] Activate parameter (ASDU 113) is not supported.

	Record the conformance test procedure result for each of the supported configuration parameter values on the right	Station type		Transmission speed				Trans-mission type		Address field of the link			Assign-ment class 2		Common address of ASDU		Information object address			Cause of trans-mission	
	√ indicates the test procedure passed for that configuration value. FAIL indicates Test Procedure failed for at least one of the Test Cases. N.A. indicates that configuration value is not supported by the device. Empty indicates the Test Procedure was not performed. (There should be no empty boxes when testing is complete).	Controlling station test (Master)	Controlled station test (Slave)	Max. Transmission speed in control direction	Min. Transmission speed in control direction	Max. Transmission speed in monitor direction	Min. Transmission speed in monitor direction	Unbalanced transmission	Balanced transmission	Zero (0) octets for address field (balanced only)	One (1) octet for address field	Two (2) octets for address field	Standard assignment of class 2 messages	Special assignments of class 2 messages	One (1) octet for Common Address of ASDU (CASDU)	Two (2) octets for Common Address of ASDU (CASDU)	One (1) octet for Information Object Address (structured or unstructured)	Two (2) octets for Information Object Address (structured or unstructured)	Three (3) octets for Information Object Address (structured or unstructured)	One (1) octet for COT field	Two (2) octets for COT field (2^{nd} octet is Originator address)
	5.4.26.20 Compatibility With Other Test Cases	N.A	✓	✓	✓	✓	✓	N.A	✓	N.A	✓	✓	✓	NA	✓	✓	✓	✓	✓	✓	✓
Test procedure function	**5.4.27.1 Test procedure – sequential procedure**	N.A	✓	✓	✓	✓	✓	N.A	✓	N.A	✓	✓	✓	NA	✓	✓	✓	✓	✓	✓	✓
	5.4.27.10 Compatibility With Other Test Cases	N.A	✓	✓	✓	✓	✓	N.A	✓	N.A	✓	✓	✓	NA	✓	✓	✓	✓	✓	✓	✓
File transfer procedure function	**5.4.28.1 File transfer procedure (monitor direction) – sequential procedure**	N.A	N.A	N.A	N.A	N.A	N.A	N.A	N.A	N.A	N.A	N.A	N.A	NA	N.A	N.A	N.A	N.A	N.A	NA	N.A
	5.4.28.10 File transfer procedure (control direction) – sequential procedure	N.A	N.A	N.A	N.A	N.A	N.A	N.A	N.A	N.A	N.A	N.A	N.A	NA	N.A	N.A	N.A	N.A	N.A	NA	N.A
	5.4.28.20 Compatibility With Other Test Cases	N.A	N.A	N.A	N.A	N.A	N.A	N.A	N.A	N.A	N.A	N.A	N.A	NA	N.A	N.A	N.A	N.A	N.A	NA	N.A
Delay acquisition procedure	**5.4.29.1 Delay acquisition procedure – sequential procedure**	N.A	✓	✓	✓	✓	✓	N.A	✓	N.A	✓	✓	✓	NA	✓	✓	✓	✓	✓	✓	✓
	5.4.29.10 Compatibility With Other Test Cases	N.A	✓	✓	✓	✓	✓	N.A	✓	N.A	✓	✓	✓	NA	✓	✓	✓	✓	✓	✓	✓
Additional Conformance Test Procedures	**5.4.30.1 Out of service behaviour**	N.A	✓	✓	✓	✓	✓	N.A	✓	N.A	✓	✓	✓	NA	✓	✓	✓	✓	✓	✓	✓
	5.4.30.10 Miscellaneous	N.A	✓	✓	✓	✓	✓	N.A	✓	N.A	✓	✓	✓	NA	✓	✓	✓	✓	✓	✓	✓
	5.4.30.20 Time invalid	N.A	N.A	N.A	N.A	N.A	N.A	N.A	N.A	N.A	N.A	N.A	N.A	NA	N.A	N.A	N.A	N.A	N.A	NA	N.A
	5.4.30.30 Compatibility With Other Test Cases	N.A	✓	✓	✓	✓	✓	N.A	✓	N.A	✓	✓	✓	NA	✓	✓	✓	✓	✓	✓	✓
Negative	**5.4.31.1 Negative tests**	N.A	✓	✓	✓	✓	✓	N.A	✓	N.A	✓	✓	✓	NA	✓	✓	✓	✓	✓	✓	✓

	Record the conformance test procedure result for each of the supported configuration parameter values on the right	Station type		Transmission speed				Trans-mission type		Address field of the link			Assign-ment class 2		Common address of ASDU		Information object address			Cause of trans-mission	
	√ indicates the test procedure passed for that configuration value. FAIL indicates Test Procedure failed for at least one of the Test Cases. N.A. indicates that configuration value is not supported by the device. Empty indicates the Test Procedure was not performed. (There should be no empty boxes when testing is complete).	Controlling station test (Master)	Controlled station test (Slave)	Max. Transmission speed in control direction	Min. Transmission speed in control direction	Max. Transmission speed in monitor direction	Min. Transmission speed in monitor direction	Unbalanced transmission	Balanced transmission	Zero (0) octets for address field (balanced only)	One (1) octet for address field	Two (2) octets for address field	Standard assignment of class 2 messages	Special assignments of class 2 messages	One (1) octet for Common Address of ASDU (CASDU)	Two (2) octets for Common Address of ASDU (CASDU)	One (1) octet for Information Object Address (structured or unstructured)	Two (2) octets for Information Object Address (structured or unstructured)	Three (3) octets for Information Object Address (structured or unstructured)	One (1) octet for COT field	Two (2) octets for COT field (2^{nd} octet is Originator address)
Conformance Procedures	**5.4.31.50 Compatibility With Other Test Cases**	N.A	✓	✓	✓	✓	✓	N.A	✓	N.A	✓	✓	✓	NA	✓	✓	✓	✓	✓	✓	✓
PIXIT related Conformance Test Procedures	**5.4.32.1 Function:**	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	5.4.32.50 Function:	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	5.4.32.100 Function:	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

5.2 Test results of command transmission

The following Tables provide the detailed test results of command transmissions required by the test procedures.

5.6.1 Test results of single command transmission

TEST RESULTS OF THE SINGLE COMMAND (SCO) 'X' = tested '-' = not tested Detailed information on enclosures per Command type. The datalink services are not shown in the details, only the command ASDUs. Each IOA could be configured S/E or only E. S+E on/off = Select and Execute command on/off S and D = Select and Deactivate command on/off E on/off = Direct Execute command on/off	ACTCONpos=Positive Activation Confirmation ACTCONneg=Negative Activation Confirmation DEACTCONpos=Deactivation Confirmation positive ACTTERM=Activation Termination If ACTTERM is stated in row 'message from the RTU', ACTCONpos with S/E=0 execute has been received before. In case of a S+E command also ACTCONpos with S/E=1 select has been received before the ACT with S/E=0! NOTE: This Table shows the only correct behaviour. Other behaviour means the test failed!

ASDU type = 45	S+E on	S+E off	S+D on	S+D off	Eon	Eoff
QU=0 (no add. def.)						
Message from RTU	ACTTERMpos	ACTTERMpos	DEACTCONpos	DEACTCONpos	ACTTERMpos	ACTTERMpos
Shown behaviour after Select / Execute	E	E	S or E	S or E	E	E
Status change RTU	Yes, HMI	Yes, HMI	No	No	Yes, HMI	Yes, HMI
Status change process	If available	If available	No	No	If available	If available
Required	PICS, 8.5, 8.6	PICS, 8.5, 8.6	PICS, 8.5, 8.6	PICS, 8.5, 8.6	PICS, 8.5, 8.6	PICS, 8.5, 8.6
Result	✓	✓	✓	✓	✓	✓
Log file available (Y/N)?	Y	Y	Y	Y	Y	Y

QU=1 (short pulse)						
Message from RTU	ACTTERMpos	ACTTERMpos	DEACTCONpos	DEACTCONpos	ACTTERMpos	ACTTERMpos
Shown behaviour after Select / Execute	E	E	S or E	S or E	E	E
Status change RTU	Yes, HMI	Yes, HMI	No	No	Yes, HMI	Yes, HMI
Status change process	If available	If available	No	No	If available	If available
Required	PICS, 8.5, 8.6	PICS, 8.5, 8.6	PICS, 8.5, 8.6	PICS, 8.5, 8.6	PICS, 8.5, 8.6	PICS, 8.5, 8.6
Result	✓	✓	✓	✓	✓	✓
Log file available (Y/N)?	Y	Y	Y	Y	Y	Y
ASDU type = 45	S+E on	S+E off	S+D on	S+D off	Eon	Eoff
QU=2 (long pulse)						
Message from RTU	ACTTERMpos	ACTTERMpos	DEACTCONpos	DEACTCONpos	ACTTERMpos	ACTTERMpos
Shown behaviour after Select / Execute	E	E	S or E	S or E	E	E
Status change RTU	Yes, HMI	Yes, HMI	No	No	Yes, HMI	Yes, HMI
Status change process	If available	If available	No	No	If available	If available
Required	PICS, 8.5, 8.6	PICS, 8.5, 8.6	PICS, 8.5, 8.6	PICS, 8.5, 8.6	PICS, 8.5, 8.6	PICS, 8.5, 8.6
Result	✓	✓	✓	✓	✓	✓
Log file available (Y/N)?	Y	Y	Y	Y	Y	Y
QU=3 (persistent)						
Message from RTU	ACTTERMpos	ACTTERMpos	DEACTCONpos	DEACTCONpos	ACTTERMpos	ACTTERMpos
Shown behaviour after Select / Execute	E	E	S or E	S or E	E	E
Status change RTU	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Status change process	If available	If available	No	No	If available	If available
Required	PICS, 8.5, 8.6	PICS, 8.5, 8.6	PICS, 8.5, 8.6	PICS, 8.5, 8.6	PICS, 8.5, 8.6	PICS, 8.5, 8.6
Result	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Log file available (Y/N)?	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
General remarks	•					

5.6.2 **Test results of double command transmission**

TEST RESULTS OF THE DOUBLE COMMAND (DCO) 'X' = tested '-' = not tested Detailed information on enclosures per Command type. The datalink services are not shown in the details, only the command ASDUs. Each IOA could be configured S/E or only E. S+E on/off = Select and Execute command on/off S and D = Select and Deactivate command on/off E on/off = Direct Execute command on/off	ACTCONpos=Positive Activation Confirmation ACTCONneg=Negative Activation Confirmation DEACTCONpos=Deactivation Confirmation positive ACTTERM=Activation Termination If ACTTERM is stated in row 'message from the RTU', ACTCONpos with S/E=0 execute has been received before. In case of a S+E command also ACTCONpos with S/E=1 select has been received before the ACT with S/E=0! NOTE: This Table shows the only correct behaviour. Other behaviour means the test failed!

ASDU type = 46	S+E on	S+E off	S+D on	S+D off	Eon	Eoff
QU=0 (no add. def.)						
Message from RTU	ACTTERMpos	ACTTERMpos	DEACTCONpos	DEACTCONpos	ACTTERMpos	ACTTERMpos
Shown behaviour after Select / Execute	E	E	S or E	S or E	E	E
Status change RTU	Yes, HMI	Yes, HMI	No	No	Yes, HMI	Yes, HMI
Status change process	If available	If available	No	No	If available	If available
Required	PICS, 8.5, 8.6	PICS, 8.5, 8.6	PICS, 8.5, 8.6	PICS, 8.5, 8.6	PICS, 8.5, 8.6	PICS, 8.5, 8.6
Result	✓	✓	✓	✓	✓	✓
Log file available (Y/N)?	Y	Y	Y	Y	Y	Y
QU=1 (short pulse)						
Message from RTU	ACTTERMpos	ACTTERMpos	DEACTCONpos	DEACTCONpos	ACTTERMpos	ACTTERMpos
Shown behaviour after Select / Execute	E	E	S or E	S or E	E	E
Status change RTU	Yes, HMI	Yes, HMI	No	No	Yes, HMI	Yes, HMI
Status change process	If available	If available	No	No	If available	If available
Required	PICS, 8.5, 8.6	PICS, 8.5, 8.6	PICS, 8.5, 8.6	PICS, 8.5, 8.6	PICS, 8.5, 8.6	PICS, 8.5, 8.6

Result	✓	✓	✓	✓	✓	✓
Log file available (Y/N)?	Y	Y	Y	Y	Y	Y
ASDU type = 46	S+E on	S+E off	S+D on	S+D off	Eon	Eoff
QU=2 (long pulse)						
Message from RTU	ACTTERMpos	ACTTERMpos	DEACTCONpos	DEACTCONpos	ACTTERMpos	ACTTERMpos
Shown behaviour after Select / Execute	E	E	S or E	S or E	E	E
Status change RTU	Yes, HMI	Yes, HMI	No	No	Yes, HMI	Yes, HMI
Status change process	If available	If available	No	No	If available	If available
Required	PICS, 8.5, 8.6	PICS, 8.5, 8.6	PICS, 8.5, 8.6	PICS, 8.5, 8.6	PICS, 8.5, 8.6	PICS, 8.5, 8.6
Result	✓	✓	✓	✓	✓	✓
Log file available (Y/N)?	Y	Y	Y	Y	Y	Y
QU=3 (persistent)						
Message from RTU	ACTTERMpos	ACTTERMpos	DEACTCONpos	DEACTCONpos	ACTTERMpos	ACTTERMpos
Shown behaviour after Select / Execute	E	E	S or E	S or E	E	E
Status change RTU	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Status change process	If available	If available	No	No	If available	If available
Required	PICS, 8.5, 8.6	PICS, 8.5, 8.6	PICS, 8.5, 8.6	PICS, 8.5, 8.6	PICS, 8.5, 8.6	PICS, 8.5, 8.6
Result	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Log file available (Y/N)?	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
General remarks:	•					

5.6.3 **Test results of regulating step command transmission**

TEST RESULTS OF THE REGULATING STEP COMMAND (RCO) 'X' = tested '-' = not tested Detailed information on enclosures per Command type. The datalink services are not shown in the details, only the command ASDUs. Each IOA could be configured S/E or only E. S+E on/off = Select and Execute command on/off S and D = Select and Deactivate command on/off E on/off = Direct Execute command on/off	ACTCONpos=Positive Activation Confirmation ACTCONneg=Negative Activation Confirmation DEACTCONpos=Deactivation Confirmation positive ACTTERM=Activation Termination If ACTTERM is stated in row 'message from the RTU', ACTCONpos with S/E=0 execute has been received before. In case of a S+E command also ACTCONpos with S/E=1 select has been received before the ACT with S/E=0! NOTE: This Table shows the only correct behaviour. Other behaviour means the test failed!

ASDU type = 47	S+E up	S+E down	S+D up	S+D down	E up	E down
QU=0 (no add. def.)						
Message from RTU	ACTTERMpos	ACTTERMpos	DEACTCONpos	DEACTCONpos	ACTTERMpos	ACTTERMpos
Shown behaviour after Select / Execute	E	E	S or E	S or E	E	E
Status change RTU	Yes, HMI	Yes, HMI	No	No	Yes, HMI	Yes, HMI
Status change process	If available	If available	No	No	If available	If available
Required	PICS, 8.5, 8.6	PICS, 8.5, 8.6	PICS, 8.5, 8.6	PICS, 8.5, 8.6	PICS, 8.5, 8.6	PICS, 8.5, 8.6
Result	✓	✓	✓	✓	✓	✓
Log file available (Y/N)?	Y	Y	Y	Y	Y	Y
QU=1 (short pulse)						
Message from RTU	ACTTERMpos	ACTTERMpos	DEACTCONpos	DEACTCONpos	ACTTERMpos	ACTTERMpos
Shown behaviour after Select / Execute	E	E	S or E	S or E	E	E
Status change RTU	Yes, HMI	Yes, HMI	No	No	Yes, HMI	Yes, HMI
Status change process	If available	If available	No	No	If available	If available

Required	PICS, 8.5, 8.6	PICS, 8.5, 8.6	PICS, 8.5, 8.6	PICS, 8.5, 8.6	PICS, 8.5, 8.6	PICS, 8.5, 8.6
Result	✓	✓	✓	✓	✓	✓
Log file available (Y/N)?	Y	Y	Y	Y	Y	Y
ASDU type = 47	S+E on	S+E off	S+D on	S+D off	Eon	Eoff
QU=2 (long pulse)						
Message from RTU	ACTTERMpos	ACTTERMpos	DEACTCONpos	DEACTCONpos	ACTTERMpos	ACTTERMpos
Shown behaviour after Select / Execute	E	E	S or E	S or E	E	E
Status change RTU	Yes, HMI	Yes, HMI	No	No	Yes, HMI	Yes, HMI
Status change process	If available	If available	No	No	If available	If available
Required	PICS, 8.5, 8.6	PICS, 8.5, 8.6	PICS, 8.5, 8.6	PICS, 8.5, 8.6	PICS, 8.5, 8.6	PICS, 8.5, 8.6
Result	✓	✓	✓	✓	✓	✓
Log file available (Y/N)?	Y	Y	Y	Y	Y	Y
QU=3 (persistent)						
Message from RTU	ACTTERMpos	ACTTERMpos	DEACTCONpos	DEACTCONpos	ACTTERMpos	ACTTERMpos
Shown behaviour after Select / Execute	E	E	S or E	S or E	E	E
Status change RTU	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Status change process	If available	If available	No	No	If available	If available
Required	PICS, 8.5, 8.6	PICS, 8.5, 8.6	PICS, 8.5, 8.6	PICS, 8.5, 8.6	PICS, 8.5, 8.6	PICS, 8.5, 8.6
Result	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Log file available (Y/N)?	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
General remarks	•					

5.6.4 **Test results of setpoint command transmission**

TEST RESULTS OF THE SETPOINT COMMAND (NVA) 'X' = tested '-' = not tested Detailed information on enclosures per Command type. The datalink services are not shown in the details, only the command ASDUs. Each IOA could be configured S/E or only E. They should not be able to support both at a time. S+E on/off = Select and Execute command on/off S and D = Select and Deactivate command on/off E on/off = Direct Execute command on/off	ACTCONpos=Positive Activation Confirmation ACTCONneg=Negative Activation Confirmation DEACTCONpos=Deactivation Confirmation positive ACTTERM=Activation Termination If ACTTERM is stated in row 'message from the RTU', ACTCONpos with S/E=0 execute has been received before. In case of a S+E command also ACTCONpos with S/E=1 select has been received before the ACT with S/E=0! NOTE: This Table shows the only correct behaviour. Other behaviour means the test failed!

ASDU type = 48	S+E	S+D	E
QL=0			
Message from RTU	ACTCONpos / ACTTERMpos[7]	DEACTCONpos	ACTCONpos / ACTTERMpos[5]
After S or E	E	S or E	E
Status change RTU	Yes, HMI	No	Yes, HMI
Status change process	If available	No	If available
Required	PICS, 8.5, 8.6	PICS, 8.5, 8.6	PICS, 8.5, 8.6
Result	✓	✓	✓
Log files available (Y/N)?	Y	Y	Y
General remarks	•		

[7] If the PICS states ACTTERM is used ACTTERM is applicable, if not ACTCON is applicable.

TEST RESULTS OF THE SETPOINT COMMAND (SCA) 'X' = tested '-' = not tested Detailed information on enclosures per Command type. The datalink services are not shown in the details, only the command ASDUs. Each IOA could be configured S/E or only E. They should not be able to support both at a time. S+E on/off = Select and Execute command on/off S and D = Select and Deactivate command on/off E on/off = Direct Execute command on/off	ACTCONpos=Positive Activation Confirmation ACTCONneg=Negative Activation Confirmation DEACTCONpos=Deactivation Confirmation positive ACTTERM=Activation Termination If ACTTERM is stated in row 'message from the RTU', ACTCONpos with S/E=0 execute has been received before. In case of a S+E command also ACTCONpos with S/E=1 select has been received before the ACT with S/E=0! NOTE: This Table shows the only correct behaviour. Other behaviour means the test failed!

ASDU type = 49	S+E	S+D	E
QL=0			
Message from RTU	ACTCONpos / ACTTERMpos[8]	DEACTCONpos	ACTCONpos / ACTTERMpos[6]
After S or E	E	S or E	E
Status change RTU	Yes, HMI	No	Yes, HMI
Status change process	If available	No	If available
Required	PICS, 8.5, 8.6	PICS, 8.5, 8.6	PICS, 8.5, 8.6
Result	✓	✓	✓
Log files available (Y/N)?	Y	Y	Y
General remarks	•		

8 If the PICS states ACTTERM is used ACTTERM is applicable, if not ACTCON is applicable.

TEST RESULTS OF THE SETPOINT COMMAND (IEEE STD 754) 'X' = tested '-' = not tested Detailed information on enclosures per Command type. The datalink services are not shown in the details, only the command ASDUs. Each IOA could be configured S/E or only E. They should not be able to support both at a time. S+E on/off = Select and Execute command on/off S and D = Select and Deactivate command on/off E on/off = Direct Execute command on/off	ACTCONpos=Positive Activation Confirmation ACTCONneg=Negative Activation Confirmation DEACTCONpos=Deactivation Confirmation positive ACTTERM=Activation Termination If ACTTERM is stated in row 'message from the RTU', ACTCONpos with S/E=0 execute has been received before. In case of a S+E command also ACTCONpos with S/E=1 select has been received before the ACT with S/E=0! NOTE: This Table shows the only correct behaviour. Other behaviour means the test failed!

ASDU type = 50	S+E	S+D	E
QL=0			
Message from RTU	ACTCONpos / ACTTERMpos[9]	DEACTCONpos	ACTCONpos / ACTTERMpos[7]
After S or E	E	S or E	E
Status change RTU	Yes, HMI	No	Yes, HMI
Status change process	If available	No	If available
Required	PICS, 8.5, 8.6	PICS, 8.5, 8.6	PICS, 8.5, 8.6
Result	✓	✓	✓
Log files available (Y/N)?	Y	Y	Y
General remarks	•		

[9] If the PICS states ACTTERM is used ACTTERM is applicable, if not ACTCON is applicable.