SIEMENS

SICAM RTUs

SICAM CMIC / ET84

Conformance Test Report of the IEC60870-5-104 Protocol Implementation for the Siemens SICAM CMIC

Tested as Controlled Station and Controlling Station Implementation in Normal and Reverse Direction

Test Report

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Preface

This document is applicable to the following product(s):

- SICAM CMIC

Purpose of this manual

This manual describes the test results of the SIEMENS internal Conformance Test “Self Certification” for the IEC60870-5-104 Protocol Implementation in SICAM CMIC and essentially contains:

- Conformance Test Results for the IEC60870-5-104 implementation in SICAM CMIC using SM-2558/ET84 firmware based on Siemens SICAM RTUs interoperability of SICAM CMIC according to IEC60870-5-104 (Document no.: DC0-013-2.05)

Target Group

The document you are reading right now is addressed to users, who are in charge of the following tasks:

- Customers
- Sales engineering and technical clarification
- Conceptual activities, as for example design and configuration
- Technical system maintenance

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1 Introduction

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1.1 Background

Siemens, Vienna, Austria manufactures digital equipment that can be used in substations. Siemens has implemented the IEC 60870-5 Telecontrol Companion Standard 104 according to the SIEMENS IEC60870-5-104 Interoperability Document for the SICAM CMIC for communication with a controlling or controlled system. The IEC 60870-5 Telecontrol Companion Standard 104 (TCS104) can be used as a communication protocol for exchanging information between Control Center(s) (controlling station) and their substations (controlled stations). The information exchanged can be for example measurands, status messages and commands.

Figure 1 shows the configuration of the test environment for the SICAM CMIC and the scope of the conformance test.

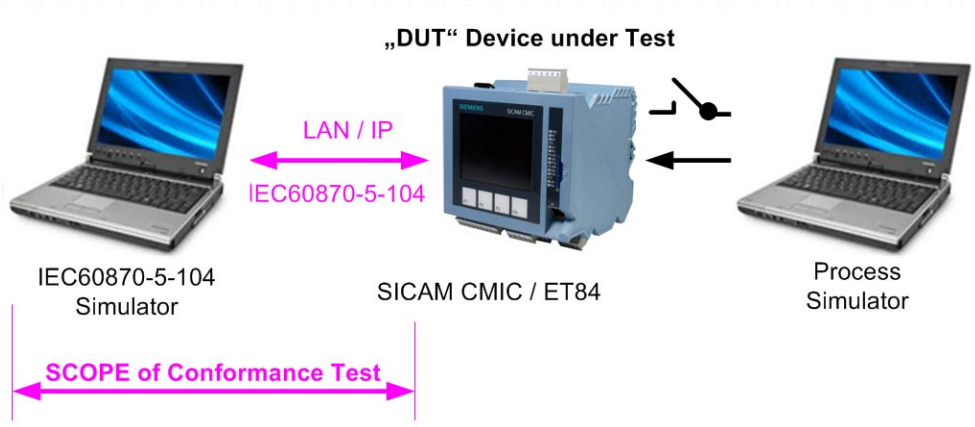

Figure 1 Configuration of the target environment

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

SIEMENS’s assignment was to answer the following question:

“Does the Siemens IEC 60870-5-104 controlling and controlled station protocol implementation (revision 1) for the SICAM CMIC conform to the IEC 60870-5-104 Companion Standard (in Standard Direction and Reverse Direction) and the SIEMENS IEC60870-5-104 Interoperability for ET84 firmware?”

To answer this question, SIEMENS has performed a type conformance test (self certification conformance testing) of the Siemens IEC 60870-5-104 Controlling/Controlled station protocol implementation for the SICAM CMIC.

1.2 Testing Viewpoints

There are two viewpoints for testing:

- **Type testing**
  The first testing viewpoint “Type testing” is the process of verifying that an implementation performs in accordance with a particular standard. A manufacturer may claim: “my equipment conforms 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 60870-5 implementations (see www.dnvkema.com/pctc).

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

- **Self-certification conformance testing**
  … same test procedures as used for type testing but self certification conformance tests will be performed by Siemens engineers only.
  Self-certification conformance test is typically performed as internal pre-testing for type test by authorized 3rd party test institute (e.g. KEMA).
  No attestation of conformity for self-certification conformance test (only test report).
  Some functionality not fully defined in IEC60870-5-104 standard may be implemented and tested based on interpretation of Siemens engineers.
  This may be different to KEMA interpretation and must be verified / fixed during type test.

- **Interoperability testing (IOP)**
  The second viewpoint, Interoperability testing (IOP), 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 self certification conformance test of the IEC 60870-5-104 implementation in the System Under Test [further SUT]. The self certification conformance test was executed at Siemens AG Österreich, Vienna (Austria) in April 2013. The results will form the basis for a Siemens internal “Self Certification Statement”. This Statement is primarily of interest to product marketers and customers, as a proof of independent verification of minimized interoperability risks.

1.4 Content of this Document

Chapter 2 shows the list of relevant normative and other references, used to provide input for the self-certification conformance test.

Chapter 3 describes the various relevant components for the self-certification conformance test and their configuration as used in the self-certification conformance test, including the System Under Test. This chapter also gives an overview and introduction to the various test groups that together constitute the self-certification conformance test.

Chapter 4 and 5 give 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 self-certification conformance test: a **Major** category and a **Minor** category. Also a **Remarks** category is introduced. These categories are further explained in this chapter.

Appendix A specifies the detailed test cases and their outcome, appendix B contains detailed comments on test results, for instance when a defect is detected, including the actual message flow if appropriate.

1.5 Glossary

- SUT = System Under Test
- PICS = Protocol Implementation Conformance Statement

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2.1 Normative

The tests defined in this document are based on the following IEC (International Electrotechnical Committee) documents in the IEC 60870-5 range: Telecontrol equipment and systems part 5: Transmission protocols:

1. IEC 60870-5-1: TELECONTROL EQUIPMENT AND SYSTEMS, PART 5, Transmission protocols: Transmission Frame Formats, IS (International Standard), 1990, further referred to as [IEC5-1]

2. IEC 60870-5-2: TELECONTROL EQUIPMENT AND SYSTEMS, PART 5, Transmission protocols: Link Transmission Procedures, IS, 1992, further referred to as [IEC5-2]

3. IEC 60870-5-3: TELECONTROL EQUIPMENT AND SYSTEMS, PART 5, Transmission protocols: General Structure of Application Data, IS, 1992, further referred to as [IEC5-3]

4. IEC 60870-5-4: 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 60870-5-5: TELECONTROL EQUIPMENT AND SYSTEMS, PART 5, Transmission protocols: Basic Application Functions, IS, 1995, further referred to as [IEC5-5]

6. IEC 60870-5-101: TELECONTROL EQUIPMENT AND SYSTEMS, PART 5, Transmission protocols: Companion standard for basic telecontrol tasks, IS, second edition 2003, further referred to as [IEC5-101].

7. IEC 60870-5-104: TELECONTROL EQUIPMENT AND SYSTEMS, PART 5, Transmission protocols: Network access for IEC 60870-5-101 using standard transport profiles, IS, second edition, further referred to as [IEC5-104].

8. IEC 60870-5-604: Telecontrol equipment and systems, Part 5-604, Conformance test cases for the IEC 60870-5-104 Companion Standard.

2.2 Other

Siemens IEC 60870-5-104 Interoperability included in the following document:

1. Ref. DC0-013-2.05: Siemens SICAM RTUs IEC 60870-5-101/104 Interoperability, chapter 6 - Interoperability of SICAM CMIC according to IEC 60870-5-104.

3 The Self Certification Conformance Test

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3.1 Components in Test Environment

The test environment consists of the following components:

- the System Under Test [SUT] = the SICAM CMIC
  controlled / controlling station implementation:
  - Software module CP-8000/CPC80 software version: revision 2
  - Software module CP-8000/ET84 software version: revision 1
  Notes:
  - CP-8000/CPC80 includes system functions of SICAM CMIC and IEC60870-5-101/-104 basic functions.
  - CP-8000/ET84 includes IEC60870-5-104 protocol specific functions.

- the KEMA UnIECim-104 version 1.25.01 (Feb 2012) protocol test platform, which runs the TCS104 simulator test suite version 1.41 and acts as a single-node Controlling Station
- the Siemens SICAM Protocol Test System version 6.0
- Non-switching HUB (Switch)
- RJ45 100 MB cables

The configured IP-addresses during the test (192.168.0.*):

- System Under Test: 192.168.0.20
- KEMA UnIECim-104: 192.168.0.127 **)
- Siemens SICAM Protocol Test System: 192.168.0.127 **)

**) Note: test software used with same IP address but not used at the same time.
(used software depends on the test cases)

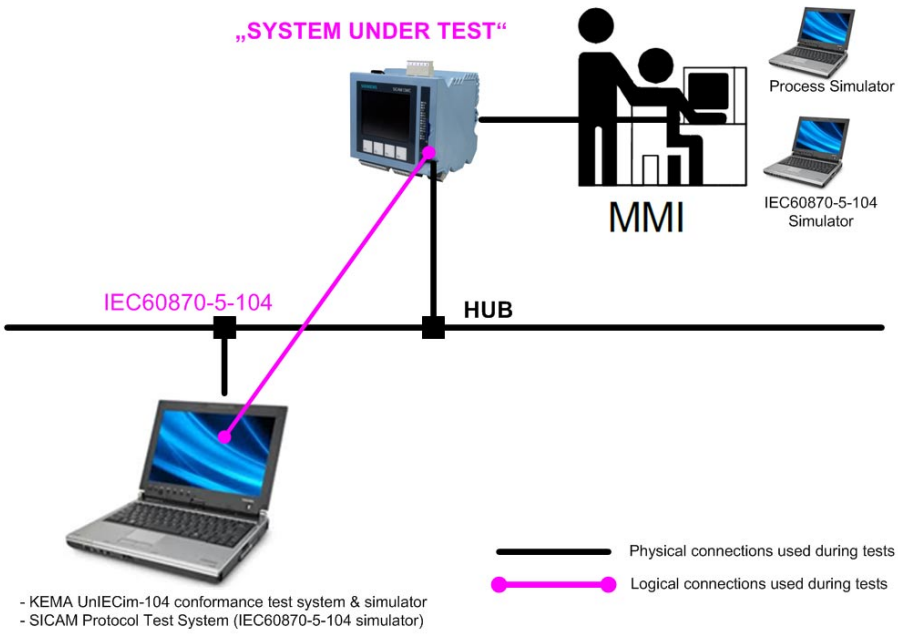

Figure 3.1 Connection and set-up of the test environment

3.2 System under Test Requirements

Next to the CS104 communication capability specified in the PID, the System Under Test (SUT) 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 pause/freeze (or equivalent, e.g. extending timers) of the communication to verify displayed or analyzed data
- 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

3.2.1 System under Test Configuration

The configuration of the SUT is as follows:

- the telecontrol communication mode is balanced (by definition) peer-to-peer, capable of using a Wide Area TCP/IP network (see also figures 1.1 and 3.1)
- IP address detail as in figure 3.1, besides other configuration details
- Common Address of ASDU (**CAA**) used during the test was **527**
- further details of the implemented protocol (interoperability sheet) subset can be found at paragraph 5 Protocol Implementation Conformance Statement (PICS)
- the Protocol Implementation Conformance Statement forms the basis for the applicable test cases in the test plan in Appendix A.

3.2.2 UnIECim Test System Requirements

The UnIECim IEC 60870-5 protocol test platform is KEMA's test system for testing IEC 60870-5 protocol implementations. The knowledge of the IEC 60870-5 protocol is in the software.

UnIECim 60870-5 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.

UnIECim 60870-5-104 is the test tool for testing Controlling or Controlled station implementations based on the IEC 60870-5 Telecontrol Companion Standard 104 (TCS 104) Network access for IEC 60870-5-101 including redundancy functionality.

3.2.3 Communication Link Requirements

The data communication network must support the following requirements for testing:

- TCP/IP and Ethernet as defined in [5-104]
- the connection is made by using a RJ45 patch cable, Ethernet pin configuration
- “Normal” performance and with a minimum of other than TCS104 traffic on the network.

3.3 Overview of the Test Suite

3.3.1 Test on Transport Provider Level

For information exchange between both end systems, a TCP/IP network is used. Tests in table A.1 verify that end systems can establish a TCP/IP connection, are able to exchange (CS104) messages and the TCP/IP connection doesn't fail permanently. White-box (internal) TCP/IP and lower tests are not performed. The tests are passed if no error is reported during a test session.

If relevant, redundant link tests are defined in Appendix A, table A.11.

3.3.2 Test on Application Level

Most of the Application Service Data Units (ASDU's) tests defined in Appendix A are automatically performed by the UnIECim test tool on each received ASDU if applicable. The tests are passed if no error is reported during a test session.

The Basic Application Functions (BAF's) tests defined in Appendix A are performed by a combination of automatic verification and manual expert analysis for each test case if applicable. The tests have passed if no defect is found during a test session.

3.3.3 Negative Tests

The Negative tests defined in Appendix A table 24 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

4 Test Results

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4.1 Summary of Test Results

Table 4.1 in this Chapter gives a summary of the type test results. Numbers shown in the table refer to test numbers of individual test cases in IEC 60870-5-604. If applicable, an end note describing a defect is added in appendix A.

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 behavior, 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 an interoperability test, 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 6 is the basis for the applicable test cases in Appendix A. 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 must be consulted in Appendix A.

Summary of Test Results:

	Test Group	Major	Minor	Remarks	Verdict
0	Configuration parameters				PASSED
1	Transport provider level		1), 5)	5.3.1.6, 5.3.1.90	PASSED
2	Data Unit Identifier				PASSED
3	ASDUs for Process information in monitor (Normal) direction				PASSED
4	ASDUs for process information in control direction				PASSED
5	ASDUs for system information in monitor direction				PASSED
6	ASDU for system information in control direction				PASSED
7	ASDU for parameters in control direction				PASSED
8	ASDU for file transfer in monitor and control direction				PASSED
9	Data Unit Identifier				PASSED
10	Information object address				PASSED
11	Station initialization				PASSED
12	Redundant connection tests				N/A
13	Cyclic data transmission				N/A
14	Data acquisition through Read				N/A
15	Acquisition of events				PASSED
16	General interrogation				PASSED
17	Clock synchronization		3)	5.4.17.10	PASSED
18	Command transmission		2)	5.4.18	PASSED
19	Transmission of integrated totals				PASSED
20	Parameter loading				PASSED
21	Test procedure				PASSED
22	File Transfer		6)	5.4.22.10	PASSED
23	Additional tests				PASSED
24	Negative tests		4)	5.4.23.20	PASSED
25	PIXIT related				N/A
	TOTAL				**PASSED**

N/A = Not Applicable

Table 4.1 Summary of test results for the System Under Test

Notes: (following remarks refers to items requested by KEMA for official KEMA test)
1) TCP/IP connection close is done by SICAM RTU using RST (Reset) and not as requested by IEC60870-5-604 using FIN-FINACK-ACK.
RST is used by SICAM RTUs IEC60870-5-104 implementation today for fast redundancy switchover.
2) actual time instead of command time is included in ACTCON, ACTTERM
3) time setting of SICAMC RTUs is executed at next change of minute. Time setting should be done immediately according IEC60870-5-604.
4) Invalid-Bit of time is not set after restart or Power up of SICAM RTUs until 1st time setting procedure.
5) ACK timeout (t1) must be selective for each sent message
(SICAM RTUs implementation use only 1 global ACK timeout counter for all sent messages)
6) IOA=0 must be sent for <TI:=126> in case of empty directory.

5 Conclusions and Recommendations

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

“Does the Siemens IEC 60870-5-104 controlling and controlled station protocol implementation CP-8000/ET84 revision 1 for the SICAM CMIC conform to Siemens SICAM RTUs Interoperability of SICAM CMIC according to IEC 60870-5-104?”

Based on the test results described in this report, Siemens declares the self-tested Siemens CS104 controlling and controlled station implementation for the SICAM CMIC implementation is in conformance with the Siemens SICAM RTUs Interoperability of SICAM CMIC according to IEC 60870-5-104 (see also notes in Table 4.1 Summary of test results for the System Under Test).

5.1 Exceptions with the [PICS]

- none -

5.2 Exceptions with the [PIXIT]

For integrated totals, it is not possible to configure individual timers per each counter.

5.3 Recommendations following from the Test

The following recommendations apply for the tested system configuration:

- IEC60870-5-104 - Transport Provider Level:
  - TCP/IP Connection close should be done using 3-way sequence (FIN-FINACK-ACK).
    Note:
    SICAM RTUs IEC60870-5-104 implementation is using actually “RST” (Reset) for TCP/IP connection close (to provide fast redundancy switch over) and not FIN-FINACK-ACK as requested by IEC60870-5-604.

  - Implementation of individual timer per each counter for t1 timeout handling.
    ACK timeout (t1) must be selective for each sent message (SICAM RTUs implementation use only 1 global ACK timeout counter for all sent messages).

- IEC60870-5-104 - Station Initialization:
  - ASDU 70 (End of init) is sent about 30 seconds after startdtcon.
    During that time RTU is still not initialized and no events are received.
    It is recommend to short this time or not answer to the startdtact until RTU is full initialized.

- IEC60870-5-104 - Command Transmission:
  - actual time is included in ACTCON and ACTTERM.
    → Command time must be included in ACTCON, ACTTERM (instead of actual time).

- IEC60870-5-104 - Clock synchronization:
  - Time setting of SICAMC RTUs is executed at next change of minute.
    Time setting should be done immediately according IEC60870-5-604.
  - Invalid-Bit of time is not set after restart or Power up of SICAM RTUs until 1st time setting procedure.

- IEC60870-5-104 - File Transfer:
  - IOA=0 must be sent for <TI:=126> in case of empty directory.

- IEC60870-5-104 - General interrogation:
  - In test number 5.4.16.40 was checked that for re-activation of a running Outstation interrogation option 3 is implemented although is can be described as undesirable behavior. It is recommended for future version to change to option 1 or 2.

5.4 Additional Information

- Siemens Device under Test "DUT" (SICAM CMIC) supports time synchronization using NTP-Server.
- Siemens Device under Test "DUT" (SICAM CMIC) supports file transfer in both monitor and control direction:
  - SICAM CMIC itself supports file transfer for sequence of events in monitor direction.
  - For remote connected devices to SICAM CMIC using IEC60870-5-101 protocol, file transfer for all file types defined in IEC60870-5-101/-104 is supported.

6 Protocol Implementation Conformance Statement (PICS)

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The Protocol Implementation Conformance Statement (PICS) in this paragraph is the basis for the applicable test cases in Appendix A. 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 must be consulted in Appendix A.

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.

Interoperability of SICAM CMIC using IEC 60870-5-104 (ET84 firmware)

This companion standard presents sets of parameters and alternatives from which subsets must be selected to implement particular telecontrol systems. Certain parameter values, such as the choice of “structured“ or “unstructured“ fields of the INFORMATION OBJECT ADDRESS of ASDUs represent mutually exclusive alternatives. This means that only one value of the defined parameters is admitted per system. Other parameters, such as the listed set of different process information in command and in monitor direction allow the specification of the complete set or subsets, as appropriate for given applications. This clause summarizes the parameters of the previous clauses to facilitate a suitable selection for a specific application. If a system is composed of equipment, stemming from different manufacturers it is necessary that all partners agree on the selected parameters.

The interoperability list is defined as in IEC 60870-5-101 and extended with parameters used in this standard. The text descriptions of parameters which are not applicable to this companion standard are strike-through (corresponding check box is marked black).

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.

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

? Function or ASDU is planned, please contact the product management

■ Function or ASDU is used in a specific project

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

A black check box indicates that the option cannot be selected in this companion standard.

6.1 System or device function

(system-specific parameter, indicate the system's or station's function by marking one of the following with '**X**')

- [X] System definition
- [ ] Controlling Station (Master)
- [ ] Controlled Station (Slave)

6.2 Network configuration

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

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

6.3 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 >1200 bit/s	Balanced interchange Circuit X.24/X.27	
~~100 bits/s~~	~~2400 bits/s~~	~~2400 bits/s~~	~~56000 bits/s~~
~~200 bits/s~~	~~4800 bits/s~~	~~4800 bits/s~~	~~64000 bits/s~~
~~300 bits/s~~	~~9600 bits/s~~	~~9600 bits/s~~	
~~600 bits/s~~	~~19200 bits/s~~	~~19200 bits/s~~	
~~1200 bits/s~~	~~38400 bits/s~~	~~38400 bits/s~~	

Transmission speed (monitor direction)

Unbalanced interchange Circuit V.24/V.28 Standard	Unbalanced interchange Circuit V.24/V.28 Recommended if >1200 bit/s	Balanced interchange Circuit X.24/X.27	
~~100 bits/s~~	~~2400 bits/s~~	~~2400 bits/s~~	~~56000 bits/s~~
~~200 bits/s~~	~~4800 bits/s~~	~~4800 bits/s~~	~~64000 bits/s~~
~~300 bits/s~~	~~9600 bits/s~~	~~9600 bits/s~~	
~~600 bits/s~~	~~19200 bits/s~~	~~19200 bits/s~~	
~~1200 bits/s~~	~~38400 bits/s~~	~~38400 bits/s~~	

6.4 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

- ~~Balanced transmission~~
- ~~Unbalanced transmission~~

Address filed of the link

- ~~not present (balanced transmission only)~~
- ~~1 Octet~~
- ~~2 Octets~~
- ~~structured~~
- ~~unstructured~~

Frame length

~~Maximum length L (number of octets, possible 9-255)~~

When using an unbalanced link layer, the following ASDU types are returned in class 2 messages (low priority) with the indicated causes of transmission:

~~The standard assignment of ASDUs to class 2 messages is used as follows:~~

Type identification	Cause of transmission
9, 11, 13, 21	<1>

~~A special assignment of ASDUs to class 2 messages is used as follows:~~

Type identification	Cause of transmission

~~Note: In response to a class 2 poll, a controlled station may respond with class 1 data when there is no class 2 data available.~~

6.5 Application layer

Transmission mode for application data

Mode 1 (Least significant octet first), as defined in clause 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**“)

☐ ~~1 Octet~~	[X] 2 Octets

Information object address
(system-specific parameter, all configurations that are used are to be marked „**X**“)

☐ ~~1 Octet~~	[X] structured
☐ ~~2 Octets~~	[X] unstructured
[X] 3 Octets	

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

☐ ~~1 Octet~~	[X] 2 Octets (with originator address) Originator address is set to zero if not used.

Length of APDU
(system-specific parameter, specify the maximum length of the APDU per system)

The maximum length of the APDU is 253 (default). The maximum length may be reduced per system.

[253] Maximum length of APDU per system

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	
	<2>	:=	~~Single-point information with time tag~~	M_SP_TA_1	
B	<3>	:=	Double-point information	M_DP_NA_1	
	<4>	:=	~~Double-point information with time tag~~	M_DP_TA_1	
B	<5>	:=	Step position information	M_ST_NA_1	
	<6>	:=	~~Step position information with time tag~~	M_ST_TA_1	
B	<7>	:=	Bitstring of 32 bit	M_BO_NA_1	
	<8>	:=	~~Bitstring of 32 bit with time tag~~	M_BO_TA_1	
B	<9>	:=	Measured value, normalized value	M_ME_NA_1	
	<10>	:=	~~Measured value, normalized value with time tag~~	M_ME_TA_1	
B	<11>	:=	Measured value, scaled value	M_ME_NB_1	
	<12>	:=	~~Measured value, scaled value with time tag~~	M_ME_TB_1	
B	<13>	:=	Measured value, short floating point value	M_ME_NC_1	
	<14>	:=	~~Measured value, short floating point value with time tag~~	M_ME_TC_1	
B	<15>	:=	Integrated totals	M_IT_NA_1	
	<16>	:=	~~Integrated totals with time tag~~	M_IT_TA_1	
	<17>	:=	~~Event of protection equipment with time tag~~	M_EP_TA_1	
	<18>	:=	~~Packed start events of protection equipment with time tag~~	M_EP_TB_1	
	<19>	:=	~~Packed output circuit information of protection equipment with time tag~~	M_EP_TC_1	
X	<20>	:=	Packed single-point information with status change detection	M_PS_NA_1	6)
	<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	
B	<38>	:=	Event of protection equipment with time tag CP56Time2a	M_EP_TD_1	
B	<39>	:=	Packed start events of protection equipment with time tag CP56Time2a	M_EP_TE_1	
B	<40>	:=	Packed output circuit information of protection equipment with time tag CP56Time2a	M_EP_TF_1	

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

6) Reception possible, thereby the blocked single-point information is deblocked and further individually processed as TI = 30 (address translation occurs algorithmic).

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	C_SE_NC_1
B	<51>	:=	Bitstring of 32 bit	C_BO_NA_1

B	<58>	:=	Single command with time tag CP56Time2a	C_SC_TA_1
B	<59>	:=	Double command with time tag CP56Time2a	C_DC_TA_1
B	<60>	:=	Regulating step command with time tag CP56Time2a	C_RC_TA_1
B	<61>	:=	Set point command, normalized value with time tag CP56Time2a	C_SE_TA_1
B	<62>	:=	Set point command, scaled value with time tag CP56Time2a	C_SE_TB_1
B	<63>	:=	Set point command, short floating point with time tag CP56Time2a	C_SE_TC_1
B	<64>	:=	Bitstring of 32 bit with time tag CP56Time2a	C_BO_TA_1

Either the ASDUs of the set <45> - <51> or of the set <58> - <64> are used.

System information in monitor direction
(station-specific parameter, mark „X“ if used)

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
	<102>	:=	Read command	C_RD_NA_1
B**	<103>	:=	Clock synchronization command	C_CS_NA_1
	<104>	:=	~~Test command~~	C_TS_NA_1
X	<105>	:=	Reset process command	C_RP_NA_1
	<106>	:=	~~Delay acquisition command~~	C_CD_NA_1
B	<107>	:=	Test command with time tag CP56time2a	C_CD_NA_1

B** … supported but not recommended (bad accuracy)

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
4)	<113>	:=	Parameter activation	P_AC_NA_1

4) … Not used in IEC 60870-5-104 Edition 2. No use case.

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)

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

Type identifier and Cause of Transmission Assignments
(station-specific parameter)

Shaded boxes are not required.
Black boxes are not permitted in this companion standard
Blank = Function or ASDU is not used.
Mark Type Identification/Cause of transmission combinations:
'**X**' if only used in the standard direction
'**R**' if only used in the reverse direction
'**B**' if used in both directions

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		B	B								B	B		B					
~~<2>~~	~~M_SP_TA_1~~																			
<3>	M_DP_NA_1		B	B								B	B		B					
~~<4>~~	~~M_DP_TA_1~~																			
<5>	M_ST_NA_1		B	B*								B*	B*		B*					
~~<6>~~	~~M_ST_TA_1~~																			
<7>	M_BO_NA_1		B	B*											B*					
~~<8>~~	~~M_BO_TA_1~~																			
<9>	M_ME_NA_1	B	B	B											B					
~~<10>~~	~~M_ME_TA_1~~																			
<11>	M_ME_NB_1	B	B	B											B					
~~<12>~~	~~M_ME_TB_1~~																			
<13>	M_ME_NC_1	B	B	B											B					
~~<14>~~	~~M_ME_TC_1~~																			
<15>	M_IT_NA_1			B												B				
~~<16>~~	~~M_IT_TA_1~~																			
~~<17>~~	~~M_EP_TA_1~~																			
~~<18>~~	~~M_EP_TB_1~~																			
~~<19>~~	~~M_EP_TC_1~~																			
<20>	M_PS_NA_1		X												X					
<21>	M_ME_ND_1																			
<30>	M_SP_TB_1			B								B	B							
<31>	M_DP_TB_1			B								B	B							
<32>	M_ST_TB_1			B*								B*	B*							
<33>	M_BO_TB_1			B*																
<34>	M_ME_TD_1			B																
<35>	M_ME_TE_1			B																
<36>	M_ME_TF_1			B																
<37>	M_IT_TB_1			B												B				
<38>	M_EP_TD_1			B																
<39>	M_EP_TE_1			B																
<40>	M_EP_TF_1			B																
<45>	C_SC_NA_1						B	B	B	B	B						B	B	B	B
<46>	C_DC_NA_1						B	B	B	B	B						B	B	B	B
<47>	C_RC_NA_1						B	B	B	B	B						B	B	B	B
<48>	C_SE_NA_1						B	B	B	B	B*						B	B	B	B
<49>	C_SE_NB_1						B	B	B	B	B*						B	B	B	B

B* … can be generated by the PLC

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
<50>	C_SE_NC_1						B	B	B	B	B*						B	B	B	B
<51>	C_BO_NA_1						B*	B*			B*						B	B	B	B
<58>	C_SC_TC_1						B	B	B	B	B						B	B	B	B
<59>	C_DC_TC_1						B	B	B	B	B						B	B	B	B
<60>	C_RC_TC_1						B	B	B	B	B						B	B	B	B
<61>	C_SE_TA_1						B	B	B	B	B*						B	B	B	B
<62>	C_SE_TB_1						B	B	B	B	B*						B	B	B	B
<63>	C_SE_TC_1						B	B	B	B	B*						B	B	B	B
<64>	C_BO_TA_1						B*	B*			B*						B	B	B	B
<70>	M_EI_NA_1*)				X															
<100>	C_IC_NA_1						B	B			B						B	B	B	B
<101>	C_CI_NA_1						B	B			B						B	B	B	B
<102>	C_RD_NA_1																			
<103>	C_CS_NA_1			B			X	X									B		B	B
~~<104>~~	~~C_TS_NA_1~~																			
<105>	C_RP_NA_1						X	X									B	B	B	B
~~<106>~~	~~C_CD_NA_1~~																			
<107>	C_TS_TA_1						B	B									B	B	B	B
<110>	P_ME_NA_1						X	X							X		B		B	
<111>	P_ME_NB_1						X	X							X		B		B	
<112>	P_ME_NC_1						X	X							X		B		B	
<113>	P_AC_NA_1						4)	4)	4)	4)							4)	4)	4)	4)
<120>	F_FR_NA_1													B			B	5)	5)	5)
<121>	F_SR_NA_1													B			B	5)	5)	5)
<122>	F_SC_NA_1					B								B			B	5)	5)	5)
<123>	F_LS_NA_1													B			B	5)	5)	5)
<124>	F_AF_NA_1													B			B	5)	5)	5)
<125>	F_SG_NA_1													B			B	5)	5)	5)
<126>	F_DR_TA_1*)			X		X														

*) … blank or X only
B* … can be generated by the PLC
4) … not used – no "Use Case"
5) … transparent transmission by system

Semantics of cause of transmission:

<0>	:=	not used
<1>	:=	periodic, cyclic (optional)
<2>	:=	background scan (optional)
<3>	:=	spontaneous
<4>	:=	initialized
<5>	:=	request or requested
<6>	:=	activation
<7>	:=	activation confirmation
<8>	:=	deactivation
<9>	:=	deactivation confirmation
<10>	:=	activation termination
<11>	:=	return information caused by a remote command
<12>	:=	return information caused by a local command
<13>	:=	file transfer
<14..19>	:=	not used
<20>	:=	interrogated by station interrogation
<21..36>	:=	interrogated by interrogation of the group 1..16
<37>	:=	requested by general counter request
<38..41>	:=	requested by counter interrogation of the group 1..4
<42, 43>	:=	not used
<44>	:=	unknown type identification
<45>	:=	unknown cause of transmission
<46>	:=	unknown common address of ASDU
<47>	:=	unknown information object address
<48, 63>	:=	not used

6.6 Basic application functions

Station initialization
(station-specific parameter, mark „**X**“ if function is used)

[X] Remote initialization

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

[B] Cyclic data transmission

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

[ ] Read procedure

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

[B] Spontaneous transmission

Note: No spontaneous transmission (blank field) is not supported

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.

[ ] Single-point information M_SP_NA_1, M_SP_TA_1, M_SP_TB_1 and M_PS_NA_1
[ ] Double-point information M_DP_NA_1, M_DP_TA_1 and M_DP_TB_1
[ ] Step position information M_ST_NA_1, M_ST_TA_1 and M_ST_TB_1
[ ] Bitstring of 32 bit M_BO_NA_1, M_BO_TA_1 and M_BO_TB_1 (if defined for a specific project)
[ ] Measured value, normalized value M_ME_NA_1, M_ME_TA_1, M_ME_ND_1 and M_ME_TD_1
[ ] Measured value, scaled value M_ME_NB_1, M_ME_TB_1 and M_ME_TE_1
[ ] Measured value, short floating point value M_ME_NC_1, M_ME_TC_1 and M_ME_TF_1

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

B	global				
B	group 1	B	group 7	B	group 13
B	group 2	B	group 8	B	group 14
B	group 3	B	group 9	B	group 15
B	group 4	B	group 10	B	group 16
B	group 5	B	group 11		
B	group 6	B	group 12		

Information Object Addresses assigned to each group must be shown in a separate table.

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

B** Clock synchronization
optional, see clause 7.6

B** … supported but not recommended (bad accuracy)

B Day of week used
RES1, GEN (time tag substituted/ not substituted) used
B SU-bit (summertime) used

Command transmission
(object-specific parameter, mark „**X**“ if function only used in standard direction, „**R**“ if only used 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
B Short pulse duration (duration determined by a system parameter in the outstation)
B Long pulse duration (duration determined by a system parameter in the outstation)
B Persistent output

X Supervision of maximum delay in command direction of commands and set point commands
0-65535s Maximum allowable delay of commands and set point commands

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

B	Mode A: Local freeze with spontaneous transmission
B	Mode B: Local freeze with counter interrogation
B	Mode C: Freeze and transmit by counter interrogation commands
	Mode D: Freeze by counter interrogation command, frozen values reported spontaneously

B	Counter read
B	Counter freeze without reset
B	Counter freeze with reset
B	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 only used in standard direction, „**R**“ if only used in the reverse direction, and „**B**“ if used in both directions)

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

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

B	Test procedure

File transfer
(station-specific parameter, mark each used function „**X**“)

File transfer in monitor direction

X*	Transparent file
X*	Transmission of disturbance data of protection equipment
X	Transmission of sequences of events
X*	Transmission of sequences of recorded analog values

File transfer in control direction

	Transparent file

X* … Data can be transparently transported by the system but not generated or evaluated.
A maximum of 220 bytes user data can be transported.

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

B	Background scan

Note: used for data which are transmitted caused by a self-initiated general interrogation

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

	~~Acquisition of transmission delay~~

Definition of time outs

Parameter	Default Value	Remarks	Selected value
t0	30 s	Time-out of connection establishment	
t1	15 s	Time-out of send or test APDUs	
t2	10 s	Time-out for acknowledges in case of no data messages t2<t1	
t3	20 s	Time-out for sending test frames in case of a long idle state t3>t1	

Maximum range of values t0-t2: 1 to 255 s, accuracy 1 s
Maximum range of values t3 (ET84): 0 to 172800 s (48h), accuracy 1 s

Maximum numbers of outstanding I format frames k and latest acknowledge

Parameter	Default Value	Remarks	Selected value
k	12 APDUs	Maximum difference receive sequence number to send state variable	
w	8 APDU´s	Latest acknowledge after receiving w I-format APDUs	

Maximum range of value k (IEC60870-5-104 standard): 1 to 32767 APDUs, accuracy 1 APDU
Maximum range of value w (IEC60870-5-104 standard): 1 to 32767 APDUs, accuracy 1 APDU

Maximum range of value k (ET84): 1 to 128, accuracy 1 APDU
Maximum range of value w (ET84): 1 to 128 APDUs, accuracy 1 APDU

Recommendation: w should not exceed 2/3 of k

Portnumber

Parameter	Value	Remarks	
Portnumber	2404	In all cases	

Redundant Connections

[4] Number N connections used in redundancy group

RFC 2200 suite

RFC 2200 is an official Internet Standard which describes the state of standardization of protocols used in the Internet as determined by the Internet Architecture Board (IAB). It offers a broad spectrum of actual standards used in the Internet. The suitable selection of documents from RFC 2200 defined in this standard for given projects has to be chosen by the user of this standard.

[X] Ethernet 802.3
[ ] Serial X.21 interface
[ ] Other selection from RFC 2200

List of valid documents from RFC 2200

1. ……
2. ……
3. ……
4. ……
5. ……
6. ……
7. etc.

A Test Results Chart

	Record the Conformance Test Procedure result for each of the supported configuration parameter values on the right		Station Type		Direction	
	✓ ..... 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	Controlled station	Normal Direction	Reversed Direction
Frame length	5.2.0.1	Maximum length L (control direction)	✓	✓	✓	**N.A.**
	5.2.0.2	Maximum length L (monitor direction)	✓	✓	✓	**N.A.**
Common Address of ASDU	5.2.0.70	Two (2) octets for Common Address of ASDU (CASDU)	✓	✓	✓	**N.A.**
Information Object Address	5.2.0.80	Three (3) octets for Information Object Address (structured or unstructured)	✓	✓	✓	**N.A.**
Cause of Transmission	5.2.0.90	Two (2) octets for COT field (2nd octet is Originator address)	✓	✓	✓	**N.A.**
Tests on Transport Provider Level	5.3.1.1	IP Frame	✓	✓	✓	**N.A.**
	5.3.1.3	TCP Frame	✓ *1*	✓ *1*	✓	**N.A.**
	5.3.1.10	CS104 Frame Layout	✓	✓	✓	**N.A.**
	5.3.1.20	CS104 I-Format APDU	✓	✓	✓	**N.A.**
	5.3.1.25	CS104 S-Format APDU	✓	✓	✓	**N.A.**
	5.3.1.30	CS104 U-Format APDU	✓	✓	✓	**N.A.**
	5.3.1.50	Transmission Procedure	✓ *2*	✓ *2*	✓	**N.A.**
	5.3.1.70	Transmission Control Using START/STOP	✓	✓	✓	**N.A.**
	5.3.1.90	Time Out Intervals	✓ *13*	✓ *13*	✓	**N.A.**
Verification of Data	5.3.2.1	Type Identification	✓	✓	✓	**N.A.**
Unit Identifier	5.3.2.10	Cause of Transmission	✓	✓	✓	**N.A.**

	Record the Conformance Test Procedure result for each of the supported configuration parameter values on the right		Station Type		Direction	
	✓ ..... 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	Controlled station	Normal Direction	Reversed Direction
	5.3.2.20	Common Address of ASDU	✓	✓	✓	**N.A.**
Verification of ASDUs	5.3.3.10	ASDU 1 Single-point Information	✓	✓	✓	**N.A.**
	5.3.3.30	ASDU 3 Double-point Information	✓	✓	✓	**N.A.**
	5.3.3.50	ASDU 5 Step-position Information	✓	✓	✓	**N.A.**
	5.3.3.70	ASDU 7 Bitstring of 32 bit	✓	✓	✓	**N.A.**
	5.3.3.90	ASDU 9 Measured value, normalised value	✓	✓	✓	**N.A.**
	5.3.3.110	ASDU 11 Measured value, scaled value	✓	✓	✓	**N.A.**
	5.3.3.130	ASDU 13 Measured value, short floating point number	✓	✓	✓	**N.A.**
	5.3.3.150	ASDU 15 Integrated Totals	✓	✓	✓	**N.A.**
	5.3.3.170	ASDU 20 Packed single-point information with status change detection	✓	✓	✓ [3]	**N.A.**
	5.3.3.190	ASDU 21 Measured value, normalised value without quality descriptor	**N.A.**	**N.A.**	**N.A.**	**N.A.**
	5.3.3.210	ASDU 30 Single-point information with time tag CP56Time2a	✓	✓	✓	**N.A.**
	5.3.3.230	ASDU 31 Double-point information with time tag CP56Time2a	✓	✓	✓	**N.A.**
	5.3.3.250	ASDU 32 Step-position information with time-tag CP56Time2a	✓	✓	✓	**N.A.**
	5.3.3.280	ASDU 33 Bitstring of 32 bit with time-tag CP56Time2a	✓	✓	✓	**N.A.**
	5.3.3.310	ASDU 34 Measured value, normalised value with time-tag CP56Time2a	✓	✓	✓	**N.A.**
	5.3.3.340	ASDU 35 Measured value, scaled value with time-tag CP56Time2a	✓	✓	✓	**N.A.**
	5.3.3.370	ASDU 36 Measured value, short floating point number with time-tag CP56Time2a	✓	✓	✓	**N.A.**
	5.3.3.400	ASDU 37 Integrated totals with time tag CP56Time2a	✓	✓	✓	**N.A.**
	5.3.3.430	ASDU 38 Event of protection equipment with time-tag CP56Time2a	✓	✓	✓	**N.A.**
	5.3.3.460	ASDU 39 Packed start events of protection equipment with time-tag CP56Time2a	✓	✓	✓	**N.A.**
	5.3.3.490	ASDU 40 Packet output circuit information of protection equipment with time tag CP56Time2a	✓	✓	✓	**N.A.**
	5.3.4.1	ASDU 45 Single Command	**N.A.**	**N.A.**	**N.A.**	**N.A.**
	5.3.4.10	ASDU 46 Double Command	**N.A.**	**N.A.**	**N.A.**	**N.A.**

	Record the Conformance Test Procedure result for each of the supported configuration parameter values on the right		Station Type		Direction	
	✓ ..... 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	Controlled station	Normal Direction	Reversed Direction
	5.3.4.20	ASDU 47 Regulating step command	**N.A.**	**N.A.**	**N.A.**	**N.A.**
	5.3.4.30	ASDU 48 Set point command, normalised value	**N.A.**	**N.A.**	**N.A.**	**N.A.**
	5.3.4.40	ASDU 49 Set point command, scaled value	**N.A.**	**N.A.**	**N.A.**	**N.A.**
	5.3.4.50	ASDU 50 Set point command, short floating point value	**N.A.**	**N.A.**	**N.A.**	**N.A.**
	5.3.4.60	ASDU 51 Bitstring of 32 bits	**N.A.**	**N.A.**	**N.A.**	**N.A.**
	5.3.4.70	ASDU 58 Single command with time tag CP56Time2a	✓	✓	✓	**N.A.**
	5.3.4.90	ASDU 59 Double command with time tag CP56Time2a	✓	✓	✓	**N.A.**
	5.3.4.110	ASDU 60 Regulating step command with time tag CP56Time2a	✓	✓	✓	**N.A.**
	5.3.4.130	ASDU 61 Set point command, normalised value with time tag CP56Time2a	✓	✓	✓	**N.A.**
	5.3.4.150	ASDU 62 Set point command, scaled value with time tag CP56Time2a	✓	✓	✓	**N.A.**
	5.3.4.170	ASDU 63 Set point command, short floating point value with time tag CP56Time2a	✓	✓	✓	**N.A.**
	5.3.4.190	ASDU 64 Bitstring of 32 bits with time tag CP56Time2a	✓	✓	✓	**N.A.**
	5.3.5.1	ASDU 70 End of Initialisation	✓	✓	✓	**N.A.**
	5.3.6.1	ASDU 100 Interrogation command	✓	✓	✓	**N.A.**
	5.3.6.10	ASDU 101 Counter interrogation command	✓	✓	✓	**N.A.**
	5.3.6.20	ASDU 102 Read command	**N.A.**	**N.A.**	**N.A.**	**N.A.**
	5.3.6.30	ASDU 103 Clock synchronisation command	✓	✓	✓	**N.A.**
	5.3.6.60	ASDU 105 Reset process command	✓	✓	✓	**N.A.**
	5.3.7.70	ASDU 107 Test command with time tag CP56Time2a	✓	✓	✓	**N.A.**
	5.3.7.1	ASDU 110 Parameter of measured value, normalised value	✓	✓	✓ [3]	**N.A.**
	5.3.7.10	ASDU 111 Parameter of measured values, scaled value	✓	✓	✓ [3]	**N.A.**
	5.3.7.20	ASDU 112 Parameter of measured values, short floating point number	✓	✓	✓ [3]	**N.A.**
	5.3.7.30	ASDU 113 Parameter activation	✓	✓	✓	**N.A.**
	5.3.8.1	ASDU 120 File ready	✓	✓	✓	**N.A.**

	Record the Conformance Test Procedure result for each of the supported configuration parameter values on the right		Station Type		Direction	
	✓ ..... 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	Controlled station	Normal Direction	Reversed Direction
	5.3.8.10	ASDU 121 Section ready	✓	✓	✓	**N.A.**
	5.3.8.30	ASDU 122 Call directory, select file, call file, call section	✓	✓	✓	**N.A.**
	5.3.8.40	ASDU 123 Last section, last segment	✓	✓	✓	**N.A.**
	5.3.8.50	ASDU 124 ACK file, ACK section	✓	✓	✓	**N.A.**
	5.3.8.60	ASDU 125 Segment	✓	✓	✓	**N.A.**
	5.3.8.70	ASDU 126 Directory	✓	✓	✓	**N.A.**
Data Unit Identifier	5.4.9.1	Type Identification	✓	✓	✓	**N.A.**
	5.4.9.4	Cause Of Transmission	✓	✓	✓	**N.A.**
	5.4.9.10	Common Address of ASDU	✓	✓	✓	**N.A.**
Information object address	5.4.10.1	Object Address	✓	✓	✓	**N.A.**
Station initialisation function	5.4.11.1	Local Initialisation of the Controlling station: (re-)boot	**N.A.**	**N.A.**	**N.A.**	**N.A.**
	5.4.11.10	Local initialisation of the Controlled station: (re-)boot	✓	✓	✓	**N.A.**
	5.4.11.20	Remote initialisation of the Controlled station	✓	✓	✓	**N.A.**
	5.4.11.30	Re-establishing a lost Started connection between the Controlling and the Controlled station when no other connections are available	✓	✓	✓	**N.A.**
	5.4.11.40	Compatibility With Other Test Cases	✓	✓	✓	**N.A.**
Redundant Link	5.4.12.1	Periodic check of ALL redundant connections	**N.A.**	✓ [4]	✓	**N.A.**
	5.4.12.10	Re-establishing a lost Started connection between the Controlling and the Controlled station when redundant connections are available: (automatic switch-over)	**N.A.**	✓	✓	**N.A.**
	5.4.12.20	Re-establishing a lost redundant connection between the Controlling and the Controlled station	**N.A.**	**N.A.**	**N.A.**	**N.A.**
	5.4.12.30	Manual switching over the Started connection to another redundant Stopped connection: (manual switch-over)	**N.A.**	✓	✓	**N.A.**
Cyclic data transmission function	5.4.13.1	Cyclic data transmission and Background Scan – sequential procedure	**N.A.**	**N.A.**	**N.A.**	**N.A.**
	5.4.13.10	Compatibility With Other Test Cases	**N.A.**	**N.A.**	**N.A.**	**N.A.**

	Record the Conformance Test Procedure result for each of the supported configuration parameter values on the right		Station Type		Direction	
	✓ ..... 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	Controlled station	Normal Direction	Reversed Direction
Data acquisition through Read function	5.4.14.1	Data acquisition through Read - sequential procedure	**N.A.**	**N.A.**	**N.A.**	**N.A.**
	5.4.14.10	Compatibility With Other Test Cases	**N.A.**	**N.A.**	**N.A.**	**N.A.**
Acquisition of events function	5.4.15.1	Acquisition of events -sequential procedure.	✓	✓	✓	**N.A.**
	5.4.15.10	Compatibility With Other Test Cases	✓	✓	✓	**N.A.**
General interrogation function	5.4.16.1	Outstation interrogation - one Logical Remote Unit (LRU) available in the controlled station.	✓ [5]	✓ [5]	✓	**N.A.**
	5.4.16.10	Outstation interrogation - more than one Logical Remote Unit (LRU) available in the controlled station -	**N.A.**	**N.A.**	**N.A.**	**N.A.**
	5.4.16.20	Re-activate a running Outstation interrogation - Option 1: the running GI continues.	**N.A.**	**N.A.**	**N.A.**	**N.A.**
	5.4.16.30	Re-activate a running Outstation interrogation Option 2: the running GI is stopped and the second GI is started.	**N.A.**	**N.A.**	**N.A.**	**N.A.**
	5.4.16.40	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 behavior!!).	✓ [6]	✓ [6]	✓	**N.A.**
	5.4.16.50	Deactivate a running Outstation interrogation	**N.A.**	**N.A.**	**N.A.**	**N.A.**
	5.4.16.60	Compatibility With Other Test Cases	✓	✓	✓	**N.A.**
Clock synchronisation function	5.4.17.1	Clock synchronisation -sequential procedure	✓	✓	✓ [7]	**N.A.**
	5.4.17.10	Clock synchronisation – Change the clock.	✓	✓	✓ [7]	**N.A.**
	5.4.17.20	Compatibility With Other Test Cases	✓	✓	✓	**N.A.**
Command transmission function	5.4.18.1	Select & Execute	✓	✓	✓ [8]	**N.A.**
	5.4.18.10	Select & Deactivation	✓	✓	✓ [8]	**N.A.**
	5.4.18.20	Direct Execute	✓	✓	✓ [8]	**N.A.**
	5.4.18.30	Select with Negative Confirmation by Controlled station (Abort)	✓	✓	✓ [8]	**N.A.**
	5.4.18.40	Select with Negative Execute Confirmation by Controlled station if Execute is received after configured delay in the controlling station	✓	✓	✓ [8]	**N.A.**
	5.4.18.50	Direct Execute with Negative Confirmation by Controlled station	✓	✓	✓ [8]	**N.A.**
	5.4.18.60	Command transmission with network delay supervision - sequential procedure: Command received WITHIN configured delay	✓	✓	✓ [8]	**N.A.**

	Record the Conformance Test Procedure result for each of the supported configuration parameter values on the right		Station Type		Direction	
	✓ ..... 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	Controlled station	Normal Direction	Reversed Direction
	5.4.18.70	Command transmission with network delay supervision - sequential procedure: Command received AFTER configured delay	✓	✓	✓ [8]	**N.A.**
	5.4.18.80	Test for all supported ASDU's	✓	✓	✓ [8]	**N.A.**
	5.4.18.90	Compatibility With Other Test Cases	✓	✓	✓	**N.A.**
Transmission of integrated totals (telecounting) function	5.4.19.1	Mode A - Local freeze with spontaneous transmission	✓	✓	✓ [9]	**N.A.**
	5.4.19.10	Mode B - Local freeze with Counter Interrogation	✓	✓	✓	**N.A.**
	5.4.19.20	Mode C – Remote initiated freeze with Counter Interrogation	✓	✓	✓	**N.A.**
	5.4.19.30	Mode D – Remote initiated freeze with spontaneous transmission	**N.A.**	**N.A.**	**N.A.**	**N.A.**
	5.4.19.40	Compatibility With Other Test Cases	✓	✓	✓	**N.A.**
Parameter loading function	5.4.20.1	Load and activate parameter	✓	✓	✓ [10]	**N.A.**
	5.4.20.10	Load and activate parameter with Negative Confirmation by Controlled station	✓	✓	✓	**N.A.**
	5.4.20.20	Compatibility With Other Test Cases	✓	✓	✓	**N.A.**
Test procedure function	5.4.21.1	Test procedure - sequential procedure	✓	✓	✓	**N.A.**
	5.4.21.10	Compatibility With Other Test Cases	✓	✓	✓	**N.A.**
File transfer procedure function	5.4.22.1	File transfer procedure (monitor direction) – sequential procedure	✓	✓	✓ [11]	**N.A.**
	5.4.22.10	File transfer procedure (control direction) – sequential procedure	✓	✓	✓ [12]	**N.A.**
	5.4.22.20	Compatibility With Other Test Cases	✓	✓	✓	**N.A.**
Additional	5.4.23.1	Out of service behaviour	✓	✓	✓	**N.A.**
Conformance Test Procedures	5.4.23.10	Miscellaneous	✓	✓	✓	**N.A.**
	5.4.23.20	Time invalid	✓ [14]	✓ [14]	✓ [14]	**N.A.**
	5.4.23.30	Compatibility With Other Test Cases	✓	✓	✓	**N.A.**
Negative Conformance Test Procedures	5.4.24.1	Negative tests	✓	✓	✓	**N.A.**
	5.4.24.2	Quality descriptor	✓	✓	✓	**N.A.**
	5.4.24.3	Command transmission	✓	✓	✓	**N.A.**

	Record the Conformance Test Procedure result for each of the supported configuration parameter values on the right		Station Type		Direction	
	✓ ..... 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	Controlled station	Normal Direction	Reversed Direction
	5.4.24.4	Summer time –Summer time bit is taken into account when using commands and events	✓	✓	✓	**N.A.**
	5.4.24.50	Compatibility With Other Test Cases	✓	✓	✓	**N.A.**

B Test Results of Command Transmission

B.1 Test Results of Single Command Transmission

TEST RESULTS OF THE DOUBLE COMMAND (DCO) „✓" = 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 & Execute command on/off S & D = Select & 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 = 58	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, 9.5 8.6	PICS, 9.5 8.6	PICS, 9.5 8.6	PICS, 9.5 8.6	PICS, 9.5 8.6	PICS, 9.5 8.6
Result	✓	✓	✓	✓	✓	✓
Log file available (Y/N)?	**N**	**N**	**N**	**N**	**N**	**N**
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, 9.5 8.6	PICS, 9.5 8.6	PICS, 9.5 8.6	PICS, 9.5 8.6	PICS, 9.5 8.6	PICS, 9.5 8.6
Result	✓	✓	✓	✓	✓	✓
Log file available (Y/N)?	**N**	**N**	**N**	**N**	**N**	**N**
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, 9.5 8.6	PICS, 9.5 8.6	PICS, 9.5 8.6	PICS, 9.5 8.6	PICS, 9.5 8.6	PICS, 9.5 8.6
Result	✓	✓	✓	✓	✓	✓
Log file available (Y/N)?	**N**	**N**	**N**	**N**	**N**	**N**
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	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, 9.5 8.6	PICS, 9.5 8.6	PICS, 9.5 8.6	PICS, 9.5 8.6	PICS, 9.5 8.6	PICS, 9.5 8.6
Result	✓	✓	✓	✓	✓	✓
Log file available (Y/N)?	**N**	**N**	**N**	**N**	**N**	**N**

B.2 Test Results of Double Command Transmission

TEST RESULTS OF THE DOUBLE COMMAND (DCO) „✓" = 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 & Execute command on/off S & D = Select & 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 = 59	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, 9.5 8.6	PICS, 9.5 8.6	PICS, 9.5 8.6	PICS, 9.5 8.6	PICS, 9.5 8.6	PICS, 9.5 8.6
Result	✓	✓	✓	✓	✓	✓
Log file available (Y/N)?	**N**	**N**	**N**	**N**	**N**	**N**
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, 9.5 8.6	PICS, 9.5 8.6	PICS, 9.5 8.6	PICS, 9.5 8.6	PICS, 9.5 8.6	PICS, 9.5 8.6
Result	✓	✓	✓	✓	✓	✓

Log file available (Y/N)?	**N**	**N**	**N**	**N**	**N**	**N**
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, 9.5 8.6	PICS, 9.5 8.6	PICS, 9.5 8.6	PICS, 9.5 8.6	PICS, 9.5 8.6	PICS, 9.5 8.6
Result	✓	✓	✓	✓	✓	✓
Log file available (Y/N)?	**N**	**N**	**N**	**N**	**N**	**N**
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	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, 9.5 8.6	PICS, 9.5 8.6	PICS, 9.5 8.6	PICS, 9.5 8.6	PICS, 9.5 8.6	PICS, 9.5 8.6
Result	✓	✓	✓	✓	✓	✓
Log file available (Y/N)?	**N**	**N**	**N**	**N**	**N**	**N**

B.3 Test Results of Setpoint Command Transmission

TEST RESULTS OF THE SETPOINT COMMAND (IEEE STD 754) „✓" = 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 & Execute command on/off S & D = Select & 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 = 63	S+E	S+D	E
QL=0			
Message from RTU	ACTCONpos / ACTTERMpos20	DEACTCONpos	ACTCONpos / ACTTERMpos21
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, 9.5 8.6	PICS, 9.5 8.6	PICS, 9.5 8.6
Result	✓	✓	✓
Log file available (Y/N)?	**N**	**N**	**N**
General remarks	Activation termination always comes with Positive activation termination, no matters if the point has really changed it status or not.		

Summary of Keynotes referenced in chapter APPENDIX A "TEST RESULTS CHART" and APPENDIX B "TEST RESULTS OF COMMAND TRANSMISSION"

1 RTU use the "RST"-Flag for closing the TCP-Connection.

2 Tested values for k = 12 and 6, and for w = 8 and 4. k= 6 is the minimum value. When sending the I-frames too fast acknowledge is not send each w frames but with bigger values (each 9 frames). When I frames are sent with some delay within them (1 seconds), S-frame are correctly send each w frames.

3 ASDU 20 is only used in receive-direction.

4 Redundancy tested with 2 connections.

5 GI sends actual value for digital input, but not for analogue (last event reported to system). Events during GI are supported and they are sent with higher priority that GI frames.

6 On request of several GI, RTU waits for an s-frame to acknowledge each activation termination before starting sending a new GI.

7 New time is only assumed after a minute-change of the internal clock.

8 Time in ACTCON and ACTTERM is the actual time when the telegrams were created.

9 The timer for the counters are configurable to "1 min", "2 min" , "3 min", "5 min", "10 min", "15 min", "30 min" or "60 min".

10 In the GI, for SFP, RTU reports the last value sent to the system and not the actual value of the point, when a event is produced during a GI.
Note: Parameter for smoothing factor not supported for <TI:=35> Measured value, scaled value with time tag CP56Time2a

11 After finishing the transfer RTU send ASDU 126 (without IOA) to indicate change in the directory, ASDU is sent without timetag and SOF. According to Siemens this is because the directory is empty and there is no file to be transferred.

If a section is continuously denied, the RTU keeps sending it, until positive acknowledge. On negative ack of the file, it is no resend. In this case ASDU 126 with COT= 3 is send with FA = 1(transfer of this file is active)

If connection is stopped during FT when re-establishing the connection RTU resends the file.

When a new FT command is received during a file transmission, RTU stops first sending and starts a new one. RTU replies with Post File transfer ASDU and FRQ qualifier = negative confirm.

12 All IOA are accepted in order to send a file. After nack of the file, RTU does not allow to resend again the file. In control direction no ASDU 126 is received after completing the transfer

13 ACK timeout (t1) must be selective for each sent message (SICAM RTUs implementation use only 1 global ACK timeout counter for all sent messages)

14 Invalid-Bit of time is not set after restart or Power up of SICAM RTUs until 1st time setting procedure.

Literature

SICAM RTUs Common Functions System and Basic System Elements	DC0-015-2
SICAM RTUs Platforms Configuration Automation Units and Automation Networks	DC0-021-2
SICAM RTUs . Ax 1703 Common Functions Protocols	DC0-023-2

Documents on Interoperability

SICAM RTUs IEC 60870-5-101/104 Interoperability	DC0-013-2

International Standards

IEC 60870-5-1: TELECONTROL EQUIPMENT AND SYSTEMS, PART 5, Transmission protocols: Transmission Frame Formats, IS (International Standard), 1990	
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