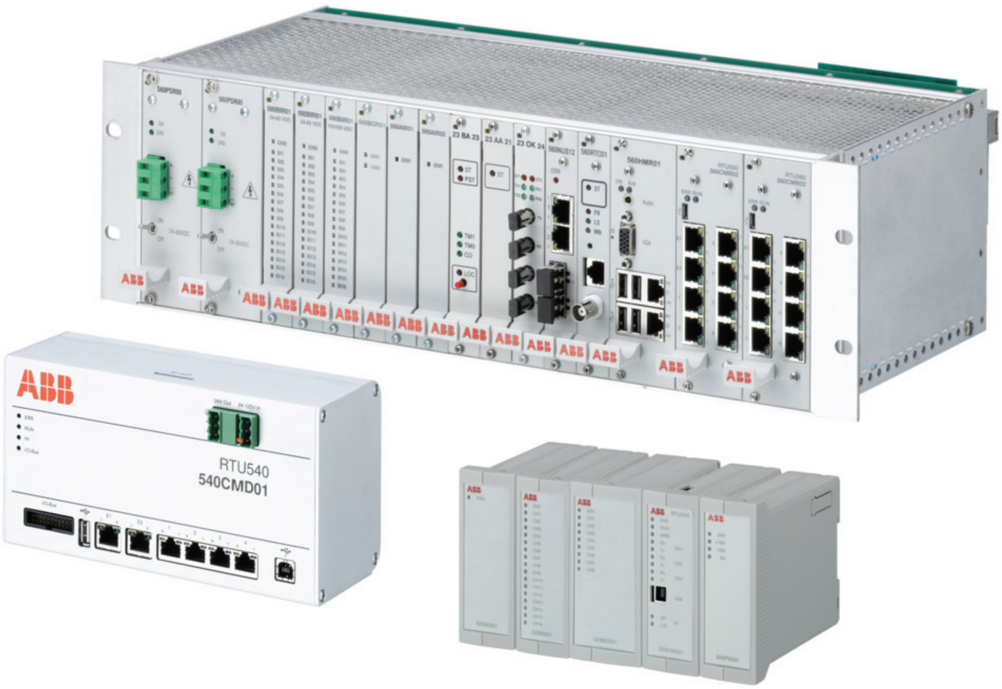
Power Grids

RTU500 series - Remote Terminal Units Host Communication Interface with IEC 60870-5-101

Protocol description



Revision

Document identity:		1KGT 150 466 V020 1
Revision:	**Date:**	**Changes:**
0	11/2000	New document
1	02/2001	Chapter 12 added Counter Interrogation Command added Interoperability list actualized
2	04/2002	Chapter Dial up added
3	11/2002	Chapter File transfer updated Chapter Transparent Data added
4	10/2003	Chapter Line Redundancy added Chapter AI Parameter Download added New redundant Time Synchronization Mode Two step commands allowed for RCO and ASO/DSO New System Events introduced
5	08/2004	New System Events introduced New Line Parameter for SEV and Commands Cause of Transmission one or two octets Interoperability List extended
6	02/2005	New System Event (SEV) #100
7	04/2006	Counter Interrogation Command C_CI_NA_1 is now supporting counter groups Reset Process Command C_RP_NA_1 will be routed to subdevice interfaces New System Events (SEV) New function: System Single Commands (SSC)
8	06/2006	New: Double transmission of information objects Deactivate Command C_RP_NA_1 explained
9	07/2007	Chapter Request for access demand added (function available in Release higher than 8.1)
10	08/2007	New System Events introduced Interoperability list corrected and updated Parameter for C_IC_NA_1 / C_CI_NA_1 corrected Support of COT 44 to 47 for commands GI initialized by PLC program
11	06/2009	Chapter Physical Layer modified Transparent data channel Modbus protocol Chapter Redundant communication lines extended Parameter In Use introduced

Document identity:		**1KGT 150 466 V020 1**
Revision:	**Date:**	**Changes:**
		Setpoint with termination message Background cycle introduced Interlock with local control authority Originator address configurable (2 octets) System events, System single commands Max. 16 Host Interfaces New Line Parameter New ASDU: C_SE_NC_1, P_ME_NA_1 Chapter Dial up updated Group Interrogation introduced <106> Delay Acquisition Command
12	10/2009	Correction Dial up Parameters Carrier Trailing Time added in Table Communication Parameter - IEC 60870-5-101 System Events updated
13	03/2011	System Command #012 “Global process image update” new Chapter: 9.11.1 Force process update image
14	07/2011	New ASDU: P_ME_NC_1 Chapter "Parameter Loading" revised Chapter “FILE TRANSFER” extended
15	11/2011	Update Chapter 7.1.2
16	12/2011	New layout
17	04/2015	New parameter: 'Allow only one interrogation running per common address of ASDU (PR#16851) Update file transfer to RCD configuration files (PR#20418) More details on command qualifiers (PR#17056) New chapter: Application layer - communication queue handling (PR#3251) Update: usage of orginator adress parameter (PR#11465) Correction: value ranges of dial-up parameters (PR#21617) Correction: qualifier of command for BSO (PR#23928) Update chapter system events and system commands New layout
18	11/2016	Update: Footnote for HCI 101/104 in table 'ASDU in monotoring direction' (PR#29542)
	01/2017	Update: Table 'Conversion of values' for DPI in monitoring direction (PR#33212)
		AMI/MFI 'Background cycle': added cycle time 15 min (PR#27626)

Document identity:		1KGT 150 466 V020 1
Revision:	**Date:**	**Changes:**
	03/2017	Update: 'Redundant communication lines' in Chapter 'Link Layer' (PR#32834)
19	06/2017	Update: Chapter 'Parameter Loading' and 'Interoperability List' (PR#32754)
	07/2017	Update: Chapter 'Application Layer General' Parameter 'Protocol edition' (PR#34995)
	09/2017	Update chapter Link Layer - General: changed cycle time offline supervision from "is set to off" to "120 s by default" (PR#35094)
20	08/2018	New layout
		Introduced new parameter 'Put in buffer' (PR#35074)

Contents

1 Introduction ... 7
1.1 Preface ... 7
1.2 References ... 7
1.3 Conventions ... 7

2 Physical Layer ... 9
2.1 Serial line-based communication ... 9
2.2 Host interface ... 10

3 Link Layer ... 11
3.1 General ... 11
3.2 Unbalanced Mode ... 12
3.3 Balanced mode ... 12
3.4 Dial-up function ... 13
3.4.1 General ... 13
3.4.2 Dial-up configuration ... 13
3.4.3 Request for access demand ... 16
3.5 Redundant communication lines ... 16
3.5.1 Unbalanced mode ... 16
3.5.2 Balanced mode ... 18

4 Application Layer ... 21
4.1 General ... 21
4.2 Communication Queue Handling ... 22
4.3 ASDU Type identification ... 24
4.3.1 ASDU in monitoring direction ... 24
4.3.2 ASDU in control direction ... 25
4.3.3 ASDU of system information in command direction ... 25
4.3.4 ASDU for file transfer ... 25

5 Parameters and Addressing ... 27
5.1 Address elements ... 27
5.1.1 Restrictions for the link address ... 27
5.1.2 Restrictions for the Common Address ... 27
5.1.3 Restrictions for the information object address ... 28
5.2 General data point parameters ... 28

6 Data Types - Monitoring Direction ... 29
6.1 AMI – Analog Measured Information ... 29
6.1.1 Supported Data Types ... 29
6.1.2 Additional Information ... 29
6.1.3 Conversion of Values ... 30
6.1.4 Conversion of Quality Descriptors ... 30
6.1.5 Conversion of Causes of Transmission ... 31
6.2 BSI – Bit String Information ... 31
6.2.1 Supported Data Types ... 31

6.2.2 Additional Information ... 32
6.2.3 Conversion of values ... 32
6.2.4 Conversion of Quality Descriptors ... 32
6.2.5 Conversion of Causes of Transmission ... 32
6.3 DMI – Digital Measured Information ... 33
6.3.1 Supported Data Types ... 33
6.3.2 Additional Information ... 33
6.3.3 Conversion of values ... 33
6.3.4 Conversion of Quality Descriptors ... 34
6.3.5 Conversion of Causes of Transmission ... 34
6.4 DPI – Double Point Information ... 34
6.4.1 Supported Data Types ... 34
6.4.2 Additional Information ... 35
6.4.3 Conversion of Values ... 35
6.4.4 Conversion of Quality Descriptors ... 35
6.4.5 Conversion of Causes of Transmission ... 35
6.5 EPI – Protection Event Information ... 35
6.5.1 Supported Data Types ... 36
6.5.2 Additional information ... 36
6.5.3 Conversion of Values ... 36
6.5.4 Conversion of Quality Descriptors ... 36
6.5.5 Conversion of Causes of Transmission ... 37
6.6 ITI – Integrated Totals Information ... 37
6.6.1 Supported Data Types ... 37
6.6.2 Additional Information ... 37
6.6.3 Conversion of Values ... 37
6.6.4 Conversion of Quality Descriptors ... 38
6.6.5 Conversion of Causes of Transmission ... 38
6.7 MFI – Measured Float Information ... 38
6.7.1 Supported Data Types ... 38
6.7.2 Values ... 38
6.7.3 Additional Information ... 39
6.7.4 Conversion of Values ... 39
6.7.5 Conversion of Quality Descriptors ... 39
6.7.6 Conversion of Causes of Transmission ... 39
6.8 SPI – Single Point Information ... 40
6.8.1 Supported Data Types ... 40
6.8.2 Additional Information ... 40
6.8.3 Conversion of Values ... 40
6.8.4 Conversion of Quality Descriptors ... 41
6.8.5 Conversion of Causes of Transmission ... 41
6.9 STI – Step Position Information ... 41
6.9.1 Supported Data Types ... 41
6.9.2 Additional Information ... 42
6.9.3 Conversion of Values ... 42
6.9.4 Conversion of Quality Descriptors ... 42

6.9.5 Conversion of Causes of Transmission....42

7 Data Types - Controlling Direction....43

7.1 ASO – Analog Setpoint Output....43
7.1.1 Supported Data Types....43
7.1.2 Command Authority....43
7.1.3 Additional information....43
7.1.4 Conversion of values....43
7.1.5 Conversion of qualifier of command....44
7.1.6 Conversion of causes of transmission....44
7.2 BSO – Bit String Output....44
7.2.1 Supported Data Types....44
7.2.2 Command Authority....44
7.2.3 Additional information....45
7.2.4 Conversion of values....45
7.2.5 Conversion of qualifier of command....45
7.2.6 Conversion of causes of transmission....45
7.3 DCO – Double Command Output....45
7.3.1 Supported Data Types....46
7.3.2 Command Authority....46
7.3.3 Additional Information....46
7.3.4 Conversion of Values....46
7.3.5 Conversion of qualifier of command....46
7.3.6 Conversion of causes of transmission....47
7.4 DSO – Digital Setpoint Output....47
7.4.1 Supported Data Types....47
7.4.2 Command Authority....47
7.4.3 Additional information....48
7.4.4 Conversion of values....48
7.4.5 Conversion of qualifier of command....48
7.4.6 Conversion of causes of transmission....48
7.5 FSO – Floating Point Setpoint Output....48
7.5.1 Supported Data Types....49
7.5.2 Command Authority....49
7.5.3 Additional Information....49
7.5.4 Conversion of values....49
7.5.5 Conversion of qualifier of command....49
7.5.6 Conversion of causes of transmission....49
7.6 RCO – Regulation Command Output....50
7.6.1 Supported Data Types....50
7.6.2 Command Authority....50
7.6.3 Additional information....50
7.6.4 Conversion of values....50
7.6.5 Conversion of qualifier of command....51
7.6.6 Conversion of causes of transmission....51
7.7 SCO – Single Command Output....51
7.7.1 Supported Data Types....52

7.7.2 Command Authority ... 52
7.7.3 Additional Information ... 52
7.7.4 Conversion of values ... 52
7.7.5 Conversion of qualifier of command ... 52
7.7.6 Conversion of causes of transmission ... 53

8 Transparent Data ... 55
8.1 Transparent data channel ... 55
8.1.1 Command direction ... 55
8.1.2 Monitoring direction ... 56
8.1.3 Request procedure ... 57
8.2 Encapsulated SPAbus messages ... 58
8.2.1 General ... 58
8.2.2 Request procedure ... 59

9 File Transfer ... 61
9.1 Supported data types ... 61
9.2 Values ... 61
9.3 Command Authority ... 62
9.4 Additional information ... 62
9.5 Conversion of causes of transmission ... 62
9.6 Download ... 62
9.7 Upload ... 62
9.8 Transmission of sequences of events ... 63
9.8.1 Scope of operation ... 63
9.8.2 Engineering in RTUtil500 ... 63
9.8.3 Runtime procedure ... 64
9.9 Transmission of sequences of recorded analog values ... 64
9.9.1 Scope of operation ... 64
9.9.2 Engineering in RTUtil500 ... 64
9.9.3 Runtime procedure ... 65

10 Internal Functions ... 67
10.1 General Interrogation ... 67
10.1.1 Supported Data Types ... 67
10.1.2 Values ... 67
10.1.3 Command Authority ... 67
10.1.4 Additional information ... 67
10.1.5 Conversion of Quality Descriptors ... 67
10.1.6 Conversion of Causes of Transmission ... 68
10.2 Counter Interrogation Command ... 68
10.2.1 Supported data types ... 68
10.2.2 Values ... 68
10.2.3 Command Authority ... 68
10.2.4 Additional information ... 68
10.2.5 Conversion of quality descriptors ... 69
10.2.6 Conversion of causes of transmission ... 69

10.3 Read Command.......... 69
10.3.1 Supported data types.......... 70
10.3.2 Values.......... 70
10.3.3 Command Authority.......... 70
10.3.4 Additional information.......... 70
10.3.5 Conversion of quality descriptors.......... 70
10.3.6 Conversion of causes of transmission.......... 70
10.4 Time Synchronization.......... 70
10.4.1 Supported Data Types.......... 71
10.4.2 Values.......... 71
10.4.3 Command Authority.......... 71
10.4.4 Additional information.......... 71
10.4.5 Conversion of Causes of Transmission.......... 71
10.5 Test Command.......... 72
10.5.1 Supported data types.......... 72
10.5.2 Values.......... 72
10.5.3 Command Authority.......... 72
10.5.4 Additional Information.......... 72
10.5.5 Conversion of quality descriptors.......... 72
10.5.6 Conversion of causes of transmission.......... 72
10.6 Reset Command.......... 73
10.6.1 Supported data types.......... 73
10.6.2 Values.......... 73
10.6.3 Command Authority.......... 73
10.6.4 Additional information.......... 73
10.6.5 Conversion of quality descriptors.......... 73
10.6.6 Conversion of causes of transmission.......... 73
10.7 Deactivate Command.......... 74
10.7.1 Supported data types.......... 74
10.7.2 Values.......... 74
10.7.3 Command Authority.......... 74
10.7.4 Additional information.......... 74
10.7.5 Conversion of quality descriptors.......... 74
10.7.6 Conversion of causes of transmission.......... 74
10.8 Delay Acquisition Command.......... 75
10.8.1 Supported data types.......... 75
10.8.2 Values.......... 75
10.8.3 Command Authority.......... 75
10.8.4 Additional Information.......... 75
10.8.5 Conversion of quality descriptors.......... 75
10.8.6 Conversion of causes of transmission.......... 75
10.9 Parameter Loading.......... 76
10.9.1 Supported data types.......... 76
10.9.2 Command Authority.......... 76
10.9.3 Additional Information.......... 76
10.9.4 Conversion of values for threshold.......... 76

10.9.5 Conversion of values for smoothing....77
10.9.6 Conversion of qualifier of parameter of measured values.... 77
10.9.7 Conversion of causes of transmission.... 77
10.10 System Events....78
10.11 System commands....79
10.11.1 Reset device process....80
10.11.2 Force process image update.... 80
10.11.3 Request redundancy change over....80

11 Interoperability List.... 81
11.1 System or device.... 81
11.2 Network configuration....81
11.3 Physical Layer.... 81
11.3.1 Transmission speed (control direction)....81
11.3.2 Transmission speed (monitor direction)....82
11.4 Link layer.... 82
11.5 Application Layer....83
11.5.1 Transmission Mode for Application Data....83
11.5.2 Common Address of ASDU....83
11.5.3 Information object address....83
11.5.4 Cause of transmission....83
11.5.5 Selection of standard ASDUs....83
11.6 Basic application functions....87
11.6.1 Station initialization....87
11.6.2 Cyclic data transmission.... 87
11.6.3 Read procedure.... 87
11.6.4 Spontaneous transmission....87
11.6.5 Double transmission of information objects with cause of transmission spontaneous.... 87
11.6.6 Station interrogation....88
11.6.7 Clock synchronization....88
11.6.8 Command transmission....88
11.6.9 Transmission of integrated totals....88
11.6.10 Parameter loading....89
11.6.11 Parameter activation.... 89
11.6.12 Test procedure.... 89
11.6.13 File transfer....89
11.6.14 Background scan.... 89
11.6.15 Acquisition of transmission delay.... 90

12 Glossary.... 91

1 Introduction

1.1 Preface

This document describes the functions of the host communication interface in RTU500 series according to IEC 60870-5-101.

RTU500 series fulfills the requirements of IEC 60870-5-101 Edition 2. Detailed information can be found in the interoperability list (see Chapter 11).

1.2 References

[1] Telecontrol equipment and systems
Part 5: Transmission protocols

Section 2: Link transmission procedures IEC 60870-5-2

First Edition, 1992-04

[2] Telecontrol equipment and systems
Part 5: Transmission protocols

Section 101: Companion standard for basic telecontrol tasks IEC 60870-5-101

Second Edition, 2003-02

[3] RTU500 series Interfaces and Protocols Release 12 (1KGT 150 939)

[4] User Manual RTUtil500 Release 12 (1KGT 150 950)

1.3 Conventions

In this document function codes of data types according to IEC 60870-5-101 are marked with brackets: <Function code>

Bold fonts with the table heading "Parameter name" are references to configuration parameters in RTUtil500. The parameter is followed by the parameter location where to find this parameter in RTUtil500. The first element of the parameter location defines the node in the hardware tree on the left side (e. g. RTU, CMU, line, IED) and the second element defines selected header control tab in the parameter window on the right side (e. g. general, interfaces, protocol).

Example:

	**Parameter name**	**Default**	**Parameter location**
In use		enabled	data point (e.g. SPI) - line T101
If enabled, the data point is transmitted to the host communication interface. This setting refers to data in monitoring and command direction.			

The tables in the next chapters include lists of the functions, options and message types supported according to the protocol structure given in IEC 60870-5 (EPA three layer model) for

The tables in the next chapters include lists of the functions, options and message types supported according to the protocol structure given in IEC 60870-5 (EPA three layer model) for

- the physical layer
- the link layer
- the application layer

This layered model is valid for the protocol IEC 60870-5-101.

2 Physical Layer

2.1 Serial line-based communication

The protocol IEC 60870-5-101 is running on the serial communication interfaces of the CMUs. For more details see RTU500 series Interfaces and Protocols Release 12 (1KGT 150 939).

Set the communication parameters according to the following table:

Parameter name	Default	Parameter location
Interface type	RS232C	CMU - serial interfaces
Type of physical interface. Select from list. Value range: RS232C, RS485 or fix if selection is not supported		
Baud rate	9600 bits/sec	CMU - serial interfaces
Value range: 50, 75, 100, 110, 150, 200, 300, 600, 1200, 1500, 2400, 4800, 9600, 19200, 38400 bits/sec; 50-600 bits/sec only on selected interfaces		
Modem control	Direct link (TxD/RxD only)	CMU - serial interfaces
Value range: • Direct link (TxD/RxD only) • WT link full duplex (no handshake) • WT link half duplex (RTS/CTS handshake) • WT link half duplex (RTS/DCD handshake) • Dial up (external modem DCD handshake) • Loop switch unit (DSTC 3002), RP570/71 Host interface only • Link with collision avoidance (DCD handshake), DNP 3 only Usage of the controls for this interface. Direct Link: No modem controls. Loop Switch Unit: RP570/71 Host Interface only. Collision Avoidance: DNP3.0 Host/Sub-Interface only		
Transmit delay time	disabled	CMU - serial interfaces
If 'Transmit Delay Time' is enabled: Delay time in Milliseconds. Value range: 1 to 10000 ms. Recommended value for WT modems in half-duplex mode: 30 ms		

Parameter name	Default	Parameter location
Allow non-standard UART mode	disabled, usage as specified in standard	CMU - serial interfaces
If enabled, it will be possible to select a non IEC 60870-5-101/Modbus conform UART mode (parity). Value range: • disabled • 1 stop bit, no parity • 1 stop bit, even parity • 1 stop bit, odd parity • 2 stop bits, no parity		

ADVICE

The possibility to use different transmission speeds in control and in monitor direction is not supported by RTU500 series.

2.2 Host interface

All host interfaces will be configured according to the following table.

Parameter name	Default	Parameter location
Host number	1	CMU - all interfaces
Logical number of this host interface. Value range: 1 to 16. The Host Number has to be unique in a system, and will point to the data in the system event block		
Interlock with local control authority	disabled	CMU - all interfaces
If enabled: No commands are accepted from the host, as long as a user has successfully requested the 'Command Authority' in the 'Integrated HMI'		

3 Link Layer

3.1 General

A link address model is used for all RTU500 series communication interfaces. The basic procedures for data transfer, protection against loss and duplication and flow control are described in [2, 5]. This link address is configurable in the line folder of RTUtil500 separately for every line. The link address must be configured only once.

Parameter name	Default	Parameter location
Linkaddress	1	RTU - Line T101
Link address of this process data point. The address may be unstructured or structured. Length 0, 1 or 2 octets (0 only balanced transmission)		

Communication primitives like framing of messages, parity checks or retransmissions are handled by the telecontrol protocol. These tasks are executed in the link layer that connects RTUs and control systems or other RTUs. The selectable parameters have to be calculated regarding the real communication technology. All parameters preset to the default values from [2, 9.5].

Parameter name	Default	Parameter location
Link address structure	8 bit unstructured	Line T101 - IEC 60870-5-101
Length of Link Address: 0, 8 or 16 bit 0 in balanced mode only Structured address with underscore as delimiter Example: 3_5_8 defines 16-bit address with 3 structure elements: 3 bit most significant 5 bit medium significant 8 bit least significant		

Table 1: Line parameters link layer IEC60870-5-101: address elements

Parameter name	Default	Parameter location
Maximum frame length	255	Line T101 - IEC 60870-5-101
Maximum frame length. Value range: 32 to 255 octets.		

Table 2: Line parameters link layer IEC60870-5-101: telegram framing

Parameter name	Default	Parameter location
Timeout acknowledgement	1 s	Line T101 - IEC 60870-5-101
Link Layer response/confirmation time out interval in seconds. Relevant at Master interface in balanced and unbalanced mode and at slave interface in balanced mode only. Value range: 0.1 to 600 sec.		
Cycle time test link	Enabled, 120 s	Line T101 - IEC 60870-5-101
Specification whether Test Link messages shall be sent If selected, Test Link message will be sent if within the specified time no Application message had been sent Relevant in balanced mode only Time period in seconds or '-' to disable.		

Table 3: Line parameters link layer IEC60870-5-101: timeouts

Parameter name	Default	Parameter location
Cycle time offline supervision	Enabled, 120 s	Line T101 - IEC 60870-5-101
Specification whether offline supervision of the primary station shall take place Relevant at slave interface and unbalanced mode only. Time period in seconds or '-' to disable.		
Gap supervision time	Enabled, 1 t0	Line T101 - IEC 60870-5-101
Specification whether the receiver shall perform a check for line idle intervals between the characters of a frame [IEC 60870-5-1, clause 6.2.4.2: Transmission rule R3 for format FT1.2]. Maximum allowed length of line idle intervals between two characters Specification: number of line idle bits or '-' to disable.		
Communication retry	Enabled, 7	Line T101 - IEC 60870-5-101
Specification whether transmission repetitions shall take place Relevant at slave interface in balanced mode only. Maximum number of transmission repetitions in case of consecutive transmission disturbances Value range: 1 to 255 or '-' to disable. Relevant at slave interface in balanced mode only.		

Table 3: Line parameters link layer IEC60870-5-101: timeouts

Parameter name	Default	Parameter location
Transmission mode	Unbalanced	Line T101 - IEC 60870-5-101
Balanced Mode: spontaneous transmission Unbalanced Mode: polling by primary station		
Single character for acknowledgements	Enabled	Line T101 - IEC 60870-5-101
Use Single Character 0xE5 as Link Layer Acknowledgement		
Link layer user class assignment according IEC	Disabled	Line T101 - IEC 60870-5-101
If enabled: Link layer user classes are assigned as defined in IEC60870-5-101. Otherwise link layer user classes are assigned according to the data point's configuration parameter 'Priority'.		
Direction bit of controlling station	0	Line T101 - IEC 60870-5-101
Specification of the direction bit DIR of the Link Layer Control Field to be used by the transmitter Value range: 0 or 1 Relevant in balanced mode only [IEC 60870-5-2, clause 6.1.2]		

Table 4: Line parameters link layer IEC60870-5-101: other parameters

3.2 Unbalanced Mode

- The controlling station is primary station, controlled station (RTU) is secondary station
- The controlling station uses SEND/CONFIRM or SEND/NO REPLY services for transmission of messages to the RTU
- The controlling station uses REQUEST/RESPOND services for the polling procedure and during establishment of the link

3.3 Balanced mode

- Controlling station and controlled station (RTU) act simultaneously as primary and secondary stations.
- Both, controlling station and controlled station use SEND/CONFIRM services for message exchange, controlling station may also use the SEND/NO REPLY service.

- During link establishment both, controlling station and controlled station use the REQUEST/RESPOND service.

3.4 Dial-up function

3.4.1 General

In the dial-up mode a communication link can be established via HAYES-compatible modems between an RTU and a higher-level system. In this case the RTU receives telephone calls and then switches over to the data mode.

When a telephone connection has been established, but communication according to the protocol does not take place the telephone connection will be terminated after elapse of the time defined with the interface parameter Maximum time period until connection is established.

Additionally, the RTU may ring up the higher-level system on its own as soon as spontaneous changes of Prio1 data points (see parameter Address) or system events have occurred or cyclical calls from the RTU have been configured. It is always the task of the control system to terminate the connection to the RTU.

If there is no communication with the control system for a configurable time, the RTU terminates the telephone connection by itself. (Parameter: Time period until hanging up because of inactivity).

When the attempt to establish the telephone connection has failed dialling will be repeated several times (interface parameter: Maximum number of dialling attempts). If the higher-level system supports a modem pool functionality and several telephone numbers have been configured the next telephone number will be called and establishing the telephone connection be attempted.

3.4.2 Dial-up configuration

In addition to the protocol-specific settings described in the chapters Physical Layer and Link Layer, some settings shall be made for the dial-up mode, too.

The dial-up mode is available only, if the parameter dial-up active on the serial communication interface (COM) of the CMU is enabled.

Parameter name	Default	Parameter location
Modem control:Dial up (external modem DCD handshake)		CMU - serial interfaces
Dial up enabled: enabled		CMU - serial interfaces
If enabled: This interface is using a dial-up connection to the sub devices or the host interfaces. Note: Not all protocols are supporting 'dial-up'. Available only, if 'Dial up' is selected		

All interface settings such as parity, baud rate, number of data bits, etc. depend on the protocol selected and are valid for both the configuration and the data mode.

The dial-up mode parameters are available in separate dialogue windows in the network and hardware Tree of the configuration tool RTUtil500.

3.4.2.1 Dial-up parameters at the the serial interfaces of the CMU

Parameter name	Default	Parameter location
Escape sequence preceding silent time	1 s	CMU - serial interfaces (dial up parameters)
Range: 1 … 255 s Minimal delay time between data mode and Hayes command mode		
Configuration string for modem	ATE0X3S0=1	CMU - serial interfaces (dial up parameters)
String Configuration string initializing the modem used. Note:The configuration string depends on the type of modem, the modem manufacturer and the modem function used.		
Dial string for modem	ATDT	CMU - serial interfaces (dial up parameters)
String Command Hayes to establish a modem connection		
Escape string for modem	+++	CMU - serial interfaces (dial up parameters)
String Command Hayes to switch from data mode to command mode		
Answer string for modem	Disable <no defaults>	CMU - serial interfaces (dial up parameters)
String Enable/Disable If enabled: An incoming call is answered with this string. Note: For standard HAYES modems the value S0=0 shall be set in the configuration string, if this feature is enabled (see modem description).		
Hang up string for modem	ATH	CMU - serial interfaces (dial up parameters)
String String requesting the modem to terminate the telephone connection.		
Connect string of modem	CONNECT	CMU - serial interfaces (dial up parameters)
String String sent by the modem if a telephone connection has been established.		
OK string of modem	OK	CMU - serial interfaces (dial up parameters)
String String sent by the modem to acknowledge a command		
Disconnect string of modem	NO CARRIER	CMU - serial interfaces (dial up parameters)
String String sent by the modem if the connection is aborted		
Ring string of modem	RING	CMU - serial interfaces (dial up parameters)
String String sent by the modem signaling an incoming call.		
Busy string of modem	BUSY	CMU - serial interfaces (dial up parameters)
String With this string the modem signals that the remote terminal called is busy.		
PIN configuration string for GSM modem	Disable	CMU - serial interfaces (dial up parameters)
String Enable/Disable		
Service configuration string for GSM modem	Disable	CMU - serial interfaces (dial up parameters)
String Enable/Disable		

3.4.2.2 Dial-up parameters of the RTU

The configuration of the dial-up timeout parameters can be found only in the network tree at the RTU node (left window) and on the specific line (right window) at the tab dial up parameters.

Parameter name	Default	Parameter location
Maximum time till link is established	60 s	Network tree only: RTU - line
Value range: 1 ... 255 s		
Maximum time interval until the connection to a higher-level system must be established. When this time has elapsed the modem connection will be terminated.		
Maximum number of dial attempts	2	Network tree only: RTU - line
Value range: 1 ... 255 attempts		
Maximum number of times a telephone number is called. If the higher-level system supports a modem-pool function the next telephone number will then be called.		
Time between dial attempts	60 s	Network tree only: RTU - line
Value range: 1 ... 15 300 s		
When an attempt has failed the number will be called again after elapse of this time.		
Time between two series of dial attempts	7 800 s	Network tree only: RTU - line
Value range: 60 … 15 300 s		
Waiting time between dial series with different telephone numbers (modem pool)		
Inactivity hang up delay	disabled	Network tree only: RTU - line
Value range: disabled, 1 ... 15 300 s		
Inactivity hang up delay after commands	disabled	Network tree only: RTU - line
Value range: disabled, 1 ... 15 300 s		
Maximum period for one telephone connection	600 s	Network tree only: RTU - line
Value range: disabled, 10 ... 15 300 s		
Cyclic calls of dial up slave	disabled	Network tree only: RTU - line
Value range: disabled / enabled		
If enabled: Start time of cyclic calls [hour, minutes]; Time interval between two calls [days, hours, minutes]		

3.4.2.3 Dial-up parameters of the control system

This window can be found only in the network tree at the connected control system.

Parameter name	Default	Parameter location
Telephone number 1	<no default>	Network tree only: Control system - Telephone numbers
Value range: string (length max. 27 characters)		
Telephone number under which a higher-level system can be called.		
Telephone number 2 ... 16	deactivated	Network tree only Control system - Telephone numbers
Value range: deactivated, string (length max. 27 characters)		
Additional telephone numbers under which a higher-level system can be called. If the higher-level system does not support the modem-pool function the telephone numbers need not to be configured.		

3.4.3 Request for access demand

‘Acquisition of events by quick-check procedure’ will only be supported by HCI101 with dial-up connections.

The global request of access demand (broadcast link address, FC = ‘REQUEST for access demand’) will only be respond with respond access demand (link address of RTU500 series RTU at this HCI101, FC = ‘RESPOND status of link or access demand’), if at least one user data class 1 is waiting for transmission in HCI101. Otherwise no respond will be send by HCI101.

3.5 Redundant communication lines

The redundant line function of RTU500 series is used to raise connection availability to the controlling station. This function is only available for the protocol IEC 60870-5-101 and it is implemented according to the Norwegian User Conventions.

General function:
- Both lines have the same link address
- The switching between the lines is generally initiated by the controlling station.
- After a redundancy switching a general interrogation must be sent from the controlling station
- During the switchover between the redundant lines the CMU has to secure that no data point information get lost.
- After a disruption the connection have to establish again.

Redundancy Switch Over condition (only available in unbalanced mode):
- As default, the redundancy switching is done according to the IEC standard (Norvegian User Convention) which switches to redundant line upon 'reset of remote link' (FC0) command.
- It is possible to change the redundancy switching: it can be configured that the switching over is done by 'request of user data' command (FC11).

Parameter name	Default	Parameter location
Redundancy switch over condition	IEC Standard: Reset of remote link (Norwegian UC) (FC0)	Line T101 - IEC 60870-5-101
Value range: - IEC Standard: Reset of remote link (Norwegian UC) (FC0) - Request User Data (FC11)		

Both the configuration of redundant lines is part of the engineering tool for the RTU500 series RTUtil500. Both lines must be connected to the same CMU. The interfaces could be configured with different physical parameters.

Steps in RTUtil500:

1. Add one communication line T101 to the network tree.
2. Link this communication within the hardware tree twice to the same CMU.

3.5.1 Unbalanced mode

After startup of the controlling station, the controlling station sends a Request Status of Link on both channels, in order to determine which channel to use as the primary channel, and send a Reset of Remote Link on the primary channel. The controlling station will continue to send a Request Status of Link message on the backup channel cyclically (see the following figures Initialization of controlling station, unbalanced mode and Initialization of controlled station, unbalanced mode).

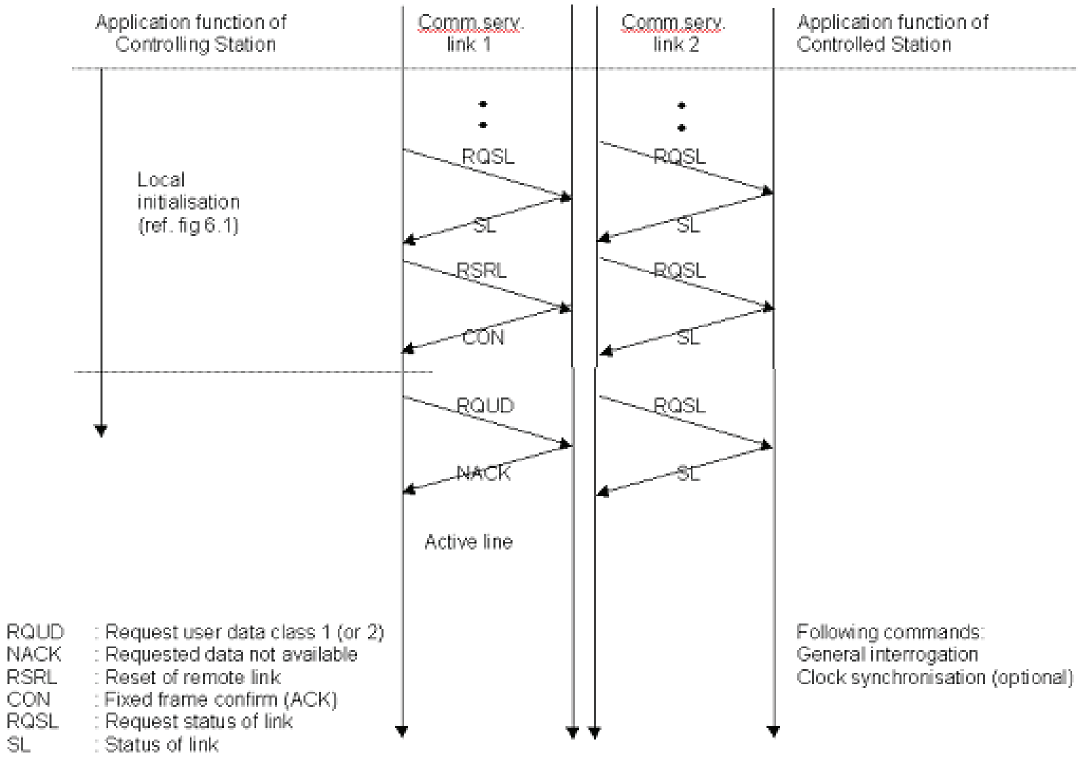


Figure 1: Initialization of controlling station, unbalanced mode

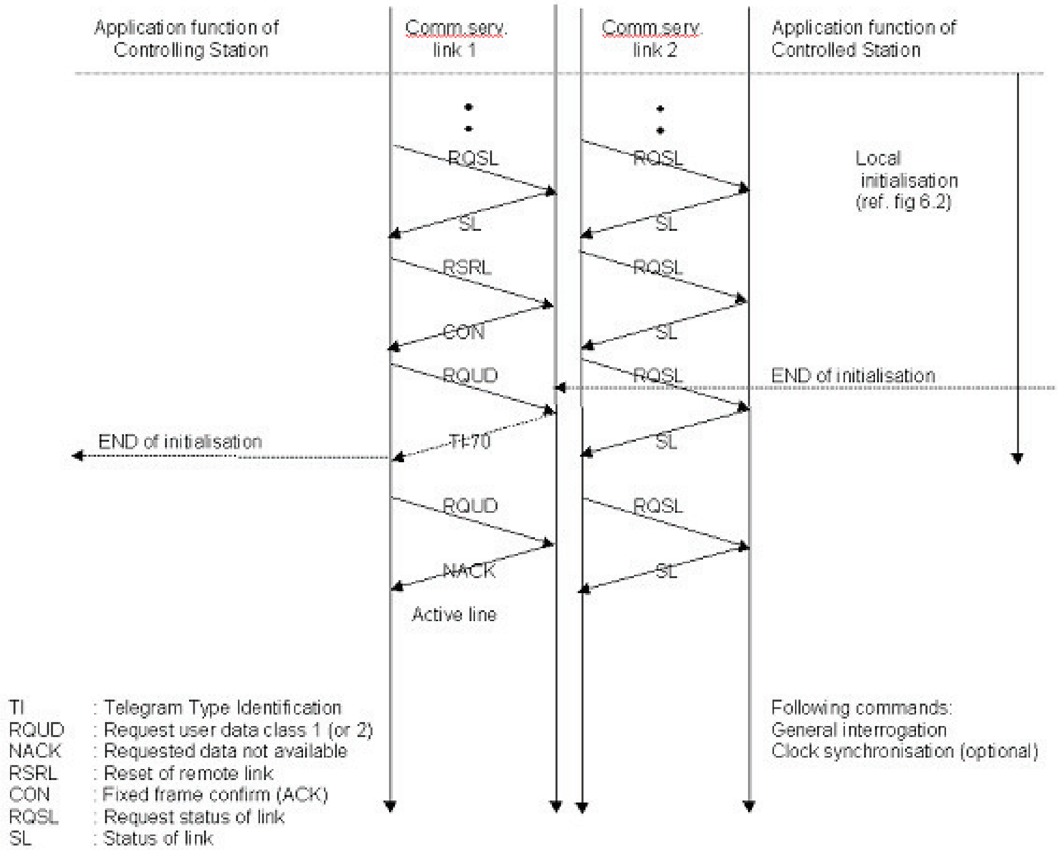
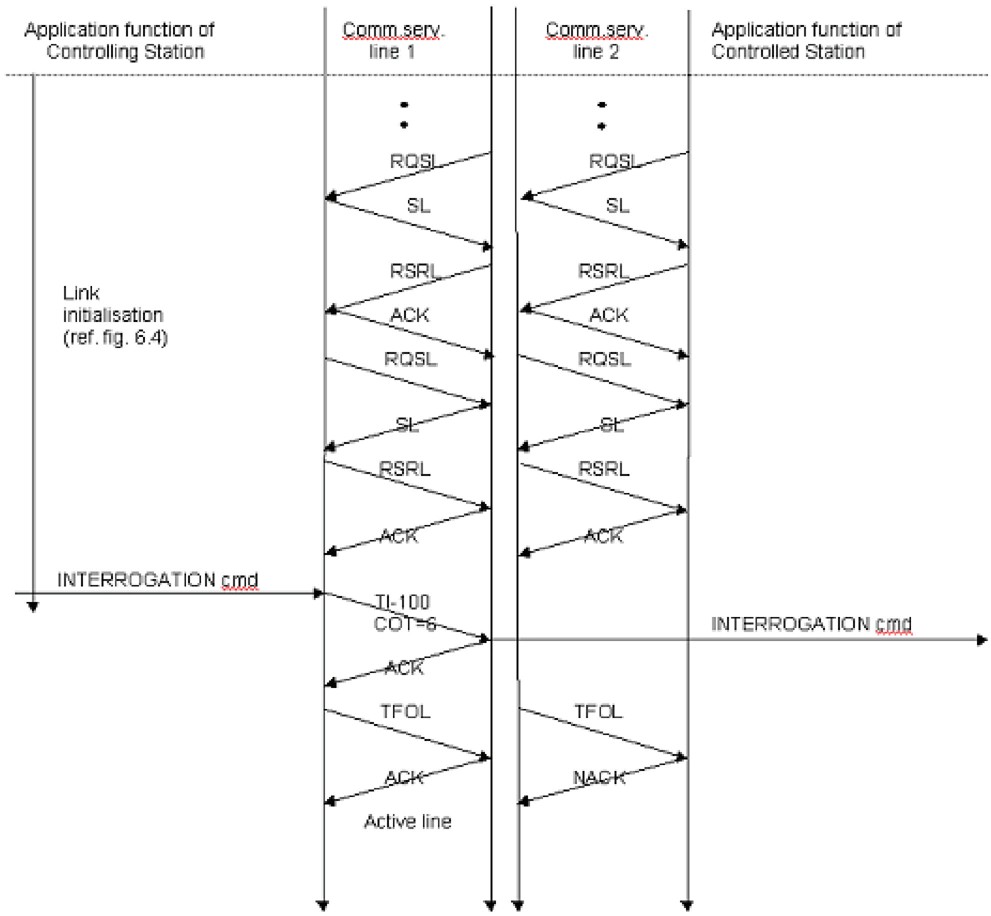


Figure 2: Initialization of controlled station, unbalanced mode

If the primary channel is interrupted, the controlling station will mark the primary channel down and send a Reset of Remote Link message to the controlled station over the backup channel. The controlled station will respond and the controlling station then will send a poll request. Once the new primary channel is established, the controlling station will begin sending a Request Status of Link message on the channel which lost communication.

3.5.2 Balanced mode

After restart of the controlling station, link connection is established in both directions and on both lines. Both links of the controlling station may by default be defined to be passive at the moment the link layer is available after restart. An interrogation command is therefore transmitted to define the active line (see the following figures Initialization of controlling station, balanced mode and Initialization of controlled station, balanced mode).



TI	: Telegram Type Identification
ACK	: Single character or fixed frame ACK
COT	: Cause of transmission
RSRL	: Reset of remote link
RQSL	: Request status of link
SL	: Status of link
TFOL	: Test function of link (FC=2)
NACK	: Message not accepted (FC=1)

Figure 3: Initialization of controlling station, balanced mode

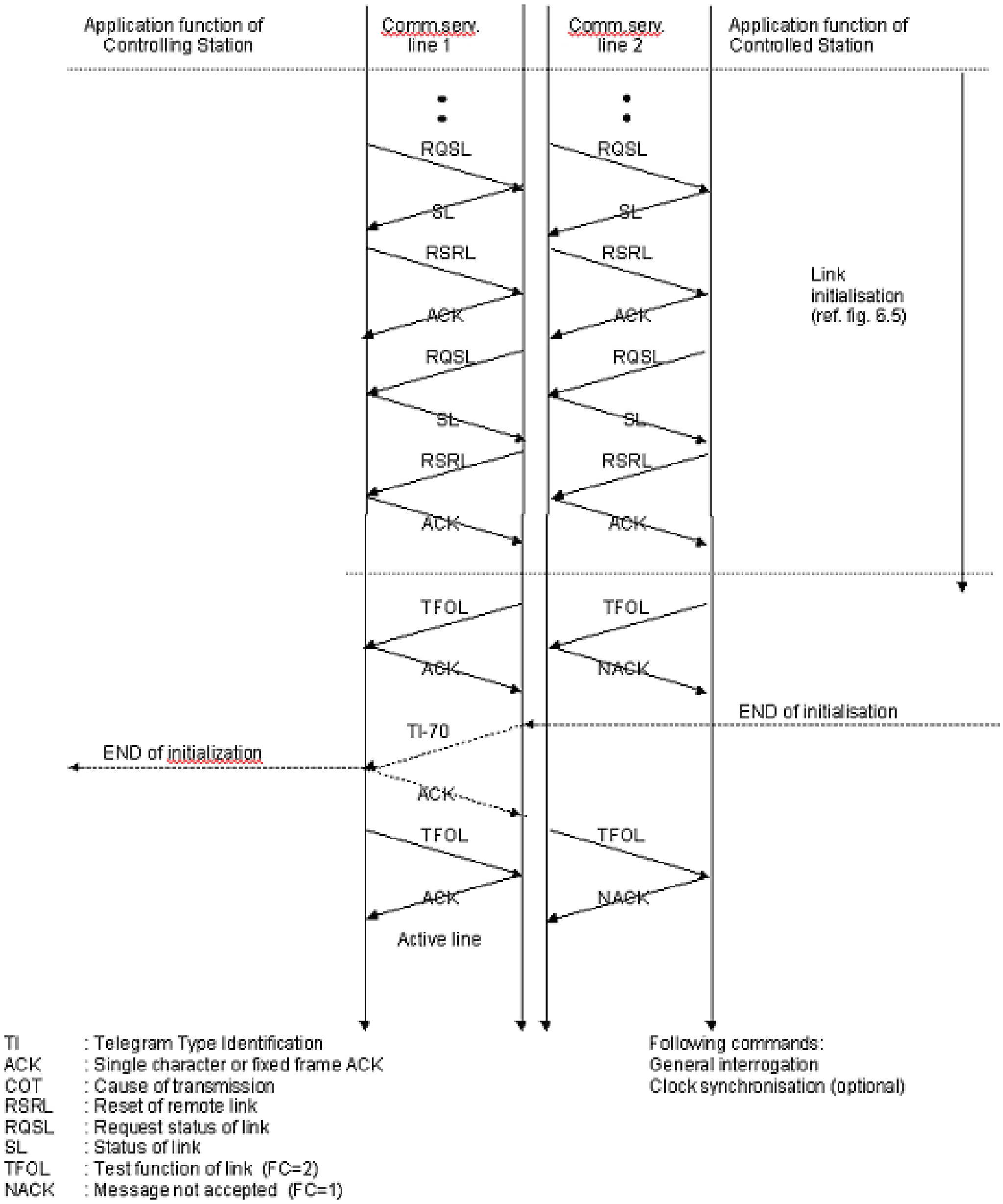


Figure 4: Initialization of controlled station, balanced mode

If communication fails on the active line when the controlling station attempts to transmit user data, a line switch will be performed, after maximum transmission retries has elapsed. A line switch will also be performed whenever the periodic line check procedure on the active line (Test function of link) times out after maximum transmission retries.

If communication fails on the active line when the controlled station attempts to transmit user data, the controlled station must wait for the controlling station to detect the failure.

4 Application Layer

4.1 General

The selectable parameters have to be calculated regarding the real communication technology. All parameters preset to the default values from the IEC standard.

Parameter name	Default	Parameter location
ASDU address of station	1	RTU - Line T101
ASDU address of the station used for station specific commands, like counter interrogation commands, reset process commands, etc.		

Parameter name	Default	Parameter location
Setpoint command with command acknowledgement	disabled	RTU - Line T101/T104
If enabled, all setpoint commands will be respond with activation termination.		
Fixed originator address	disabled	RTU - Line T101/T104
If enabled, a fix originator address can be configured. This originator address is set in telegrams send by this host communication interface. Originator address. Value range 0 to 255. only possible to enable if special protocol profiles are selected		

Table 5: RTU parameters application layer

Parameter name	Default	Parameter location
ASDU address structure	8 bit unstructured	Line T101 - IEC 60870-5-101
Length of Common Address of ASDU: 8 or 16 bit Structured address with underscore as delimiter Example: 3_5_8 defines 16-bit address with 3 structure elements: 3 bit most significant 5 bit medium significant 8 bit least significan		
Information object address structure	16 bit unstructured	Line T101 - IEC 60870-5-101
Length of Information Object Address: 8, 16 or 24 bit Structured address with underscore as delimiter Example: 3_5_6_3_7 defines 24-bit address with 5 structure elements		
Cause of transmission length	8 bit	Line T101 - IEC 60870-5-101
Selection: 8 or 16 bit If 16 bit is selected, the second octet (Originator Address) is set to 0 in send frames and is ignored in received frames		

Table 6: Line parameters application layer IEC 60870-5-101: telegram framing

Parameter name	Default	Parameter location
Protocol edition	Edition 1	Line T101/104 - IEC 60870-5-101/104
Edition 1: Timer t1 is retriggered with any transmitted telegram i.e. there is only one timer t1. Edition 2: Separate timer t1 for each sent telegram i.e. if any timer t1 expires connection is closed.		
Protocol profile	Default	Line T101/104 - IEC 60870-5-101/104
Selection of IEC60870-5-104 protocol profile. Default value 'Default' equals the IEC standard. Other selections activate special IEC protocol profiles.		

Table 7: Line parameters application layer IEC 60870-5-101: other parameters

Parameter name	Default	Parameter location
Transmission with full timestamp	disabled	Line T101 - IEC 60870-5-101
Specification of the format of time tags for process information: - short format: CP24Time2a (minutes and milliseconds up to 59.59999) - long format: CP56Time2a (complete date and time representation, 2 character year representation 00 to 99)		
Background scan cycle	disabled	Line T101/104 - IEC 60870-5-101/104
If enabled: Background scan according to IEC60870-5-101/104 will be send with the configured cycle time. Cycle time of background scan in minutes or '-' to disable.		
Acknowledge Commands on reception	disabled	Line T101/104 - IEC 60870-5-101/104
Specification whether Activation Confirmation shall be sent immediately after receiption of a command Necessary if the primary station uses a fix timeout period with low tolerance Has no affect on the source of Activation Termination		
Send analog events with value 0 in GI	disabled	Line T101/104 - IEC 60870-5-101/104
If enabled: For subdevice communication interfaces with IEC60870-5-103. Selected values are transmitted with '0' during General Interrogation		
Double transmission mode	disabled	Line T101 - IEC 60870-5-101
If enabled: (and if Transmit with Timestamp is enabled) Information in monitoring direction will be transmitted twice: 1. With high priority, without time stamp. 2. With low priority, with time stamp. (Pulse counter PCV are not affected)		
Exclusive access to interfaces of redundant lines	disabled	Line T101 - IEC 60870-5-101
If enabled, the serial interfaces of a redundant subdevice communication line will be accessed exclusive. That means as long as one interface is accessed all other interfaces of this redundant line are blocked.		
Treat value 'no counter requested (not used)' of RQT qualifier of C_CI_NA_1 as 'general request counter'	disabled	Line T101/104 - IEC 60870-5-101/104
If enabled: Qualifier of counter interrogation command 'no counter requested' is treated as 'general request counter'.		
Event buffer overflow strategy	Delete oldest event	Line T101/104 - IEC 60870-5-101/104
Delete oldest event: In case of overflow the oldest events will be removed from the concerned queue to get space for new events and put in a one-stage image. Delete newest event: In case of overflow the newest events are not entered to the queue but written to a one-stage process image instead.		
Parameter Loading	enabled	Line T101/104 - IEC 60870-5-101/104
If enabled: Parameter loading requests are supported. If disabled: Parameter loading requests will be responded negative.		
Type specific address range	disabled	Line T101/104 - IEC 60870-5-101/104
If enabled, IEC address of different RTU data types are independent, so data points of different type may have the same address.		
Routed diagnosis support	enabled	Line T101 - IEC 60870-5-101
If enabled: Routed diagnosis is activated.		
Allow only one general interrogation running per common address of ASDU	disabled	Line T101/104 - IEC 60870-5-101/104
If enabled: Only one running general interrogation per common address of ASDU is allowed.		

Table 7: Line parameters application layer IEC 60870-5-101: other parameters

4.2 Communication Queue Handling

The host interface has 7 different communication queues and an additional process image:

- Command acknowledgment queue

- Priority 1 queue for monitoring data (except integrated totals and measured values) (Priority 1 for monitoring data can be configured individual per data point)
- Priority 2 queue for monitoring data (except integrated totals and measured values) (Priority 2 for monitoring data can be configured individual per data point)
- Integrated totals (ITI) queue (The priority of the ITI queue can be assigned in total as Prio 1 or Prio 2)
- Spontaneous measured value queue
- Requested information queue incl. file transfer
- Sequence of event queue (SOE) queue (The SOE queue is only used if double transmission mode is activated)

The queue priority is assigned by function/ cause of transmission (COT) or by configuration

Highest Priority:
- Command acknowledgment queue (COT=6…10)

Priority level 1:
- Priority 1 Monitoring data queue (COT=3)
- Integrated totals queue (if configured as priority 1) (COT=3)

Priority level 2:
- Priority 2 Monitoring data queue (COT=3)
- Integrated totals queue (if configured as priority 2) (COT=3)
- Spontaneous measured value queue (COT=3)
- Requested information queue incl. file transfer (COT=37..41 and COT =13)
- SOE queue (if double transmission mode is activated)

Lowest priority:
- Interrogated data, direct from process image (COT=20…36)
- Periodic/ cyclic measured values, direct from process image (COT=1)
- Background cycle, direct from process image (COT=2)

Parameter name	Default	Parameter location
Buffer size of priority 1 datapoints	500 entries	CMU - all interfaces
Transmit buffer size for priority 1 data. Value range: 100 to 10000 entries		
Buffer size of priority 2 datapoints	500 entries	CMU - all interfaces
Transmit buffer size for priority 2 data. Value range: 100 to 10000 entries		
Buffer size of Integrated Totals (ITI)	1000 entries	CMU - all interfaces
Transmit buffer size for Integrated Total. Value range: 10 to 10000 entries		
Priority of ITI queue	2	CMU - all interfaces
Priority of the transmit buffer for Integrated Totals. Value range: 1 or 2		
Buffer size of spontaneous transmitted Analog Measured values (AMI)	500 entries	CMU - all interfaces
Transmit buffer size for spontaneous transmitted measurements. Value range: 100 to 100000		
Queue storage timeout	aktiviert, 120 min	CMU - all interfaces
Delay time, before the buffers are cleared. Value range: disabled, 1 to 10080 minutes		

It is possible to disable buffering for selected monitoring data points:

Parameter name	Default	Parameter location
Put in buffer	Enabled	data point - line T101/T104
If enabled: parameter changes will be stored in buffer when host is offline. If disabled: GI is mandatory to get current value.		

4.3 ASDU Type identification

Overview on type identifications for data elements of the application layer defined in [2].

The column "RTU data type" shows the type of data with must be configured in RTUtil500.

4.3.1 ASDU in monitoring direction

ASDU	Description	Type identification	RTU data type
M_SP_NA_1	Single-point information	<1>	SPI
M_SP_TA_1	Single-point information with time tag	<2>	SPI
M_SP_TB_1	Single-point information with time tag CP56Time2a	<30>	SPI
M_DP_NA_1	Double-Point information	<3>	DPI
M_DP_TA_1	Double-Point information with time tag	<4>	DPI
M_DP_TB_1	Double-Point information with time tag CP56Time2a	<31>	DPI
M_ST_NA_1	Step position information	<5>	STI
M_ST_TA_1	Step position information with time tag	<6>	STI
M_ST_TB_1	Step position information with time tag CP56Time2a	<32>	STI
M_BO_NA_1	Bitstring of 32 bit	<7>	BSI8/16/32[1]
M_BO_TA_1	Bitstring of 32 bit with time tag	<8>	BSI8/16/32[1]
M_BO_TB_1	Bitstring of 32 bit with time tag CP56Time2a	<33>	BSI8/16/32[1]
M_ME_NA_1	Measured value, normalized value	<9>	AMI DMI8/16
M_ME_TA_1	Measured value, normalized value with time tag	<10>	AMI DMI8/16
M_ME_TD_1	Measured value, normalized value with time tag CP56Time2a	<34>	AMI DMI8/16
M_ME_NB_1	Measured value, scaled value	<11>	AMI
M_ME_TB_1	Measured value, scaled value with time tag	<12>	AMI
M_ME_TE_1	Measured value, scaled value with time tag CP56Time2a	<35>	AMI
M_ME_NC_1	Measured value, short floating point	<13>	MFI
M_ME_TC_1	Measured value, short floating point value with time tag	<14>	MFI
M_ME_TF_1	Measured value, short floating point value with time tag CP56Time2a	<36>	MFI
M_IT_NA_1	Integrated totals	<15>	ITI
M_IT_TA_1	Integrated totals with time tag	<16>	ITI
M_IT_TB_1	Integrated totals with time tag CP56Time2a	<37>	ITI
M_EP_TA_1	Event of protection equipment with time tag	<17>	EPI

Table 8: ASDU in monitoring direction

ASDU	Description	Type identification	RTU data type
M_EP_TD_1	Event of protection equipment with time tag CP56Time2a	<38>	EPI

Table 8: ASDU in monitoring direction

1 BSI32 is not supported for local I/O.

4.3.2 ASDU in control direction

ASDU	Description	Type identification	RTU data type
C_SC_NA_1	Single command	<45>	SCO
C_DC_NA_1	Double command	<46>	DCO
C_RC_NA_1	Regulation step command	<47>	RCO
C_SE_NA_1	Set point command, normalized value	<48>	ASO DSO8/16
C_SE_NB_1	Set point command, scaled value	<49>	ASO DSO8/16
C_SE_NC_1	Set point command, short floating point	<50>	FSO
C_BO_NA_1	Bitstring of 32 bit	<51>	BSO1/2/8/16/32

Table 9: ASDU in control direction

4.3.3 ASDU of system information in command direction

ASDU	Description	Type identification
C_IC_NA_1	Interrogation Command	<100>
C_CI_NA_1	Counter interrogation command	<101>
C_RD_NA_1	Read command	<102>
C_CS_NA_1	Clock synchronization command	<103>
C_TS_NA_1	Test command	<104>
C_RP_NA_1	Reset process command	<105>
C_CD_NA_1	Delay acquisition command	<106>
P_ME_NA_1	Parameter of measured value, normalized	<110>
P_ME_NB_1	Parameter of measured value, scaled value	<111>
P_ME_NC_1	Parameter of measured value, floating point value	<112>

Table 10: System information in command direction

4.3.4 ASDU for file transfer

ASDU	Description	Type identification
F_FR_NA_1	File ready	<120>
F_SR_NA_1	Section ready	<121>
F_SC_NA_1	Call directory, select file, …	<122>
F_LS_NA_1	Last section, last segment	<123>

Table 11: ASDU for file transfer

ASDU	Description	Type identification
F_AF_NA_1	Ack file, ack section	<124>
F_SG_NA_1	Segment	<125>
F_DR_TA_1	Directory	<126>

Table 11: ASDU for file transfer

5 Parameters and Addressing

5.1 Address elements

Selection according to [2]. The sizes of the addressing fields can be configured as shown in the following table:

Parameter name	Default	Parameter location
Link address structure	8 bit unstructured	Line T101 - IEC 60870-5-101
Length of Link Address: 0, 8 or 16 bit 0 in balanced mode only Structured address with underscore as delimiter Example: 3_5_8 defines 16-bit address with 3 structure elements: 3 bit most significant 5 bit medium significant 8 bit least significant		

Parameter name	Default	Parameter location
ASDU address structure	8 bit unstructured	Line T101 - IEC 60870-5-101
Length of Common Address of ASDU: 8 or 16 bit Structured address with underscore as delimiter Example: 3_5_8 defines 16-bit address with 3 structure elements: 3 bit most significant 5 bit medium significant 8 bit least significan		
Information object address structure	16 bit unstructured	Line T101 - IEC 60870-5-101
Length of Information Object Address: 8, 16 or 24 bit Structured address with underscore as delimiter Example: 3_5_6_3_7 defines 24-bit address with 5 structure elements		
Cause of transmission length	8 bit	Line T101 - IEC 60870-5-101
Selection: 8 or 16 bit If 16 bit is selected, the second octet (Originator Address) is set to 0 in send frames and is ignored in received frames		

Table 12: Address element configuration

5.1.1 Restrictions for the link address

The value 0 is only allowed in balanced mode.

Parameter name	Default	Parameter location
Linkaddress	1	RTU - Line T101
Link address of this process data point. The address may be unstructured or structured. Length 0, 1 or 2 octets (0 only balanced transmission)		

5.1.2 Restrictions for the Common Address

The value 0 is not allowed.

The highest possible address value (255 for 1 octet common address length and 65 535 for 2 octet common address length) is reserved for broadcast calls in control direction and therefore must not be used as station address.

	Parameter name	Default	Parameter location
ASDU address of station		1	RTU - Line T101
ASDU address of the station used for station specific commands, like counter interrogation commands, reset process commands, etc.			

	Parameter name	Default	Parameter location
ASDU address		1	data point - Line T101
Application Service Data Unit. The address may be unstructured or structured. Length 1 or 2 octets.			

5.1.3 Restrictions for the information object address

All addresses must be unique within one station. The type of presentation (ASDU format) is not part of the identification of an object.

The value 0 is not allowed.

	Parameter name	Default	Parameter location
Information object		1	data point - Line T101
Address of the Information Object. The address may be unstructured or structured. Length 1, 2 or 3 octets			

5.2 General data point parameters

	Parameter name	Default	Parameter location
In use		enabled	data point (e.g. SPI) - line T101
If enabled, the data point is transmitted to the host communication interface. This setting refers to data in monitoring and command direction.			

	Parameter name	Default	Parameter location
Group interrogation active		disabled	data point - Line T101/T104
If enabled: Data point belongs to an interrogation group			
Interrogation group number		disabled	data point - Line T101/T104/GP104
If enabled: Data point belongs to an interrogation group. Enter group number for group interrogation. Value range: 1 to 16 or '-' to disable.			

Table 13: General data point parameters

6 Data Types - Monitoring Direction

6.1 AMI – Analog Measured Information

Analog process information indicated by 16 bit used as a measured value from analog inputs in normalized or scaled format.

6.1.1 Supported Data Types

IEC 60870-5-101				RTU	
ASDU	**Type identification**	**Data type property**	**Data type**	**Parameter name**	**Parameter location**
M_ME_NA_1	<9>	normalized without timestamp	AMI	Transmission format: Normalized	AMI - line T101/ T104/GP104
M_ME_TA_1	<10>	normalized with timestamp CP24Time2a	AMI	Transmission format: Normalized	AMI - line T101
				Transmit with timestamp	AMI - line T101
M_ME_NB_1	<11>	scaled without timestamp	AMI	Transmission format: Scaled	AMI - line T101/ T104/GP104
M_ME_TB_1	<12>	scaled with timestamp CP24Time2a	AMI	Transmission format: Scaled	AMI - line T101
				Transmit with timestamp	AMI - line T101
M_ME_TD_1	<34>	normalized with timestamp CP56Time2a	AMI	Transmission format: Normalized	AMI - line T101/ T104/GP104
				Transmission with timestamp	AMI - line T101/ T104/GP104
				Transmit with full timestamp	Line T101 - IEC 60870-5-101
M_ME_TE_1	<35>	scaled with timestamp CP56Time2a	AMI	Transmission format: Scaled	AMI - line T101/ T104/GP104
				Transmission with timestamp	AMI - line T101/ T104/GP104
				Transmit with full timestamp	Line T101 - IEC 60870-5-101

Table 14: AMI - Supported data types

6.1.2 Additional Information

Parameter name	Default	Parameter location
Spontanous transmission	enabled	data point - Line T101/T104/GP104
if enabled: Spontaneous transmission of this process data point1)		

Parameter name	Default	Parameter location
Background cycle	disabled	data point - Line T101/T104/GP104
If enabled: Cyclic transmission of this process data point out of the process image of the host interface with given cycle time of the background cycle. Value range: disabled, 1 sec, 2, 4, 5, 8, 10, 16, 30, 60 sec, 2 min, 5 min, 10 min, 15 min1)		

[1]It is possible to set both parameters at the same data point. That means that the concerning data point is directly send to the NCC on every change and additional after the configured time period.

Parameter name	Default	Parameter location
Put in buffer	Enabled	data point - line T101/T104
If enabled: value changes will be stored in buffer when host is offline. If disabled: GI is mandatory to get current value.		

6.1.3 Conversion of Values

Parameter name	Default	Parameter location
Transmission format	Normalized	AMI - line T101/104
Transmission format for this data point: Normalized: Value range -1.0 ... +1.0 Scaled: Value range -32768.0 ... +32767.0.		
Maximum value	1 (Normalized) 32767 (Scaled)	AMI - line T101/104
+100 % within RTU internal communication get converted to parameter 'Maximum value' in the external communication protocol. Normalized: Value range -1.0 ... +1.0. Scaled: Value range -32768.0 ... +32767.0.		
Minimum value	-1 (Normalized -32768 (Scaled)	AMI - line T101/104
-100 % within RTU internal communication get converted to parameter 'Minimum value' in the external communication protocol. Normalized: Value range -1.0 ... +1.0. Scaled: Value range -32768.0 ... +32767.0.		

Range	RTU internal value	IEC 60870-5-101
Range min.	-100 %	Minimum value
...	...	
Range max.	+100 %	Maximum value

Table 15: AMI - Conversion of values

6.1.4 Conversion of Quality Descriptors

RTU		IEC 60870-5-101
Internal communication (short)	**Internal communication (long)**	**Communication**
OV	Overflow	Overflow
BL	Blocked	Blocked

Table 16: AMI - Conversion of quality descriptors

RTU		IEC 60870-5-101
Internal communication (short)	**Internal communication (long)**	**Communication**
SB	Substituted	Substituted
NT	Not Topical	Not Topical
IV	Invalid	Invalid

Table 16: AMI - Conversion of quality descriptors

6.1.5 Conversion of Causes of Transmission

RTU		IEC 60870-5-101
Internal communication (short)	**Internal communication (long)**	**Communication**
T	Test	Test
P/N	Positive/negative confirmation	- Irrelevant -
Cause	Spontaneous	3 - spontaneous
	Periodic / cyclic	1 - periodic / cyclic
	Background scan	2 - background scan
	Requested	5 - requested
	Interrogated	20, 21 ... 36 - interrogated

Table 17: AMI - Conversion of causes of transmission

6.2 BSI – Bit String Information

Binary process information is indicated by 8, 16 or 32 bit.

6.2.1 Supported Data Types

IEC 60870-5-101			RTU		
ASDU	**Type identification**	**Data type property**	**Data type**	**Parameter name**	**Parameter location**
M_BO_NA_1	<7>	without timestamp	BSI		
M_BO_TA_1	<8>	with timestamp CP24Time2a	BSI	Transmit with timestamp	BSI - line T101
M_BO_TB_1	<33>	with timestamp CP56Time2a	BSI	Transmission with timestamp	BSI - line T101/T104/GP104
				Transmit with full timestamp	line T101- IEC 60870-5-101

Table 18: BSI - Supported data types

6.2.2 Additional Information

Parameter name	Default	Parameter location
Put in buffer	Enabled	data point - line T101/T104
If enabled: value changes will be stored in buffer when host is offline. If disabled: GI is mandatory to get current value.		

6.2.3 Conversion of values

Range	RTU internal value	IEC 60870-5-101
Range min.	0	0
...	...	
Range max.	BSI8: Bit mask of 8 bit; range ... 255	255
	BSI16: Bit mask of 16 bit; range ... 65 535	65 535
	BSI32: Bit mask of 32 bit; range ... 4 294 967 295	4 294 967 295

Table 19: BSI - Conversion of values

6.2.4 Conversion of Quality Descriptors

RTU		IEC 60870-5-101
Internal communication (short)	**Internal communication (long)**	**Communication**
OV	Overflow	Overflow
BL	Blocked	Blocked
SB	Substituted	Substituted
NT	Not Topical	Not Topical
IV	Invalid	Invalid

Table 20: BSI - Conversion of quality descriptors

6.2.5 Conversion of Causes of Transmission

RTU		IEC 60870-5-101
Internal communication (short)	**Internal communication (long)**	**Communication**
T	Test	Test
P/N	Positive/negative confirmation	- Irrelevant -
Cause	Spontaneous	3 - spontaneous
	Background scan	2 - background scan

Table 21: BSI - Conversion of causes of transmission

RTU		IEC 60870-5-101
Internal communication (short)	**Internal communication (long)**	**Communication**
	Requested	5 - requested
	Interrogated	20, 21 ... 36 - interrogated

Table 21: BSI - Conversion of causes of transmission

6.3 DMI – Digital Measured Information

Binary process information indicated by 8 or 16 bit is used as a measured value from digital inputs in normalized format.

6.3.1 Supported Data Types

IEC 60870-5-101				RTU	
ASDU	**Type identification**	**Data type property**	**Data type**	**Parameter name**	**Parameter location**
M_ME_NA_1	<9>	without timestamp	DMI		
M_ME_TA_1	<10>	with timestamp CP24Time2a	DMI	Transmit with timestamp	DMI - line T101
M_ME_TD_1	<34>	with timestamp CP56Time2a	DMI	Transmission with timestamp	DMI - line T101/ T104/GP104
				Transmit with full timestamp	Line T101 - IEC 60870-5-101

Table 22: DMI - Supported data types

6.3.2 Additional Information

Parameter name	Default	Parameter location
Put in buffer	Enabled	data point - line T101/T104
If enabled: value changes will be stored in buffer when host is offline. If disabled: GI is mandatory to get current value.		

6.3.3 Conversion of values

Range	RTU internal value	IEC 60870-5-101
Range min.	-100 %	-1
...	...	
Range max.	+100 %	$+1\text{-}2e^{-15}$

Table 23: DMI - Conversion of values

6.3.4 Conversion of Quality Descriptors

RTU		IEC 60870-5-101
Internal communication (short)	Internal communication (long)	Communication
OV	Overflow	Overflow
BL	Blocked	Blocked
SB	Substituted	Substituted
NT	Not Topical	Not Topical
IV	Invalid	Invalid

Table 24: DMI - Conversion of quality descriptors

6.3.5 Conversion of Causes of Transmission

RTU		IEC 60870-5-101
Internal communication (short)	Internal communication (long)	Communication
T	Test	Test
P/N	Positive/negative confirmation	- Irrelevant -
Cause	Spontaneous	3 - spontaneous
	Periodic / cyclic	1 - periodic / cyclic
	Background scan	2 - background scan
	Requested	5 - requested
	Interrogated	20, 21 ... 36 - interrogated

Table 25: DMI - Conversion of causes of transmission

6.4 DPI – Double Point Information

Binary process information is indicated by two bits.

6.4.1 Supported Data Types

IEC 60870-5-101				RTU	
ASDU	Type identification	Data type property	Data type	Parameter name	Parameter location
M_DP_NA_1	<3>	without timestamp	DPI		
M_DP_TA_1	<4>	with timestamp CP24Time2a	DPI	Transmit with timestamp	DPI - line T101
M_DP_TB_1	<31>	with timestamp CP56Time2a	DPI	Transmission with timestamp	DPI - line T101/T104/ GP104
				Transmit with full timestamp	line T101 - IEC 60870-5-101

Table 26: DPI - Supported data types

6.4.2 Additional Information

Parameter name	Default	Parameter location
Put in buffer	Enabled	data point - line T101/T104
If enabled: value changes will be stored in buffer when host is offline. If disabled: GI is mandatory to get current value.		

6.4.3 Conversion of Values

RTU internal value	IEC 60870-5-101
intermediate	11
off	01
on	10
indeterminate	00

Table 27: DPI – Conversion of values

6.4.4 Conversion of Quality Descriptors

RTU		IEC 60870-5-101
Internal communication (short)	**Internal communication (long)**	**Communication**
BL	Blocked	Blocked
SB	Substituted	Substituted
NT	Not Topical	Not Topical
IV	Invalid	Invalid

Table 28: DPI - Conversion of quality descriptors

6.4.5 Conversion of Causes of Transmission

RTU		IEC 60870-5-101
Internal communication (short)	**Internal communication (long)**	**Communication**
T	Test	Test
P/N	Positive/negative confirmation	- Irrelevant -
Cause	Spontaneous	3 - spontaneous
	Background scan	2 - background scan
	Requested	5 - requested
	Interrogated	20, 21 ... 36 - interrogated

Table 29: DPI - Conversion of causes of transmission

6.5 EPI – Protection Event Information

Binary process information is indicated by two bits and relative timetag (used by protection relays).

6.5.1 Supported Data Types

IEC 60870-5-101				RTU	
ASDU	**Type identification**	**Data type property**	**Data type**	**Parameter name**	**Parameter location**
M_EP_TA_1	<17>	with timestamp CP24Time2a	EPI		
M_EP_TD_1	<38>	with timestamp CP56Time2a	EPI	Transmit with full timestamp	line T101- IEC 60870-5-101

Table 30: EPI - Supported data types

6.5.2 Additional information

The EPI contents a elapsed time tag of the protection event with the range of 0..59 999 ms.

Parameter name	Default	Parameter location
Put in buffer	Enabled	data point - line T101/T104

If enabled: value changes will be stored in buffer when host is offline.
If disabled: GI is mandatory to get current value.

6.5.3 Conversion of Values

RTU internal value	IEC 60870-5-101
intermediate	0
off	1
on	2
indeterminate	3

Table 31: EPI - Conversion of values

6.5.4 Conversion of Quality Descriptors

RTU		IEC 60870-5-101
Internal communication (short)	**Internal communication (long)**	**Communication**
EI	Elapsed time valid	Elapsed time valid
BL	Blocked	Blocked
SB	Substituted	Substituted
NT	Not Topical	Not Topical
IV	Invalid	Invalid

Table 32: EPI - Conversion of quality descriptors

6.5.5 Conversion of Causes of Transmission

RTU		IEC 60870-5-101
Internal communication (short)	**Internal communication (long)**	**Communication**
T	Test	Test
P/N	Positive/negative confirmation	- Irrelevant -
Cause	Spontaneous	3 - spontaneous
	Background scan	2 - background scan

Table 33: EPI - Conversion of causes of transmission

6.6 ITI – Integrated Totals Information

Binary process information is indicated by 32 bits as a count value.

6.6.1 Supported Data Types

IEC 60870-5-101			RTU		
ASDU	**Type identification**	**Data type property**	**Data type**	**Parameter name**	**Parameter location**
M_IT_NA_1	<15>	without timestamp	ITI		
M_IT_TA_1	<16>	with timestamp CP24Time2a	ITI	Transmit with timestamp	ITI - line T101
M_IT_TB_1	<37>	with timestamp CP56Time2a	ITI	Transmission with timestamp	ITI - line T101/T104/GP104
				Transmit with full timestamp	line T101 - IEC 60870-5-101

Table 34: ITI - Supported data types

6.6.2 Additional Information

Parameter name	Default	Parameter location
Put in buffer	Enabled	data point - line T101/T104
If enabled: value changes will be stored in buffer when host is offline. If disabled: GI is mandatory to get current value.		

6.6.3 Conversion of Values

Range	RTU internal value	IEC 60870-5-101
Range min.	- 2 147 483 648	- 2 147 483 648
	0 (from local I/O)	0
...	...	
Range max.	2 147 483 647	2 147 483 647

Table 35: ITI - Conversion of values

6.6.4 Conversion of Quality Descriptors

RTU		IEC 60870-5-101
Internal communication (short)	**Internal communication (long)**	**Communication**
SEQ	Sequence number	Sequence number
CY	Carry	Carry
CA	Adjusted	Adjusted
IV	Invalid	Invalid

Table 36: ITI - Conversion of quality descriptors

6.6.5 Conversion of Causes of Transmission

RTU		IEC 60870-5-101
Internal communication (short)	**Internal communication (long)**	**Communication**
T	Test	Test
P/N	Positive/negative confirmation	- Irrelevant -
Cause	Spontaneous	3 - spontaneous
	Requested	5 - requested
	Interrogated	37, 38 … 41 - interrogated

Table 37: ITI - Conversion of causes of transmission

6.7 MFI – Measured Float Information

32 bit analog process information is used as a measured value in float format.

6.7.1 Supported Data Types

IEC 60870-5-101			RTU		
ASDU	**Type identification**	**Data type property**	**Data type**	**Parameter name**	**Parameter location**
M_ME_NC_1	<13>	without timestamp	MFI		
M_ME_TC_1	<14>	with timestamp CP24Time2a	MFI	Transmit with timestamp	MFI - line T101
M_ME_TF_1	<36>	with timestamp CP56Time2a	MFI	Transmission with timestamp	MFI - line T101/ T104/GP104
				Transmit with full timestamp	Line T101 - IEC 60870-5-101

Table 38: MFI - Supported data types

6.7.2 Values

R32–IEEE STD 754

6.7.3 Additional Information

Parameter name	Default	Parameter location
Spontanous transmission	enabled	data point - Line T101/T104/GP104
if enabled: Spontaneous transmission of this process data point1)		
Background cycle	disabled	data point - Line T101/T104/GP104
If enabled: Cyclic transmission of this process data point out of the process image of the host interface with given cycle time of the background cycle. Value range: disabled, 1 sec, 2, 4, 5, 8, 10, 16, 30, 60 sec, 2 min, 5 min, 10 min, 15 min1)		

1)It is possible to set both parameters at the same data point. That means that the concerning data point is directly send to the NCC on every change and additional after the configured time period.

Parameter name	Default	Parameter location
Put in buffer	Enabled	data point - line T101/T104
If enabled: value changes will be stored in buffer when host is offline. If disabled: GI is mandatory to get current value.		

6.7.4 Conversion of Values

Range	RTU internal value	IEC 60870-5-101
Range min.	-3.4 x 10e38	-3.4 x $10e^{38}$
...	...	
Range max.	+3.4 x 10e38	+3.4 x $10e^{38}$

Table 39: MFI - Conversion of values

6.7.5 Conversion of Quality Descriptors

RTU		IEC 60870-5-101
Internal communication (short)	**Internal communication (long)**	**Communication**
OV	Overflow	Overflow
BL	Blocked	Blocked
SB	Substituted	Substituted
NT	Not Topical	Not Topical
IV	Invalid	Invalid

Table 40: MFI - Conversion of quality descriptors

6.7.6 Conversion of Causes of Transmission

RTU		IEC 60870-5-101
Internal communication (short)	**Internal communication (long)**	**Communication**
T	Test	Test

Table 41: MFI - Conversion of causes of transmission

RTU		IEC 60870-5-101
Internal communication (short)	Internal communication (long)	Communication
P/N	Positive/negative confirmation	- Irrelevant -
Cause	Spontaneous	3 - spontaneous
	Periodic / cyclic	1 - periodic / cyclic
	Background scan	2 - background scan
	Requested	5 - requested
	Interrogated	20, 21 ... 36 - interrogated

Table 41: MFI - Conversion of causes of transmission

6.8 SPI – Single Point Information

Binary process information is indicated by one bit.

6.8.1 Supported Data Types

IEC 60870-5-101				RTU	
ASDU	Type identification	Data type property	Data type	Parameter name	Parameter location
M_SP_NA_1	<1>	without timestamp	SPI		
M_SP_TA_1	<2>	with timestamp CP24Time2a	SPI	Transmit with timestamp	SPI - line T101
M_SP_TB_1	<30>	with timestamp CP56Time2a	SPI	Transmission with timestamp	SPI - line T101/T104/ GP104
				Transmit with full timestamp	Line T101 - IEC 60870-5-101

Table 42: SPI - Supported data types

6.8.2 Additional Information

Parameter name	Default	Parameter location
Put in buffer	Enabled	data point - line T101/T104

If enabled: value changes will be stored in buffer when host is offline.
If disabled: GI is mandatory to get current value.

6.8.3 Conversion of Values

RTU internal value	IEC 60870-5-101
off	0
on	1

Table 43: SPI - Conversion of values

6.8.4 Conversion of Quality Descriptors

RTU		IEC 60870-5-101
Internal communication (short)	Internal communication (long)	Communication
BL	Blocked	Blocked
SB	Substituted	Substituted
NT	Not Topical	Not Topical
IV	Invalid	Invalid

Table 44: SPI - Conversion of quality descriptors

6.8.5 Conversion of Causes of Transmission

RTU		IEC 60870-5-101
Internal communication (short)	Internal communication (long)	Communication
T	Test	Test
P/N	Positive/negative confirmation	- Irrelevant -
Cause	Spontaneous	3 - spontaneous
	Background scan	2 - background scan
	Requested	5 - requested
	Interrogated	20, 21 ... 36 - interrogated

Table 45: SPI - Conversion of causes of transmission

6.9 STI – Step Position Information

Binary process information is indicated by 8 bits.

6.9.1 Supported Data Types

IEC 60870-5-101			RTU		
ASDU	Type identification	Data type property	Data type	Parameter name	Parameter location
M_ST_NA_1	<5>	without timestamp	STI		
M_ST_TA_1	<6>	with timestamp CP24Time2a	STI	Transmit with timestamp	STI - line T101
M_ST_TB_1	<32>	with timestamp CP56Time2a	STI	Transmission with timestamp	STI - line T101/T104/GP104
				Transmit with full timestamp	line T101 - IEC 60870-5-101

Table 46: STI - Supported data types

6.9.2 Additional Information

Parameter name	Default	Parameter location
Put in buffer	Enabled	data point - line T101/T104
If enabled: value changes will be stored in buffer when host is offline. If disabled: GI is mandatory to get current value.		

6.9.3 Conversion of Values

Range	RTU internal value	IEC 60870-5-101
Range min.	-63	-63
...	...	
Range max.	+63	+63

Table 47: STI - Conversion of values

6.9.4 Conversion of Quality Descriptors

RTU		IEC 60870-5-101
Internal communication (short)	**Internal communication (long)**	**Communication**
OV	Overflow	Overflow
BL	Blocked	Blocked
SB	Substituted	Substituted
NT	Not Topical	Not Topical
IV	Invalid	Invalid
T	Transient Bit	Transient Bit

Table 48: STI - Conversion of quality descriptors

6.9.5 Conversion of Causes of Transmission

RTU		IEC 60870-5-101
Internal communication (short)	**Internal communication (long)**	**Communication**
T	Test	Test
P/N	Positive/negative confirma-tion	- Irrelevant -
Cause	Spontaneous	3 - spontaneous
	Background scan	2 - background scan
	Requested	5 - requested
	Interrogated	20, 21 ... 36 - interrogated

Table 49: STI - Conversion of causes of transmission

7 Data Types - Controlling Direction

7.1 ASO – Analog Setpoint Output

Analog process command (16 bit signed number).

7.1.1 Supported Data Types

IEC 60870-5-101			RTU		
ASDU	**Type identification**	**Data type property**	**Data type**	**Parameter name**	**Parameter location**
C_SE_NA_1	<48>	normalized, without time tag	ASO	Transmission format: Normalized	ASO - line T101/ T104/GP104
C_SE_NB_1	<49>	scaled, without time tag	ASO	Transmission format: Scaled	ASO - line T101/ T104/GP104

Table 50: ASO - Supported data types

7.1.2 Command Authority

See also parameter Interlock with local control authority

(Table Interface parameters - IEC 60870-5-101 in chapter Physical Layer (page "2-1"))

7.1.3 Additional information

Analog set-point output is a persistent output.

7.1.4 Conversion of values

Range	RTU internal value	IEC 60870-5-101
Range min.	-100 %	Normalized: -1 Scaled: -32 768
...	...	
Range max.	+100 %	Normalized: $+1-2e^{-15}$ Scaled: +32 767

Table 51: ASO - Conversion of values

7.1.5 Conversion of qualifier of command

RTU		IEC 60870-5-101
Internal communication (short)	**Internal communication (long)**	**Communication**
SE	Select / Execute	Select / Execute (1 select, 0 execute)
QL	default	0 - default

Table 52: ASO - conversion of qualifier of command

7.1.6 Conversion of causes of transmission

RTU		IEC 60870-5-101
Internal communication (short)	**Internal communication (long)**	**Communication**
T	Test	Ignored
P/N	Positive/negative confirmation	Relevant in monitor direction only
Cause	Activation	6 - Activation
	Activation Confirmation	7 - Activation Confirmation
	Deactivation	8 - Deactivation
	Deactivation Confirmation	9 - Deactivation Confirmation
	Activation Termination	10 - Activation Termination
	Negative Confirmation	45 … 47 - Unknown

Table 53: ASO - Conversion of causes of transmission

7.2 BSO – Bit String Output

Binary process command (1, 2, 8, 16, 32 bit unsigned number).

7.2.1 Supported Data Types

IEC 60870-5-101			RTU		
ASDU	**Type identification**	**Data type property**	**Data type**	**Parameter name**	**Parameter location**
C_BO_NA_1	<51>	without time tag	BSO		

Table 54: BSO - Supported data types

7.2.2 Command Authority

See also parameter Interlock with local control authority

(Table Interface parameters - IEC 60870-5-101 in chapter Physical Layer (page "2-1"))

7.2.3 Additional information

Always persistent output. A new command with value 0 (all bits) has to be generated.

7.2.4 Conversion of values

Range	RTU internal value	IEC 60870-5-101
Range min.	0	0
…	…	
Range max.	4 294 967 295	4 294 967 295

Table 55: BSO - Conversion of values

7.2.5 Conversion of qualifier of command

RTU		IEC 60870-5-101
Internal communication (short)	**Internal communication (long)**	**Communication**
SE	only direct execute	only direct execute

Table 56: BSO - conversion of qualifier of command

7.2.6 Conversion of causes of transmission

RTU		IEC 60870-5-101
Internal communication (short)	**Internal communication (long)**	**Communication**
T	Test	Ignored
P/N	Positive/negative confirmation	Relevant in monitor direction only
Cause	Activation	6 - Activation
	Activation Confirmation	7 - Activation Confirmation
	Activation Termination	10 - Activation Termination
	Negative Confirmation	45 … 47 - Unknown

Table 57: BSO - Conversion of causes of transmission

7.3 DCO – Double Command Output

Binary process command (two bits).

7.3.1 Supported Data Types

IEC 60870-5-101				RTU	
ASDU	Type identification	Data type property	Data type	Parameter name	Parameter location
C_DC_NA_1	<46>	without time-stamp	DCO		

Table 58: DCO - Supported data types

7.3.2 Command Authority

See also parameter Interlock with local control authority

(Table Interface parameters - IEC 60870-5-101 in chapter Physical Layer (page "2-1"))

7.3.3 Additional Information

None

7.3.4 Conversion of Values

RTU internal value	IEC 60870-5-101
off	01
on	10

Table 59: DCO - Conversion of values

7.3.5 Conversion of qualifier of command

RTU		IEC 60870-5-101
Internal communication (short)	Internal communication (long)	Communication
SE	Select / Execute	Select / Execute (1 select, 0 execute)
QU	default	0 - no additional definition
	overwritten for local I/O by command output duration parameter	1 - short pulse duration
	overwritten for local I/O by command output duration parameter	2 - long pulse duration
	overwritten for local I/O by command output type parameter	3 - persistent output

Table 60: DCO - conversion of qualifier of command

RTU		IEC 60870-5-101
Internal communication (short)	**Internal communication (long)**	**Communication**
	IEC61850 client: function is used to specify command check attributes	9... 15 - reserved for the selection of other predefined functions

Table 60: DCO - conversion of qualifier of command

7.3.6 Conversion of causes of transmission

RTU		IEC 60870-5-101
Internal communication (short)	**Internal communication (long)**	**Communication**
T	Test	Ignored
P/N	Positive/negative confirmation	Relevant in monitor direction only
Cause	Activation	6 - Activation
	Activation Confirmation	7 - Activation Confirmation
	Deactivation	8 - Deactivation
	Deactivation Confirmation	9 - Deactivation Confirmation
	Activation Termination	10 - Activation Termination
	Negative Confirmation	45 … 47 - Unknown

Table 61: DCO - Conversion of causes of transmission

7.4 DSO – Digital Setpoint Output

Binary process command (8 or 16 bit signed number).

7.4.1 Supported Data Types

IEC 60870-5-101			RTU		
ASDU	**Type identification**	**Data type property**	**Data type**	**Parameter name**	**Parameter location**
C_SE_NA_1	<48>	normalized, without time tag	DSO	Transmission format: Normalized	DSO - line T101/ T104/GP104
C_SE_NB_1	<49>	scaled, without time tag	DSO	Transmission format: Scaled	DSO - line T101/ T104/GP104

Table 62: DSO - Supported data types

7.4.2 Command Authority

See also parameter Interlock with local control authority

(Table Interface parameters - IEC 60870-5-101 in chapter Physical Layer (page "2-1"))

7.4.3 Additional information

Digital set-point output is a persistent output.

7.4.4 Conversion of values

Range	RTU internal value	IEC 60870-5-101
Range min.	-100 %	-1
…	…	
Range max.	+100 %	$+1-2e^{-15}$

Table 63: DSO - Conversion of values

7.4.5 Conversion of qualifier of command

RTU		IEC 60870-5-101
Internal communication (short)	**Internal communication (long)**	**Communication**
SE	Select / Execute	Select / Execute (1 select, 0 execute)
QL	default	0 - default

Table 64: DSO - conversion of qualifier of command

7.4.6 Conversion of causes of transmission

RTU		IEC 60870-5-101
Internal communication (short)	**Internal communication (long)**	**Communication**
T	Test	Ignored
P/N	Positive/negative confirmation	Relevant in monitor direction only
Cause	Activation	6 - Activation
	Activation Confirmation	7 - Activation Confirmation
	Deactivation	8 - Deactivation
	Deactivation Confirmation	9 - Deactivation Confirmation
	Activation Termination	10 - Activation Termination
	Negative Confirmation	45 … 47 - Unknown

Table 65: DSO - Conversion of causes of transmission

7.5 FSO – Floating Point Setpoint Output

Floating point process command (32 bit short floating point number)

7.5.1 Supported Data Types

IEC 60870-5-101			RTU		
ASDU	Type identification	Data type property	Data type	Parameter name	Parameter location
C_SE_NC_1	<50>	without time tag	FSO		

Table 66: FSO - Supported data types

7.5.2 Command Authority

See also parameter Interlock with local control authority

(Table Interface parameters - IEC 60870-5-101 in chapter Physical Layer (page "2-1"))

7.5.3 Additional Information

None

7.5.4 Conversion of values

Range	RTU internal value	IEC 60870-5-101
Range min.	-3.4 x 10e38	-3.4 x 10e38
...	...	
Range max.	+3.4 x 10e38	+3.4 x 10e38

Table 67: FSO - Conversion of values

7.5.5 Conversion of qualifier of command

RTU		IEC 60870-5-101
Internal communication (short)	Internal communication (long)	Communication
SE	Select / Execute	Select / Execute (1 select, 0 execute)
QL	default	0 - default

Table 68: FSO - conversion of qualifier of command

7.5.6 Conversion of causes of transmission

RTU		IEC 60870-5-101
Internal communication (short)	Internal communication (long)	Communication
T	Test	Ignored
P/N	Positive/negative confirmation	Relevant in monitor direction only

Table 69: FSO - Conversion of causes of transmission

RTU		IEC 60870-5-101
Internal communication (short)	**Internal communication (long)**	**Communication**
Cause	Activation	6 - Activation
	Activation Confirmation	7 - Activation Confirmation
	Deactivation	8 - Deactivation
	Deactivation Confirmation	9 - Deactivation Confirmation
	Activation Termination	10 - Activation Termination
	Negative Confirmation	45 … 47 - Unknown

Table 69: FSO - Conversion of causes of transmission

7.6 RCO – Regulation Command Output

Regulation step command (two bits).

7.6.1 Supported Data Types

IEC 60870-5-101			RTU		
ASDU	**Type identification**	**Data type property**	**Data type**	**Parameter name**	**Parameter location**
C_RC_NA_1	<47>	without time tag	RCO		

Table 70: RCO - Supported data types

7.6.2 Command Authority

See also parameter Interlock with local control authority

(Table Interface parameters - IEC 60870-5-101 in chapter Physical Layer (page "2-1"))

7.6.3 Additional information

Regulation step commands are in principle retriggerable commands.

In order to retrigger a running two step regulation command, it is not necessary to resend the command Select.

7.6.4 Conversion of values

RTU internal value	IEC 60870-5-101
Lower	01
Higher	10

Table 71: RCO - Conversion of values

7.6.5 Conversion of qualifier of command

RTU		IEC 60870-5-101
Internal communication (short)	**Internal communication (long)**	**Communication**
SE	Select / Execute	Select / Execute (1 select, 0 execute)
QU	default	0 - no additional definition
	overwritten for local I/O by command output duration parameter	1 - short pulse duration
	overwritten for local I/O by command output duration parameter	2 - long pulse duration
	overwritten for local I/O by command output type parameter	3 - persistent output
	IEC61850 client: function is used to specify command check attributes	9… 15 - reserved for the selection of other predefined functions

Table 72: RCO - conversion of qualifier of command

7.6.6 Conversion of causes of transmission

RTU		IEC 60870-5-101
Internal communication (short)	**Internal communication (long)**	**Communication**
T	Test	Ignored
P/N	Positive/negative confirmation	Relevant in monitor direction only
Cause	Activation	6 - Activation
	Activation Confirmation	7 - Activation Confirmation
	Deactivation	8 - Deactivation
	Deactivation Confirmation	9 - Deactivation Confirmation
	Activation Termination	10 - Activation Termination
	Negative Confirmation	45 … 47 - Unknown

Table 73: RCO - Conversion of causes of transmission

7.7 SCO – Single Command Output

Binary process command (one bit).

7.7.1 Supported Data Types

IEC 60870-5-101			RTU		
ASDU	Type identification	Data type property	Data type	Parameter name	Parameter location
C_SC_NA_1	<45>	without time-stamp	SCO		

Table 74: SCO - Supported data types

7.7.2 Command Authority

See also parameter Interlock with local control authority

(Table Interface parameters - IEC 60870-5-101 in chapter Physical Layer (page "2-1"))

7.7.3 Additional Information

None

7.7.4 Conversion of values

RTU internal value	IEC 60870-5-101
off	0
on	1

Table 75: SCO - Conversion of values

7.7.5 Conversion of qualifier of command

RTU		IEC 60870-5-101
Internal communication (short)	Internal communication (long)	Communication
SE	Select / Execute	Select / Execute (1 select, 0 execute)
QU	default	0 - no additional definition
	overwritten for local I/O by command output duration parameter	1 - short pulse duration
	overwritten for local I/O by command output duration parameter	2 - long pulse duration
	overwritten for local I/O by command output type parameter	3 - persistent output

Table 76: SCO - conversion of qualifier of command

RTU		IEC 60870-5-101
Internal communication (short)	**Internal communication (long)**	**Communication**
	IEC61850 client: function is used to specify command check attributes	9... 15 - reserved for the selection of other predefined functions

Table 76: SCO - conversion of qualifier of command

7.7.6 Conversion of causes of transmission

RTU		IEC 60870-5-101
Internal communication (short)	**Internal communication (long)**	**Communication**
T	Test	Ignored
P/N	Positive/negative confirmation	Relevant in monitor direction only
Cause	Activation	6 - Activation
	Activation Confirmation	7 - Activation Confirmation
	Deactivation	8 - Deactivation
	Deactivation Confirmation	9 - Deactivation Confirmation
	Activation Termination	10 - Activation Termination
	Negative Confirmation	45 … 47 - Unknown

Table 77: SCO - Conversion of causes of transmission

8 Transparent Data

In automation systems may be required information that is not mapped to the IEC 60870-5-101 protocol. This information includes several device specific parameters etc.

Several type identifications of the private range have been selected to enable transparent data transfer through the RTU500 series RTU to subordinated devices.

8.1 Transparent data channel

8.1.1 Command direction

With the Transparent Data Message C_TD_NA_1 the Controlling Station is able to request data from subordinate devices through the RTU500 series.

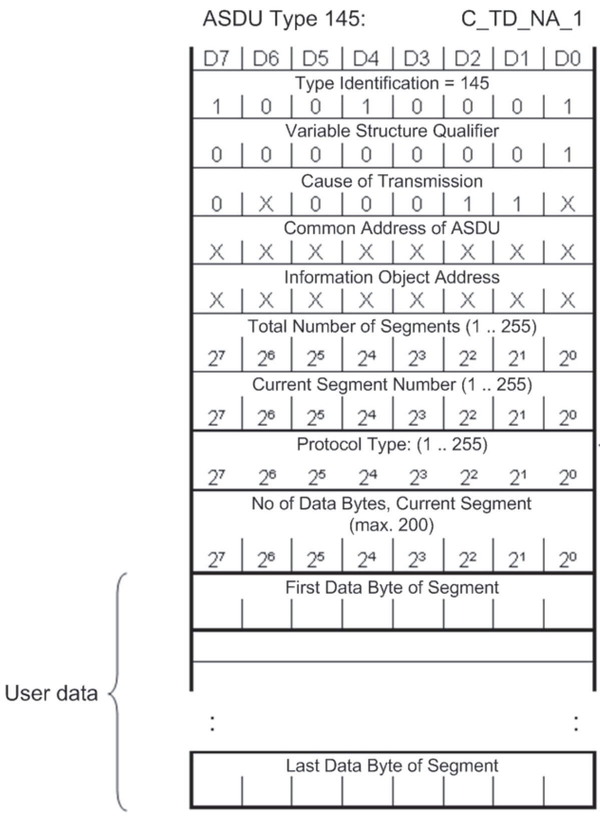
The Type Ident is 145, ASDU address and the Information object address must be configured in RTUtil500.

The Transparent Data Message C_TD_NA_1 will be answered from the RTU by sending the message back to Controlling Station with Cause of Transmission 7 (activation confirmation).

When the message is accepted by the RTU (message can be processed by the RTU and device answers to the request message), the RTU sends a “positive confirmation” ACTCON, otherwise (message cannot be processed by the RTU) the RTU sends a “negative confirmation” ACTCON.

Every transparent data command is checked on ASDU address, information object address and “No of Data Bytes in Current Segment“.

If the ASDU address or information object address does not match to the configuration in RTUtil500 or the “No of Data Bytes in Current Segment” is higher than 200, the command is confirmed negative.



Protocol Type	Value in Protocol Type field
SPAbus	7
RP570/571	8*
Modbus	9
IEC 60870-5-101	101*
IEC 60870-5-102	102
IEC 60870-5-103	103*
IEC 60870-5-104	104*
IEC 1107	107

* : reserved for future use

Figure 5: ASDU Type 145

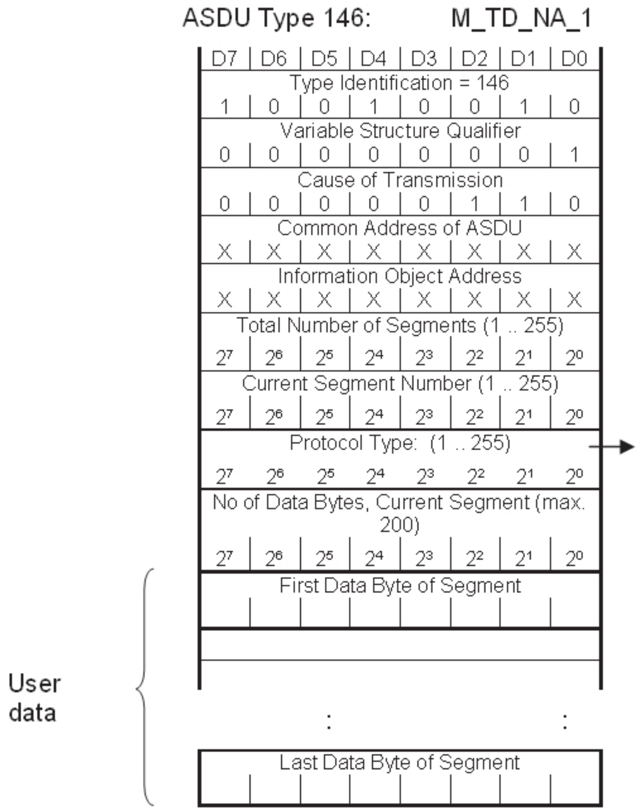
8.1.2 Monitoring direction

With the Transparent Data Response M_TD_NA_1, the RTU is able to transmit any data as transparent data to a Controlling Station.

The Type Ident is 146, theLink address, ASDU address and the Information object address must be configured by RTUtil500. They are equal to the one used in command direction.

The maximum amount of segments is 255, each of them contains up to 200 data bytes.

If all data can be sent in one message (data segmentation not necessary), the contents of both segmentation control fields are set to 1.



Protocol Type	Value in Protocol Type field
SPAbus	7
RP570/571	8*
Modbus	9
IEC 60870-5-101	101*
IEC 60870-5-102	102
IEC 60870-5-103	103*
IEC 60870-5-104	104*
IEC 62056-21	107

* : reserved for future use

Figure 6: ASDU Type 146

8.1.3 Request procedure

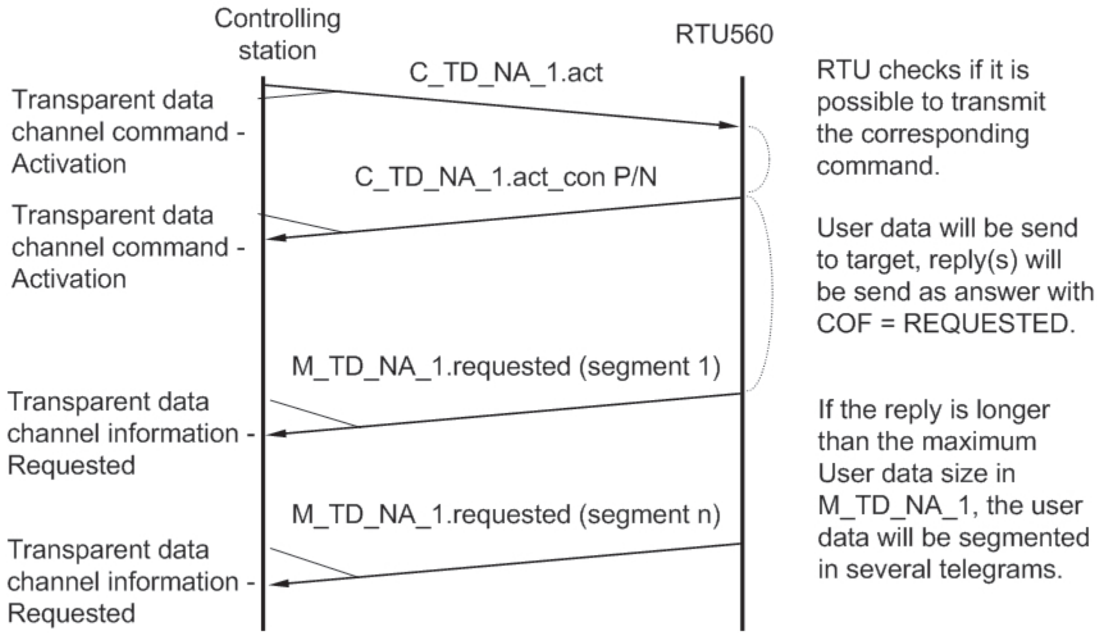


Figure 7: Request procedure

8.2 Encapsulated SPAbus messages

8.2.1 General

With the Transparent Data Message C_SB_NA_1 the Controlling Station is able to request data and execute commands of a SPAbus device connected to a subordinate device through the RTU560.

The Type Ident is 133, the ASDU address and the Information object address must be configured in RTUtil500.

The Transparent Data Message C_SB_NA_1 will be answered from RTU by sending the message back to Central System with Cause of Transmission 7 (activation confirmation).

When the message is accepted by the subordinate device (Device answers to the request message), the RTU sends a "positive confirmation" ACTCON with the reply data included, otherwise (message cannot be processed) the RTU sends a "negative confirmation" ACTCON.

Every transparent data command is checked on ASDU address, information object address and “No of Data Bytes in Current Segment“.

If the ASDU address, information object address or “No of Data Bytes” does not match to the configuration in RTUtil500, the command is confirmed negative.

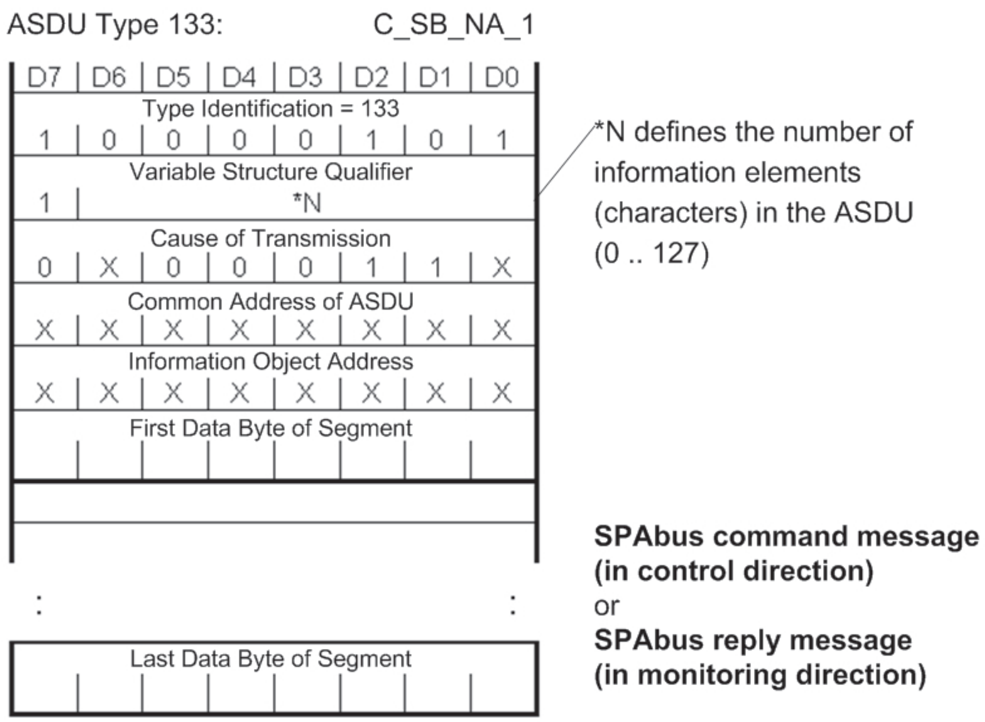


Figure 8: ASDU Type 133

8.2.2 Request procedure

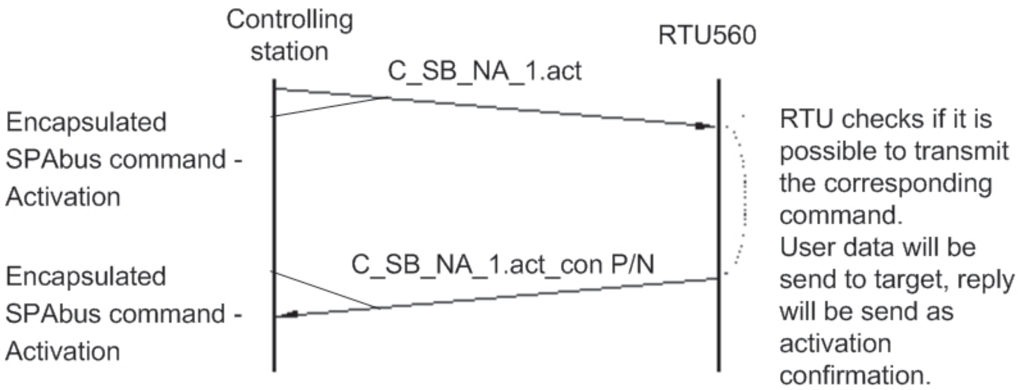


Figure 9: Request procedure

9 File Transfer

The file transfer is used for exchanging files between a control center and a RTU500 series or a subordinated device.

Before starting file transfer to an RTU, the control center can deactivate the RTU (stop periodic measurements), in order to have highest possible bandwidth for the file transfer. If no new configuration files are loaded into the RTU between deactivation and reset command, the RTU restarts with the same configuration data as before.

If a file transfer is started without preceding deactivation command, the RTU will continue its normal operation during the complete file transfer process. The downloaded configuration will become active only after a restart of the RTU.

The file name in the protocol is fixed for the following supported file types to 1 (transparent file).

Supported file types:

- RCD configuration file
- PRO configuration file (PLC boot project file)
- Disturbance recorder of various protocols and device types. See corresponding SCI description for details.
- UNDEF file not specified in greater detail

The name of file in the protocol for ‘Sequence of events’ is 3 and ‘Sequence of analog values’ is 4.

- Sequence of events file
- Sequence of recorded analog values file

9.1 Supported data types

IEC 60870-5-101			RTU		
ASDU	**Type identification**	**Data type property**	**Data type**	**Parameter name**	**Parameter location**
F_FR_NA_1	<120>				
F_SR_NA_1	<121>				
F_SC_NA_1	<122>				
F_LS_NA_1	<123>				
F_AF_NA_1	<124>				
F_SG_NA_1	<125>				
F_DR_TA_1	<126>				

Table 78: File transfer - Supported data types

9.2 Values

None.

9.3 Command Authority

None

9.4 Additional information

F_DR_TA_1 cannot be generated by RTU500 series, but routed to/from subordinated devices.

9.5 Conversion of causes of transmission

RTU		IEC 60870-5-101
Internal communication (short)	**Internal communication (long)**	**Communication**
T	Test	Ignored
P/N	Positive/negative confirmation	Relevant in monitor direction only
Cause	Spontaneous	3 – spontaneous (126)
	Requested	5 – requested (122, 126)
	File transfer	13 - file transfer

Table 79: File transfer - Conversion of causes of transmission

9.6 Download

The download of configuration files does not trigger any restarting mechanism in the RTU500 series. For activating the new configuration file, the control center has to issue a Reset Process Command (C_RP_NA_1, ASDU 105) after writing the files to the RTU500 series.

The RCD configuration file is distributed to every CMU board in the system concerned after download is completed. Configuration file distribution will only be done, if the file belongs to the RTU itself. Otherwise the file transfer will only be routed to the subordinated device it belongs to. In this case the file transfer handling is done by the subordinated device (e.g. a RTU of the RTU500 series).

PRO configuration file is only stored local these download is completed. This means, that PLC functions using this configuration file has to be located on the same CMU-board where the host communication interface handling the file transfer is located.

The distribution is done between the message F_LS_NA_1 and the message F_AF_NA_1 and may last a couple of seconds.

The message F_AF_NA_1 is only acknowledged positive, when file transfer and file distribution was successful. If a file transfer to a RTU500 series is confirmed negative, the downloaded file was not stored and the previous file is not deleted or overwritten.

9.7 Upload

All supported file types can also be uploaded from a RTU of the RTU500 series or an IED.

See documentation of the relevant subdevice communication interface for support of (disturbance) file upload.

9.8 Transmission of sequences of events

9.8.1 Scope of operation

Sequences of events (SOE) (for example single point information, double point information measured values, integrated totals) acquired in a controlled station are transmitted via the file transfer defined in IEC 60870-5-5 and IEC 60870-5-101.ed.2 (2003) (chapter 7.4.11.3) when onward transmission to the controlling station is required.

ASDUs with the following type identifications may be transmitted as spontaneous digital information:

<30>	Single-point information with time tag CP56Time2a	M_SP_TB_1
<31>	Double-point information with time tag CP56Time2a	M_DP_TB_1
<32>	Step position information with time tag CP56Time2a	M_ST_TB_1
<33>	Bitstring of 32 bit with time tag CP56Time2a	M_BO_TB_1
<34>	Measured value, normalized value with time tag CP56Time2a	M_ME_TD_1
<35>	Measured value, scaled value with time tag CP56Time2a	M_ME_TE_1
<36>	Measured value, short floating point value with time tag CP56Time2a	M_ME_TF_1
<37>	Integrated totals with time tag CP56Time2a	M_IT_TB_1
<38>	Event of protection equipment with time tag CP56Time2a	M_EP_TD_1

Table 80: Supported ASDUs

ASDUs with the following type identifications are not supported:

<39>	Packed start events of protection equipment with time tag CP56Time2a	M_EP_TE_1
<40>	Packed output circuit information of protection equipment with time tag CP56Time2a	M_EP_TF_1

Table 81: Not supported ASDUs

The variable structure qualifier is set to 1, i.e. only one information object is transmitted per ASDU.

9.8.2 Engineering in RTUtil500

Recording and transmission of sequences of events are only activated, if preconfigured in RTUtil500.

Transmission of sequences of events (spontaneous digital events) is activated by configuring one FTR object of file type 'Sequence of events' in the Hardware Tree. It is possible to configure a single FTR of file type 'Sequence of events' as child of an FDR object (file type 'UNDEF') but not as child of the RTU itself. By enabling the FTR of file type 'Sequence of events' (setting 'In use') for a HCI the FTR is activated.

The FTR object contains the parameters Max. contained ASDUs and Sections per file. The product of both parameters defines the number of recorded events buffered including the point of time at which they are acquired. If the predefined product is exceeded the RTU informs spontaneously the controlling station about an available file for transfer. The parameter Max. contained ASDUs has a value range from 1 to 5 000 and the default value is 1 000. The parameter Sections per file has a value range from 1 to 100 and the default value is 1.

RTU objects of type SPI, DPI, STI, BSIx, AMI, DMI, MFI, ITI, EPI, SEV offer the checkbox Include in sequence of event file. If enabled events will be recorded and transmitted to the controlling station via file transfer.

9.8.3 Runtime procedure

The structure of the record of sequences of events in a section of a file is composed according IEC 60870-5-101.ed.2 (2003) (chapter 7.4.11.3.1). The transmission procedures are performed according IEC 60870-5-101.ed.2 (2003) (chapter 7.4.11.3.2).

FTR of file type 'Sequence of events' is available as volatile file / memory area, i.e. after RTU restart the file is available for transfer after the above described buffer limit is exceeded.

FTR requests of file type 'Sequence of events' are supported only by one requester at the same time.

9.9 Transmission of sequences of recorded analog values

9.9.1 Scope of operation

Sequences of recorded analog values (for example, measured values, integrated totals) acquired in a controlled station are transmitted via the file transfer defined in IEC 60870-5-5 and IEC 60870-5-101.ed.2 (2003) (chapter 7.4.11.4) when onward transmission to the controlling station is required.

The following information elements may be transmitted as sequences of recorded analog values:

- binary counter reading (ITI)
- normalized value with quality descriptor (AMI and DMI).

9.9.2 Engineering in RTUtil500

Recording and transmission of sequences of analog values are only activated, if preconfigured in RTUtil500.

Transmission of sequences of recorded analog values is activated by configuring one FTR object of file type 'Sequence of recorded analog values' in the Hardware Tree. It is possible to configure a single FTR of file type 'Sequence of recorded analog values' as child of an FDR object (file type 'UNDEF') but not as child of the RTU itself. By enabling the FTR of file type 'Sequence of recorded analog values' (setting 'In use') for a HCI the FTR is activated.

The time interval between information elements is to be calculated as product of the factor <1..255> and the time base in <seconds, minutes or hours>. The result of this calculation has to be converted in seconds for configuration in RTUtil500. The FTR object contains the parameter Time interval for setting the time interval for data recording. The resolution of parameterTime interval is seconds and the value range is from 1 to 918 000 seconds (=255 hours). Default value of parameter Time interval is 10 seconds.

The FTR object contains the parameter Max. contained information elements of a record identifier. That parameter determines the number of buffered information elements. If this parameters is exceeded the RTU informs spontaneously the controlling station about an available file for transfer. The parameter has a value range from 1 to 3 600 and the default value is 300.

RTU objects of type AMI, DMI and ITI offer the checkbox Include in sequence of recorded analog value file. If enabled the values will be recorded and transmitted via file transfer. Enclosed is the parameter Record identifier defining a unique value for identifying the set of information elements (normalized values or counter readings), i.e. the address of the complete sequence of recorded analog values. Value range is from 1 to 65 535. The parameter Record identifier is sensitive only, if parameter Include in sequence of recorded analog value file is enabled.

9.9.3 Runtime procedure

The structure of data files containing sequences of recorded analog values is composed according IEC 60870-5-101.ed.2 (2003) (chapter 7.4.11.4.1). The transmission procedures are performed according IEC 60870-5-101.ed2003 (chapter 7.4.11.4.2).

FTR of file type 'Sequence of recorded analog values' is available as volatile file / memory area, i.e. after RTU restart the file is available for transfer after the above described buffer limit is exceeded.

FTR requests of file type 'Sequence of recorded analog value' are supported only by one requester at the same time.

10 Internal Functions

10.1 General Interrogation

The general interrogation includes single point information, double point information, step positions, measured values, bit strings and RTU system events, whereas integrated totals are excluded. The interrogation of a selected part of the process information by a group interrogation is supported. The process values transmitted in the course of the interrogation are marked with the cause of transmission 20 (General Interrogation) or 21 to 36.

When events occur during the general interrogation, the General Interrogation is interrupted, and the events are transmitted immediately.

10.1.1 Supported Data Types

IEC 60870-5-101			RTU		
ASDU	**Type identification**	**Data type property**	**Data type**	**Parameter name**	**Parameter location**
C_IC_NA_1	<100>				

Table 82: General Interrogation - Supported data types

10.1.2 Values

20, 21 … 36

10.1.3 Command Authority

None

10.1.4 Additional information

The general interrogation is responded from the HCI’s process image.

10.1.5 Conversion of Quality Descriptors

RTU		IEC 60870-5-101
Internal communication (short)	**Internal communication (long)**	**Communication**
QOI	Qualifier of Interrogation	20 – General interrogation 21 – Interrogation Group 1 22 – Interrogation Group 2 … 36 – Interrogation Group 16

Table 83: General Interrogation - Conversion of quality descriptors

10.1.6 Conversion of Causes of Transmission

RTU		IEC 60870-5-101
Internal communication (short)	**Internal communication (long)**	**Communication**
T	Test	Ignored
P/N	Positive/negative confirmation	Relevant in monitor direction only
Cause	Activation	6 - Activation
	Activation Confirmation	7 - Activation Confirmation
	Activation Termination	10 - Activation Termination
	Negative Confirmation	45 … 47 - Unknown

Table 84: General Interrogation - Conversion of causes of transmission

A General Interrogation (with QOI=20) can be generated also by the Function Block GI_OUT of a PLC program. All process data points will be transmitted to the NCC with COT=20.

10.2 Counter Interrogation Command

Process command to interrogate a binary counter

10.2.1 Supported data types

IEC 60870-5-101			RTU		
ASDU	**Type identification**	**Data type property**	**Data type**	**Parameter name**	**Parameter location**
C_IC_NA_1	<101>				

Table 85: Counter Interrogation Command - Supported data types

10.2.2 Values

0 … 5

10.2.3 Command Authority

None

10.2.4 Additional information

The link address must be same as used for system events.

The ASDU address must be same.

The information object address must be zero.

If link, ASDU or information object address does not match, the command is confirmed negative.

Only counter data of the local PDP is readable. The counter interrogation command for subordinated devices is not supported.

10.2.5 Conversion of quality descriptors

RTU		IEC 60870-5-101
Internal communication (short)	**Internal communication (long)**	**Communication**
RQT	No counter requested	0 - No counter requested
	request counter group 1	1 - request counter group 1
	request counter group 2	2 - request counter group 2
	request counter group 3	3 - request counter group 3
	request counter group 4	4 - request counter group 4
	general request counter	5 - general request counter
FRZ	No freeze or reset	0 - No freeze or reset
	counter freeze without reset	1 - counter freeze without reset
	counter freeze with reset	2 - counter freeze with reset
	counter reset	3 - counter reset

Table 86: Counter Interrogation Command - Conversion of quality descriptors

10.2.6 Conversion of causes of transmission

RTU		IEC 60870-5-101
Internal communication (short)	**Internal communication (long)**	**Communication**
T	Test	Ignored
P/N	Positive/negative confirmation	Relevant in monitor direction only
Cause	Activation	6 - Activation
	Activation Confirmation	7 - Activation Confirmation
	Activation Termination	10 - Activation Termination
	Negative Confirmation	45 … 47 - Unknown

Table 87: Counter Interrogation Command - Conversion of causes of transmission

10.3 Read Command

Process command to read a specific data point.

10.3.1 Supported data types

IEC 60870-5-101				RTU	
ASDU	**Type identification**	**Data type property**	**Data type**	**Parameter name**	**Parameter location**
C_RD_NA_1	<102>				

Table 88: Read Command - Supported data types

10.3.2 Values

None.

10.3.3 Command Authority

None

10.3.4 Additional information

The process data point with the link, ASDU and information object address of the C_RD_NA_1 command is read and send to NCC with cause of transmission requested.

The timestamp of the process data point is the actual time of the RTU.

10.3.5 Conversion of quality descriptors

RTU		IEC 60870-5-101
Internal communication (short)	**Internal communication (long)**	**Communication**
SE	Select / Execute	Only S/E = 0 (execute) supported

Table 89: Read Command - Conversion of quality descriptors

10.3.6 Conversion of causes of transmission

RTU		IEC 60870-5-101
Internal communication (short)	**Internal communication (long)**	**Communication**
T	Test	Ignored
P/N	Positive/negative confirmation	Relevant in monitor direction only
Cause	Request	5 - Request
	Negative Confirmation	45 … 47 - Unknown

Table 90: Read Command - Conversion of caused of transmission

10.4 Time Synchronization

The RTU500 series supports different methods of time synchronization. The time synchronization can be done via the communication line with the protocol IEC 60870-5-101.

The eight time masters have their own priority. If a higher prior master will fail, the time master with the lower priority will synchronize the RTU. If the higher prior time master is available again, he will continue synchronizing.

Parameter name	Default	Parameter location
Time administration	Not used	RTU Parameters
Primary device for time synchronization. This device is always allowed to synchronize the RTU if availble. If not, the next device is used.		

10.4.1 Supported Data Types

IEC 60870-5-101				RTU	
ASDU	**Type identification**	**Data type property**	**Data type**	**Parameter name**	**Parameter location**
C_CS_NA_1	<103>				

Table 91: Time Synchronization - Supported data types

10.4.2 Values

Complete time and date information in CP56Time2a format.

10.4.3 Command Authority

None

10.4.4 Additional information

Time Synchronization is configurable.

Parameter: Time interval of clock synchronization commands.

(siehe Tabelle Linienparameter - IEC 60870-5-101 in chapter " 3-1").

10.4.5 Conversion of Causes of Transmission

RTU		IEC 60870-5-101
Internal communication (short)	**Internal communication (long)**	**Communication**
T	Test	Ignored
P/N	Positive/negative confirmation	Relevant in monitor direction only
Cause	Activation	6 - Activation
	Activation Confirmation	7 - Activation Confirmation
	Spontaneous	3 - Spontaneous
	Negative Confirmation	45 … 47 - Unknown

Table 92: Time synchronization - Conversion of causes of transmission

10.5 Test Command

Process command to test a HCI of RTU500 series.

10.5.1 Supported data types

IEC 60870-5-101				RTU	
ASDU	Type identification	Data type property	Data type	Parameter name	Parameter location
C_TS_NA_1	<104>				

Table 93: Test Command - Supported data types

10.5.2 Values

0x55AA

10.5.3 Command Authority

None

10.5.4 Additional Information

None

10.5.5 Conversion of quality descriptors

RTU		IEC 60870-5-101
Internal communication (short)	Internal communication (long)	Communication
SE	Select / Execute	Only S/E = 0 (execute) supported

Table 94: Test Command - Conversion of quality descriptors

10.5.6 Conversion of causes of transmission

RTU		IEC 60870-5-101
Internal communication (short)	Internal communication (long)	Communication
T	Test	Ignored
P/N	Positive/negative confirmation	Relevant in monitor direction
Cause	Activation	6 - Activation
	Activation Confirmation	7 - Activation Confirmation
	Negative Confirmation	45 … 47 - Unknown

Table 95: Test Command - Conversion of causes of transmission

10.6 Reset Command

Process command to reset the RTU500 series RTU.

10.6.1 Supported data types

IEC 60870-5-101				RTU	
ASDU	Type identification	Data type property	Data type	Parameter name	Parameter location
C_RP_NA_1	<105>				

Table 96: Reset Command - Supported data types

10.6.2 Values

1

10.6.3 Command Authority

None

10.6.4 Additional information

The reset process command is not acknowledged.

The reset process command will be routed to a subdevice communication interface, if necessary.

10.6.5 Conversion of quality descriptors

RTU		IEC 60870-5-101
Internal communication (short)	Internal communication (long)	Communication
SE	Select / Execute	Only S/E = 0 (execute) supported

Table 97: Reset Command - Conversion of quality descriptors

10.6.6 Conversion of causes of transmission

RTU		IEC 60870-5-101
Internal communication (short)	Internal communication (long)	Communication
T	Test	Ignored
P/N	Not used	Not relevant
Cause	REMOTE_RESET	Not relevant

Table 98: Reset Command - Conversion of causes of transmission

10.7 Deactivate Command

Process command to deactivate the host communication interface of the RTU500 series.

10.7.1 Supported data types

IEC 60870-5-101			RTU		
ASDU	**Type identification**	**Data type property**	**Data type**	**Parameter name**	**Parameter location**
C_RP_NA_1	<105>				

Table 99: Deactivate Command - Supported data types

10.7.2 Values

128

10.7.3 Command Authority

None

10.7.4 Additional information

The Deactivate Command stops the transmission of periodic measurements, process commands are negative acknowledged (ACTCON neg).

Spontaneous informations (including Integrated Totals) are still sent.

10.7.5 Conversion of quality descriptors

RTU		IEC 60870-5-101
Internal communication (short)	**Internal communication (long)**	**Communication**
SE	Select / Execute	Only S/E = 0 (execute) supported

Table 100: Deactivate Command - Conversion of quality descriptors

10.7.6 Conversion of causes of transmission

RTU		IEC 60870-5-101
Internal communication (short)	**Internal communication (long)**	**Communication**
T	Test	Ignored
P/N	Not used	Not relevant
Cause	Activation	6 - Activation
	Activation Confirmation	7 - Activation Confirmation
	Negative Confirmation	45 … 47 - Unknown

Table 101: Deactivate Command - Conversion of causes of transmission

10.8 Delay Acquisition Command

10.8.1 Supported data types

IEC 60870-5-101			RTU		
ASDU	Type identification	Data type property	Data type	Parameter name	Parameter location
C_CD_NA_1	<106>				

Table 102: Delay Acquisition Command - Supported data types

10.8.2 Values

Two octet binary time CP16Time2a.

10.8.3 Command Authority

None

10.8.4 Additional Information

None

10.8.5 Conversion of quality descriptors

RTU		IEC 60870-5-101
Internal communication (short)	Internal communication (long)	Communication
SE	Select / Execute	Only S/E = 0 (execute) supported

Table 103: Delay Acquisition Command - Conversion of quality descriptors

10.8.6 Conversion of causes of transmission

RTU		IEC 60870-5-101
Internal communication (short)	Internal communication (long)	Communication
T	Test	Ignored
P/N	Not used	Used in monitoring direction only
Cause	Spontaneous	3 - Spontaneous
	Activation	6 - Activation
	Activation Confirmation	7 - Activation Confirmation
	Negative Confirmation	45 … 47 - Unknown

Table 104: Delay Acquisition Command - Conversion of causes of transmission

10.9 Parameter Loading

Parameter loading is used to change parameters of measured values, which are locally connected to the analog input boards of the RTU500 series. A routing to subordinated devices is not supported by RTU500 series.

Parameter loading is enabled per default. Deviating from standard in RTU500 the IOA used to carry information in control and monitor direction are the same for the parameter types.

Parameter name	Default	Parameter location
Parameter Loading	Enabled	Line T101/104
If enabled: Parameter loading requests are supported. If disabled: Parameter loading requests will be responded negative.		

To achieve full conformity with standard parameter loading can be disabled. If parameter loading is disabled request will be responded with negative activation confirmation.

10.9.1 Supported data types

IEC 60870-5-101			RTU		
ASDU	**Type identification**	**Data type property**	**Data type**	**Parameter name**	**Parameter location**
P_ME_NA_1	<110>	Parameter sent as a normalized value			
P_ME_NB_1	<111>	Parameter sent as a scaled value			
P_ME_NC_1	<112>	Parameter sent as a floating point value			

Table 105: Parameter Loading - Supported data types

10.9.2 Command Authority

None

10.9.3 Additional Information

None

10.9.4 Conversion of values for threshold

Range	RTU internal value	IEC 60870-5-101 value
Range min.	1 %	Normalized: 328 Scaled: 10 Floating point: 1.0
...	...	

Table 106: Parameter Loading - Conversion of values for threshold

Range	RTU internal value	IEC 60870-5-101 value
Range max.	+12 %	Normalized: 3 933 Scaled: 120 Floating point: 12.0

Table 106: Parameter Loading - Conversion of values for threshold

10.9.5 Conversion of values for smoothing

Range	RTU internal value	IEC 60870-5-101 value
Range min.	1	Normalized: not available Scaled: 1 Floating point: 1.0
...	...	
Range max.	128	Normalized: not available Scaled: 128 Floating point: 128.0

Table 107: Parameter Loading - Conversion of values for smoothing

The following values are processed: 1, 2, 4, 8, 16, 32, 64, 128

10.9.6 Conversion of qualifier of parameter of measured values

RTU		IEC 60870-5-101
Internal communication (short)	**Internal communication (long)**	**Communication**
QPM	Threshold Value	1 – Threshold value
	Smoothing factor	2 – Smoothing factor

Table 108: Parameter Loading - Conversion of qualifier of parameter of measured values

10.9.7 Conversion of causes of transmission

RTU		IEC 60870-5-101
Internal communication (short)	**Internal communication (long)**	**Communication**
P/N	Not used	Relevant in monitor direction only
Cause	Activation	6 - Activation
	Activation Confirmation	7 - Activation Confirmation
	Negative Confirmation	45 … 47 - Unknown

Table 109: Parameter Loading - Conversion of causes of transmission

10.10 System Events

The host interface manages internal status messages of the RTU500 series. These status messages can be created from the host itself or other activities of the RTU500 series. The system events of other activities are sent via internal communication and are processed by the HCI.

Parameter name	Default	Parameter location
Fix SEV address schema	enabled	SDI - line
Value range: enabled/ disabled if enabled: a base address for the whole block of system events is defined at the SDI node if disabled: individual addresses per SEV can be defined In order to avoid collisions, the addresses of the system events may not be used for other process objects.		
In use	enabled	SDI - line
Value range: enabled/ disabled if disabled: no SEVs will be transmitted on this line		

The following table shows the system events available for the host interface. System events send spontaneous as SPI with or without timestamp and contained in a general interrogation (without timestamp):

Description of system event	Address offset
At least one indication faulty	SEV#016
At least one analog value faulty	SEV#017
At least one digital value faulty	SEV#018
At least one integrated total faulty	SEV#019
At least one object or regulation command faulty	SEV#020
At least one analog output faulty	SEV#021
At least one digital output faulty	SEV#022
RTU is faulty	SEV#023
Device/ RTU active	SEV#024
RTU synchronized	SEV#025
External clock inoperable	SEV#026
Local printer offline	SEV#027
At least one indication oscillating	SEV#028
Battery voltage low (RTU560E only)	SEV#029
AC power supply failure (RTU560E only)	SEV#030
Test mode active	SEV#042
At least one data object simulated	SEV#043
At least one data communication equipment (DCE) faulty	SEV#044
Device connected	SEV#045
At least one PLC function not running	SEV#046
At least one PLC function cycle time exceeded	SEV#047
Device/ RTU inoperable	SEV#048
Device/ RTU is out of service	SEV#049
Power supply failure in RTU central sub-rack	SEV#059

Table 110: Description of system events

Description of system event	Address offset
Command supervision circuit x disconnected or faulty, 1 ≤ x ≤ 32	SEV#064 ... #095
SNTP client 1 is synchronized	SEV#096
SNTP client 2 is synchronized	SEV#097
Local control authority active	SEV#100
Host x Online, 1 ≤ x ≤ 16	SEV#101 ... #116
Host interface x: At least one change of information lost, 1 ≤ x ≤ 16	SEV#117 ... #132
Host interface x: At least one pulse counter lost, 1 ≤ x ≤ 16	SEV#133 ... #148
CMU x is inoperable, 1 ≤ x ≤ 16	SEV#149 … #164
Database identity tag	SEV#174
Device reachable on redundant line x, 1 ≤ x ≤ 4	SEV#180 … #183
Device active on redundant line x, 1 ≤ x ≤ 4	SEV#184 … #187
Device preferred on redundant line x, 1 ≤ x ≤ 4	#SEV188 … #191
Network element x is operable, 1 ≤ x ≤ 32	SEV#192 … #223
CMU x is active, 1 ≤ x ≤ 16	SEV#224 … #239
Process command collision with host x, 1 ≤ x ≤ 16	SEV#242 ... #257
Command collision with Integrated HMI	SEV#258
Command collision with web server	SEV#259
Command collision with PLC	SEV#260
HMI Client x online,1 ≤ x ≤ 16	SEV#261 ... #276
PRP interface x: Network interface E1 link on, 1 ≤ x ≤ 8	SEV#277 ... #284
PRP interface x: Network interface E2 link on, 1 ≤ x ≤ 8	SEV#285 ... #292
Host interface x: SOE buffer filling status is not reached, 1 ≤ x ≤ 16	SEV#293 ... #308
CAM Client x online, 1 ≤ x ≤ 4	SEV#309 ... #312
RTC battery voltage low[1]	SEV#313

Table 110: Description of system events

1 540CID01, 540CMD01 and 560CMR01/02

ADVICE

System event #174 "Database identity tag" is not sent spontaneous but send in a general interrogation with timestamp

10.11 System commands

System Single Commands (SSC) are accepted by the host communication interface with protocol IEC 60870-5-101. If the command is addressed to the RTU itself, the RTU performs the command. If the command is addressed to the connected subdevice, the SSC command is sent to the corresponding subinterface.

SSC supported	Description of SSC	Address offset
X	Set device out of service	#001
X	Reset device process	#002
X	Connect/disconnect device	#003
X	Set redundant line 1 / 2 as preferred line	#004, #005

Table 111: Description of system single commands (SSC)

SSC supported	Description of SSC	Address offset
	Set redundant line 3 / 4 as preferred line	#006, #007
X	Force global process image update, i.e. force process image update of all subdevices	#012
X	Request redundancy change over for the active CMU x, $1 \le x \le 16$	#016 ... #031

Table 111: Description of system single commands (SSC)

10.11.1 Reset device process

The SSC command performs a reset for the addressed device. If the command is addressed to the RTU itself, the RTU performs a restart. If the command is addressed to the connected subdevice, the SSC command is sent to the corresponding sub-device interface.

RTU internal value	Status
off	<Ignored>
on	reset device process

Table 112: Conversion of values SSC#002

10.11.2 Force process image update

If the SSC command is addressed to the RTU itself, SSC commands "force process image update" are delegated to all sub-device interfaces. If the SSC command is addressed to the connected sub-device, the command is routed to the corresponding sub-device interface.

RTU internal value	Status
off	<Ignored>
on	Force process image update

Table 113: Conversion of values SSC#012

10.11.3 Request redundancy change over

The SSC command performs a switchover to the CMU specified by the command. If the command is addressed to the RTU itself, the RTU forces a CMU reset when the CMU is active and the standby partner is ok. If the command is addressed to the connected subdevice, the SSC command is sent to the corresponding subinterface.

RTU internal value	Status
off	<Ignored>
on	Request redundancy change over

Table 114: Conversion of values SSC#016 ... #031

11 Interoperability List

The selected parameters are marked in the white boxes as follows:

☐ Function or ASDU is not used
[X] 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

11.1 System or device

(system-specific parameter)

☐ System definition
☐ Controlling station definition (master)
[X] Controlled station definition (slave)

11.2 Network configuration

(network-specific parameter)

[X] Point-to-point
[X] Multiple point-to-point
[X] Multipoint-party line
[X] Multipoint-star

11.3 Physical Layer

(network-specific parameter)

11.3.1 Transmission speed (control direction)

Unbalanced interchange
Circuit V.24/V.28
Standard

[X] 100bit/s
[X] 200bit/s
[X] 300bit/s
[X] 600bit/s
[X] 1 200bit/s

Unbalanced interchange
Circuit V.24/V.28
Recommended if >1 200 bit/s

[X] 2 400bit/s
[X] 4 800bit/s
[X] 9 600bit/s

Balanced interchange
Circuit X.24/X.27

[X] 2 400bit/s
[X] 4 800bit/s
[X] 9 600bit/s
[X] 19 200bit/s

- [X] 38 400bit/s
- [ ] 56 000bit/s
- [ ] 64 000bit/s

11.3.2 Transmission speed (monitor direction)

Unbalanced interchange
Circuit V.24/V.28
Standard

- [X] 100bit/s
- [X] 200bit/s
- [X] 300bit/s
- [X] 600bit/s
- [X] 1 200bit/s

Unbalanced interchange
Circuit V.24/V.28
Recommended if >1 200 bit/s

- [X] 2 400bit/s
- [X] 4 800bit/s
- [X] 9 600bit/s

Balanced interchange
Circuit X.24/X.27

- [X] 2 400bit/s
- [X] 4 800bit/s
- [X] 9 600bit/s
- [X] 19 200bit/s
- [X] 38 400bit/s
- [ ] 56 000bit/s
- [ ] 64 000bit/s

11.4 Link layer

(network-specific parameter)

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 transmission
- [X] Unbalanced transmission

Frame length

255	Maximum length L (control direction)
255	Maximum length L (monitor direction)
≤255	Time during which repetitions are permitted (Trp) or number of repetitions

Address field of the link

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

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
10, 12, 14, 34, 35, 36	<1>
1, 2, 3, 4, 5, 6, 7, 8, 15, 16, 17, 30, 31, 32, 33, 37, 38	<3>

11.5 Application Layer

11.5.1 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.

11.5.2 Common Address of ASDU

(system-specific parameter)

☒ One octet ☒ Two octets

11.5.3 Information object address

(system-specific parameter)

☒ One octet
☒ Two octets
☒ Three octets

☒ Structured
☒ Unstructured

11.5.4 Cause of transmission

(system-specific parameter)

☒ One octet

☒ Two octets
(with originator address = 0)

11.5.5 Selection of standard ASDUs

11.5.5.1 Process information in monitor direction

(station-specific parameter)

☒ <1> := Single-point information M_SP_NA_1
☒ <2> := Single-point information with time tag M_SP_TA_1
☒ <3> := Double-point information M_DP_NA_1
☒ <4> := Double-point information with time tag M_DP_TA_1
☒ <5> := Step position information M_ST_NA_1

X	<6>	:=	Step position information with time tag	M_ST_TA_1
X	<7>	:=	Bitstring of 32 bit	M_BO_NA_1
X	<8>	:=	Bitstring of 32 bit with time tag	M_BO_TA_1
X	<9>	:=	Measured value, normalized value	M_ME_NA_1
X	<10>	:=	Measured value, normalized value with time tag	M_ME_TA_1
X	<11>	:=	Measured value, scaled value	M_ME_NB_1
X	<12>	:=	Measured value, scaled value with time tag	M_ME_TB_1
X	<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
X	<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
	<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
	<20>	:=	Packed single-point information with status change detection	M_PS_NA_1
	<21>	:=	Measured value, normalized value without quality descriptor	M_ME_ND_1

X	<30>	:=	Single-point information with time tag CP56Time2a	M_SP_TB_1
X	<31>	:=	Double-point information with time tag CP56Time2a	M_DP_TB_1
X	<32>	:=	Step position information with time tag CP56Time2a	M_ST_TB_1
X	<33>	:=	Bitstring of 32 bit with time tag CP56Time2a	M_BO_TB_1
X	<34>	:=	Measured value, normalized value with time tag CP56Time2a	M_ME_TD_1
X	<35>	:=	Measured value, scaled value with time tag CP56Time2a	M_ME_TE_1
X	<36>	:=	Measured value, short floating point value with time tag CP56Time2a	M_ME_TF_1
X	<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
	<39>	:=	Packed start events of protection equipment with time tag CP56Time2a	M_EP_TE_1
	<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.

11.5.5.2 Process information in control direction

(station-specific parameter)

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

11.5.5.3 System information in monitor direction

(station-specific parameter)

[X] <70> := End of initialization M_EI_NA_1

11.5.5.4 System information in control direction

(station-specific parameter)

[X]	<100>	:=	Interrogation command	C_IC_NA_1
[X]	<101>	:=	Counter interrogation command	C_CI_NA_1
[X]	<102>	:=	Read command	C_RD_NA_1
[X]	<103>	:=	Clock synchronization command	C_CS_NA_1
[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
[X]	<107>	:=	Test command with time tag CP56Time2a	C_TS_TA_1

11.5.5.5 Parameter in control direction

(station-specific parameter)

[X[1]]	<110>	:=	Parameter of measured value, normalized value	P_ME_NA_1
[X[1]]	<111>	:=	Parameter of measured value, scaled value	P_ME_NB_1
[X[1]]	<112>	:=	Parameter of measured value, short floating point value	P_ME_NC_1
[ ]	<113>	:=	Parameter activation	P_AC_NA_1

1 Deviation from standard explained in chapter "Parameter Loading" more detailed

11.5.5.6 File transfer

(station-specific parameter)

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

11.5.5.7 Type identification and case of transmission assignments

(station-specific parameter)

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	X		X						(x)	(x)		X					
<2>	M_SP_TA_1			X		X						(x)	(x)							
<3>	M_DP_NA_1		X	X		X						(x)	(x)		X					
<4>	M_DP_TA_1			X		X						(x)	(x)							
<5>	M_ST_NA_1		X	X		X						(x)	(x)		X					
<6>	M_ST_TA_1			X		X						(x)	(x)							
<7>	M_BO_NA_1		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
<8>	M_BO_TA_1			X		X														
<9>	M_ME_NA_1	X	X	X		X									X					
<10>	M_ME_TA_1	X		X		X														
<11>	M_ME_NB_1	X	X	X		X									X					
<12>	M_ME_TB_1	X		X		X														
<13>	M_ME_NC_1	X	X	X		X									X					
<14>	M_ME_TC_1	X		X		X														
<15>	M_IT_NA_1			X		X										X				
<16>	M_IT_TA_1			X		X										X				
<17>	M_EP_TA_1			X																
<18>	M_EP_TB_1																			
<19>	M_EP_TC_1																			
<20>	M_PS_NA_1																			
<21>	M_ME_ND_1																			
<30>	M_SP_TB_1			X		X						(x)	(x)							
<31>	M_DP_TB_1			X		X						(x)	(x)							
<32>	M_ST_TB_1			X		X						(x)	(x)							
<33>	M_BO_TB_1			X		X														
<34>	M_ME_TD_1	X		X		X														
<35>	M_ME_TE_1	X		X		X														
<36>	M_ME_TF_1	X		X		X														
<37>	M_IT_TB_1			X		X										X				
<38>	M_EP_TD_1			X																
<39>	M_EP_TE_1																			
<40>	M_EP_TF_1																			
<45>	C_SC_NA_1						X	X	X	X	X							X	X	X
<46>	C_DC_NA_1						X	X	X	X	X							X	X	X
<47>	C_RC_NA_1						X	X	X	X	X							X	X	X
<48>	C_SE_NA_1						X	X	X	X	X							X	X	X
<49>	C_SE_NB_1						X	X	X	X	X							X	X	X
<50>	C_SE_NC_1						X	X	X	X	X							X	X	X
<51>	C_BO_NA_1						X	X			X							X	X	X
<70>	M_EI_NA_1				X															
<100>	C_IC_NA_1						X	X			X							X	X	X
<101>	C_CI_NA_1						X	X			X							X	X	X
<102>	C_RD_NA_1					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	X
<110>	P_ME_NA_1						X	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
<111>	P_ME_NB_1						X	X									X			
<112>	P_ME_NC_1						X	X										X	X	X
<113>	P_AC_NA_1																X			
<120>	F_FR_NA_1													X				X	X	X
<121>	F_SR_NA_1													X				X	X	X
<122>	F_SC_NA_1					X								X				X	X	X
<123>	F_LS_NA_1													X				X	X	X
<124>	F_AF_NA_1													X				X	X	X
<125>	F_SG_NA_1													X				X	X	X
<126>	F_DR_TA_1[1]			X		X														

1 Blank or X only.

(x) Functionality 'Local' or 'Remote' can be assigned by PLC.

11.6 Basic application functions

11.6.1 Station initialization

(station-specific parameter)

☒ Remote initialization

11.6.2 Cyclic data transmission

(station-specific parameter)

☒ Cyclic data transmission

11.6.3 Read procedure

(station-specific parameter)

☒ Read procedure

11.6.4 Spontaneous transmission

(station-specific parameter)

☒ Spontaneous transmission

11.6.5 Double transmission of information objects with cause of transmission spontaneous

(station-specific parameter)

The following type identifications will 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
☒ 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 number M_ME_NC_1, M_ME_TC_1 and M_ME_TF_1

11.6.6 Station interrogation

(station-specific parameter)

☒ global

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

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

11.6.7 Clock synchronization

(station-specific parameter)

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

11.6.8 Command transmission

(object-specific parameter)

☒ Direct command transmission
☒ Direct set point command transmission
☒ Select and execute command
☒ Select and execute set point command
☒ C_SE ACTTERM used (configurable)
☒ No additional definition
☐ Short-pulse duration (duration determined by a system parameter in the controlled station)
☐ Long-pulse duration (duration determined by a system parameter in the controlled station)
☒ Persistent output

11.6.9 Transmission of integrated totals

(station- or object-specific parameter)

- [x] Mode A: local freeze with spontaneous transmission
- [x] Mode B: local freeze with counter interrogation
- [x] Mode C: freeze and transmit by counter interrogation commands
- [x] Mode D: freeze by counter-interrogation command, frozen values reported spontaneously
- [x] Counter read
- [x] Counter freeze without reset
- [x] Counter freeze with reset

- [ ] Counter reset
- [x] General request counter
- [x] Request counter group 1
- [x] Request counter group 2
- [x] Request counter group 3
- [x] Request counter group 4

11.6.10 Parameter loading

(object-specific parameter)

- [x] Threshold value
- [x] Smoothing factor
- [ ] Low limit for transmission of measured value
- [ ] High limit for transmission of measured values value

11.6.11 Parameter activation

(object-specific parameter)

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

11.6.12 Test procedure

(station-specific parameter)

- [x] Test procedure

11.6.13 File transfer

(station-specific parameter)

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 analogue values

File transfer in control direction

- [x] Transparent file

11.6.14 Background scan

(station-specific parameter)

- [x] Background scan

11.6.15 Acquisition of transmission delay

(station-specific parameter)

[X] Acquisition of transmission delay

12 Glossary

AC	Alternating Current
AMI	Analog Measured value Input
ASDU	Application Service Data Unit
ASO	Analog Setpoint command Output
BSI	Bit String Input
BSO	Bit String Output
CAM	Central User Account Management
CMU	Communication and Data Processing Unit
CTS	Clear to Send
DCD	Data Carrier Detect
DCE	Data Communication Equipment
DCO	**D**ouble **C**ommand **O**utput
DMI	Digital Measured value Input (8, 16 bit)
DO	Digital Output
DPI	Double Point Input
DSO	Digital Setpoint command Output (8, 16 bit)
EPI	Event of Protection equipment Input (1 bit)
FC	Functional Constraint
FDR	File transfer directory
FSO	Floating Setpoint Command Output
FTR	File transfer file
GSM	Global Standard for Mobile Communications
HCI	Human Maschine Interface (here Integrated HMI function of the RTU500 series)
IED	Intelligent Electronic Device
IOA	Information Object Address
ITI	Integrated Totals Input
MAX	Maximum
MFI	Analog Measured value Floating Input
Min	Minimum
MS	Microsoft
NCC	Network Control Center

PDP	Process Data Processing
PIN	Personal Identity Number
PLC	Programmable Logic Control
PRP	Parallel Redundancy Protocol
RCD	RTU Configuration Data
RCO	Regulation step Command Output
RTC	Real Time Clock
RTS	Request to Send
RTU	Remote Terminal Unit
SCI	Sub-Device Communication Interface
SCO	Single Command Output
SEV	System Event
SNTP	Simple Network Time Protocol (according to RFC 4330)
SOE	Sequence-of-Event Queue
SPI	Single Point Input or Single point information
SSC	System Single Command
STI	Step position Input
UART	Universal Asynchronous Receiver-transmitter

Note:

The specifications, data, design or other information contained in this document (the “Brochure”) - together: the “Information” - shall only be for information purposes and shall in no respect be binding. The Brochure does not claim to be exhaustive. Technical data in the Information are only approximate figures. We reserve the right at any time to make technical changes or modify the contents of this document without prior notice. The user shall be solely responsible for the use of any application example or information described within this document. The described examples and solutions are examples only and do not represent any comprehensive or complete solution. The user shall determine at its sole discretion, or as the case may be, customize, program or add value to the ABB products including software by creating solutions for the end customer and to assess whether and to what extent the products are suitable and need to be adjusted or customized.

This product is designed to be connected to and to communicate information and data via a network interface. It is the users sole responsibility to provide and continuously ensure a secure connection between the product and users or end customers network or any other network (as the case may be). The user shall establish and maintain any appropriate measures (such as but not limited to the installation of firewalls, application of authentication measures, encryption of data, installation of anti-virus programs, etc) to protect the product, the network, its system and the interface against any kind of security breaches, unauthorized access, interference, intrusion, leakage and/or theft of data or information. ABB AG is not liable for any damages and/or losses related to such security breaches, any unauthorized access, interference, intrusion, leakage and/or theft of data or information.

ABB AG shall be under no warranty whatsoever whether express or implied and assumes no responsibility for the information contained in this document or for any errors that may appear in this document. ABB AG's liability under or in connection with this Brochure or the files included within the Brochure, irrespective of the legal ground towards any person or entity, to which the Brochure has been made available, in view of any damages including costs or losses shall be excluded. In particular ABB AG shall in no event be liable for any indirect, consequential or special damages, such as – but not limited to – loss of profit, loss of production, loss of revenue, loss of data, loss of use, loss of earnings, cost of capital or cost connected with an interruption of business or operation, third party claims. The exclusion of liability shall not apply in the case of intention or gross negligence. The present declaration shall be governed by and construed in accordance with the laws of Switzerland under exclusion of its conflict of laws rules and of the Vienna Convention on the International Sale of Goods (CISG).

Visit us

ABB AG
Power Grids
P.O. Box 10 03 51
68128 Mannheim, Germany

www.abb.com/remote-terminal-units

1KGT 150 466 V020 1

RTU500 series

RTU500 series Remote Terminal Unit
Protocol description
Subdevice Communication Interface with IEC 60870-5-101

Power and productivity
for a better world™

Revision

Document identity:		1KGT 150 473 V015 1
Revision:	Date:	Changes:
0	01/2001	Base version
1	04/2002	
2	12/2002	Chapter Dial up added Chapter File transfer updated Chapter Transparent data added
3	10/2003	Select before operate for RCO, ASO and DSO
4	02/2006	Chapter Dial up extended (FW ≥ Rel. 7 only) Chapter Redundant lines added (FW ≥ Rel. 7 only) Chapter System events updated (FW ≥ Rel. 7 only) Chapter System Commands added (FW ≥ Rel. 7 only)
5	02/2006	System Event #044 and 49 added
6	06/2006	Small error correction
7	07/2007	Chapter Listen mode added (FW ≥ Rel. 8.1 only)
8	08/2007	Update Line Parameter COT length 1 or 8 octets (Release ≥ 8.2.1) COT 44 .. 47 supported Interoperability list updated
9	06/2009	Line Parameter updated Chapter Physical Layer updated Test Command included Transparent Data Modbus protocol New ASDU: C_SE_NC_1
10	10/2009	Carrier TrailingTime added to Table 1 System Events added
11	03/2011	System Command #012 “Process image update”
12	02/2012	New Layout
13	09/2012	Threshold supervision for AMI and MFI added
14	05/2015	Support NT-Flag (PR#12254) More details on command qualifiers (PR#17056) ITI value range corrected (PR#22711) Correction: value ranges of dial-up parameters (PR#21617) Correction: qualifier of command for BSO (PR#23928) Update chapter system events and system commands New Layout
15	01/2017	Update: Table "conversion of values" for DPI in monitoring direction (PR#33212)

Contents

1 Introduction.......... 1-1
1.1 Preface.......... 1-1
1.2 References.......... 1-1
1.3 Conventions.......... 1-1

2 Physical Layer.......... 2-1

3 Link Layer.......... 3-1
3.1 General.......... 3-1
3.2 Unbalanced mode.......... 3-3
3.3 Balanced mode.......... 3-3
3.4 Dial-up function.......... 3-3
3.4.1 General.......... 3-3
3.4.2 Modem pool.......... 3-4
3.4.3 Dial-up configuration.......... 3-4
3.4.4 Configuration hints.......... 3-9
3.5 Redundant communication lines.......... 3-9
3.5.1 General.......... 3-9
3.5.2 Switch over handling.......... 3-10
3.5.3 Redundant communication lines with dial up.......... 3-10
3.6 Listen mode.......... 3-10

4 Application Layer.......... 4-1
4.1 General.......... 4-1
4.2 ASDU Type identification.......... 4-2
4.2.1 ASDU in monitoring direction.......... 4-2
4.2.2 ASDU in control direction.......... 4-3
4.2.3 ASDU of system information in command direction.......... 4-4
4.2.4 ASDU for file transfer.......... 4-4

5 Parameters and addressing.......... 5-1
5.1 Address elements.......... 5-1
5.1.1 Restrictions for the link address.......... 5-1
5.1.2 Restrictions for the Common Address.......... 5-1
5.1.3 Restrictions for the information object address.......... 5-1

6 Data types - monitoring direction.......... 6-1
6.1 SPI – Single Point Information.......... 6-1
6.1.1 Supported data types.......... 6-1
6.1.2 Additional information.......... 6-1
6.1.3 Conversion of values.......... 6-1
6.1.4 Conversion of quality descriptors.......... 6-2
6.1.5 Conversion of causes of transmission.......... 6-2
6.2 DPI – Double Point Information.......... 6-2

6.2.1 Supported data types ... 6-2
6.2.2 Additional information ... 6-3
6.2.3 Conversion of values ... 6-3
6.2.4 Conversion of quality descriptors ... 6-3
6.2.5 Conversion of causes of transmission ... 6-4
6.3 STI – Step Position Information ... 6-4
6.3.1 Supported data types ... 6-4
6.3.2 Additional information ... 6-4
6.3.3 Conversion of values ... 6-5
6.3.4 Conversion of quality descriptors ... 6-5
6.3.5 Conversion of causes of transmission ... 6-5
6.4 BSI – Bit String Information ... 6-5
6.4.1 Supported data types ... 6-6
6.4.2 Additional information ... 6-6
6.4.3 Conversion of values ... 6-6
6.4.4 Conversion of quality descriptors ... 6-6
6.4.5 Conversion of causes of transmission ... 6-7
6.5 ITI – Integrated Totals Information ... 6-7
6.5.1 Supported data types ... 6-7
6.5.2 Additional information ... 6-7
6.5.3 Conversion of values ... 6-8
6.5.4 Conversion of quality descriptors ... 6-8
6.5.5 Conversion of causes of transmission ... 6-8
6.6 DMI – Digital Measured Information ... 6-8
6.6.1 Supported data types ... 6-9
6.6.2 Additional information ... 6-9
6.6.3 Conversion of values ... 6-9
6.6.4 Conversion of quality descriptors ... 6-9
6.6.5 Conversion of causes of transmission ... 6-10
6.7 AMI – Analog Measured Information ... 6-10
6.7.1 Supported data types ... 6-10
6.7.2 Additional information ... 6-11
6.7.3 Conversion of values ... 6-11
6.7.4 Conversion of quality descriptors ... 6-12
6.7.5 Conversion of causes of transmission ... 6-12
6.8 MFI – Measured Float Information ... 6-12
6.8.1 Supported data types ... 6-13
6.8.2 Values ... 6-13
6.8.3 Additional information ... 6-13
6.8.4 Conversion of values ... 6-13
6.8.5 Conversion of quality descriptors ... 6-14
6.8.6 Conversion of causes of transmission ... 6-14

7 Data types - controlling direction ... 7-1

7.1 SCO – Single Command Output 7-1
7.1.1 Supported data types 7-1
7.1.2 Command authority 7-1
7.1.3 Additional information 7-1
7.1.4 Conversion of values 7-1
7.1.5 Conversion of qualifier of command 7-1
7.1.6 Conversion of causes of transmission 7-2
7.2 DCO – Double Command Output 7-2
7.2.1 Supported data types 7-2
7.2.2 Command authority 7-2
7.2.3 Additional information 7-2
7.2.4 Conversion of values 7-2
7.2.5 Conversion of qualifier of command 7-3
7.2.6 Conversion of causes of transmission 7-3
7.3 RCO – Regulation Command Output 7-3
7.3.1 Supported data types 7-3
7.3.2 Command authority 7-3
7.3.3 Additional information 7-3
7.3.4 Conversion of values 7-4
7.3.5 Conversion of qualifier of command 7-4
7.3.6 Conversion of causes of transmission 7-4
7.4 ASO – Analog Setpoint Output 7-4
7.4.1 Supported data types 7-5
7.4.2 Command authority 7-5
7.4.3 Additional information 7-5
7.4.4 Conversion of values 7-5
7.4.5 Conversion of qualifier of command 7-5
7.4.6 Conversion of causes of transmission 7-6
7.5 DSO – Digital Setpoint Output 7-6
7.5.1 Supported data types 7-6
7.5.2 Command authority 7-6
7.5.3 Additional information 7-6
7.5.4 Conversion of values 7-6
7.5.5 Conversion of qualifier of command 7-7
7.5.6 Conversion of causes of transmission 7-7
7.6 FSO – Floating Point Setpoint Output 7-7
7.6.1 Supported data types 7-7
7.6.2 Command authority 7-7
7.6.3 Additional information 7-8
7.6.4 Conversion of values 7-8
7.6.5 Conversion of qualifier of command 7-8
7.6.6 Conversion of causes of transmission 7-8
7.7 BSO – Bit String Output 7-8
7.7.1 Supported data types 7-9

7.7.2 Command authority ... 7-9
7.7.3 Additional information ... 7-9
7.7.4 Conversion of values ... 7-9
7.7.5 Conversion of qualifier of command ... 7-9
7.7.6 Conversion of causes of transmission ... 7-9

8 File transfer ... 8-1
8.1 Supported data types ... 8-1
8.2 Values ... 8-1
8.3 Command authority ... 8-1
8.4 Additional information ... 8-1
8.5 Conversion of causes of transmission ... 8-1
8.6 Download ... 8-2
8.7 Upload ... 8-2

9 Transparent data ... 9-1
9.1 Command direction ... 9-1
9.2 Monitoring direction ... 9-2
9.3 Request procedure ... 9-3
9.4 Encapsulated SPAbus messages ... 9-3
9.4.1 General ... 9-3
9.4.2 Request procedure ... 9-4

10 Internal functions ... 10-1
10.1 General Interrogation ... 10-1
10.1.1 Supported data types ... 10-1
10.1.2 Values ... 10-1
10.1.3 Command authority ... 10-1
10.1.4 Additional information ... 10-1
10.1.5 Conversion of quality descriptors ... 10-1
10.1.6 Conversion of causes of transmission ... 10-1
10.2 Read Command ... 10-2
10.2.1 Supported data types ... 10-2
10.2.2 Values ... 10-2
10.2.3 Command authority ... 10-2
10.2.4 Additional information ... 10-2
10.2.5 Conversion of quality descriptors ... 10-3
10.2.6 Conversion of causes of transmission ... 10-3
10.3 Time Synchronization ... 10-3
10.3.1 Supported data types ... 10-3
10.3.2 Values ... 10-3
10.3.3 Command authority ... 10-4
10.3.4 Additional information ... 10-4
10.3.5 Conversion of causes of transmission ... 10-4
10.4 Test Command ... 10-4

10.4.1 Supported data types 10-4
10.4.2 Values 10-4
10.4.3 Command authority 10-4
10.4.4 Additional information 10-4
10.4.5 Conversion of quality descriptors 10-5
10.4.6 Conversion of causes of transmission 10-5
10.5 Reset Command 10-5
10.5.1 Supported data types 10-5
10.5.2 Values 10-5
10.5.3 Command authority 10-5
10.5.4 Additional information 10-5
10.5.5 Conversion of quality descriptors 10-6
10.5.6 Conversion of causes of transmission 10-6
10.6 System events 10-6
10.6.1 Status change device OFFLINE to device ONLINE 10-7
10.6.2 Status change device ONLINE to device OFFLINE 10-7
10.7 System commands 10-8
10.7.1 Set device out of service 10-8
10.7.2 Reset device process 10-8
10.7.3 Connect/disconnect device 10-9
10.7.4 Set redundant line as preferred line 10-9
10.7.5 Force process image update 10-9
10.7.6 Request redundancy change over 10-9

11 Interoperability List 11-1
11.1 System or device 11-1
11.2 Network configuration 11-1
11.3 Physical Layer 11-1
11.3.1 Transmission speed (control direction) 11-1
11.3.2 Transmission speed (monitor direction) 11-2
11.4 Link layer 11-2
11.5 Application Layer 11-3
11.5.1 Transmission mode for application data 11-3
11.5.2 Common address of ASDU 11-3
11.5.3 Information object address 11-3
11.5.4 Cause of transmission 11-3
11.5.5 Selection of standard ASDUs 11-3
11.6 Basic application functions 11-7
11.6.1 Station initialization 11-7
11.6.2 Cyclic data transmission 11-7
11.6.3 Read procedure 11-7
11.6.4 Spontaneous transmission 11-7
11.6.5 Double transmission of information objects with cause of transmission spontaneous 11-8

11.6.6 Station interrogation..11-8
11.6.7 Clock synchronization... 11-8
11.6.8 Command transmission.. 11-8
11.6.9 Transmission of integrated totals.. 11-9
11.6.10 Parameter loading..11-9
11.6.11 Parameter activation... 11-9
11.6.12 Test procedure...11-9
11.6.13 File transfer... 11-9
11.6.14 Background scan...11-10
11.6.15 Acquisition of transmission delay.. 11-10

12 Glossary... 12-1

1 Introduction

1.1 Preface

This document describes the functions of the subdevice communication interface in RTU500 series according to IEC 60870-5-101.

RTU500 series fulfills the requirements of IEC 60870-5-101 Edition 2. Detailed information can be found in the interoperability list (see Chapter 11).

1.2 References

[1] Telecontrol equipment and systems
Part 5: Transmission protocols
Section 2: Link transmission procedures IEC 60870-5-2
First Edition, 1992-04

[2] Telecontrol equipment and systems
Part 5: Transmission protocols
Section 101: Companion standard for basic telecontrol tasks IEC 60870-5-101
Second Edition, 2003-02

[3] RTU500 series interfaces and protocols (1KGT 150 853)

[4] RTUtil500 users guide (1KGT 150 801)

1.3 Conventions

In this document function codes of data types according to IEC 60870-5-101 are marked with square brackets: <Function code>

Bold fonts with the table heading "Parameter name" are references to configuration parameters in RTUtil500. The parameter is followed by the parameter location where to find this parameter in RTUtil500. The first element of the parameter location defines the node in the hardware tree on the left side (e. g. RTU, CMU, line, IED) and the second element defines selected header control tab in the parameter window on the right side (e. g. general, interfaces, protocol).

Example:

	Parameter name	Default	Parameter location
In Use		Enabled	data point (e.g. SPI) - line T101/104
Value range: enabled / disabled If enabled: Object is processed by HCI.			

In this document references to elements of the standard and other references will be printed in brackets. Example: [2, 7.4]

The tables in the next chapters include lists of the functions, options and message types supported according to the protocol structure given in IEC 60870-5 (EPA three layer model) for

- the physical layer
- the link layer
- the application layer

This layered model is valid for the protocol IEC 60870-5-101.

2 Physical Layer

The protocol IEC 60870-5-101 is running on serial communication interfaces of the CMUs. For more details see RTU500 series interfaces and protocols (1KGT 150 939) [3].

Set the communication parameters according to the following table:

Parameter name	Default	Parameter location
Interface Type	RS232C	CMU - serial interfaces
value range: RS232C, RS485 or fix if selection is not supported		
COM Speed	9600 bits/sec	CMU - serial interfaces
value range: 50, 75, 100, 110, 150, 200, 300, 600, 1200, 1500, 2400, 4800, 9600, 19200, 38400 bits/sec; 50-600 bits/sec only on selected interfaces		
Modem control	direct link (TxD/ RxD only)	CMU - serial interfaces
Modem control: – Direct link (TxD/ RxD only) – WT link full duplex (no handshake) – WT link half duplex (RTS/ CTS handshake) – WT link half duplex (RTS/ DCD handshake) – Dial up (external modem DCD handshake) – Loop switch unit (RP570/71 Host interface only, DSTC 3002) – Link with collision avoidance (DCD handshake, DNP 3 only)		
Transmit delay time	disabled	CMU - serial interfaces
value range: disabled, 1... 10000 ms		

Parameter name	Default	Parameter location
Allow non-standard UART mode	disabled	CMU - serial interfaces
value range: – disabled – 1 stopbit, even parity – 1 stopbit, odd parity – 1 stopbit, no parity – 2 stopbit, no parity		

The possibility from [2, 5.1.1 and 8.2], to use different transmission speeds in control and in monitor direction is not supported by RTU500 series.

3 Link Layer

3.1 General

A link address model is used for all RTU500 series communication interfaces. The basic procedures for data transfer, protection against loss and duplication and flow control are described in [2, 5]. This link address is configurable in the line folder of RTUtil500 separately for every line. The link address must be configured only once.

Parameter name	Default	Parameter location
Linkaddress	1	RTU - Line T101
Link address of this process data point. The address may be unstructured or structured. Length 0, 1 or 2 octets (0 only balanced transmission)		

Communication primitives like framing of messages, parity checks or retransmissions are handled by the telecontrol protocol. These tasks are executed in the link layer that connects RTUs and control systems or other RTUs. The selectable parameters have to be calculated regarding the real communication technology. All parameters preset to the default values from [2, 9.5].

Parameter name	Default	Parameter location
Link address length/structureLink address length	8 bit unstructured	Line T101 - IEC 60870-5-101
value range: 0, 8 or 16 bit; Structured or unstructured (0 only in balanced mode) Structured address with underscore as delimiter. Example: 3_5_8 defines 16-bit address with 3 structure elements: 3 bit most significant, 5 bit medium significant, 8 bit least significantLength of Link Address: 0, 8 or 16 bit 0 in balanced mode only		

Table 1: Line parameters link layer IEC60870-5-101: address elements

Parameter name	Default	Parameter location
Maximum frame length	255	Line T101 - IEC 60870-5-101
Maximum frame length. Value range: 32 to 255 octets.		

Table 2: Line parameters link layer IEC60870-5-101: telegram framing

Parameter name	Default	Parameter location
Timeout acknowledgement	1 s	Line T101 - IEC 60870-5-101
Link Layer response/confirmation time out interval in seconds. Relevant at Master interface in balanced and unbalanced mode and at slave interface in balanced mode only. Value range: 0.1 to 600 sec.		
Cycle time test link	Enabled, 120 s	Line T101 - IEC 60870-5-101
Specification whether Test Link messages shall be sent If selected, Test Link message will be sent if within the specified time no Application message had been sent Relevant in balanced mode only Time period in seconds or '-' to disable.		
Gap supervision time	Enabled, 1 t0	Line T101 - IEC 60870-5-101
Specification whether the receiver shall perform a check for line idle intervals between the characters of a frame [IEC 60870-5-1, clause 6.2.4.2: Transmission rule R3 for format FT1.2]. Maximum allowed length of line idle intervals between two characters Specification: number of line idle bits or '-' to disable.		
Communication retry	Enabled, 7	Line T101 - IEC 60870-5-101
Specification whether transmission repetitions shall take place Relevant at slave interface in balanced mode only. Maximum number of transmission repetitions in case of consecutive transmission disturbances Value range: 1 to 255 or '-' to disable. Relevant at slave interface in balanced mode only.		

Table 3: Line parameters link layer IEC60870-5-101: timeouts

Parameter name	Default	Parameter location
Transmission mode	Unbalanced	Line T101 - IEC 60870-5-101
Balanced Mode: spontaneous transmission Unbalanced Mode: polling by primary station		
Single character for acknowledgements	Enabled	Line T101 - IEC 60870-5-101
Use Single Character 0xE5 as Link Layer Acknowledgement		
Direction bit of controlling station	0	Line T101 - IEC 60870-5-101
Specification of the direction bit DIR of the Link Layer Control Field to be used by the transmitter Value range: 0 or 1 Relevant in balanced mode only [IEC 60870-5-2, clause 6.1.2]		
Max. number of class 1 pollings	1	Line T101 - IEC 60870-5-101
Number of class 1 pollings. Value range: 1 to 255. Only relevant in unbalanced mode.		
Max. number of class 2 pollings	1	Line T101 - IEC 60870-5-101
Number of class 2 pollings. Value range: 1 to 255. Only relevant in unbalanced mode.		

Table 4: Line parameters link layer IEC60870-5-101: other parameters

3.2 Unbalanced mode

- the controlling station is primary station, controlled station (RTU) is secondary station
- the controlling station uses SEND/CONFIRM or SEND/NO REPLY services for transmission of messages to the RTU
- the controlling station uses REQUEST/RESPOND services for the polling procedure and during establishment of the link

3.3 Balanced mode

- Controlling station and controlled station (RTU) act simultaneously as primary and secondary stations.
- Both, controlling station and controlled station use SEND/CONFIRM services for message exchange, controlling station may also use the SEND/NO REPLY service.
- During link establishment both, controlling station and controlled station use the REQUEST/RESPOND service.

3.4 Dial-up function

3.4.1 General

In the dial-up mode a communication link can be established via HAYES-compatible modems between a RTU500 series RTU and subordinate devices.

After start-up of the RTU all devices connected to lines configured for dial up mode are called once. The first call will be made only when the RTU has been synchronized or when min. 5 minutes has passed since start-up. After all devices have been called once, the RTU changes to the cyclic dialing up mode.

If the RTU itself is not about to establish a telephone connection it receives telephone calls from subordinate devices, which have been configured on the respective communication line, and switches over to the data/protocol mode after the modem connection has been established properly. The RTU as dial up master has to end the connection to a subordinated device otherwise it cannot be differed between a communication link failure or a hang up of the subordinated device. As long as a subordinated device is connected and the protocol link is established the device is marked as connected.

When a telephone connection has been established, but communication according to the protocol does not take place the telephone connection will be terminated after elapse of the time defined with the interface parameter maximum time interval until connection is established.

When the attempt to establish the telephone connection has failed dial up will be repeated several times (interface parameter: Maximum number of dial-up attempts). If this value is exceeded the device will be marked as not operational and the qualifier invalid will be assigned to its data points. The device status is signaled by the system event messages of the device. Then this device will be interrogated in a configurable background cycle (interface parameter: time interval between two series on dial-up attempts).

When connection to a subordinate device is terminated properly the status of the device and of its data points will remain unchanged. Only if the connection is terminated abnormally, the device will be marked not operational and the qualifier invalid is assigned to its data points.

3.4.2 Modem pool

To improve the availability of subordinated devices connected via dial up connection RTU500 series can handle a pool of up to 4 modems per CMU depending on the CMU type. Connections to subordinated devices can be shared between the modems of a pool. Subordinated devices are not assigned to a specific modem but can be dialed up via every of the configured modems or can dial in to every modem of the modem pool. The responsibility for a modem connection can switch between the modems every time a subordinated device is connected.

Every modem of a pool is assigned to an interface of the RTU. The settings of the interfaces can be configured individually.

3.4.3 Dial-up configuration

In addition to the protocol-specific settings described in the chapters Physical Layer and Link Layer, some settings shall be made for the dial-up mode, too.

The dial-up mode is available only, if the parameter dial-up active on the serial communication interface (COM) of the CMU is enabled.

	Parameter name	Default	Parameter location
Modem Control: **Dial up (external modem DCD handshake)**			CMU - serial interfaces
Dial up active: enabled		disabled	CMU - serial interfaces
value range: enable/ disable			

All interface settings such as parity, baud rate, number of data bits, etc. depend on the protocol selected and are valid for both the configuration and the data mode.

The dial-up mode parameters are available in separate dialogue windows in the network and hardware Tree of the configuration tool RTUtil500.

Dial-up parameters at the the serial interfaces of the CMU

Parameter name	Default	Parameter location
Escape sequence preceding silent time	1 s	CMU - serial interfaces (dial up parameters)
Range: 1 … 255 s Minimal delay time between data mode and Hayes command mode		
Configuration string for modem	ATE0X3S0=1	CMU - serial interfaces (dial up parameters)
String Configuration string initializing the modem used. Note:The configuration string depends on the type of modem, the modem manufacturer and the modem function used.		
Dial string for modem	ATDT	CMU - serial interfaces (dial up parameters)
String Command Hayes to establish a modem connection		
Escape string for modem	+++	CMU - serial interfaces (dial up parameters)
String Command Hayes to switch from data mode to command mode		
Answer string for modem	Disable <no defaults>	CMU - serial interfaces (dial up parameters)
String Enable/Disable If enabled: An incoming call is answered with this string. Note: For standard HAYES modems the value S0=0 shall be set in the configuration string, if this feature is enabled (see modem description).		
Hang up string for modem	ATH	CMU - serial interfaces (dial up parameters)
String String requesting the modem to terminate the telephone connection.		
Connect string of modem	CONNECT	CMU - serial interfaces (dial up parameters)
String String sent by the modem if a telephone connection has been established.		
OK string of modem	OK	CMU - serial interfaces (dial up parameters)
String String sent by the modem to acknowledge a command		
Disconnect string of modem	NO CARRIER	CMU - serial interfaces (dial up parameters)
String String sent by the modem if the connection is aborted		
Ring string of modem	RING	CMU - serial interfaces (dial up parameters)
String String sent by the modem signaling an incoming call.		
Busy string of modem	BUSY	CMU - serial interfaces (dial up parameters)
String		

Parameter name	Default	Parameter location
With this string the modem signals that the remote terminal called is busy.		
PIN configuration string for GSM modem	Disable	CMU - serial interfaces (dial up parameters)
String Enable/Disable		
Service configuration string for GSM modem	Disable	CMU - serial interfaces (dial up parameters)
String Enable/Disable		

Dial-up parameters of the RTU

The configuration of the dial-up timeout parameters can be found only in the network tree at the RTU node (left window) and on the specific line (right window) at the tab dial up parameters.

Parameter name	Default	Parameter location
Maximum time till link is established	60 s	Network tree only: RTU - line
Value range: 1 ... 255 s Maximum time interval until the connection to a higher-level system must be established. When this time has elapsed the modem connection will be terminated.		
Maximum number of dial attempts	2	Network tree only: RTU - line
Value range: 1 ... 255 attempts Maximum number of times a telephone number is called. If the higher-level system supports a modem-pool function the next telephone number will then be called.		
Time between dial attempts	60 s	Network tree only: RTU - line
Value range: 1 ... 15 300 s When an attempt has failed the number will be called again after elapse of this time.		
Time between two series of dial attempts	7 800 s	Network tree only: RTU - line
Value range: 60 … 15 300 s Waiting time between dial series with different telephone numbers (modem pool)		
Inactivity hang up delay	15 s	Network tree only: RTU - line
Value range: disabled, 1 ... 15 300 s		
Inactivity hang up delay after commands	30 s	Network tree only: RTU - line
Value range: disabled, 1 ... 15 300 s		
Maximum period for one telephone connection	600 s	Network tree only: RTU - line
Value range: disabled, 10 ... 15 300 s		

For the modem pool configuration at the subdevice interface also up to 4 modems can be connected to the serial interface of the CMU. The telephone numbers of this modem pool can be found only in the network tree at the RTU node (left window) and on the specific line (right window) at the tab telephone numbers.

Parameter name	Default	Parameter location
Telephone number of this RTU: **Telephone number 1**	<no default>	Networktree only: RTU - line
Value range: String (length max. 27 characters) Telephone number under which this RTU may be called.		
Telephone number 2 ... 4	disabled	Networktree only: RTU - line
Value range: disabled, string (length max. 27 characters) Additional telephone numbers under which this RTU may be called. This numbers shall only be configured if for this communication interface also additional modems are connected and configured to the serial interfaces of the CMU.		

Dial-up parameters of the IED

The processing parameter for dial up by subordinate devices shall be configured for each subordinate device separately.

The dialog for the configuration of the telephone numbers of the IED can be found only in the network tree at the IED node (left window) and on the specific line (right window) at the tab telephone numbers.

Parameter name	Default	Parameter location
Telephone number of this IED: **Telephone number 1**	<no default>	Network tree only: IED - line
Value range: string (length max. 27 characters) Telephone number under which this IED may be called.		
Telephone number 2 ... 4	disabled	Network tree only: IED - line
Value range: disabled, string (length max. 27 characters) Additional telephone numbers under which this IED may be called.		

Under the tab "Anwahl" dial-up parameters it is possible to configure cyclic calls of the subdevice communication interface.

Parameter name	Default	Parameter location
cyclic call of the dial-up master	disabled	Network tree only: IED - line
Value range: disabled / enabled		
Start time of cyclic calls	06:00	Network tree only: IED - line
Value range: 0 .. 23 hours : 0 .. 59 minutes The cyclic calls are made relative to this absolute time of a day.		
Time interval between two calls	0 days, 6 hours, 0 minutes	Network tree only: IED - line
Value range: 0 .. 364 days, 0 .. 23 hours, 0 .. 59 minutes Within this time interval the subordinate device will be called. The time of call is related to the start time of cyclic calls.		

3.4.4 Configuration hints

Observe the following items when configuring a network with dial up mode:

- The dial up mode supports only unsymmetrical operation as transfer mode according to IEC 60870-5-101.
- The call-back function is not supported by the dial up mode functionality but may be implemented by means of special types of modems.
- When you are configuring the call times of all the subordinate devices on a line make sure that the call times do not overlap. Otherwise the call times cannot be kept.
- If the subordinate device is a RTU500 series RTU the transmission of system events should not be filtered for this line.

3.5 Redundant communication lines

3.5.1 General

The redundant line function of RTU500 series is used to raise connection availability to controlled stations. This function is only available for the protocol IEC 60870-5-101 in unbalanced mode and it is implemented according to the “Norwegian User Conventions”.

General function:

- Addressing have to be the same for all lines
- The switching between the lines is generally initiated by the RTU500 series.
- After a redundancy switching a general interrogation is sent from the RTU500 series
- During the switchover between redundant lines the subordinated device has to secure that no data point information get lost.
- After a disruption the connection have to establish again.
- Only one line is used for process communication.

The configuration of redundant lines is part of the engineering tool for the RTU500 series RTUtil500. Up to four lines of one CMU can be used for a redundant communication line, depending on the CMU type. The interfaces could be configured with different physical parameters.

Redundant communication lines can have different status for every subordinated device. Handling of status is done individually per subordinated device. A device can be reachable on a line. Reachable means that at least a link connection to a device is possible. The line used for process data communication is called the active line.

The priorities are derived from the interface used for a redundant communication line. Interface CP1 has highest priority followed by CP2, CPA and CPB. The line index used for signalization and controlling is increased by one according to the lines priority starting with one. The line with the highest priority is the preferred line used for process communication.

To signalize the reachability of a subordinated device system event Device reachable on redundant line x is used. An active line is signalized with Device active on redundant line x.

To control the behavior of redundant lines the preferred line can be modified using system single command Set redundant line x as preferred line. At system startup the modifications get lost and the system will start up with the initial preferred line.

3.5.2 Switch over handling

As already described one line is used for process communication. On all other redundant communication lines a cyclic check for reachability is done according to the Norwegian User Conventions.

At initial state the preferred line of a subordinated device gets active if the device is reachable. If the communication link on the active line gets lost, the RTU switches the process communication over to the reachable line with highest priority and this line is now the active one.

A switch over to another line will only be done if the subordinated device is no more reachable on the active line or the preferred line to the device gets reachable again.

3.5.3 Redundant communication lines with dial up

Redundant communication lines can be combined with dial up functionality as described in this document. If multiple lines are configured for dial up, they are handled as modem pool and have the same priority.

Switch over to a dial up line is first done, if no more direct connected line is reachable. If a direct connected line gets reachable again a switch over to the direct connected line is done.

The reachable status is set if a subordinated device is connected and at least a communication link check is possible. It will first be reset if a device can no more be reached with a dial up connection or the communication link check fails.

Link addresses of subordinated devices on non-dial-up lines must be unique within all devices. If dial up is used together with redundant lines, the link address of all subordinated devices is set to 1 on dial up lines disregarding the configured value. The common address of ASDU address must therefore be unique within all devices. This reduces the time of connection establishment in case of dial in of subordinated devices.

3.6 Listen mode

While replacing an existing RTU with a new one and a safety start up, the new one can run in listen mode parallel to the existing one. The old system operates the command and monitoring direction. The RTU with listen mode listens on the monitoring direction and evaluates the received messages.

If listen mode is configured, the subdevice communication interface IEC 60870-5-101 will send no requests to the serial interface. It will only process the telegrams received. The telegrams will be extracted, translated and the values will be sent to the internal communication of the RTU. Addressing, conversion of values, threshold supervision etc. are done as configured in RTUtil500. The data base of the RTU will be updated too. Process commands received from the internal communication of the RTU500 series are generally rejected and negative confirmed. The received process information could be displayed with the WEB server and will be forward to the host communication interfaces of the RTU. The transmission line should be disconnected from the RTU.

This functionality will be configured in RTUtil500 with the line parameter Listen mode. The operating mode cannot be changed during runtime.

4 Application Layer

4.1 General

The selectable parameters have to be calculated regarding the real communication technology. All parameters preset to the default values from [2, 9.5].

Parameter name	Default	Parameter location
Setpoint command with command acknowledgement	disabled	RTU - line T101/104
If enabled, all setpoint commands will be respond with activation termination.		
Test command cycle time	disabled	RTU - line T101/104
If enabled: The cycle time of the test command can be configured. Value range: 0 to 65535 or '-' to disable.		
Originator address	disabled	RTU - line T101/104
Originator address Value range 0 to 255.		

Table 5: RTU parameters application layer

Parameter name	Default	Parameter location
ASDU address structure (16bit)	8 bit unstructured	Line T101 - IEC 60870-5-101
Length of Address fixed to 16 bit! Structured address with underscore as delimiter Example: 3_5_8 defines 16-bit address with 3 structure elements: 3 bit most significant 5 bit medium significant 8 bit least significant		
Information object address structure (24bit)	16 bit unstructured	Line T101 - IEC 60870-5-101
Length of Information Object Address fixed to 24 bit! Structured address with underscore as delimiter Example: 3_5_6_3_7 defines 24-bit address with 5 structure elements		
Cause of transmission length	8 bit	Line T101 - IEC 60870-5-101
Selection: 8 or 16 bit If 16 bit is selected, the second octet (Originator Address) is set to 0 in send frames and is ignored in received frames		

Table 6: Line parameters application layer IEC 60870-5-101: address elements

Parameter name	Default	Parameter location
Protocol profile	Default	Line T101/104 - IEC 60870-5-101/104
Selection of IEC60870-5-104 protocol profile. Default value 'Default' equals the IEC standard. Other selections activate special IEC protocol profiles.		
Exclusive access to interfaces of redundant lines	Disabled	Line T101 - IEC 60870-5-101
If enabled, the serial interfaces of a redundant subdevice communication line will be accessed exclusive. That means as long as one interface is accessed all other interfaces of this redundant line are blocked.		
Routed diagnosis support	Enabled	Line T101/104 - IEC 60870-5-101/104
If enabled: Routed diagnosis is activated.		
Time interval of clock synchronization commands	Disabled	Line T101/104 - IEC 60870-5-101/104
Specification whether Time Synchronization of the secondary station shall take place. Time period in seconds, Value range: 60 to 65000 or'-' to disable. Approved value for SPA-Bus devices is 60 seconds.		
Listen mode	Disabled	Line T101 - IEC 60870-5-101
If enabled: System listens on the monitoring direction and evaluates the received messages. All received process commands are negative confirmed. Default value: disabled.		
Offline delay	Disabled	Line T101/104 - IEC 60870-5-101/104
If enabled, connection failures of subordinated devices will be suppressed for the configured time. If the connection is available again within this time, no signalisation is done. Default value is 'disabled'. Delay time: 0..600 sec or '-' to disable.		

Table 7: Line parameters application layer IEC 60870-5-101: other parameters

4.2 ASDU Type identification

Overview on type identifications for data elements of the application layer defined in [2].

The column "RTU data type" shows the type of data with must be configured in RTUtil500.

4.2.1 ASDU in monitoring direction

ASDU	Description	Type identification	RTU data type
M_SP_NA_1	Single-point information	<1>	SPI
M_SP_TA_1	Single-point information with time tag	<2>	SPI

Table 8: ASDU in monitoring direction

ASDU	Description	Type identification	RTU data type
M_SP_TB_1	Single-point information with time tag CP56Time2a	<30>	SPI
M_PS_NA_1	Packed single-point information with status change detection	<20>	SP
M_DP_NA_1	Double-Point information	<3>	DPI
M_DP_TA_1	Double-Point information with time tag	<4>	DPI
M_DP_TB_1	Double-Point information with time tag CP56Time2a	<31>	DPI
M_ST_NA_1	Step position information	<5>	STI
M_ST_TA_1	Step position information with time tag	<6>	STI
M_ST_TB_1	Step position information with time tag CP56Time2a	<32>	STI
M_BO_NA_1	Bitstring of 32 bit	<7>	BSI8/16/32
M_BO_TA_1	Bitstring of 32 bit with time tag	<8>	BSI8/16/32
M_BO_TB_1	Bitstring of 32 bit with time tag CP56Time2a	<33>	BSI8/16/32
M_ME_NA_1	Measured value, normalized value	<9>	AMI DMI8/16
M_ME_TA_1	Measured value, normalized value with time tag	<10>	AMI DMI8/16
M_ME_TD_1	Measured value, normalized value with time tag CP56Time2a	<34>	AMI DMI8/16
M_ME_NB_1	Measured value, scaled value	<11>	AMI
M_ME_TB_1	Measured value, scaled value with time tag	<12>	AMI
M_ME_TE_1	Measured value, scaled value with time tag CP56Time2a	<35>	AMI
M_ME_NC_1	Measured value, short floating point	<13>	MFI
M_ME_TC_1	Measured value, short floating point value with time tag	<14>	MFI
M_ME_TF_1	Measured value, short floating point value with time tag CP56Time2a	<36>	MFI
M_IT_NA_1	Integrated totals	<15>	ITI
M_IT_TA_1	Integrated totals with time tag	<16>	ITI
M_IT_TB_1	Integrated totals with time tag CP56Time2a	<37>	ITI

Table 8: ASDU in monitoring direction

4.2.2 ASDU in control direction

ASDU	Description	Type identification	RTU data type
C_SC_NA_1	Single command	<45>	SCO
C_DC_NA_1	Double command	<46>	DCO
C_RC_NA_1	Regulation step command	<47>	RCO
C_SE_NA_1	Set point command, normalized value	<48>	ASO DSO8/16
C_SE_NB_1	Set point command, scaled value	<49>	ASO DSO8/16
C_SE_NC_1	Set point command, short floating point	<50>	FSO
C_BO_NA_1	Bitstring of 32 bit	<51>	BSO1/2/8/16/32

Table 9: ASDU in control direction

4.2.3 ASDU of system information in command direction

ASDU	Description	Type identification
C_IC_NA_1	Interrogation Command	<100>
C_RD_NA_1	Read command	<102>
C_CS_NA_1	Clock synchronization command	<103>
C_TS_NA_1	Test command	<104>
C_RP_NA_1	Reset process command	<105>

Table 10: System information in command direction

4.2.4 ASDU for file transfer

ASDU	Description	Type identification
F_FR_NA_1	File ready	<120>
F_SR_NA_1	Section ready	<121>
F_SC_NA_1	Call directory, select file, …	<122>
F_LS_NA_1	Last section, last segment	<123>
F_AF_NA_1	Ack file, ack section	<124>
F_SG_NA_1	Segment	<125>
F_DR_TA_1	Directory	<126>

Table 11: ASDU for file transfer

5 Parameters and addressing

5.1 Address elements

Selection according to [2]. The sizes of the addressing fields can be configured as shown in the following table:

Parameter name	Default	Parameter location
Link address length/structure	8 bit unstructured	Line T101 - IEC 60870-5-101
value range: 0, 8 or 16 bit; Structured or unstructured (0 only in balanced mode) Structured address with underscore as delimiter. Example: 3_5_8 defines 16-bit address with 3 structure elements: 3 bit most significant, 5 bit medium significant, 8 bit least significant		
Parameter name	**Default**	**Parameter location**
ASDU address length/structure	8 bit unstructured	Line T101 - IEC 60870-5-101
Value range: 8 or 16 bit; structured or unstructured Structured address with underscore as delimiter. Example: 3_5_8 defines 16-bit address with 3 structure elements: 3 bit most significant, 5 bit medium significant, 8 bit least significant		
Information object address length/structure	16 bit unstructured	Line T101 - IEC 60870-5-101
Value range: 8, 16 or 24 bit; structured or unstructured Structured address with underscore as delimiter. Example: 3_5_6_3_7 defines 24-bit address with 5 structure elements		
Cause of transmission length	8 bit	Line T101 - IEC 60870-5-101
Value range: 8 or 16 bit If 16 bit is selected, the second octet (originator address) is set to 0 within send frames and is ignored in received frames.		

Table 12: Address elements

5.1.1 Restrictions for the link address

The value 0 is only allowed in balanced mode.

5.1.2 Restrictions for the Common Address

The value 0 is not allowed.

The highest possible address value (255 for 1 octet common address length and 65 535 for 2 octet common address length) is reserved for broadcast calls in control direction and therefore must not be used as station address.

5.1.3 Restrictions for the information object address

All addresses must be unique within one station. The type of presentation (ASDU format) is not part of the identification of an object.

The value 0 is not allowed.

6 Data types - monitoring direction

6.1 SPI – Single Point Information

Binary process information is indicated by one bit.

6.1.1 Supported data types

IEC 60870-5-101			RTU		
ASDU	**Type identification**	**Data type property**	**Data type**	**Parameter name**	**Parameter location**
M_SP_NA_1	<1>	without timestamp			
M_SP_TA_1	<2>	with timestamp CP24Time2a			
M_SP_TB_1	<30>	with timestamp CP56Time2a			
M_PS_NA_1	<20>	packed	SPI	Position	SPI - line T101

Table 13: SPI - Supported data types

6.1.2 Additional information

Readable by a read command (see Chapter 10.2, "Read Command").

Parameter name	Default	Parameter location
Read command status	no	data point (e.g. SPI) - line (Sub parameter)
value range: no, cyclic time, absolute time no: no read command enabled; cyclic time: cyclic read command enabled; absolute time: read command at abosute point of time once a day enabled		

Parameter name	Default	Parameter location
Position	1 (only valid for packed events M_PS)	SPI - line (Address)
value range: 1...16 Bitposition within packed event M_PS		

6.1.3 Conversion of values

RTU internal value	IEC 60870-5-101
off	0
on	1

Table 14: SPI - Conversion of values

6.1.4 Conversion of quality descriptors

RTU		IEC 60870-5-101
Internal communication (short)	Internal communication (long)	Communication
BL	Blocked	Blocked
SB	Substituted	Substituted
NT	Not Topical	Not Topical
IV	Invalid	Invalid

Table 15: SPI - Conversion of quality descriptors

6.1.5 Conversion of causes of transmission

RTU		IEC 60870-5-101
Internal communication (short)	Internal communication (long)	Communication
T	Test	Test
P/N	Positive/negative confirmation	- Irrelevant -
Cause	Spontaneous	3 - spontaneous
	spontaneous (in case of a value change)	2 - background scan
	spontaneous (in case of a value change)	5 - requested
	return information caused by a remote command	11 - return information caused by a re-mote command
	return information caused by a local command	12 - return information caused by a local command
	spontaneous (in case of a value change)	20, 21 ... 36 - interrogated

Table 16: SPI - Conversion of causes of transmission

6.2 DPI – Double Point Information

Binary process information is indicated by two bits.

6.2.1 Supported data types

IEC 60870-5-101			RTU		
ASDU	Type iden-tification	Data type property	Data type	Parameter name	Parameter location
M_DP_NA_1	<3>	without timestamp			
M_DP_TA_1	<4>	with timestamp CP24Time2a			

Table 17: DPI - Supported data types

IEC 60870-5-101			RTU		
ASDU	Type identification	Data type property	Data type	Parameter name	Parameter location
M_DP_TB_1	<31>	with timestamp CP56Time2a			

Table 17: DPI - Supported data types

6.2.2 Additional information

Readable by a read command (see Chapter 10.2, "Read Command").

Parameter name	Default	Parameter location
Read command status	no	data point (e.g. SPI) - line (Sub parameter)
value range: no, cyclic time, absolute time no: no read command enabled; cyclic time: cyclic read command enabled; absolute time: read command at abosute point of time once a day enabled		

6.2.3 Conversion of values

RTU internal value	IEC 60870-5-101
intermediate	11
off	01
on	10
indeterminate	00

Table 18: DPI – Conversion of values

6.2.4 Conversion of quality descriptors

RTU		IEC 60870-5-101
Internal communication (short)	Internal communication (long)	Communication
BL	Blocked	Blocked
SB	Substituted	Substituted
NT	Not Topical	Not Topical
IV	Invalid	Invalid

Table 19: DPI - Conversion of quality descriptors

6.2.5 Conversion of causes of transmission

RTU		IEC 60870-5-101
Internal communication (short)	**Internal communication (long)**	**Communication**
T	Test	Test
P/N	Positive/negative confirmation	- Irrelevant -
Cause	Spontaneous	3 - spontaneous
	spontaneous (in case of a value change)	2 - background scan
	spontaneous (in case of a value change)	5 - requested
	return information caused by a remote command	11 - return information caused by a re-mote command
	return information caused by a local command	12 - return information caused by a local command
	spontaneous (in case of a value change)	20, 21 ... 36 - interrogated

Table 20: DPI - Conversion of causes of transmission

6.3 STI – Step Position Information

Binary process information is indicated by 8 bits.

6.3.1 Supported data types

IEC 60870-5-101			RTU		
ASDU	**Type identification**	**Data type property**	**Data type**	**Parameter name**	**Parameter location**
M_ST_NA_1	<5>	without timestamp			
M_ST_TA_1	<6>	with timestamp CP24Time2a			
M_ST_TB_1	<32>	with timestamp CP56Time2a			

Table 21: STI - Supported data types

6.3.2 Additional information

Readable by a read command (see Chapter 10.2, "Read Command").

Parameter name	Default	Parameter location
Read command status	no	data point (e.g. SPI) - line (Sub parameter)
value range: no, cyclic time, absolute time no: no read command enabled; cyclic time: cyclic read command enabled; absolute time: read command at abosute point of time once a day enabled		

6.3.3 Conversion of values

Range	RTU internal value	IEC 60870-5-101
Range min.	-63	-63
...	...	
Range max.	+63	+63

Table 22: STI - Conversion of values

6.3.4 Conversion of quality descriptors

RTU		IEC 60870-5-101
Internal communication (short)	Internal communication (long)	Communication
OV	Overflow	Overflow
BL	Blocked	Blocked
SB	Substituted	Substituted
NT	Not Topical	Not Topical
IV	Invalid	Invalid
T	Transient Bit	Transient Bit

Table 23: STI - Conversion of quality descriptors

6.3.5 Conversion of causes of transmission

RTU		IEC 60870-5-101
Internal communication (short)	Internal communication (long)	Communication
T	Test	Test
P/N	Positive/negative confirmation	- Irrelevant -
Cause	Spontaneous	3 - spontaneous
	spontaneous (in case of a value change)	2 - background scan
	spontaneous (in case of a value change)	5 - requested
	return information caused by a remote command	11 - return information caused by a re-mote command
	return information caused by a local command	12 - return information caused by a local command
	spontaneous (in case of a value change)	20, 21 ... 36 - interrogated

Table 24: STI - Conversion of causes of transmission

6.4 BSI – Bit String Information

Binary process information is indicated by 8, 16 or 32 bit.

6.4.1 Supported data types

IEC 60870-5-101			RTU		
ASDU	**Type identification**	**Data type property**	**Data type**	**Parameter name**	**Parameter location**
M_BO_NA_1	<7>	without timestamp			
M_BO_TA_1	<8>	with timestamp CP24Time2a			
M_BO_TB_1	<33>	with timestamp CP56Time2a			

Table 25: BSI - Supported data types

6.4.2 Additional information

Readable by a read command (see Chapter 10.2, "Read Command").

	Parameter name	Default	Parameter location
Read command status		no	data point (e.g. SPI) - line (Sub parameter)
value range: no, cyclic time, absolute time no: no read command enabled; cyclic time: cyclic read command enabled; absolute time: read command at abosute point of time once a day enabled			

6.4.3 Conversion of values

Range	RTU internal value	IEC 60870-5-101
Range min.	0	0
...	...	
Range max.	BSI8: Bit mask of 8 bit; range ... 255	255
	BSI16: Bit mask of 16 bit; range ... 65 535	65 535
	BSI32: Bit mask of 32 bit; range ... 4 294 967 295	4 294 967 295

Table 26: BSI - Conversion of values

6.4.4 Conversion of quality descriptors

RTU		IEC 60870-5-101
Internal communication (short)	**Internal communication (long)**	**Communication**
OV	Overflow	Overflow
BL	Blocked	Blocked
SB	Substituted	Substituted

Table 27: BSI - Conversion of quality descriptors

RTU		IEC 60870-5-101
Internal communication (short)	Internal communication (long)	Communication
NT	Not Topical	Not Topical
IV	Invalid	Invalid

Table 27: BSI - Conversion of quality descriptors

6.4.5 Conversion of causes of transmission

RTU		IEC 60870-5-101
Internal communication (short)	Internal communication (long)	Communication
T	Test	Test
P/N	Positive/negative confirmation	- Irrelevant -
Cause	Spontaneous	3 - spontaneous
	spontaneous (in case of a value change)	2 - background scan
	spontaneous (in case of a value change)	5 - requested
	spontaneous (in case of a value change)	20, 21 ... 36 - interrogated

Table 28: BSI - Conversion of causes of transmission

6.5 ITI – Integrated Totals Information

Binary process information is indicated by 32 bits as a count value.

6.5.1 Supported data types

IEC 60870-5-101			RTU		
ASDU	Type identification	Data type property	Data type	Parameter name	Parameter location
M_IT_NA_1	<15>	without timestamp			
M_IT_TA_1	<16>	with timestamp CP24Time2a			
M_IT_TB_1	<37>	with timestamp CP56Time2a			

Table 29: ITI - Supported data types

6.5.2 Additional information

Readable by a read command (see Chapter 10.2, "Read Command").

	Parameter name	Default	Parameter location
	Read command status	no	data point (e.g. SPI) - line (Sub parameter)
	value range: no, cyclic time, absolute time no: no read command enabled; cyclic time: cyclic read command enabled; absolute time: read command at abosute point of time once a day enabled		

6.5.3 Conversion of values

Range	RTU internal value	IEC 60870-5-101
Range min.	- 2 147 483 648	- 2 147 483 648
...	...	
Range max.	2 147 483 647	2 147 483 647

Table 30: ITI - Conversion of values

6.5.4 Conversion of quality descriptors

RTU		IEC 60870-5-101
Internal communication (short)	**Internal communication (long)**	**Communication**
SEQ	Sequence number	Sequence number
CY	Carry	Carry
CA	Adjusted	Adjusted
IV	Invalid	Invalid

Table 31: ITI - Conversion of quality descriptors

6.5.5 Conversion of causes of transmission

RTU		IEC 60870-5-101
Internal communication (short)	**Internal communication (long)**	**Communication**
T	Test	Test
P/N	Positive/negative confirmation	- Irrelevant -
Cause	Spontaneous	3 - spontaneous
	spontaneous (in case of a value change)	5 - requested
	Interrogated	37, 38 … 41 - interrogated

Table 32: ITI - Conversion of causes of transmission

6.6 DMI – Digital Measured Information

Binary process information indicated by 8 or 16 bit is used as a measured value from digital inputs in normalized format.

6.6.1 Supported data types

IEC 60870-5-101			RTU		
ASDU	Type identification	Data type property	Data type	Parameter name	Parameter location
M_ME_NA_1	<9>	without timestamp			
M_ME_TA_1	<10>	with timestamp CP24Time2a			
M_ME_TD_1	<34>	with timestamp CP56Time2a			

Table 33: DMI - Supported data types

6.6.2 Additional information

Readable by a read command (see Chapter 10.2, "Read Command").

Parameter name	Default	Parameter location
Read command status	no	data point (e.g. SPI) - line (Sub parameter)
value range: no, cyclic time, absolute time no: no read command enabled; cyclic time: cyclic read command enabled; absolute time: read command at abosute point of time once a day enabled		

6.6.3 Conversion of values

Range	RTU internal value	IEC 60870-5-101
Range min.	-100 %	-1
...	...	
Range max.	+100 %	$+1-2e_{-15}$

Table 34: DMI - Conversion of values

6.6.4 Conversion of quality descriptors

RTU		IEC 60870-5-101
Internal communication (short)	Internal communication (long)	Communication
OV	Overflow	Overflow
BL	Blocked	Blocked
SB	Substituted	Substituted
NT	Not Topical	Not Topical
IV	Invalid	Invalid

Table 35: DMI - Conversion of quality descriptors

6.6.5 Conversion of causes of transmission

RTU		IEC 60870-5-101
Internal communication (short)	**Internal communication (long)**	**Communication**
T	Test	Test
P/N	Positive/negative confirmation	- Irrelevant -
Cause	Spontaneous	3 - spontaneous
	spontaneous (in case of a value change)	1 - periodic / cyclic
	spontaneous (in case of a value change)	2 - background scan
	spontaneous (in case of a value change)	5 - requested
	spontaneous (in case of a value change)	20, 21 ... 36 - interrogated

Table 36: DMI - Conversion of causes of transmission

6.7 AMI – Analog Measured Information

Analog process information indicated by 16 bit used as a measured value from analog inputs in normalized or scaled format.

6.7.1 Supported data types

IEC 60870-5-101			RTU		
ASDU	**Type identification**	**Data type property**	**Data type**	**Parameter name**	**Parameter location**
M_ME_NA_1	<9>	normalized without timestamp	AMI	Transmission format: normalized	AMI - line T101/104
M_ME_TA_1	<10>	normalized with timestamp CP24Time2a	AMI	Transmission format: normalized	AMI - line T101/104
M_ME_NB_1	<11>	scaled without timestamp	AMI	Transmission format: scaled	AMI - line T101/104
M_ME_TB_1	<12>	scaled with timestamp CP24Time2a	AMI	Transmission format: scaled	AMI - line T101/104
M_ME_TD_1	<34>	normalized with timestamp CP56Time2a	AMI	Transmission format: normalized	AMI - line T101/104
M_ME_TE_1	<35>	scaled with timestamp CP56Time2a	AMI	Transmission format: scaled	AMI - line T101/104

Table 37: AMI - Supported data types

6.7.2 Additional information

Parameter name	Default	Parameter location
Transmission format	normalized	protocol and address parameters
value range: normalized / scaled normalized: value representation -100% (-1) to +100 % (+1); scaled: value representation: -32,767 to +32,768		
Maximum value	max. range	protocol and address parameters
Maximum value in the external protocol is converted to +100% on RTU internal communication (IC).		
Minimum value	max. range	protocol and address parameters
Minimum value in the external protocol is converted to -100% on RTU internal communication (IC).		

Parameter name	Default	Parameter location
Threshold supervision	disabled	data point - line (Sub parameter)
value range: enabled / disabled enabled: the object is supervised by the threshold supervision; disabled: every received value is transmitted.		
Type	disabled	data point - line (Sub parameter)
value range: absolute / integrated		
Threshold	5 %	data point - line (Sub parameter)
value range: 0… 100 % Dead-band value for threshold supervision.		

Readable by a read command (see Chapter 10.2, "Read Command").

Parameter name	Default	Parameter location
Read command status	no	data point (e.g. SPI) - line (Sub parameter)
value range: no, cyclic time, absolute time no: no read command enabled; cyclic time: cyclic read command enabled; absolute time: read command at abosute point of time once a day enabled		

6.7.3 Conversion of values

Parameter name	Default	Parameter location
Maximum value	1 (normalized) 32767 (scaled)	data point - line T101/104
Maximum raw value in the telegram, to be converted to 100% internal representation.		
Minimum value	-1 (normalized -32768 (scaled)	data point - line T101/104
Minimum value in the telegram, to be converted to -100% (internal communication)		

Range	RTU internal value	IEC 60870-5-101
Range min.	-100 %	Minimum value
...	...	
Range max.	+100 %	Maximum value

Table 38: AMI - Conversion of values

6.7.4 Conversion of quality descriptors

RTU		IEC 60870-5-101
Internal communication (short)	**Internal communication (long)**	**Communication**
OV	Overflow	Overflow
BL	Blocked	Blocked
SB	Substituted	Substituted
NT	Not Topical	Not Topical
IV	Invalid	Invalid

Table 39: AMI - Conversion of quality descriptors

6.7.5 Conversion of causes of transmission

RTU		IEC 60870-5-101
Internal communication (short)	**Internal communication (long)**	**Communication**
T	Test	Test
P/N	Positive/negative confirmation	- Irrelevant -
Cause	Spontaneous	3 - spontaneous
	spontaneous (in case of a value change)	1 - periodic / cyclic
	spontaneous (in case of a value change)	2 - background scan
	spontaneous (in case of a value change)	5 - requested
	spontaneous (in case of a value change)	20, 21 ... 36 - interrogated

Table 40: AMI - Conversion of causes of transmission

6.8 MFI – Measured Float Information

32 bit analog process information is used as a measured value in float format.

6.8.1 Supported data types

IEC 60870-5-101			RTU		
ASDU	Type identification	Data type property	Data type	Parameter name	Parameter location
M_ME_NC_1	<13>	without timestamp			
M_ME_TC_1	<14>	with timestamp CP24Time2a			
M_ME_TF_1	<36>	with timestamp CP56Time2a			

Table 41: MFI - Supported data types

6.8.2 Values

R32–IEEE STD 754

6.8.3 Additional information

Parameter name	Default	Parameter location
Threshold supervision	disabled	data point - line (Sub parameter)
value range: enabled / disabled enabled: the object is supervised by the threshold supervision; disabled: every received value is transmitted.		
Type	disabled	data point - line (Sub parameter)
value range: absolute / integrated		
Threshold	5 %	data point - line (Sub parameter)
value range: 0… 100 % Dead-band value for threshold supervision.		

Readable by a read command (see Chapter 10.2, "Read Command").

Parameter name	Default	Parameter location
Read command status	no	data point (e.g. SPI) - line (Sub parameter)
value range: no, cyclic time, absolute time no: no read command enabled; cyclic time: cyclic read command enabled; absolute time: read command at abosute point of time once a day enabled		

6.8.4 Conversion of values

Range	RTU internal value	IEC 60870-5-101
Range min.	-3.4 x 10e38	-3.4 x 10e38
...	...	

Table 42: MFI - Conversion of values

Range	RTU internal value	IEC 60870-5-101
Range max.	+3.4 x 10e38	+3.4 x 10e38

Table 42: MFI - Conversion of values

6.8.5 Conversion of quality descriptors

RTU		IEC 60870-5-101
Internal communication (short)	**Internal communication (long)**	**Communication**
OV	Overflow	Overflow
BL	Blocked	Blocked
SB	Substituted	Substituted
NT	Not Topical	Not Topical
IV	Invalid	Invalid

Table 43: MFI - Conversion of quality descriptors

6.8.6 Conversion of causes of transmission

RTU		IEC 60870-5-101
Internal communication (short)	**Internal communication (long)**	**Communication**
T	Test	Test
P/N	Positive/negative confirmation	- Irrelevant -
Cause	Spontaneous	3 - spontaneous
	spontaneous (in case of a value change)	1 - periodic / cyclic
	spontaneous (in case of a value change)	2 - background scan
	spontaneous (in case of a value change)	5 - requested
	spontaneous (in case of a value change)	20, 21 ... 36 - interrogated

Table 44: MFI - Conversion of causes of transmission

7 Data types - controlling direction

7.1 SCO – Single Command Output

Binary process command (one bit)

7.1.1 Supported data types

IEC 60870-5-101			RTU		
ASDU	Type identification	Data type property	Data type	Parameter name	Parameter location
C_SC_NA_1	<45>	without timestamp			

Table 45: SCO - Supported data types

7.1.2 Command authority

None

7.1.3 Additional information

None

7.1.4 Conversion of values

RTU internal value	IEC 60870-5-101
off	0
on	1

Table 46: SCO - Conversion of values

7.1.5 Conversion of qualifier of command

RTU		IEC 60870-5-101
Internal communication (short)	Internal communication (long)	Communication
SE	Select / Execute	Select / Execute (1 select, 0 execute)
QU	default	0 - no additional definition

Table 47: SCO - conversion of qualifier of command

7.1.6 Conversion of causes of transmission

RTU		IEC 60870-5-101
Internal communication (short)	**Internal communication (long)**	**Communication**
T	Test	Ignored
P/N	Positive/negative confirmation	Relevant in monitor direction only
Cause	Activation	6 - Activation
	Activation Confirmation	7 - Activation Confirmation
	Deactivation	8 - Deactivation
	Deactivation Confirmation	9 - Deactivation Confirmation
	Activation Termination	10 - Activation Termination
	Negative Confirmation	45 … 47 - Unknown

Table 48: SCO - Conversion of causes of transmission

7.2 DCO – Double Command Output

Binary process command (two bits)

7.2.1 Supported data types

IEC 60870-5-101			RTU		
ASDU	**Type identification**	**Data type property**	**Data type**	**Parameter name**	**Parameter location**
C_DC_NA_1	<46>	without timestamp			

Table 49: DCO - Supported data types

7.2.2 Command authority

None

7.2.3 Additional information

None

7.2.4 Conversion of values

RTU internal value	IEC 60870-5-101
off	01
on	10

Table 50: DCO - Conversion of values

7.2.5 Conversion of qualifier of command

RTU		IEC 60870-5-101
Internal communication (short)	**Internal communication (long)**	**Communication**
SE	Select / Execute	Select / Execute (1 select, 0 execute)
QU	default	0 - no additional definition

Table 51: DCO - conversion of qualifier of command

7.2.6 Conversion of causes of transmission

RTU		IEC 60870-5-101
Internal communication (short)	**Internal communication (long)**	**Communication**
T	Test	Ignored
P/N	Positive/negative confirmation	Relevant in monitor direction only
Cause	Activation	6 - Activation
	Activation Confirmation	7 - Activation Confirmation
	Deactivation	8 - Deactivation
	Deactivation Confirmation	9 - Deactivation Confirmation
	Activation Termination	10 - Activation Termination
	Negative Confirmation	45 … 47 - Unknown

Table 52: DCO - Conversion of causes of transmission

7.3 RCO – Regulation Command Output

Regulation step command (two bits)

7.3.1 Supported data types

IEC 60870-5-101			RTU		
ASDU	**Type iden-tification**	**Data type property**	**Data type**	**Parame-ter name**	**Parameter location**
C_RC_NA_1	<47>	without time tag			

Table 53: RCO - Supported data types

7.3.2 Command authority

None

7.3.3 Additional information

Regulation step commands are in principle retriggerable commands.

In order to retrigger a running two step regulation command, it is not necessary to resend the command Select.

7.3.4 Conversion of values

RTU internal value	IEC 60870-5-101
Lower	01
Higher	10

Table 54: RCO - Conversion of values

7.3.5 Conversion of qualifier of command

RTU		IEC 60870-5-101
Internal communication (short)	Internal communication (long)	Communication
SE	Select / Execute	Select / Execute (1 select, 0 execute)
QU	default	0 - no additional definition

Table 55: RCO - conversion of qualifier of command

7.3.6 Conversion of causes of transmission

RTU		IEC 60870-5-101
Internal communication (short)	Internal communication (long)	Communication
T	Test	Ignored
P/N	Positive/negative confirmation	Relevant in monitor direction only
Cause	Activation	6 - Activation
	Activation Confirmation	7 - Activation Confirmation
	Deactivation	8 - Deactivation
	Deactivation Confirmation	9 - Deactivation Confirmation
	Activation Termination	10 - Activation Termination
	Negative Confirmation	45 … 47 - Unknown

Table 56: RCO - Conversion of causes of transmission

7.4 ASO – Analog Setpoint Output

Analog process command (16 bit signed number)

7.4.1 Supported data types

IEC 60870-5-101			RTU		
ASDU	Type identification	Data type property	Data type	Parameter name	Parameter location
C_SE_NA_1	<48>	normalized, without time tag	ASO	Transmission format: Normalized	ASO - line T101/104
C_SE_NB_1	<49>	scaled, without time tag	ASO	Transmission format: Scaled	ASO - line T101/104

Table 57: ASO - Supported data types

7.4.2 Command authority

None

7.4.3 Additional information

None

7.4.4 Conversion of values

Range	RTU internal value	IEC 60870-5-101
Range min.	-100 %	Normalized: -1 Scaled: -32 768
...	...	
Range max.	+100 %	Normalized: +1-2e-15 Scaled: +32 767

Table 58: ASO - Conversion of values

7.4.5 Conversion of qualifier of command

RTU		IEC 60870-5-101
Internal communication (short)	Internal communication (long)	Communication
SE	Select / Execute	Select / Execute (1 select, 0 execute)
QL	default	0 - default

Table 59: ASO - conversion of qualifier of command

7.4.6 Conversion of causes of transmission

RTU		IEC 60870-5-101
Internal communication (short)	Internal communication (long)	Communication
T	Test	Ignored
P/N	Positive/negative confirmation	Relevant in monitor direction only
Cause	Activation	6 - Activation
	Activation Confirmation	7 - Activation Confirmation
	Deactivation	8 - Deactivation
	Deactivation Confirmation	9 - Deactivation Confirmation
	Activation Termination	10 - Activation Termination
	Negative Confirmation	45 … 47 - Unknown

Table 60: ASO - Conversion of causes of transmission

7.5 DSO – Digital Setpoint Output

Binary process command (8 or 16 bit signed number)

7.5.1 Supported data types

IEC 60870-5-101			RTU		
ASDU	Type identification	Data type property	Data type	Parameter name	Parameter location
C_SE_NA_1	<48>	normalized, without time tag	DSO	Transmission format: Normalized	DSO - line T101/104
C_SE_NB_1	<49>	scaled, without time tag	DSO	Transmission format: Scaled	DSO - line T101/104

Table 61: DSO - Supported data types

7.5.2 Command authority

None

7.5.3 Additional information

None

7.5.4 Conversion of values

Range	RTU internal value	IEC 60870-5-101
Range min.	-100 %	-1
…	…	

Table 62: DSO - Conversion of values

Range	RTU internal value	IEC 60870-5-101
Range max.	+100 %	+1-2e-15

Table 62: DSO - Conversion of values

7.5.5 Conversion of qualifier of command

RTU		IEC 60870-5-101
Internal communication (short)	Internal communication (long)	Communication
SE	Select / Execute	Select / Execute (1 select, 0 execute)
QL	default	0 - default

Table 63: DSO - conversion of qualifier of command

7.5.6 Conversion of causes of transmission

RTU		IEC 60870-5-101
Internal communication (short)	Internal communication (long)	Communication
T	Test	Ignored
P/N	Positive/negative confirmation	Relevant in monitor direction only
Cause	Activation	6 - Activation
	Activation Confirmation	7 - Activation Confirmation
	Deactivation	8 - Deactivation
	Deactivation Confirmation	9 - Deactivation Confirmation
	Activation Termination	10 - Activation Termination
	Negative Confirmation	45 … 47 - Unknown

Table 64: DSO - Conversion of causes of transmission

7.6 FSO – Floating Point Setpoint Output

Floating point process command (32 bit short floating point number)

7.6.1 Supported data types

IEC 60870-5-101			RTU		
ASDU	Type identification	Data type property	Data type	Parameter name	Parameter location
C_SE_NC_1	<50>	without time tag			

Table 65: FSO - Supported data types

7.6.2 Command authority

None

7.6.3 Additional information

None

7.6.4 Conversion of values

Range	RTU internal value	IEC 60870-5-101
Range min.	-3.4 x 10e38	-3.4 x 10e38
...	...	
Range max.	+3.4 x 10e38	+3.4 x 10e38

Table 66: FSO - Conversion of values

7.6.5 Conversion of qualifier of command

RTU		IEC 60870-5-101
Internal communication (short)	Internal communication (long)	Communication
SE	Select / Execute	Select / Execute (1 select, 0 execute)
QL	default	0 - default

Table 67: FSO - conversion of qualifier of command

7.6.6 Conversion of causes of transmission

RTU		IEC 60870-5-101
Internal communication (short)	Internal communication (long)	Communication
T	Test	Ignored
P/N	Positive/negative confirmation	Relevant in monitor direction only
Cause	Activation	6 - Activation
	Activation Confirmation	7 - Activation Confirmation
	Deactivation	8 - Deactivation
	Deactivation Confirmation	9 - Deactivation Confirmation
	Activation Termination	10 - Activation Termination
	Negative Confirmation	45 … 47 - Unknown

Table 68: FSO - Conversion of causes of transmission

7.7 BSO – Bit String Output

Binary process command (1, 2, 8, 16, 32 bit unsigned number)

7.7.1 Supported data types

IEC 60870-5-101			RTU		
ASDU	Type identification	Data type property	Data type	Parameter name	Parameter location
C_BO_NA_1	<51>	without time tag			

Table 69: BSO - Supported data types

7.7.2 Command authority

None

7.7.3 Additional information

None

7.7.4 Conversion of values

Range	RTU internal value	IEC 60870-5-101
Range min.	0	0
...	...	
Range max.	65535	65535

Table 70: BSO - Conversion of values

7.7.5 Conversion of qualifier of command

RTU		IEC 60870-5-101
Internal communication (short)	Internal communication (long)	Communication
SE	only direct execute	only direct execute

Table 71: BSO - conversion of qualifier of command

7.7.6 Conversion of causes of transmission

RTU		IEC 60870-5-101
Internal communication (short)	Internal communication (long)	Communication
T	Test	Ignored
P/N	Positive/negative confirmation	Relevant in monitor direction only
Cause	Activation	6 - Activation
	Activation Confirmation	7 - Activation Confirmation
	Activation Termination	10 - Activation Termination
	Negative Confirmation	45 … 47 - Unknown

Table 72: BSO - Conversion of causes of transmission

8 File transfer

The file transfer is used for exchanging files between a control center and a subordinated device connected to a RTU560.

The file name in the protocol is fixed for all supported file types to 1 (transparent file).

Supported file types:
- RCD configuration file
- PRO configuration file (PLC boot project file)
- Disturbance record file (various protocols and device types)
- UNDEF file not specified in detail

8.1 Supported data types

IEC 60870-5-101			RTU		
ASDU	Type identification	Data type property	Data type	Parameter name	Parameter location
F_FR_NA_1	<120>				
F_SR_NA_1	<121>				
F_SC_NA_1	<122>				
F_LS_NA_1	<123>				
F_AF_NA_1	<124>				
F_SG_NA_1	<125>				
F_DR_TA_1	<126>				

Table 73: File transfer - Supported data types

8.2 Values

None.

8.3 Command authority

None

8.4 Additional information

None

8.5 Conversion of causes of transmission

RTU		IEC 60870-5-101
Internal communication (short)	Internal communication (long)	Communication
T	Test	Ignored

Table 74: File transfer - Conversion of causes of transmission

RTU		IEC 60870-5-101
Internal communication (short)	**Internal communication (long)**	**Communication**
P/N	Positive/negative confirmation	Relevant in monitor direction only
Cause	Spontaneous	3 – spontaneous (126)
	Requested	5 – requested (122, 126)
	File transfer	13 - file transfer

Table 74: File transfer - Conversion of causes of transmission

8.6 Download

The download of configuration files does not trigger any restarting mechanism in the subordinated device. For activating the new configuration file, the control center has to issue a Reset Process Command (C_RP_NA_1, TI 105) after writing the files to the device.

The file transfer will only be routed to the subordinated device it belongs to. The distribution is done between the message F_LS_NA_1 and the message F_AF_NA_1 and may last a couple of seconds. The message F_AF_NA_1 is only acknowledged positively when file distribution were successful.

8.7 Upload

All supported file types can also be uploaded from a RTU of the RTU500 series or an IED.

See documentation of the relevant subdevice communication interface for support of (disturbance) file upload.

9 Transparent data

In automation systems may be required information that is not mapped to the IEC 60870-5-101 protocol. This information includes several device specific parameters etc.

Several type identifications of the private range have been selected to enable transparent data transfer through the RTU500 series RTU to subordinated devices.

9.1 Command direction

With the Transparent Data Message C_TD_NA_1 the Controlling Station is able to request data from subordinate devices through the RTU500 series.

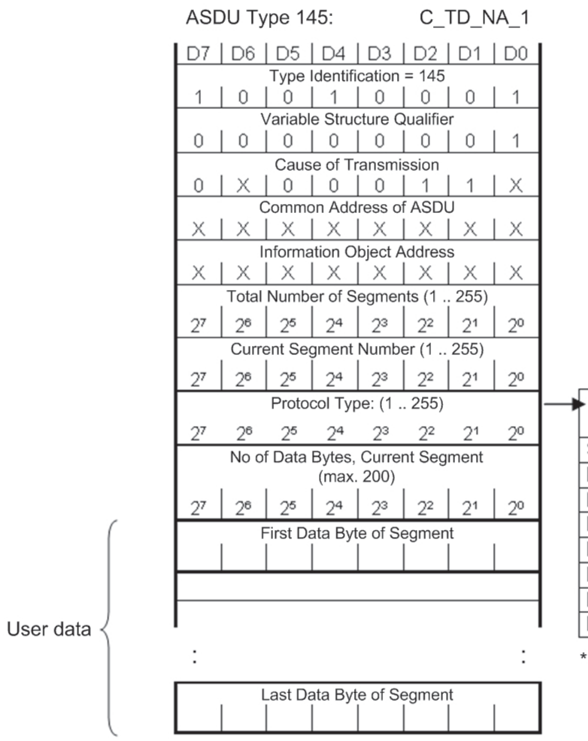
The Type Ident is 145, ASDU address and the Information object address must be configured in RTUtil500.

The Transparent Data Message C_TD_NA_1 will be answered from the RTU by sending the message back to Controlling Station with Cause of Transmission 7 (activation confirmation).

When the message is accepted by the RTU (message can be processed by the RTU and device answers to the request message), the RTU sends a “positive confirmation” ACTCON, otherwise (message cannot be processed by the RTU) the RTU sends a “negative confirmation” ACTCON.

Every transparent data command is checked on ASDU address, information object address and “No of Data Bytes in Current Segment“.

If the ASDU address or information object address does not match to the configuration in RTUtil500 or the “No of Data Bytes in Current Segment” is higher than 200, the command is confirmed negative.



Protocol Type	Value in Protocol Type field
SPAbus	7
RP570/571	8*
Modbus	9
IEC 60870-5-101	101*
IEC 60870-5-102	102
IEC 60870-5-103	103*
IEC 60870-5-104	104*
IEC 1107	107

* : reserved for future use

Figure 1: ASDU Type 145

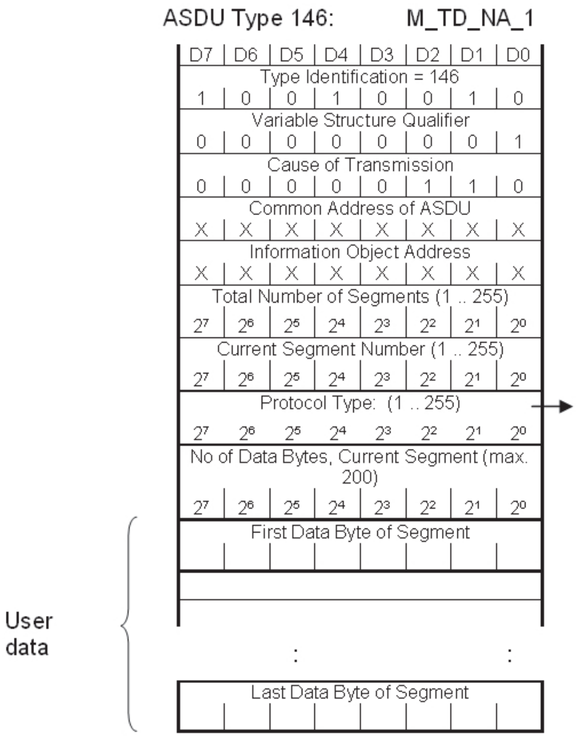
9.2 Monitoring direction

With the Transparent Data Response M_TD_NA_1, the RTU is able to receive any data as transparent data from subordinate devices.

The Type Ident is 146, theLink address, ASDU address and the Information object address must be configured by RTUtil500. They are equal to the one used in command direction.

The maximum amount of segments is 255, each of them contains up to 200 data bytes.

If all data can be sent in one message (data segmentation not necessary), the contents of both segmentation control fields are set to 1.



Protocol Type	Value in Protocol Type field
SPAbus	7
RP570/571	8*
Modbus	9
IEC 60870-5-101	101*
IEC 60870-5-102	102
IEC 60870-5-103	103*
IEC 60870-5-104	104*
IEC 62056-21	107

* : reserved for future use

Figure 2: ASDU Type 146

9.3 Request procedure

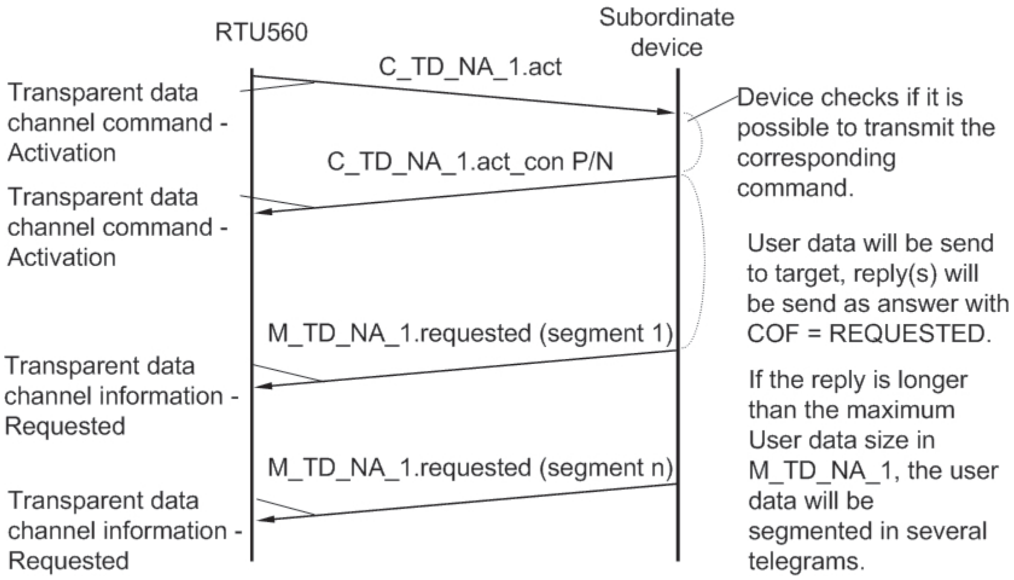


Figure 3: Request procedure

9.4 Encapsulated SPAbus messages

9.4.1 General

With the Transparent Data Message C_SB_NA_1 the Controlling Station is able to request data and execute commands of a SPAbus device connected to a subordinate device through the RTU560.

The Type Ident is 133, the ASDU address and the Information object address must be configured in RTUtil500.

The Transparent Data Message C_SB_NA_1 will be answered from RTU by sending the message back to Central System with Cause of Transmission 7 (activation confirmation).

When the message is accepted by the subordinate device (Device answers to the request message), the RTU sends a "positive confirmation" ACTCON with the reply data included, otherwise (message cannot be processed) the RTU sends a "negative confirmation" ACTCON.

Every transparent data command is checked on ASDU address, information object address and “No of Data Bytes in Current Segment“.

If the ASDU address, information object address or “No of Data Bytes” does not match to the configuration in RTUtil500, the command is confirmed negative.

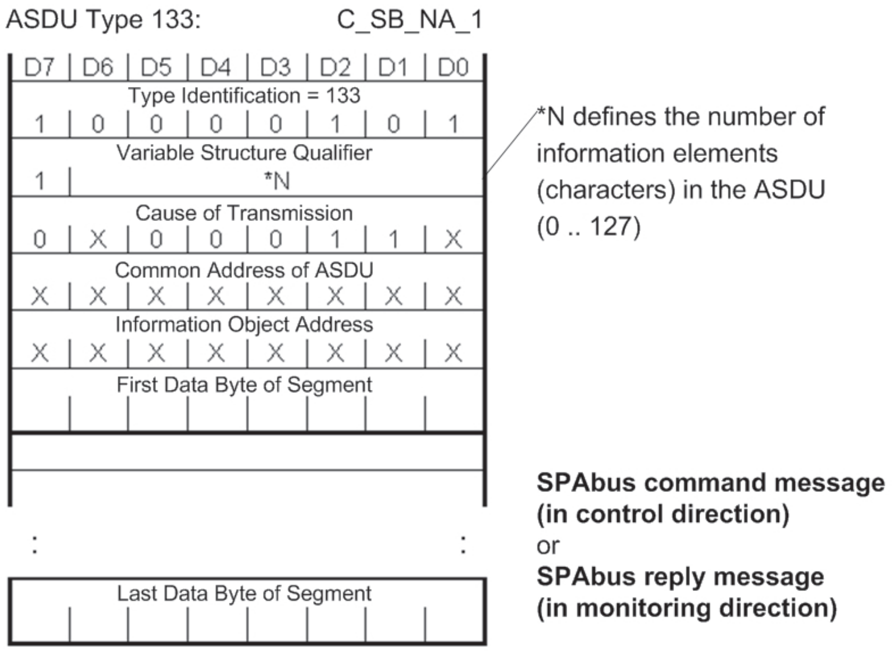


Figure 4: ASDU Type 133

9.4.2 Request procedure

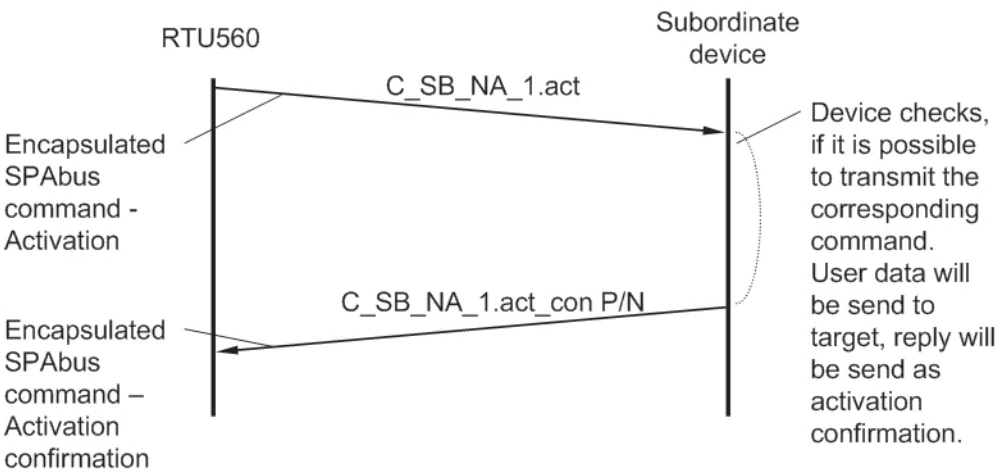


Figure 5: Request procedure

10 Internal functions

10.1 General Interrogation

The general interrogation to the subordinated devices is send directly after the initialization of the RTU and on every change of the subordinated link from state OFFLINE to state ONLINE.

A redundancy switchover causes also a general interrogation if the subdevice interface is configured as non-redundant (CMU is an additional non-redundant board in a redundant station).

10.1.1 Supported data types

IEC 60870-5-101			RTU		
ASDU	Type identification	Data type property	Data type	Parameter name	Parameter location
C_IC_NA_1	<100>				

Table 75: General Interrogation - Supported data types

10.1.2 Values

20

10.1.3 Command authority

None

10.1.4 Additional information

None

10.1.5 Conversion of quality descriptors

RTU		IEC 60870-5-101
Internal communication (short)	Internal communication (long)	Communication
QOI	Qualifier of Interrogation	20 – General interrogation

Table 76: General Interrogation - Conversion of quality descriptors

10.1.6 Conversion of causes of transmission

RTU		IEC 60870-5-101
Internal communication (short)	Internal communication (long)	Communication
T	Test	Ignored
P/N	Positive/negative confirmation	Relevant in monitor direction only
Cause	Activation	6 - Activation

Table 77: General Interrogation - Conversion of causes of transmission

RTU		IEC 60870-5-101
Internal communication (short)	**Internal communication (long)**	**Communication**
	Activation Confirmation	7 - Activation Confirmation
	Activation Termination	10 - Activation Termination
	Negative Confirmation	44 … 47 - Unknown

Table 77: General Interrogation - Conversion of causes of transmission

10.2 Read Command

Process command to read a specific data point.

10.2.1 Supported data types

IEC 60870-5-101			RTU		
ASDU	**Type identification**	**Data type property**	**Data type**	**Parameter name**	**Parameter location**
C_RD_NA_1	<102>				

Table 78: Read Command - Supported data types

10.2.2 Values

None.

10.2.3 Command authority

None

10.2.4 Additional information

A read command can be configured for every data point of the monitoring direction.

The read command can be configured in two modes:

– Absolute time
  The read command for the specific data point is send at the configured time within a day. It is send only once per day.
– Cyclic time
  The read command for the specific data point is send cyclic. The time period must be configured. The time period is configured in minutes. Possible values are 1 to 1 440 minutes.

Parameter name	Default	Parameter location
Read command status	no	data point (e.g. SPI) - line (Sub parameter)
value range: no, cyclic time, absolute time no: no read command enabled; cyclic time: cyclic read command enabled; absolute time: read command at abosute point of time once a day enabled		

10.2.5 Conversion of quality descriptors

RTU		IEC 60870-5-101
Internal communication (short)	**Internal communication (long)**	**Communication**
SE	Select / Execute	Only S/E = 0 (execute) supported

Table 79: Read Command - Conversion of quality descriptors

10.2.6 Conversion of causes of transmission

RTU		IEC 60870-5-101
Internal communication (short)	**Internal communication (long)**	**Communication**
T	Test	Ignored
P/N	Positive/negative confirmation	Relevant in monitor direction only
Cause	Request	5 - Request
	Negative Confirmation	44 … 47 - Unknown

Table 80: Read Command - Conversion of caused of transmission

10.3 Time Synchronization

If the RTU500 series should synchronize subordinated devices, it must be configured.

Parameter name	Default	Parameter location
Time interval of clock synchronization commands	Disabled	Line T101/104 - IEC 60870-5-101/104
Value range: disabled, 60 ... 65000 s		
Specification whether time synchronization of the secondary station shall take place. Approved value for RTU500 series secondary stations: 300 s		

ADVICE

The time synchronization command is only send to subordinated devices which are in state ONLINE, and only if the time tag of the own RTU is valid (synchronized).

10.3.1 Supported data types

IEC 60870-5-101			RTU		
ASDU	**Type identification**	**Data type property**	**Data type**	**Parameter name**	**Parameter location**
C_CS_NA_1	<103>				

Table 81: Time Synchronization - Supported data types

10.3.2 Values

Complete time and date information in CP56Time2a format.

10.3.3 Command authority

None

10.3.4 Additional information

None

10.3.5 Conversion of causes of transmission

RTU		IEC 60870-5-101
Internal communication (short)	**Internal communication (long)**	**Communication**
T	Test	Ignored
P/N	Positive/negative confirmation	Relevant in monitor direction only
Cause	Activation	6 - Activation
	Activation Confirmation	7 - Activation Confirmation
	Spontaneous	3 - Spontaneous
	Negative Confirmation	44 … 47 - Unknown

Table 82: Time synchronization - Conversion of causes of transmission

10.4 Test Command

10.4.1 Supported data types

IEC 60870-5-101			RTU		
ASDU	**Type identification**	**Data type property**	**Data type**	**Parameter name**	**Parameter location**
C_TS_NA_1	<104>				

Table 83: Test Command - Supported data types

10.4.2 Values

0x55AA

10.4.3 Command authority

None

10.4.4 Additional information

	Parameter name	Default	Parameter location
Test command cycle			IED Parameter
The cycle time of the test command can be configured. Value range: 0 … 65.535 s			

10.4.5 Conversion of quality descriptors

RTU		IEC 60870-5-101
Internal communication (short)	**Internal communication (long)**	**Communication**
SE	Select / Execute	Only S/E = 0 (execute) supported

Table 84: Test Command - Conversion of quality descriptors

10.4.6 Conversion of causes of transmission

RTU		IEC 60870-5-101
Internal communication (short)	**Internal communication (long)**	**Communication**
T	Test	Ignored
P/N	Positive/negative confirmation	Relevant in monitor direction
Cause	Activation	6 - Activation
	Activation Confirmation	7 - Activation Confirmation
	Negative Confirmation	45 … 47 - Unknown

Table 85: Test Command - Conversion of causes of transmission

10.5 Reset Command

Command to reset a subordinated RTU.

10.5.1 Supported data types

IEC 60870-5-101			RTU		
ASDU	**Type identification**	**Data type property**	**Data type**	**Parameter name**	**Parameter location**
C_RP_NA_1	<105>				

Table 86: Reset Command - Supported data types

10.5.2 Values

1

10.5.3 Command authority

None

10.5.4 Additional information

The subdevice communication interface will not generate this command, but it will route this command, received from a host communication interface.

10.5.5 Conversion of quality descriptors

RTU		IEC 60870-5-101
Internal communication (short)	**Internal communication (long)**	**Communication**
SE	Select / Execute	Only S/E = 0 (execute) supported

Table 87: Reset Command - Conversion of quality descriptors

10.5.6 Conversion of causes of transmission

RTU		IEC 60870-5-101
Internal communication (short)	**Internal communication (long)**	**Communication**
T	Test	Ignored
P/N	Not used	Not relevant
Cause	REMOTE_RESET	Not relevant

Table 88: Reset Command - Conversion of causes of transmission

10.6 System events

The subdevice communication interface manages internal status messages for every device connected to this line. These status messages are created from the subdevice communication interface itself for every connected device.

Parameter name	Default	Parameter location
Fix SEV address schema	enabled	SDI - line
Value range: enabled/ disabled if enabled: a base address for the whole block of system events is defined at the SDI node if disabled: individual addresses per SEV can be defined In order to avoid collisions, the addresses of the system events may not be used for other process objects.		
In use	enabled	SDI - line
Value range: enabled/ disabled if disabled: no SEVs will be transmitted on this line		

The subdevice communication interface generates the following system events:

IED SEVs influenced by the SCI	Description of system event	Address offset
X	Device is active While initialization the value of SEV#024 is set to ON. On a running system this system event does not change anymore.	#024
X	At least one DCE (data communication equipment) faulty	#044

Table 89: Description of system events

IED SEVs influ-enced by the SCI	Description of system event	Address offset
X	Device connected (controled by SSC#003)	#045
X	Device inoperable The SEV#048 is set in dependency of the state of the subordinated de-vice.	#048
X	Device out of service (controled by SSC#001)	#049
X	Device reachable on redundant line 1 / 2	#180, #181
X	Device reachable on redundant line 3 / 4	#182, #183
X	Device active on redundant line 1 / 2	#184, #185
X	Device active on redundant line 3 / 4	#186, #187
X	Device preferred on redundant line 1 / 2	#188, #189
X	Device preferred on redundant line 3 / 4	#190, #191
X1)	Process command collision with host x, 1 ≤ x ≤ 16	#242 ... #257
X1)	Process command collision with Integrated HMI	#258
X1)	Process command collision with webserver	#259
X1)	Process command collision with PLC	#260

Table 89: Description of system events

1) **The process command collision will be signalized as 1ms impulse in two following system events.**

10.6.1 Status change device OFFLINE to device ONLINE

If the state of a subordinated device or line changes from OFFLINE to ONLINE, a general interrogation command is send to the concerning device(s).

The system event "device inoperable" (SEV#048) with value 0 is sent as SPI to the internal commu-nication for every device that changed its state to ONLINE.

10.6.2 Status change device ONLINE to device OFFLINE

If the state of a subordinated device or line changes from ONLINE to OFFLINE all configured data points connected to these devices are sent to the internal communication with the actual state, marked as INVALID (IV) or NOT TOPICAL (NT) and with the timestamp of the own RTU. INVALID or NOT TOPICAL is set depending on the configuration parameter Information object qualifier.

Parameter name	Default	Parameter location
Information object qualifier (usage for disconnected subordinated devices)	Mark as invalid (IV)	RTU - Parameter
Value range: Mark as invalid (IV) / Mark as not topical (NT)		

ADVICE

Also in not topical (NT) configuration are data points which have not been updated since RTU startup marked as invalid (IV).

The system event DEVICE_INOPERABLE (48) with value 1 is sent as SPI to the internal communication for every device that changed its state to OFFLINE.

10.7 System commands

The behavior of subordinated devices connected to a sub-device communication interface with protocol IEC 60870-5-101 can be modified with system single commands (SSC).

If system commands are configured to a subordinated device not directly connected to the sub-device communication interface they are send as single command with the protocol address configured for this SSC in RTUtil500 to the next subordinated device. Devices directly connected to a sub-device communication interface are processed by the sub-device communication interface itself.

The following system single commands are supported:

SSC supported	Description of SSC	Address offset
X	Set device out of service	#001
X	Reset device process	#002
X	Connect/disconnect device	#003
X	Set redundant line 1 / 2 as preferred line	#004, #005
X	Set redundant line 3 / 4 as preferred line	#006, #007
X	Force global process image update, i.e. force process image update of all subdevices	#012
X	Request redundancy change over for the active CMU x, $1 \leq x \leq 16$	#016 ... #031

Table 90: Description of system single commands (SSC)

10.7.1 Set device out of service

The processing of a subordinated device can be stopped using the system single command Set device out of service. The current status is signalized with the system event SEV#048 "Device out of service". Initial status is in service. If a device is taken out of service no communication at all will be done and the device will not be dialed-up. Process information referencing to this device will be send spontaneously as invalid and received process commands to this device will be confirmed negative.

If the device is set in service again, a general interrogation is done to get the current process status of the subordinated device.

RTU internal value	Status
off	Set device in service
on	Set device out of service

Table 91: Conversion of values SSC#001

10.7.2 Reset device process

The SSC command ‘Reset device process’ will be send as reset command (C_RP) to subordinated devices of type IED. If the subordinated device is of type RTU500 series it will be send as single command (C_SC) with the protocol address configured for this system single command. Depending on the device, a command confirmation of the reset process command will not be received.

RTU internal value	Status
off	<Ignored>
on	reset device process

Table 92: Conversion of values SSC#002

10.7.3 Connect/disconnect device

In case of a dial up connection it is possible to force a connection to a specified device with system single command Connect device.

RTU internal value	Status
off	disconnect a dial up connection of device
on	connect a dial up connection to device

Table 93: Conversion of values

10.7.4 Set redundant line as preferred line

To modify the preferred redundant line in case of configured redundant communication lines the system single command "Set redundant line x as preferred line" is used.

RTU internal value	Status
off	<ignored>
on	set redundant line as preferred line

Table 94: Conversion of values

10.7.5 Force process image update

If the command is addressed to a subordinated device and this device is an RTU of RTU500 series and for this RTU the SSC#12 "force process image update" is also defined, the SSC command is delegated to the connected sub-RTU. If not, a general interogation command (GI) is performed to the connected device.

RTU internal value	Status
off	<Ignored>
on	Force process image update

Table 95: Conversion of values SSC#012

10.7.6 Request redundancy change over

The SSC command will only be send to a subordinated device of the type RTU500 series. It will be send as single command (C_SC) with the protocol address configured for this SSC.

RTU internal value	Status
off	<Ignored>

Table 96: Conversion of values SSC#016 ... #031

RTU internal value	Status
on	Request redundancy change over

Table 96: Conversion of values SSC#016 ... #031

11 Interoperability List

The selected parameters are 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

11.1 System or device

(system-specific parameter)

☐ System definition
☒ Controlling station definition (master)
☐ Controlled station definition (slave)

11.2 Network configuration

(network-specific parameter)

☒ Point-to-point
☒ Multiple point-to-point
☒ Multipoint-party line
☒ Multipoint-star

11.3 Physical Layer

(network-specific parameter)

11.3.1 Transmission speed (control direction)

Unbalanced interchange
Circuit V.24/V.28
Standard

X 100bit/s
X 200bit/s
X 300bit/s
X 600bit/s
X 1 200bit/s

Unbalanced interchange
Circuit V.24/V.28
Recommended if >1 200 bit/s

X 2 400bit/s
X 4 800bit/s
X 9 600bit/s

Balanced interchange
Circuit X.24/X.27

X 2 400bit/s
X 4 800bit/s
X 9 600bit/s
X 19 200bit/s
X 38 400bit/s

- [ ] 56 000bit/s
- [ ] 64 000bit/s

11.3.2 Transmission speed (monitor direction)

Unbalanced interchange
Circuit V.24/V.28
Standard

- [X] 100bit/s
- [X] 200bit/s
- [X] 300bit/s
- [X] 600bit/s
- [X] 1 200bit/s

Unbalanced interchange
Circuit V.24/V.28
Recommended if >1 200 bit/s

- [X] 2 400bit/s
- [X] 4 800bit/s
- [X] 9 600bit/s

Balanced interchange
Circuit X.24/X.27

- [X] 2 400bit/s
- [X] 4 800bit/s
- [X] 9 600bit/s
- [X] 19 200bit/s
- [X] 38 400bit/s
- [ ] 56 000bit/s
- [ ] 64 000bit/s

11.4 Link layer

(network-specific parameter)

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 transmission
- [X] Unbalanced transmission

Frame length

255	Maximum length L (control direction)
255	Maximum length L (monitor direction)
≤255	Time during which repetitions are permitted (Trp) or number of repetitions

Address field of the link

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

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

11.5 Application Layer

11.5.1 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.

11.5.2 Common address of ASDU

(system-specific parameter)

☒ One octet

☒ Two octets

11.5.3 Information object address

(system-specific parameter)

☒ One octet
☒ Two octets
☒ Three octets

☒ Structured
☒ Unstructured

11.5.4 Cause of transmission

(system-specific parameter)

☒ One octet

☒ Two octets
(with originator address = 0)

11.5.5 Selection of standard ASDUs

Process information in monitor direction

(station-specific parameter)

☒ <1>	:=	Single-point information	M_SP_NA_1
☒ <2>	:=	Single-point information with time tag	M_SP_TA_1
☒ <3>	:=	Double-point information	M_DP_NA_1
☒ <4>	:=	Double-point information with time tag	M_DP_TA_1
☒ <5>	:=	Step position information	M_ST_NA_1
☒ <6>	:=	Step position information with time tag	M_ST_TA_1
☒ <7>	:=	Bitstring of 32 bit	M_BO_NA_1
☒ <8>	:=	Bitstring of 32 bit with time tag	M_BO_TA_1

[X] <9>	:=	Measured value, normalized value	M_ME_NA_1
[X] <10>	:=	Measured value, normalized value with time tag	M_ME_TA_1
[X] <11>	:=	Measured value, scaled value	M_ME_NB_1
[X] <12>	:=	Measured value, scaled value with time tag	M_ME_TB_1
[X] <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
[X] <15>	:=	Integrated totals	M_IT_NA_1
[X] <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
[ ] <21>	:=	Measured value, normalized value without quality descriptor	M_ME_ND_1

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

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

System information in monitor direction

(station-specific parameter)

[X] <70>	:=	End of initialization	M_EI_NA_1

System information in control direction

(station-specific parameter)

[X]	<100>	:=	Interrogation command	C_IC_NA_1
[ ]	<101>	:=	Counter interrogation command	C_CI_NA_1
[X]	<102>	:=	Read command	C_RD_NA_1
[X]	<103>	:=	Clock synchronization command	C_CS_NA_1
[X]	<105>	:=	Reset process command	C_RP_NA_1
[ ]	<106>	:=	Delay acquisition command	

Parameter in control direction

(station-specific parameter)

[ ]	<110>	:=	Parameter of measured value, normalized value	P_ME_NA_1
[ ]	<111>	:=	Parameter of measured value, scaled value	P_ME_NB_1
[ ]	<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)

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

Type identification and case of transmission assignments

(station-specific parameter)

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	X		X						X	X		X					
<2>	M_SP_TA_1			X		X						X	X							
<3>	M_DP_NA_1		X	X		X						X	X		X					
<4>	M_DP_TA_1			X		X						X	X							
<5>	M_ST_NA_1		X	X		X						X	X		X					
<6>	M_ST_TA_1			X		X						X	X							
<7>	M_BO_NA_1		X	X		X									X					
<8>	M_BO_TA_1			X		X														
<9>	M_ME_NA_1	X	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
<10>	M_ME_TA_1	X		X		X														
<11>	M_ME_NB_1	X	X	X		X									X					
<12>	M_ME_TB_1	X		X		X														
<13>	M_ME_NC_1	X	X	X		X									X					
<14>	M_ME_TC_1	X		X		X														
<15>	M_IT_NA_1			X		X														
<16>	M_IT_TA_1			X		X														
<17>	M_EP_TA_1			X																
<18>	M_EP_TB_1																			
<19>	M_EP_TC_1																			
<20>	M_PS_NA_1																			
<21>	M_ME_ND_1																			
<30>	M_SP_TB_1			X		X						X	X							
<31>	M_DP_TB_1			X		X						X	X							
<32>	M_ST_TB_1			X		X						X	X							
<33>	M_BO_TB_1			X		X														
<34>	M_ME_TD_1	X		X		X														
<35>	M_ME_TE_1	X		X		X														
<36>	M_ME_TF_1	X		X		X														
<37>	M_IT_TB_1			X		X														
<38>	M_EP_TD_1			X																
<39>	M_EP_TE_1																			
<40>	M_EP_TF_1																			
<45>	C_SC_NA_1						X	X	X	X	X						X	X	X	X
<46>	C_DC_NA_1						X	X	X	X	X						X	X	X	X
<47>	C_RC_NA_1						X	X	X	X	X						X	X	X	X
<48>	C_SE_NA_1						X	X	X	X	X						X	X	X	X
<49>	C_SE_NB_1						X	X	X	X	X						X	X	X	X
<50>	C_SE_NC_1						X	X	X	X	X						X	X	X	X
<51>	C_BO_NA_1						X	X			X						X	X	X	X
<70>	M_EI_NA_1				X															
<100>	C_IC_NA_1						X	X			X						X	X	X	X
<101>	C_CI_NA_1																X			
<102>	C_RD_NA_1					X											X	X	X	X
<103>	C_CS_NA_1			X			X	X									X	X	X	X
<104>	C_TS_NA_1						X	X									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
<105>	C_RP_NA_1						X	X									X	X	X	X
<106>	C_CD_NA_1																X			
<110>	P_ME_NA_1																X			
<111>	P_ME_NB_1																X			
<112>	P_ME_NC_1																X			
<113>	P_AC_NA_1																X			
<120>	F_FR_NA_1													X			X	X	X	X
<121>	F_SR_NA_1													X			X	X	X	X
<122>	F_SC_NA_1					X								X			X	X	X	X
<123>	F_LS_NA_1													X			X	X	X	X
<124>	F_AF_NA_1													X			X	X	X	X
<125>	F_SG_NA_1													X			X	X	X	X
<126>	F_DR_TA_1[1]			X		X														

1 Blank or X only.

(x) Functionality 'Local' or 'Remote' can be assigned by PLC.

11.6 Basic application functions

11.6.1 Station initialization

(station-specific parameter)

[X] Remote initialization

11.6.2 Cyclic data transmission

(station-specific parameter)

[X] Cyclic data transmission

11.6.3 Read procedure

(station-specific parameter)

[X] Read procedure

11.6.4 Spontaneous transmission

(station-specific parameter)

[X] Spontaneous transmission

11.6.5 Double transmission of information objects with cause of transmission spontaneous

(station-specific parameter)

The following type identifications will 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
- [ ] 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 number M_ME_NC_1, M_ME_TC_1 and M_ME_TF_1

11.6.6 Station interrogation

(station-specific parameter)

- [X] global

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

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

11.6.7 Clock synchronization

(station-specific parameter)

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

11.6.8 Command transmission

(object-specific parameter)

- [X] Direct command transmission
- [X] Direct set point command transmission
- [X] Select and execute command
- [X] Select and execute set point command
- [X] C_SE ACTTERM used
- [X] No additional definition
- [ ] Short-pulse duration (duration determined by a system parameter in the controlled station)
- [ ] Long-pulse duration (duration determined by a system parameter in the controlled station)
- [X] Persistent output

11.6.9 Transmission of integrated totals

(station- or object-specific parameter)

- [ ] Mode A: local freeze with spontaneous transmission
- [ ] Mode B: local freeze with counter interrogation
- [ ] Mode C: freeze and transmit by counter interrogation commands
- [ ] Mode D: freeze by counter-interrogation command, frozen values reported spontaneously
- [X] Counter read
- [ ] Counter freeze without reset
- [ ] Counter freeze with reset
- [ ] Counter reset
- [ ] General request counter
- [ ] Request counter group 1
- [ ] Request counter group 2
- [ ] Request counter group 3
- [ ] Request counter group 4

11.6.10 Parameter loading

(object-specific parameter)

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

11.6.11 Parameter activation

(object-specific parameter)

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

11.6.12 Test procedure

(station-specific parameter)

- [X] Test procedure

11.6.13 File transfer

(station-specific parameter)

File transfer in monitor direction

- [X] Transparent file
- [X] Transmission of disturbance data of protection equipment
- [ ] Transmission of sequences of events
- [ ] Transmission of sequences of recorded analogue values

File transfer in control direction

- [X] Transparent file

11.6.14 Background scan

(station-specific parameter)

☐ Background scan

11.6.15 Acquisition of transmission delay

(station-specific parameter)

☐ Acquisition of transmission delay

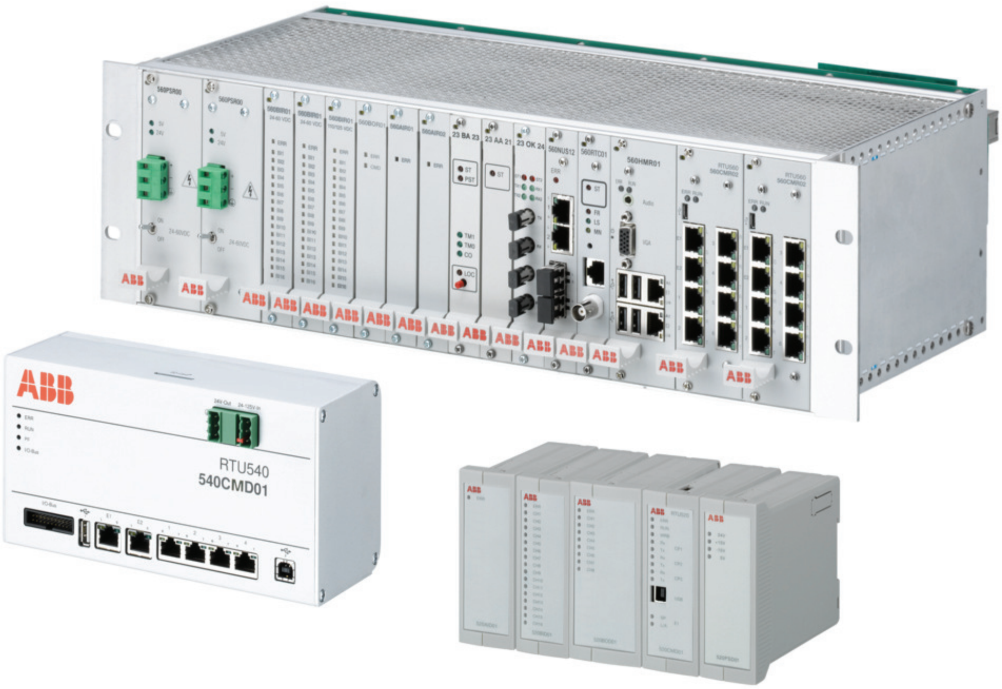
12 Glossary

AMI	Analog Measured value Input
ASO	Analog Setpoint command Output
BSI	Bit String Input
BSO	Bit String Output
CMU	Communication and Data Processing Unit
DCE	Data Communication Equipment
DCO	**D**ouble **C**ommand **O**utput
DMI	Digital Measured value Input (8, 16 bit)
DPI	Double Point Input
DSO	Digital Setpoint command Output (8, 16 bit)
FSO	Floating Setpoint Command Output
HCI	Human Maschine Interface (here Integrated HMI function of the RTU500 series)
IED	Intelligent Electronic Device
ITI	Integrated Totals Input
MFI	Analog Measured value Floating Input
MS	Microsoft
PLC	Programmable Logic Control
RCD	RTU Configuration Data
RCO	Regulation step Command Output
RTU	Remote Terminal Unit
SCI	Sub-Device Communication Interface
SCO	Single Command Output
SEV	System Event
SPI	Single Point Input or Single point information
SSC	System Single Command
STI	Step position Input

Power Grids

RTU500 series - Remote Terminal Units Host Communication Interface with IEC 60870-5-104

Protocol description



Revision

Document identity:		1KGT 150 482 V020 1
Revision:	**Date:**	**Changes:**
0	02/2001	Initial Version
1	12/2002	Chapter File Transfer updated Chapter Transparent Data added (Available with RTU FW Release 6)
2	08/2004	Chapter Link Layer updated New chapters: Redundant Network, Multi-Hosts New chapter: Parameter Download New Mode for Time Synchronization Two step commands for RCO, ASO, DCO New System Events: SEV 64 - 95 New Line Parameter for SEV and command acknowl. Interoperability List updated
3	02/2005	New System Event (SEV) #100
4	04/2006	New function: Process commands with time stamp Interrogation groups in C_IC_NA_1 supported C_RP_NA_1 will be routed to subdevices New System Events New function: System Single Commands (SSC)
5	06/2006	Deactivate Command C_RP_NA_1 explained
6	08/2007	New System Events (SEV) Interoperability list corrected and updated Parameter for C_IC_NA_1 / C_CI_NA_1 corrected COT 44 to 47 supported, COT corrected GI initialized by PLC program
7	06/2009	Chapter Physical Layer modified Transparent data channel Modbus protocol Parameter In Use introduced Setpoint Command with termination message Background scan cycle introduced Originator address configurable System events, System single commands Max. 16 Host Interfaces New ASDU: C_SE_NC_1, C_SE_TC_1, P_ME_NA_1 Parameter: Protocol Profile

Document identity:		1KGT 150 482 V020 1
Revision:	**Date:**	**Changes:**
		Counter Interrogation Groups Verification of command age
8	11/2009	System Events updated
9	02/2010	Line Parameter corrected
10	03/2011	System Command #012 “Global process image update” New Chapter: Force process update image
11	07/2011	New ASDU: P_ME_NC_1 Chapter “Parameter Loading” revised Chapter “FILE TRANSFER” extended
12	09/2011	Update Chapter: Transmission of sequences of events
13	09/2011	Update Chapter 7.1.2
14	03/2012	New layout
15	04/2012	Timeout handling (t1) configurable
16	04/2015	New parameter: Allow only one interrogation running per common address of ASDU (PR#16851) Update filetransfer to RCD configuration files (PR#20418) More details on command qualifiers (PR#17056) New chapter: Application layer - communication queue handling (PR#3251) Update: usage of orginator adress parameter (PR#11465) Chapter Parameter loading corrected (PR#12364, 13336) Correction: qualifier of command for BSO (PR#23928) Update chapter system events and system commands New layout
17	11/2015	Added new line parameters to chapter Application layer (PR#10656)
	05/2016	Removed Link address from chapters 'Transparent data' and 'Counter interrogation command' (PR#28618)
	11/2016	Values for conversion of values for threshold and for smoothing corrected (#PR32751)
		Update: Footnote for HCI 101/104 in table "ASDU in monotoring direction" (PR#29542)
	01/2017	Update: Table "conversion of values" for DPI in monitoring direction (PR#33213)
		AMI/MFI 'Background cycle': added cycle time 15 min (PR#27626)
		New chapter: Secure Communication According IEC 62351-3 (PR#9078)
18	06/2017	Update: Chapter 'Parameter Loading' and 'Interoperability List' (PR#32754)
	07/2017	Update: Chapter 'Verification mode of command age' (PR#32761)
		Update: Chapter 'Application Layer General' Parameter 'Protokoll edition' (PR#34995)

Document identity:		**1KGT 150 482 V020 1**
Revision:	**Date:**	**Changes:**
	08/2017	Chapter 'Definition of timeouts' updated (PR#33141)
19	02/2018	Chapter 'Ethernet ports' updated (PR#36631)
	04/2018	New layout
20	06/2018	Renamed chapter 'Ethernet Ports' (PR#38297)
	08/2018	Introduced new parameter 'Put in buffer' (PR#35074)

Contents

1 Introduction ... 7
1.1 Preface ... 7
1.2 References ... 7
1.3 Conventions ... 7

2 Physical Layer ... 9
2.1 IP based Communication ... 9
2.2 Host interface ... 9

3 Link Layer ... 11
3.1 General ... 11
3.2 Multi-Host Connection ... 11
3.2.1 Configuration with one Ethernet interface ... 11
3.2.2 Configuration with two Ethernet interfaces ... 11

4 Application Layer ... 13
4.1 General ... 13
4.2 Communication Queue Handling ... 15
4.3 Verification mode of command age ... 16
4.4 ASDU Type identification ... 16
4.4.1 ASDU in monitoring direction ... 16
4.4.2 ASDU in control direction ... 17
4.4.3 ASDU of system information in command direction ... 18
4.4.4 ASDU for file transfer ... 18

5 Parameters and Addressing ... 19
5.1 General data point parameters ... 19
5.2 Address elements ... 19
5.2.1 Restrictions for the Common Address ... 19
5.2.2 Restrictions for the information object address ... 20

6 Data Types - Monitoring Direction ... 21
6.1 AMI – Analog Measured Information ... 21
6.1.1 Supported Data Types ... 21
6.1.2 Additional Information ... 21
6.1.3 Conversion of Values ... 22
6.1.4 Conversion of Quality Descriptors ... 22
6.1.5 Conversion of Causes of Transmission ... 22
6.2 BSI – Bit String Information ... 23
6.2.1 Supported Data Types ... 23
6.2.2 Additional Information ... 23
6.2.3 Conversion of values ... 23
6.2.4 Conversion of Quality Descriptors ... 24
6.2.5 Conversion of Causes of Transmission ... 24
6.3 DMI – Digital Measured Information ... 24
6.3.1 Supported Data Types ... 24

6.3.2 Additional Information 25
6.3.3 Conversion of values 25
6.3.4 Conversion of Quality Descriptors 25
6.3.5 Conversion of Causes of Transmission 25
6.4 DPI – Double Point Information 25
6.4.1 Supported Data Types 26
6.4.2 Additional Information 26
6.4.3 Conversion of Values 26
6.4.4 Conversion of Quality Descriptors 26
6.4.5 Conversion of Causes of Transmission 26
6.5 EPI – Protection Event Information 27
6.5.1 Supported Data Types 27
6.5.2 Additional information 27
6.5.3 Conversion of Values 27
6.5.4 Conversion of Quality Descriptors 28
6.5.5 Conversion of Causes of Transmission 28
6.6 ITI – Integrated Totals Information 28
6.6.1 Supported Data Types 28
6.6.2 Additional Information 28
6.6.3 Conversion of Values 29
6.6.4 Conversion of Quality Descriptors 29
6.6.5 Conversion of Causes of Transmission 29
6.7 MFI – Measured Float Information 29
6.7.1 Supported Data Types 29
6.7.2 Values 30
6.7.3 Additional Information 30
6.7.4 Conversion of Values 30
6.7.5 Conversion of Quality Descriptors 30
6.7.6 Conversion of Causes of Transmission 31
6.8 SPI – Single Point Information 31
6.8.1 Supported Data Types 31
6.8.2 Additional Information 31
6.8.3 Conversion of Values 32
6.8.4 Conversion of Quality Descriptors 32
6.8.5 Conversion of Causes of Transmission 32
6.9 STI – Step Position Information 32
6.9.1 Supported Data Types 32
6.9.2 Additional Information 33
6.9.3 Conversion of Values 33
6.9.4 Conversion of Quality Descriptors 33
6.9.5 Conversion of Causes of Transmission 33

7 Data Types - Controlling Direction 35
7.1 ASO – Analog Setpoint Output 35
7.1.1 Supported Data Types 35
7.1.2 Command Authority 35
7.1.3 Additional information 35

7.1.4 Conversion of values 35
7.1.5 Conversion of qualifier of command 36
7.1.6 Conversion of causes of transmission 36
7.2 BSO – Bit String Output 36
7.2.1 Supported Data Types 36
7.2.2 Command Authority 36
7.2.3 Additional information 37
7.2.4 Conversion of values 37
7.2.5 Conversion of qualifier of command 37
7.2.6 Conversion of causes of transmission 37
7.3 DCO – Double Command Output 37
7.3.1 Supported Data Types 38
7.3.2 Command Authority 38
7.3.3 Additional Information 38
7.3.4 Conversion of Values 38
7.3.5 Conversion of qualifier of command 38
7.3.6 Conversion of causes of transmission 39
7.4 DSO – Digital Setpoint Output 39
7.4.1 Supported Data Types 39
7.4.2 Command Authority 40
7.4.3 Additional information 40
7.4.4 Conversion of values 40
7.4.5 Conversion of qualifier of command 40
7.4.6 Conversion of causes of transmission 40
7.5 FSO – Floating Point Setpoint Output 41
7.5.1 Supported Data Types 41
7.5.2 Command Authority 41
7.5.3 Additional Information 41
7.5.4 Conversion of values 41
7.5.5 Conversion of qualifier of command 42
7.5.6 Conversion of causes of transmission 42
7.6 RCO – Regulation Command Output 42
7.6.1 Supported Data Types 42
7.6.2 Command Authority 42
7.6.3 Additional information 43
7.6.4 Conversion of values 43
7.6.5 Conversion of qualifier of command 43
7.6.6 Conversion of causes of transmission 43
7.7 SCO – Single Command Output 44
7.7.1 Supported Data Types 44
7.7.2 Command Authority 44
7.7.3 Additional Information 44
7.7.4 Conversion of values 44
7.7.5 Conversion of qualifier of command 45
7.7.6 Conversion of causes of transmission 45

8 Transparent Data 47

8.1 Transparent data channel ... 47
8.1.1 Command direction ... 47
8.1.2 Monitoring direction ... 48
8.1.3 Request procedure ... 49
8.2 Encapsulated SPAbus messages ... 50
8.2.1 General ... 50
8.2.2 Request procedure ... 51

9 File Transfer ... 53
9.1 Supported data types ... 53
9.2 Values ... 53
9.3 Command Authority ... 54
9.4 Additional information ... 54
9.5 Conversion of causes of transmission ... 54
9.6 Download ... 54
9.7 Upload ... 54
9.8 Transmission of sequences of events ... 55
9.8.1 Scope of operation ... 55
9.8.2 Engineering in RTUtil500 ... 55
9.8.3 Runtime procedure ... 56
9.9 Transmission of sequences of recorded analog values ... 56
9.9.1 Scope of operation ... 56
9.9.2 Engineering in RTUtil500 ... 56
9.9.3 Runtime procedure ... 57

10 Internal Functions ... 59
10.1 General Interrogation ... 59
10.1.1 Supported Data Types ... 59
10.1.2 Values ... 59
10.1.3 Command Authority ... 59
10.1.4 Additional information ... 59
10.1.5 Conversion of Quality Descriptors ... 59
10.1.6 Conversion of Causes of Transmission ... 60
10.2 Counter Interrogation Command ... 60
10.2.1 Supported data types ... 60
10.2.2 Values ... 60
10.2.3 Command Authority ... 60
10.2.4 Additional information ... 60
10.2.5 Conversion of quality descriptors ... 61
10.2.6 Conversion of causes of transmission ... 61
10.3 Read Command ... 61
10.3.1 Supported data types ... 61
10.3.2 Values ... 62
10.3.3 Command Authority ... 62
10.3.4 Additional information ... 62
10.3.5 Conversion of quality descriptors ... 62
10.3.6 Conversion of causes of transmission ... 62

10.4 Time Synchronization ... 62
10.4.1 Supported Data Types ... 63
10.4.2 Values ... 63
10.4.3 Command Authority ... 63
10.4.4 Additional information ... 63
10.4.5 Conversion of Causes of Transmission ... 63
10.5 Test Command ... 63
10.5.1 Supported data types ... 63
10.5.2 Values ... 64
10.5.3 Command Authority ... 64
10.5.4 Additional information ... 64
10.5.5 Conversion of quality descriptors ... 64
10.5.6 Conversion of causes of transmission ... 64
10.6 Reset Command ... 64
10.6.1 Supported data types ... 64
10.6.2 Values ... 65
10.6.3 Command Authority ... 65
10.6.4 Additional information ... 65
10.6.5 Conversion of quality descriptors ... 65
10.6.6 Conversion of causes of transmission ... 65
10.7 Deactivate Command ... 65
10.7.1 Supported data types ... 65
10.7.2 Values ... 66
10.7.3 Command Authority ... 66
10.7.4 Additional information ... 66
10.7.5 Conversion of quality descriptors ... 66
10.7.6 Conversion of causes of transmission ... 66
10.8 Parameter Loading ... 66
10.8.1 Supported data types ... 67
10.8.2 Command Authority ... 67
10.8.3 Additional Information ... 67
10.8.4 Conversion of values for threshold ... 67
10.8.5 Conversion of values for smoothing ... 67
10.8.6 Conversion of qualifier of parameter of measured values ... 68
10.8.7 Conversion of causes of transmission ... 68
10.9 System Events ... 68
10.10 System commands ... 70
10.10.1 Reset device process ... 70
10.10.2 Force process image update ... 71
10.10.3 Request redundancy change over ... 71

11 Secure Communication according IEC 62351-3 ... 73
11.1 Technology Overview ... 73
11.2 TLS Version ... 73
11.3 TCP Ports ... 73
11.4 Supported Cipher Suites ... 73
11.5 Certificates ... 74

11.6 RTUtil500 Engineering ... 74
11.7 Certificate Upload via the RTU500 Web Server ... 75

12 Interoperability List ... 77
12.1 System or device ... 77
12.2 Network configuration ... 77
12.3 Physical Layer ... 77
12.3.1 Transmission speed (control direction) ... 77
12.3.2 Transmission speed (monitor direction) ... 78
12.4 Link Layer ... 79
12.5 Application Layer ... 79
12.5.1 Transmission Mode for Application Data ... 79
12.5.2 Common Address of ASDU ... 79
12.5.3 Information object address ... 80
12.5.4 Cause of transmission ... 80
12.5.5 Length of APDU ... 80
12.5.6 Selection of standard ASDUs ... 80
12.6 Basic application functions ... 84
12.6.1 Station initialization ... 84
12.6.2 Cyclic data transmission ... 84
12.6.3 Read procedure ... 85
12.6.4 Spontaneous transmission ... 85
12.6.5 Double transmission of information objects with cause of transmission spontaneous ... 85
12.6.6 Station interrogation ... 85
12.6.7 Clock synchronization ... 85
12.6.8 Command transmission ... 86
12.6.9 Transmission of integrated totals ... 86
12.6.10 Parameter loading ... 86
12.6.11 Parameter activation ... 86
12.6.12 Test procedure ... 87
12.6.13 File transfer ... 87
12.6.14 Background scan ... 87
12.6.15 Acquisition of transmission delay ... 87
12.6.16 Definition of timeouts ... 87
12.6.17 Maximum number of outstanding I format APDUs k and latest acknowledge APDUs (w) ... 88
12.6.18 Port number ... 88
12.6.19 Redundant connections ... 88
12.6.20 RFC 2200 suite ... 88

13 Glossary ... 89

1 Introduction

1.1 Preface

This document describes the functions of the host communication interface in RTU500 series according to IEC 60870-5-104.

RTU500 series fulfills the requirements of IEC 60870-5-104 Edition 2. Detailed information can be found in the interoperability list (see Chapter 12).

1.2 References

[1] Telecontrol equipment and systems – Part 5-104

Transmission protocols –

Network access for IEC 60870-5-101

using standard transport profiles
Second edition 06-2006

[2] RTU500 series Interfaces and Protocols Release 12 (1KGT 150 939)

[3] User Manual RTUtil500 Release 12 (1KGT 150 950)

1.3 Conventions

In this document function codes of data types according to IEC 60870-5-104 are marked with brackets: <Function code>

Bold fonts with the table heading "Parameter name" are references to configuration parameters in RTUtil500. The parameter is followed by the parameter location where to find this parameter in RTUtil500. The first element of the parameter location defines the node in the hardware tree on the left side (e. g. RTU, CMU, line, IED) and the second element defines selected header control tab in the parameter window on the right side (e. g. general, interfaces, protocol).

Example:

Parameter name	Default	Parameter location
In use	enabled	data point (e.g. SPI) - line T104
If enabled, the data point is transmitted to the host communication interface. This setting refers to data in monitoring and command direction.		

The tables in the next chapters include lists of the functions, options and message types supported according to the protocol structure given in IEC 60870-5 (EPA three layer model) for

The tables in the next chapters include lists of the functions, options and message types supported according to the protocol structure given in IEC 60870-5 (EPA three layer model) for

- the physical layer
- the link layer
- the application layer

This layered model is valid for the protocol IEC 60870-5-104.

2 Physical Layer

2.1 IP based Communication

The protocol IEC 60870-5-104 is running on the Ethernet-Interfaces of the CMU. For more details see RTU500 series Interfaces and Protocols Release 12 (1KGT 150 939).

For each Ethernet interface following parameters can be configured:

Parameter name	Default	Parameter location
Interface mode	Auto-negotiation	CMU - Network Interfaces
Transmisssion rate and duplex modes. Possible values are: - 100BaseTx half duplex - 100BaseTx full duplex - 10BaseT half duplex - 10BaseT full duplex - Auto-negotiation Default value: Auto-negotiation		
Node name	none	CMU - Network Interfaces
Node name of RTU at this ethernet interface		
IP Address	0.0.0.0	CMU - Network Interfaces
IP Address of this RTU interface		
Subnet mask	0.0.0.0	CMU - Network Interfaces
Subnet mask of IP address		
Default gateway IP	0.0.0.0	CMU - Network Interfaces
IP address of default gateway		

Following Ethernet line parameters can be configured for the master:

Parameter name	Default	Parameter location
Master IP Address	0.0.0.0 (only one host, all master IP addresses accepted)	Line Tx - IEC 60870-5-104
IP address(es) of the controlling station(s) Simultaneous communication with up to 8 hosts from the same message queues With or without identical sequence number for one message sent to all hosts Address 0.0.0.0 allowed in case of link to only one host		
2nd Master IP Address (upto 8th)	disabled	Line Tx - IEC 60870-5-104
Additional IP address to establish a redundant link.		
Send same sequence number	disabled	Line Tx - IEC 60870-5-104
If more than one host is connected to the same Ethernet interface, responses to the (redundant) hosts are sent with the same sequence number, if the parameter Send same sequence number is enabled		

2.2 Host interface

All host interfaces will be configured according to the following table.

Parameter name	Default	Parameter location
Host number	1	CMU - all interfaces
Logical number of this host interface. Value range: 1 to 16. The Host Number has to be unique in a system, and will point to the data in the system event block		
Interlock with local control authority	disabled	CMU - all interfaces
If enabled: No commands are accepted from the host, as long as a user has successfully requested the 'Command Authority' in the 'Integrated HMI'		

3 Link Layer

3.1 General

Protection against loss and duplication of message is handled as defined in [1, 5.1].

One or more parameter Master IP address is necessary, if more than one master station is connected to the network. For more details see chapter "3-4".

Parameter name	Default	Parameter location
Master IP Address	0.0.0.0 (only one host, all master IP addresses accepted)	Line Tx - IEC 60870-5-104
IP address(es) of the controlling station(s) Simultaneous communication with up to 8 hosts from the same message queues With or without identical sequence number for one message sent to all hosts Address 0.0.0.0 allowed in case of link to only one host		
2nd Master IP Address (upto 8th)	disabled	Line Tx - IEC 60870-5-104
Additional IP address to establish a redundant link.		
Send same sequence number	disabled	Line Tx - IEC 60870-5-104
If more than one host is connected to the same Ethernet interface, responses to the (redundant) hosts are sent with the same sequence number, if the parameter Send same sequence number is enabled		

3.2 Multi-Host Connection

Up to 16 hosts (NCC) can be connected to one RTU500 series system. In this case the RTU needs the IP addresses of the NCCs in order to distinguish the logical connections.

3.2.1 Configuration with one Ethernet interface

One host communication interface IEC 60870-5-104 of the RTU500 series is able to communicate with up to 8 NCCs. All NCCs can be located in different subnets according to the Ethernet interface configuration of the CMUs. If parameter Send same sequence number (see page "3-1") is enabled, responses to the (redundant) hosts are sent with the same sequence number.

3.2.2 Configuration with two Ethernet interfaces

For this configuration two physical Ethernet interfaces are needed with separate IP addresses. The two interfaces communicate with independent host lines. Dependent on the used RTU500 series hardware, the IP addresses of the links to the controlling station (NCC) have to be in different subnets or not.

For further information about the rules and restrictions of network configuration, please refer to the RTU500 series Function Description Part 6.

4 Application Layer

4.1 General

The selectable parameters have to be calculated regarding the real communication technology. All parameters preset to the default values from the IEC standard.

Parameter name	Default	Parameter location
ASDU address of station	1	RTU - Line T104
ASDU address of the station used for station specific commands, like counter interrogation commands, reset process commands, etc.		
Parameter name	**Default**	**Parameter location**
Setpoint command with command acknowl-edgement	disabled	RTU - Line T101/T104
If enabled, all setpoint commands will be respond with activation termination.		
Fixed originator address	disabled	RTU - Line T101/T104
If enabled, a fix originator address can be configured. This originator address is set in telegrams send by this host communication interface. Originator address. Value range 0 to 255. only possible to enable if special protocol profiles are selected		

Table 1: RTU parameters application layer

Parameter name	Default	Parameter location
Maximum difference receive sequence number (k)	12 APDUs	Line T104 - IEC 60870-5-104
k: maximum difference receive sequence number to send sequence count variable 1 to 32767 APDUs; default value: 12 APDUs		
Latest acknowledge after number of I format (w)	8 APDUs	Line T104 - IEC 60870-5-104
Latest acknowledge after receiving w I format APDUs 1 to 32767 APDUs; default value: 8 APDUs (w should not exceed two-thirds of k)		
ASDU address structure (16bit)	16 bit (2 octets)	Line T104 - IEC 60870-5-104
Length of Address fixed to 16 bit! Structured address with underscore as delimiter Example: 3_5_8 defines 16-bit address with 3 structure elements: 3 bit most significant 5 bit medium significant 8 bit least significant		
Information object address structure (24bit)	24 bit (3 octets)	Line T104 - IEC 60870-5-104
Length of Information Object Address fixed to 24 bit! Structured address with underscore as delimiter Example: 3_5_6_3_7 defines 24-bit address with 5 structure elements		
Maximum length of APDU	253 byte	Line T104 - IEC 60870-5-104
32 to 253 octets (byte) Default value: 253 octets		

Table 2: Parameters application layer IEC 60870-5-104: telegram framing

Parameter name	Default	Parameter location
Time out of connection establishment (t0)	30 sec	Line T104 - IEC 60870-5-104
t0: Time-out of connection establishment 1 to 255 seconds; default value: 30 seconds		
Send or test APDUs (t1)	15 sec	Line T104 - IEC 60870-5-104
t1: Time-out of send APDUs or test APDUs 1 to 255 seconds; default value: 15 seconds		
Acknowledge no data message (t2)	10 sec	Line T104 - IEC 60870-5-104
t2: Time-out for acknowledges in case of no data messages 1 to 255 seconds; default value: 10 seconds t2 < t1		
Sending test frames (t3)	30 sec	Line T104 - IEC 60870-5-104
t3: Timeout for sending test frames in case of a long idle state. Value range: 1 to 65535 seconds.		

Table 3: Parameters application layer IEC 60870-5-104: timeouts

Parameter name	Default	Parameter location
Protocol edition	Edition 1	Line T101/104 - IEC 60870-5-101/104
Edition 1: Timer t1 is retriggered with any transmitted telegram i.e. there is only one timer t1. Edition 2: Separate timer t1 for each sent telegram i.e. if any timer t1 expires connection is closed.		
Protocol profile	Default	Line T101/104 - IEC 60870-5-101/104
Selection of IEC60870-5-104 protocol profile. Default value 'Default' equals the IEC standard. Other selections activate special IEC protocol profiles.		
Background scan cycle	disabled	Line T101/104 - IEC 60870-5-101/104
If enabled: Background scan according to IEC60870-5-101/104 will be send with the configured cycle time. Cycle time of background scan in minutes or '-' to disable.		
Acknowledge Commands on reception	disabled	Line T101/104 - IEC 60870-5-101/104
Specification whether Activation Confirmation shall be sent immediately after receiption of a command Necessary if the primary station uses a fix timeout period with low tolerance Has no affect on the source of Activation Termination		
Send analog events with value 0 in GI	disabled	Line T101/104 - IEC 60870-5-101/104
If enabled: For subdevice communication interfaces with IEC60870-5-103. Selected values are transmitted with '0' during General Interrogation		
Exclusive started connection	disabled	Line T104 - IEC 60870-5-104
If enabled: Only the connection that last received a STARTDT is exclusivly the started connection. All other connections are handled as stopped connections.		
Treat value 'no counter requested (not used)' of RQT qualifier of C_CI_NA_1 as 'general request counter'	disabled	Line T101/104 - IEC 60870-5-101/104
If enabled: Qualifier of counter interrogation command 'no counter requested' is treated as 'general request counter'.		
Event buffer overflow strategy	Delete oldest event	Line T101/104 - IEC 60870-5-101/104
Delete oldest event: In case of overflow the oldest events will be removed from the concerned queue to get space for new events and put in a one-stage image. Delete newest event: In case of overflow the newest events are not entered to the queue but written to a one-stage process image instead.		
Parameter Loading	enabled	Line T101/104 - IEC 60870-5-101/104
If enabled: Parameter loading requests are supported. If disabled: Parameter loading requests will be responded negative.		

Table 4: Line parameters application layer IEC 60870-5-104: other parameters

Parameter name	Default	Parameter location
Allow only one general interrogation running per common address of ASDU	disabled	Line T101/104 - IEC 60870-5-101/104
If enabled: Only one running general interrogation per common address of ASDU is allowed.		

Table 4: Line parameters application layer IEC 60870-5-104: other parameters

4.2 Communication Queue Handling

The host interface has 7 different communication queues and an additional process image:

- Command acknowledgment queue
- Priority 1 queue for monitoring data (except integrated totals and measured values) (Priority 1 for monitoring data can be configured individual per data point)
- Priority 2 queue for monitoring data (except integrated totals and measured values) (Priority 2 for monitoring data can be configured individual per data point)
- Integrated totals (ITI) queue (The priority of the ITI queue can be assigned in total as Prio 1 or Prio 2)
- Spontaneous measured value queue
- Requested information queue incl. file transfer

The queue priority is assigned by function/ cause of transmission (COT) or by configuration

Highest Priority:

- Command acknowledgment queue (COT=6…10)

Priority level 1:

- Priority 1 Monitoring data queue (COT=3)
- Integrated totals queue (if configured as priority 1) (COT=3)

Priority level 2:

- Priority 2 Monitoring data queue (COT=3)
- Integrated totals queue (if configured as priority 2) (COT=3)
- Spontaneous measured value queue (COT=3)
- Requested information queue incl. file transfer (COT=37..41 and COT =13)
- SOE queue (if double transmission mode is activated)

Lowest priority:

- Interrogated data, direct from process image (COT=20…36)
- Periodic/ cyclic measured values, direct from process image (COT=1)
- Background cycle, direct from process image (COT=2)

Parameter name	Default	Parameter location
Buffer size of priority 1 datapoints	500 entries	CMU - all interfaces
Transmit buffer size for priority 1 data. Value range: 100 to 10000 entries		
Buffer size of priority 2 datapoints	500 entries	CMU - all interfaces
Transmit buffer size for priority 2 data. Value range: 100 to 10000 entries		
Buffer size of Integrated Totals (ITI)	1000 entries	CMU - all interfaces
Transmit buffer size for Integrated Total. Value range: 10 to 10000 entries		
Priority of ITI queue	2	CMU - all interfaces
Priority of the transmit buffer for Integrated Totals. Value range: 1 or 2		
Buffer size of spontaneous transmitted Analog Measured values (AMI)	500 entries	CMU - all interfaces
Transmit buffer size for spontaneous transmitted measurements. Value range: 100 to 100000		

Parameter name	Default	Parameter location
Queue storage timeout	aktiviert, 120 min	CMU - all interfaces
Delay time, before the buffers are cleared. Value range: disabled, 1 to 10080 minutes		

It is possible to disable buffering for selected monitoring data points:

Parameter name	Default	Parameter location
Put in buffer	Enabled	data point - line T101/T104
If enabled: parameter changes will be stored in buffer when host is offline. If disabled: GI is mandatory to get current value.		

4.3 Verification mode of command age

The protocol IEC 60870-5-104 allows also commands with time stamp [ASDU 58 ... 64]. The RTU500 series can verify this time stamp and rejects commands with old time stamp.

Parameter name	Default	Parameter location
Verification mode of command age	No verification	RTU - line T104
Selection, if timestamp of received command telegrams has to be verified. According to the selection, a command telegram can be rejected, if the selected conditions are not fulfilled.		
Max. accepted time window	30 s	RTU - line T104
Within this time window a process command telegram will be accepted, according to the specified mode.		
Summer time bit	disabled	RTU - line T104
If enabled: If the control system supports summer time bit, it is taken into account when calculating accepted time window for commands.		

Verification mode:

- No verification: The time stamp of the command is not verified.
- Tolerant verification:
  If RTU is not time-synchronized: The time stamp of the command is not verified.
  If RTU is time-synchronized: The time stamp is verified. The time difference may not exceed the parameter Max. accepted time window.
- Strict verification:
  If RTU is not time-synchronized: The command is rejected.
  If RTU is time-synchronized: The time stamp is verified. The time difference may not exceed the parameter Max. accepted time window.

4.4 ASDU Type identification

Overview on type identifications for data elements of the application layer defined in [2].

The column "RTU data type" shows the type of data with must be configured in RTUtil500.

4.4.1 ASDU in monitoring direction

ASDU	Description	Type identification	RTU data type
M_SP_NA_1	Single-point information	<1>	SPI

Table 5: ASDU in monitoring direction

ASDU	Description	Type identification	RTU data type
M_SP_TB_1	Single-point information with time tag CP56Time2a	<30>	SPI
M_DP_NA_1	Double-Point information	<3>	DPI
M_DP_TB_1	Double-Point information with time tag CP56Time2a	<31>	DPI
M_ST_NA_1	Step position information	<5>	STI
M_ST_TB_1	Step position information with time tag CP56Time2a	<32>	STI
M_BO_NA_1	Bitstring of 32 bit	<7>	BSI8/16/32[1]
M_BO_TB_1	Bitstring of 32 bit with time tag CP56Time2a	<33>	BSI8/16/32[1]
M_ME_NA_1	Measured value, normalized value	<9>	AMI DMI8/16
M_ME_TD_1	Measured value, normalized value with time tag CP56Time2a	<34>	AMI DMI8/16
M_ME_NB_1	Measured value, scaled value	<11>	AMI
M_ME_TE_1	Measured value, scaled value with time tag CP56Time2a	<35>	AMI
M_ME_NC_1	Measured value, short floating point	<13>	MFI
M_ME_TF_1	Measured value, short floating point value with time tag CP56Time2a	<36>	MFI
M_IT_NA_1	Integrated totals	<15>	ITI
M_IT_TB_1	Integrated totals with time tag CP56Time2a	<37>	ITI
M_EP_TD_1	Event of protection equipment with time tag CP56Time2a	<38>	EPI

Table 5: ASDU in monitoring direction

1 BSI32 is not supported for local I/O.

4.4.2 ASDU in control direction

ASDU	Description	Type identification	RTU data type
C_SC_NA_1	Single command	<45>	SCO
C_DC_NA_1	Double command	<46>	DCO
C_RC_NA_1	Regulation step command	<47>	RCO
C_SE_NA_1	Set point command, normalized value	<48>	ASO DSO8/16
C_SE_NB_1	Set point command, scaled value	<49>	ASO DSO8/16
C_SE_NC_1	Set point command, short floating point	<50>	FSO
C_BO_NA_1	Bitstring of 32 bit	<51>	BSO1/2/8/16/32
C_SC_TA_1	Single command with time tag	<58>	SCO
C_DC_TA_1	Double command with time tag	<59>	DCO
C_RC_TA_1	Regulation step command with time tag	<60>	RCO

Table 6: ASDU in control direction

ASDU	Description	Type identification	RTU data type
C_SE_TA_1	Setpoint command, normalized value with time tag	<61>	ASO DSO8/16
C_SE_TB_1	Setpoint command, scaled value with time tag	<62>	ASO DSO8/16
C_SE_TC_1	Setpoint command, short floating point, with time tag	<63>	FSO
C_BO_TA_1	Bitstring of 32 bit with time tag	<64>	BSO1/2/8/16/32

Table 6: ASDU in control direction

4.4.3 ASDU of system information in command direction

ASDU	Description	Type identification
C_IC_NA_1	Interrogation Command	<100>
C_CI_NA_1	Counter interrogation command	<101>
C_RD_NA_1	Read command	<102>
C_CS_NA_1	Clock synchronization command	<103>
C_RP_NA_1	Reset process command	<105>
C_TS_NA_1	Test command	<107>
P_ME_NA_1	Parameter of measured value, normalized	<110>
P_ME_NB_1	Parameter of measured value, scaled value	<111>
P_ME_NC_1	Parameter of measured value, floating point value	<112>

Table 7: System information in command direction

4.4.4 ASDU for file transfer

ASDU	Description	Type identification
F_FR_NA_1	File ready	<120>
F_SR_NA_1	Section ready	<121>
F_SC_NA_1	Call directory, select file, …	<122>
F_LS_NA_1	Last section, last segment	<123>
F_AF_NA_1	Ack file, ack section	<124>
F_SG_NA_1	Segment	<125>
F_DR_TA_1	Directory	<126>

Table 8: ASDU for file transfer

5 Parameters and Addressing

5.1 General data point parameters

Parameter name	Default	Parameter location
In use	enabled	data point (e.g. SPI) - line T104
If enabled, the data point is transmitted to the host communication interface. This setting refers to data in monitoring and command direction.		

Parameter name	Default	Parameter location
Group interrogation active	disabled	data point - Line T101/T104
If enabled: Data point belongs to an interrogation group		
Interrogation group number	disabled	data point - Line T101/T104/GP104
If enabled: Data point belongs to an interrogation group. Enter group number for group interrogation. Value range: 1 to 16 or '-' to disable.		

Table 9: General data point parameters

5.2 Address elements

Selection according to [1]. The address fields have the following size:

Parameter name	Default	Parameter location
Common address ASDU length	2 octets (fixed)	
Information object address length	3 octets (fixed)	
Cause of transmission length	2 octets (fixed)	

5.2.1 Restrictions for the Common Address

The value 0 is not allowed.

The highest possible address value (255 for 1 octet common address length and 65 535 for 2 octet common address length) is reserved for broadcast calls in control direction and therefore must not be used as station address.

Parameter name	Default	Parameter location
ASDU address of station	1	RTU - Line T104
ASDU address of the station used for station specific commands, like counter interrogation commands, reset process commands, etc.		

Parameter name	Default	Parameter location
ASDU address	1	data point - Line T104
Application Service Data Unit. The address may be unstructured or structured. Length: 2 octets.		

5.2.2 Restrictions for the information object address

All addresses must be unique within one station. The type of presentation (ASDU format) is not part of the identification of an object.

The value 0 is not allowed.

Parameter name	Default	Parameter location
Information object	1	data point - Line T104
Address of the Information Object. The address may be unstructured or structured. Length: 3 octets		

6 Data Types - Monitoring Direction

6.1 AMI – Analog Measured Information

Analog process information indicated by 16 bit used as a measured value from analog inputs in normalized or scaled format.

6.1.1 Supported Data Types

IEC 60870-5-104			RTU		
ASDU	**Type identification**	**Data type property**	**Data type**	**Parameter name**	**Parameter location**
M_ME_NA_1	<9>	normalized without timestamp	AMI	Transmission format: Normalized	AMI - line T101/ T104/GP104
M_ME_NB_1	<11>	scaled without timestamp	AMI	Transmission format: Scaled	AMI - line T101/ T104/GP104
M_ME_TD_1	<34>	normalized with timestamp CP56Time2a	AMI	Transmission format: Normalized	AMI - line T101/ T104/GP104
				Transmission with timestamp	AMI - line T101/ T104/GP104
M_ME_TE_1	<35>	scaled with timestamp CP56Time2a	AMI	Transmission format: Scaled	AMI - line T101/ T104/GP104
				Transmission with timestamp	AMI - line T101/ T104/GP104

Table 10: AMI - Supported data types

6.1.2 Additional Information

Parameter name	Default	Parameter location
Spontanous transmission	enabled	data point - Line T101/T104/GP104
if enabled: Spontaneous transmission of this process data point1)		
Background cycle	disabled	data point - Line T101/T104/GP104
If enabled: Cyclic transmission of this process data point out of the process image of the host interface with given cycle time of the background cycle. Value range: disabled, 1 sec, 2, 4, 5, 8, 10, 16, 30, 60 sec, 2 min, 5 min, 10 min, 15 min1)		

1)It is possible to set both parameters at the same data point. That means that the concerning data point is directly send to the NCC on every change and additional after the configured time period.

Parameter name	Default	Parameter location
Put in buffer	Enabled	data point - line T101/T104
If enabled: value changes will be stored in buffer when host is offline. If disabled: GI is mandatory to get current value.		

6.1.3 Conversion of Values

Parameter name	Default	Parameter location
Transmission format	Normalized	AMI - line T101/104
Transmission format for this data point: Normalized: Value range -1.0 ... +1.0 Scaled: Value range -32768.0 ... +32767.0.		
Maximum value	1 (Normalized) 32767 (Scaled)	AMI - line T101/104
+100 % within RTU internal communication get converted to parameter 'Maximum value' in the external communication protocol. Normalized: Value range -1.0 ... +1.0. Scaled: Value range -32768.0 ... +32767.0.		
Minimum value	-1 (Normalized -32768 (Scaled)	AMI - line T101/104
-100 % within RTU internal communication get converted to parameter 'Minimum value' in the external communication protocol. Normalized: Value range -1.0 ... +1.0. Scaled: Value range -32768.0 ... +32767.0.		

Range	RTU internal value	IEC 60870-5-104
Range min.	-100 %	Minimum value
...	...	
Range max.	+100 %	Maximum value

Table 11: AMI - Conversion of values

6.1.4 Conversion of Quality Descriptors

RTU		IEC 60870-5-104
Internal communication (short)	**Internal communication (long)**	**Communication**
OV	Overflow	Overflow
BL	Blocked	Blocked
SB	Substituted	Substituted
NT	Not Topical	Not Topical
IV	Invalid	Invalid

Table 12: AMI - Conversion of quality descriptors

6.1.5 Conversion of Causes of Transmission

RTU		IEC 60870-5-104
Internal communication (short)	**Internal communication (long)**	**Communication**
T	Test	Test
P/N	Positive/negative confirmation	- Irrelevant -
Cause	Spontaneous	3 - spontaneous

Table 13: AMI - Conversion of causes of transmission

RTU		IEC 60870-5-104
Internal communication (short)	**Internal communication (long)**	**Communication**
	Periodic / cyclic	1 - periodic / cyclic
	Background scan	2 - background scan
	Requested	5 - requested
	Interrogated	20, 21 ... 36 - interrogated

Table 13: AMI - Conversion of causes of transmission

6.2 BSI – Bit String Information

Binary process information is indicated by 8, 16 or 32 bit.

6.2.1 Supported Data Types

IEC 60870-5-104				RTU	
ASDU	**Type identification**	**Data type property**	**Data type**	**Parameter name**	**Parameter location**
M_BO_NA_1	<7>	without timestamp	BSI		
M_BO_TB_1	<33>	with timestamp CP56Time2a	BSI	Transmission with timestamp	BSI - line T101/T104/GP104

Table 14: BSI - Supported data types

6.2.2 Additional Information

Parameter name	Default	Parameter location
Put in buffer	Enabled	data point - line T101/T104

If enabled: value changes will be stored in buffer when host is offline.
If disabled: GI is mandatory to get current value.

6.2.3 Conversion of values

Range	RTU internal value	IEC 60870-5-104
Range min.	0	0
...	...	
Range max.	BSI8: Bit mask of 8 bit; range ... 255	255
	BSI16: Bit mask of 16 bit; range ... 65 535	65 535
	BSI32: Bit mask of 32 bit; range ... 4 294 967 295	4 294 967 295

Table 15: BSI - Conversion of values

6.2.4 Conversion of Quality Descriptors

RTU		IEC 60870-5-104
Internal communication (short)	**Internal communication (long)**	**Communication**
OV	Overflow	Overflow
BL	Blocked	Blocked
SB	Substituted	Substituted
NT	Not Topical	Not Topical
IV	Invalid	Invalid

Table 16: BSI - Conversion of quality descriptors

6.2.5 Conversion of Causes of Transmission

RTU		IEC 60870-5-104
Internal communication (short)	**Internal communication (long)**	**Communication**
T	Test	Test
P/N	Positive/negative confirmation	- Irrelevant -
Cause	Spontaneous	3 - spontaneous
	Background scan	2 - background scan
	Requested	5 - requested
	Interrogated	20, 21 ... 36 - interrogated

Table 17: BSI - Conversion of causes of transmission

6.3 DMI – Digital Measured Information

Binary process information indicated by 8 or 16 bit is used as a measured value from digital inputs in normalized format.

6.3.1 Supported Data Types

IEC 60870-5-104			RTU		
ASDU	**Type identification**	**Data type property**	**Data type**	**Parameter name**	**Parameter location**
M_ME_NA_1	<9>	without timestamp	DMI		
M_ME_TD_1	<34>	with timestamp CP56Time2a	DMI	Transmission with timestamp	DMI - line T101/T104/GP104

Table 18: DMI - Supported data types

6.3.2 Additional Information

Parameter name	Default	Parameter location
Put in buffer	Enabled	data point - line T101/T104
If enabled: value changes will be stored in buffer when host is offline. If disabled: GI is mandatory to get current value.		

6.3.3 Conversion of values

Range	RTU internal value	IEC 60870-5-104
Range min.	-100 %	-1
...	...	
Range max.	+100 %	$+1-2e^{-15}$

Table 19: DMI - Conversion of values

6.3.4 Conversion of Quality Descriptors

RTU		IEC 60870-5-104
Internal communication (short)	**Internal communication (long)**	**Communication**
OV	Overflow	Overflow
BL	Blocked	Blocked
SB	Substituted	Substituted
NT	Not Topical	Not Topical
IV	Invalid	Invalid

Table 20: DMI - Conversion of quality descriptors

6.3.5 Conversion of Causes of Transmission

RTU		IEC 60870-5-104
Internal communication (short)	**Internal communication (long)**	**Communication**
T	Test	Test
P/N	Positive/negative confirmation	- Irrelevant -
Cause	Spontaneous	3 - spontaneous
	Periodic / cyclic	1 - periodic / cyclic
	Background scan	2 - background scan
	Requested	5 - requested
	Interrogated	20, 21 ... 36 - interrogated

Table 21: DMI - Conversion of causes of transmission

6.4 DPI – Double Point Information

Binary process information is indicated by two bits.

6.4.1 Supported Data Types

IEC 60870-5-104				RTU	
ASDU	**Type identification**	**Data type property**	**Data type**	**Parameter name**	**Parameter location**
M_DP_NA_1	<3>	without timestamp	DPI		
M_DP_TB_1	<31>	with timestamp CP56Time2a	DPI	Transmission with timestamp	DPI - line T101/T104/ GP104

Table 22: DPI - Supported data types

6.4.2 Additional Information

Parameter name	Default	Parameter location
Put in buffer	Enabled	data point - line T101/T104
If enabled: value changes will be stored in buffer when host is offline. If disabled: GI is mandatory to get current value.		

6.4.3 Conversion of Values

RTU internal value	IEC 60870-5-104
intermediate	11
off	01
on	10
indeterminate	00

Table 23: DPI – Conversion of values

6.4.4 Conversion of Quality Descriptors

RTU		IEC 60870-5-104
Internal communication (short)	**Internal communication (long)**	**Communication**
BL	Blocked	Blocked
SB	Substituted	Substituted
NT	Not Topical	Not Topical
IV	Invalid	Invalid

Table 24: DPI - Conversion of quality descriptors

6.4.5 Conversion of Causes of Transmission

RTU		IEC 60870-5-104
Internal communication (short)	**Internal communication (long)**	**Communication**
T	Test	Test

Table 25: DPI - Conversion of causes of transmission

RTU		IEC 60870-5-104
Internal communication (short)	Internal communication (long)	Communication
P/N	Positive/negative confirmation	- Irrelevant -
Cause	Spontaneous	3 - spontaneous
	Background scan	2 - background scan
	Requested	5 - requested
	Interrogated	20, 21 ... 36 - interrogated

Table 25: DPI - Conversion of causes of transmission

6.5 EPI – Protection Event Information

Binary process information is indicated by two bits and relative timetag (used by protection relays).

6.5.1 Supported Data Types

IEC 60870-5-104				RTU	
ASDU	Type identification	Data type property	Data type	Parameter name	Parameter location
M_EP_TD_1	<38>	with timestamp CP56Time2a	EPI		

Table 26: EPI - Supported data types

6.5.2 Additional information

The EPI contents a elapsed time tag of the protection event with the range of 0..59 999 ms.

Parameter name	Default	Parameter location
Put in buffer	Enabled	data point - line T101/T104

If enabled: value changes will be stored in buffer when host is offline.
If disabled: GI is mandatory to get current value.

6.5.3 Conversion of Values

RTU internal value	IEC 60870-5-104
intermediate	0
off	1
on	2
indeterminate	3

Table 27: EPI - Conversion of values

6.5.4 Conversion of Quality Descriptors

RTU		IEC 60870-5-104
Internal communication (short)	**Internal communication (long)**	**Communication**
EI	Elapsed time valid	Elapsed time valid
BL	Blocked	Blocked
SB	Substituted	Substituted
NT	Not Topical	Not Topical
IV	Invalid	Invalid

Table 28: EPI - Conversion of quality descriptors

6.5.5 Conversion of Causes of Transmission

RTU		IEC 60870-5-104
Internal communication (short)	**Internal communication (long)**	**Communication**
T	Test	Test
P/N	Positive/negative confirmation	- Irrelevant -
Cause	Spontaneous	3 - spontaneous
	Background scan	2 - background scan

Table 29: EPI - Conversion of causes of transmission

6.6 ITI – Integrated Totals Information

Binary process information is indicated by 32 bits as a count value.

6.6.1 Supported Data Types

IEC 60870-5-104			RTU		
ASDU	**Type identification**	**Data type property**	**Data type**	**Parameter name**	**Parameter location**
M_IT_NA_1	<15>	without timestamp	ITI		
M_IT_TB_1	<37>	with timestamp CP56Time2a	ITI	Transmission with timestamp	ITI - line T101/T104/GP104

Table 30: ITI - Supported data types

6.6.2 Additional Information

	Parameter name	Default	Parameter location
Put in buffer		Enabled	data point - line T101/T104

If enabled: value changes will be stored in buffer when host is offline.
If disabled: GI is mandatory to get current value.

6.6.3 Conversion of Values

Range	RTU internal value	IEC 60870-5-104
Range min.	- 2 147 483 648 0 (from local I/O)	- 2 147 483 648 0
...	...	
Range max.	2 147 483 647	2 147 483 647

Table 31: ITI - Conversion of values

6.6.4 Conversion of Quality Descriptors

RTU		IEC 60870-5-104
Internal communication (short)	**Internal communication (long)**	**Communication**
SEQ	Sequence number	Sequence number
CY	Carry	Carry
CA	Adjusted	Adjusted
IV	Invalid	Invalid

Table 32: ITI - Conversion of quality descriptors

6.6.5 Conversion of Causes of Transmission

RTU		IEC 60870-5-104
Internal communication (short)	**Internal communication (long)**	**Communication**
T	Test	Test
P/N	Positive/negative confirmation	- Irrelevant -
Cause	Spontaneous	3 - spontaneous
	Requested	5 - requested
	Interrogated	37, 38 … 41 - interrogated

Table 33: ITI - Conversion of causes of transmission

6.7 MFI – Measured Float Information

32 bit analog process information is used as a measured value in float format.

6.7.1 Supported Data Types

IEC 60870-5-104			RTU		
ASDU	**Type identification**	**Data type property**	**Data type**	**Parameter name**	**Parameter location**
M_ME_NC_1	<13>	without time-stamp	MFI		

Table 34: MFI - Supported data types

IEC 60870-5-104			RTU		
ASDU	Type identification	Data type property	Data type	Parameter name	Parameter location
M_ME_TF_1	<36>	with timestamp CP56Time2a	MFI	Transmission with timestamp	MFI - line T101/ T104/GP104

Table 34: MFI - Supported data types

6.7.2 Values

R32–IEEE STD 754

6.7.3 Additional Information

Parameter name	Default	Parameter location
Spontanous transmission	enabled	data point - Line T101/T104/GP104
if enabled: Spontaneous transmission of this process data point1)		
Background cycle	disabled	data point - Line T101/T104/GP104
If enabled: Cyclic transmission of this process data point out of the process image of the host interface with given cycle time of the background cycle. Value range: disabled, 1 sec, 2, 4, 5, 8, 10, 16, 30, 60 sec, 2 min, 5 min, 10 min, 15 min1)		

1)It is possible to set both parameters at the same data point. That means that the concerning data point is directly send to the NCC on every change and additional after the configured time period.

Parameter name	Default	Parameter location
Put in buffer	Enabled	data point - line T101/T104
If enabled: value changes will be stored in buffer when host is offline. If disabled: GI is mandatory to get current value.		

6.7.4 Conversion of Values

Range	RTU internal value	IEC 60870-5-104
Range min.	-3.4 x 10e38	-3.4 x $10e^{38}$
...	...	
Range max.	+3.4 x 10e38	+3.4 x $10e^{38}$

Table 35: MFI - Conversion of values

6.7.5 Conversion of Quality Descriptors

RTU		IEC 60870-5-104
Internal communication (short)	Internal communication (long)	Communication
OV	Overflow	Overflow
BL	Blocked	Blocked

Table 36: MFI - Conversion of quality descriptors

RTU		IEC 60870-5-104
Internal communication (short)	**Internal communication (long)**	**Communication**
SB	Substituted	Substituted
NT	Not Topical	Not Topical
IV	Invalid	Invalid

Table 36: MFI - Conversion of quality descriptors

6.7.6 Conversion of Causes of Transmission

RTU		IEC 60870-5-104
Internal communication (short)	**Internal communication (long)**	**Communication**
T	Test	Test
P/N	Positive/negative confirmation	- Irrelevant -
Cause	Spontaneous	3 - spontaneous
	Periodic / cyclic	1 - periodic / cyclic
	Background scan	2 - background scan
	Requested	5 - requested
	Interrogated	20, 21 ... 36 - interrogated

Table 37: MFI - Conversion of causes of transmission

6.8 SPI – Single Point Information

Binary process information is indicated by one bit.

6.8.1 Supported Data Types

IEC 60870-5-104			RTU		
ASDU	**Type identification**	**Data type property**	**Data type**	**Parameter name**	**Parameter location**
M_SP_NA_1	<1>	without timestamp	SPI		
M_SP_TB_1	<30>	with timestamp CP56Time2a	SPI	Transmission with timestamp	SPI - line T101/T104/GP104

Table 38: SPI - Supported data types

6.8.2 Additional Information

Parameter name	Default	Parameter location
Put in buffer	Enabled	data point - line T101/T104
If enabled: value changes will be stored in buffer when host is offline. If disabled: GI is mandatory to get current value.		

6.8.3 Conversion of Values

RTU internal value	IEC 60870-5-104
off	0
on	1

Table 39: SPI - Conversion of values

6.8.4 Conversion of Quality Descriptors

RTU		IEC 60870-5-104
Internal communication (short)	**Internal communication (long)**	**Communication**
BL	Blocked	Blocked
SB	Substituted	Substituted
NT	Not Topical	Not Topical
IV	Invalid	Invalid

Table 40: SPI - Conversion of quality descriptors

6.8.5 Conversion of Causes of Transmission

RTU		IEC 60870-5-104
Internal communication (short)	**Internal communication (long)**	**Communication**
T	Test	Test
P/N	Positive/negative confirmation	- Irrelevant -
Cause	Spontaneous	3 - spontaneous
	Background scan	2 - background scan
	Requested	5 - requested
	Interrogated	20, 21 ... 36 - interrogated

Table 41: SPI - Conversion of causes of transmission

6.9 STI – Step Position Information

Binary process information is indicated by 8 bits.

6.9.1 Supported Data Types

IEC 60870-5-104			RTU		
ASDU	**Type identification**	**Data type property**	**Data type**	**Parameter name**	**Parameter location**
M_ST_NA_1	<5>	without timestamp	STI		
M_ST_TB_1	<32>	with timestamp CP56Time2a	STI	Transmission with timestamp	STI - line T101/T104/GP104

Table 42: STI - Supported data types

IEC 60870-5-104			RTU		
ASDU	Type identification	Data type property	Data type	Parameter name	Parameter location

Table 42: STI - Supported data types

6.9.2 Additional Information

	Parameter name	Default	Parameter location
Put in buffer		Enabled	data point - line T101/T104
If enabled: value changes will be stored in buffer when host is offline. If disabled: GI is mandatory to get current value.			

6.9.3 Conversion of Values

Range	RTU internal value	IEC 60870-5-104
Range min.	-63	-63
...	...	
Range max.	+63	+63

Table 43: STI - Conversion of values

6.9.4 Conversion of Quality Descriptors

RTU		IEC 60870-5-104
Internal communication (short)	**Internal communication (long)**	**Communication**
OV	Overflow	Overflow
BL	Blocked	Blocked
SB	Substituted	Substituted
NT	Not Topical	Not Topical
IV	Invalid	Invalid
T	Transient Bit	Transient Bit

Table 44: STI - Conversion of quality descriptors

6.9.5 Conversion of Causes of Transmission

RTU		IEC 60870-5-104
Internal communication (short)	**Internal communication (long)**	**Communication**
T	Test	Test
P/N	Positive/negative confirmation	- Irrelevant -
Cause	Spontaneous	3 - spontaneous
	Background scan	2 - background scan
	Requested	5 - requested

Table 45: STI - Conversion of causes of transmission

RTU		IEC 60870-5-104
Internal communication (short)	**Internal communication (long)**	**Communication**
	Interrogated	20, 21 ... 36 - interrogated

Table 45: STI - Conversion of causes of transmission

7 Data Types - Controlling Direction

7.1 ASO – Analog Setpoint Output

Analog process command (16 bit signed number).

7.1.1 Supported Data Types

IEC 60870-5-104			RTU		
ASDU	Type identification	Data type property	Data type	Parameter name	Parameter location
C_SE_NA_1	<48>	normalized, without time tag	ASO	Transmission format: Normalized	ASO - line T101/ T104/GP104
C_SE_TA_1	<61>	normalized, with time tag CP56Time2a	ASO	Transmission format: Normalized	ASO - line T104/ GP104
C_SE_NB_1	<49>	scaled, without time tag	ASO	Transmission format: Scaled	ASO - line T101/ T104/GP104
C_SE_TB_1	<62>	scaled, with time tag CP56Time2a	ASO	Transmission format: Scaled	ASO - line T104/ GP104

Table 46: ASO - Supported data types

7.1.2 Command Authority

See also parameter Interlock with local control authority

(Table Interface parameters - IEC 60870-5-104 in chapter Physical Layer (page "2-1"))

7.1.3 Additional information

Analog set-point output is a persistent output.

7.1.4 Conversion of values

Range	RTU internal value	IEC 60870-5-104
Range min.	-100 %	Normalized: -1 Scaled: -32 768
...	...	
Range max.	+100 %	Normalized: $+1\text{-}2e^{-15}$ Scaled: +32 767

Table 47: ASO - Conversion of values

7.1.5 Conversion of qualifier of command

RTU		IEC 60870-5-104
Internal communication (short)	Internal communication (long)	Communication
SE	Select / Execute	Select / Execute (1 select, 0 execute)
QL	default	0 - default

Table 48: ASO - conversion of qualifier of command

7.1.6 Conversion of causes of transmission

RTU		IEC 60870-5-104
Internal communication (short)	Internal communication (long)	Communication
T	Test	Ignored
P/N	Positive/negative confirmation	Relevant in monitor direction only
Cause	Activation	6 - Activation
	Activation Confirmation	7 - Activation Confirmation
	Deactivation	8 - Deactivation
	Deactivation Confirmation	9 - Deactivation Confirmation
	Activation Termination	10 - Activation Termination
	Negative Confirmation	45 … 47 - Unknown

Table 49: ASO - Conversion of causes of transmission

7.2 BSO – Bit String Output

Binary process command (1, 2, 8, 16, 32 bit unsigned number).

7.2.1 Supported Data Types

IEC 60870-5-104				RTU	
ASDU	Type identification	Data type property	Data type	Parameter name	Parameter location
C_BO_NA_1	<51>	without time tag	BSO		
C_BO_TA_1	<64>	with time tag, CP56Time2a	BSO		

Table 50: BSO - Supported data types

7.2.2 Command Authority

See also parameter Interlock with local control authority

(Table Interface parameters - IEC 60870-5-104 in chapter Physical Layer (page "2-1"))

7.2.3 Additional information

Always persistent output. A new command with value 0 (all bits) has to be generated.

7.2.4 Conversion of values

Range	RTU internal value	IEC 60870-5-104
Range min.	0	0
...	...	
Range max.	4 294 967 295	4 294 967 295

Table 51: BSO - Conversion of values

7.2.5 Conversion of qualifier of command

RTU		IEC 60870-5-104
Internal communication (short)	Internal communication (long)	Communication
SE	only direct execute	only direct execute

Table 52: BSO - conversion of qualifier of command

7.2.6 Conversion of causes of transmission

RTU		IEC 60870-5-104
Internal communication (short)	Internal communication (long)	Communication
T	Test	Ignored
P/N	Positive/negative confirmation	Relevant in monitor direction only
Cause	Activation	6 - Activation
	Activation Confirmation	7 - Activation Confirmation
	Activation Termination	10 - Activation Termination
	Negative Confirmation	45 … 47 - Unknown

Table 53: BSO - Conversion of causes of transmission

7.3 DCO – Double Command Output

Binary process command (two bits).

7.3.1 Supported Data Types

IEC 60870-5-104				RTU	
ASDU	Type identification	Data type property	Data type	Parameter name	Parameter location
C_DC_NA_1	<46>	without timestamp	DCO		
C_DC_TA_1	<59>	with timestamp CP56Time2a	DCO		

Table 54: DCO - Supported data types

7.3.2 Command Authority

See also parameter Interlock with local control authority

(Table Interface parameters - IEC 60870-5-104 in chapter Physical Layer (page "2-1"))

7.3.3 Additional Information

None

7.3.4 Conversion of Values

RTU internal value	IEC 60870-5-104
off	01
on	10

Table 55: DCO - Conversion of values

7.3.5 Conversion of qualifier of command

RTU		IEC 60870-5-104
Internal communication (short)	Internal communication (long)	Communication
SE	Select / Execute	Select / Execute (1 select, 0 execute)
QU	default	0 - no additional definition
	overwritten for local I/O by command output duration parameter	1 - short pulse duration
	overwritten for local I/O by command output duration parameter	2 - long pulse duration

Table 56: DCO - conversion of qualifier of command

RTU		IEC 60870-5-104
Internal communication (short)	**Internal communication (long)**	**Communication**
	overwritten for local I/O by command output type parameter	3 - persistent output
	IEC61850 client: function is used to specify command check attributes	9... 15 - reserved for the selection of other predefined functions

Table 56: DCO - conversion of qualifier of command

7.3.6 Conversion of causes of transmission

RTU		IEC 60870-5-104
Internal communication (short)	**Internal communication (long)**	**Communication**
T	Test	Ignored
P/N	Positive/negative confirmation	Relevant in monitor direction only
Cause	Activation	6 - Activation
	Activation Confirmation	7 - Activation Confirmation
	Deactivation	8 - Deactivation
	Deactivation Confirmation	9 - Deactivation Confirmation
	Activation Termination	10 - Activation Termination
	Negative Confirmation	45 … 47 - Unknown

Table 57: DCO - Conversion of causes of transmission

7.4 DSO – Digital Setpoint Output

Binary process command (8 or 16 bit signed number).

7.4.1 Supported Data Types

IEC 60870-5-104			RTU		
ASDU	**Type identification**	**Data type property**	**Data type**	**Parameter name**	**Parameter location**
C_SE_NA_1	<48>	normalized, without time tag	DSO	Transmission format: Normalized	DSO - line T101/T104/GP104
C_SE_TA_1	<61>	normalized, with time tag CP56Time2a	DSO	Transmission format: Normalized	DSO - line T104/GP104
C_SE_NB_1	<49>	scaled, without time tag	DSO	Transmission format: Scaled	DSO - line T101/T104/GP104

Table 58: DSO - Supported data types

IEC 60870-5-104			RTU		
ASDU	Type identification	Data type property	Data type	Parameter name	Parameter location
C_SE_TB_1	<62>	scaled, with time tag CP56Time2a	DSO	Transmission format: Scaled	DSO - line T104/ GP104

Table 58: DSO - Supported data types

7.4.2 Command Authority

See also parameter Interlock with local control authority

(Table Interface parameters - IEC 60870-5-104 in chapter Physical Layer (page "2-1"))

7.4.3 Additional information

Digital set-point output is a persistent output.

7.4.4 Conversion of values

Range	RTU internal value	IEC 60870-5-104
Range min.	-100 %	-1
...	...	
Range max.	+100 %	$+1-2e^{-15}$

Table 59: DSO - Conversion of values

7.4.5 Conversion of qualifier of command

RTU		IEC 60870-5-104
Internal communication (short)	Internal communication (long)	Communication
SE	Select / Execute	Select / Execute (1 select, 0 execute)
QL	default	0 - default

Table 60: DSO - conversion of qualifier of command

7.4.6 Conversion of causes of transmission

RTU		IEC 60870-5-104
Internal communication (short)	Internal communication (long)	Communication
T	Test	Ignored
P/N	Positive/negative confirmation	Relevant in monitor direction only
Cause	Activation	6 - Activation

Table 61: DSO - Conversion of causes of transmission

RTU		IEC 60870-5-104
Internal communication (short)	Internal communication (long)	Communication
	Activation Confirmation	7 - Activation Confirmation
	Deactivation	8 - Deactivation
	Deactivation Confirmation	9 - Deactivation Confirmation
	Activation Termination	10 - Activation Termination
	Negative Confirmation	45 … 47 - Unknown

Table 61: DSO - Conversion of causes of transmission

7.5 FSO – Floating Point Setpoint Output

Floating point process command (32 bit short floating point number)

7.5.1 Supported Data Types

IEC 60870-5-104			RTU		
ASDU	Type identification	Data type property	Data type	Parameter name	Parameter location
C_SE_NC_1	<50>	without time tag	FSO		
C_SE_TC_1	<63>	with time tag CP56Time2a	FSO		

Table 62: FSO - Supported data types

7.5.2 Command Authority

See also parameter Interlock with local control authority

(Table Interface parameters - IEC 60870-5-104 in chapter Physical Layer (page "2-1"))

7.5.3 Additional Information

None

7.5.4 Conversion of values

Range	RTU internal value	IEC 60870-5-104
Range min.	-3.4 x 10e38	-3.4 x 10e38
...	...	
Range max.	+3.4 x 10e38	+3.4 x 10e38

Table 63: FSO - Conversion of values

7.5.5 Conversion of qualifier of command

RTU		IEC 60870-5-104
Internal communication (short)	**Internal communication (long)**	**Communication**
SE	Select / Execute	Select / Execute (1 select, 0 execute)
QL	default	0 - default

Table 64: FSO - conversion of qualifier of command

7.5.6 Conversion of causes of transmission

RTU		IEC 60870-5-104
Internal communication (short)	**Internal communication (long)**	**Communication**
T	Test	Ignored
P/N	Positive/negative confirma-tion	Relevant in monitor direction only
Cause	Activation	6 - Activation
	Activation Confirmation	7 - Activation Confirmation
	Deactivation	8 - Deactivation
	Deactivation Confirmation	9 - Deactivation Confirmation
	Activation Termination	10 - Activation Termination
	Negative Confirmation	45 … 47 - Unknown

Table 65: FSO - Conversion of causes of transmission

7.6 RCO – Regulation Command Output

Regulation step command (two bits).

7.6.1 Supported Data Types

IEC 60870-5-104			RTU		
ASDU	**Type iden-tification**	**Data type property**	**Data type**	**Parame-ter name**	**Parameter location**
C_RC_NA_1	<47>	without time tag	RCO		
C_RC_TA_1	<60>	with time tag CP56Time2a	RCO		

Table 66: RCO - Supported data types

7.6.2 Command Authority

See also parameter Interlock with local control authority

(Table Interface parameters - IEC 60870-5-104 in chapter Physical Layer (page "2-1"))

7.6.3 Additional information

Regulation step commands are in principle retriggerable commands.

In order to retrigger a running two step regulation command, it is not necessary to resend the command Select.

7.6.4 Conversion of values

RTU internal value	IEC 60870-5-104
Lower	01
Higher	10

Table 67: RCO - Conversion of values

7.6.5 Conversion of qualifier of command

RTU		IEC 60870-5-104
Internal communication (short)	**Internal communication (long)**	**Communication**
SE	Select / Execute	Select / Execute (1 select, 0 execute)
QU	default	0 - no additional definition
	overwritten for local I/O by command output duration parameter	1 - short pulse duration
	overwritten for local I/O by command output duration parameter	2 - long pulse duration
	overwritten for local I/O by command output type parameter	3 - persistent output
	IEC61850 client: function is used to specify command check attributes	9... 15 - reserved for the selection of other predefined functions

Table 68: RCO - conversion of qualifier of command

7.6.6 Conversion of causes of transmission

RTU		IEC 60870-5-104
Internal communication (short)	**Internal communication (long)**	**Communication**
T	Test	Ignored
P/N	Positive/negative confirmation	Relevant in monitor direction only
Cause	Activation	6 - Activation
	Activation Confirmation	7 - Activation Confirmation

Table 69: RCO - Conversion of causes of transmission

RTU		IEC 60870-5-104
Internal communication (short)	**Internal communication (long)**	**Communication**
	Deactivation	8 - Deactivation
	Deactivation Confirmation	9 - Deactivation Confirmation
	Activation Termination	10 - Activation Termination
	Negative Confirmation	45 … 47 - Unknown

Table 69: RCO - Conversion of causes of transmission

7.7 SCO – Single Command Output

Binary process command (one bit).

7.7.1 Supported Data Types

IEC 60870-5-104			RTU		
ASDU	**Type identification**	**Data type property**	**Data type**	**Parameter name**	**Parameter location**
C_SC_NA_1	<45>	without timestamp	SCO		
C_SC_TA_1	<58>	with timestamp CP56Time2a	SCO		

Table 70: SCO - Supported data types

7.7.2 Command Authority

See also parameter Interlock with local control authority

(Table Interface parameters - IEC 60870-5-104 in chapter Physical Layer (page "2-1"))

7.7.3 Additional Information

None

7.7.4 Conversion of values

RTU internal value	IEC 60870-5-104
off	0
on	1

Table 71: SCO - Conversion of values

7.7.5 Conversion of qualifier of command

RTU		IEC 60870-5-104
Internal communication (short)	**Internal communication (long)**	**Communication**
SE	Select / Execute	Select / Execute (1 select, 0 execute)
QU	default	0 - no additional definition
	overwritten for local I/O by command output duration parameter	1 - short pulse duration
	overwritten for local I/O by command output duration parameter	2 - long pulse duration
	overwritten for local I/O by command output type parameter	3 - persistent output
	IEC61850 client: function is used to specify command check attributes	9... 15 - reserved for the selection of other predefined functions

Table 72: SCO - conversion of qualifier of command

7.7.6 Conversion of causes of transmission

RTU		IEC 60870-5-104
Internal communication (short)	**Internal communication (long)**	**Communication**
T	Test	Ignored
P/N	Positive/negative confirmation	Relevant in monitor direction only
Cause	Activation	6 - Activation
	Activation Confirmation	7 - Activation Confirmation
	Deactivation	8 - Deactivation
	Deactivation Confirmation	9 - Deactivation Confirmation
	Activation Termination	10 - Activation Termination
	Negative Confirmation	45 … 47 - Unknown

Table 73: SCO - Conversion of causes of transmission

8 Transparent Data

In automation systems may be required information that is not mapped to the IEC 60870-5-104 protocol. This information includes several device specific parameters etc.

Several type identifications of the private range have been selected to enable transparent data transfer through the RTU500 series RTU to subordinated devices.

8.1 Transparent data channel

8.1.1 Command direction

With the Transparent Data Message C_TD_NA_1 the Controlling Station is able to request data from subordinate devices through the RTU500 series.

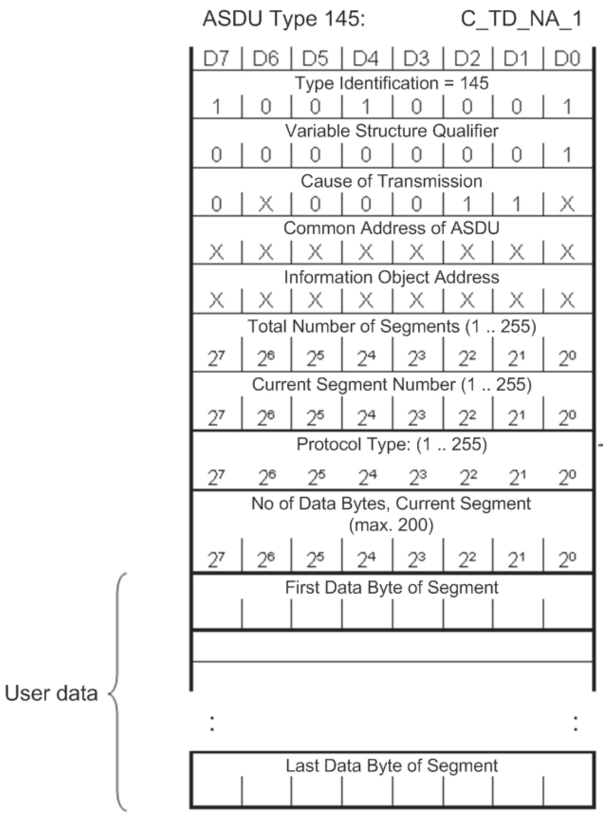
The Type Ident is 145, ASDU address and the Information object address must be configured in RTUtil500.

The Transparent Data Message C_TD_NA_1 will be answered from the RTU by sending the message back to Controlling Station with Cause of Transmission 7 (activation confirmation).

When the message is accepted by the RTU (message can be processed by the RTU and device answers to the request message), the RTU sends a “positive confirmation” ACTCON, otherwise (message cannot be processed by the RTU) the RTU sends a “negative confirmation” ACTCON.

Every transparent data command is checked on ASDU address, information object address and “No of Data Bytes in Current Segment“.

If the ASDU address or information object address does not match to the configuration in RTUtil500 or the “No of Data Bytes in Current Segment” is higher than 200, the command is confirmed negative.



Protocol Type	Value in Protocol Type field
SPAbus	7
RP570/571	8*
Modbus	9
IEC 60870-5-101	101*
IEC 60870-5-102	102
IEC 60870-5-103	103*
IEC 60870-5-104	104*
IEC 1107	107

* : reserved for future use

Figure 1: ASDU Type 145

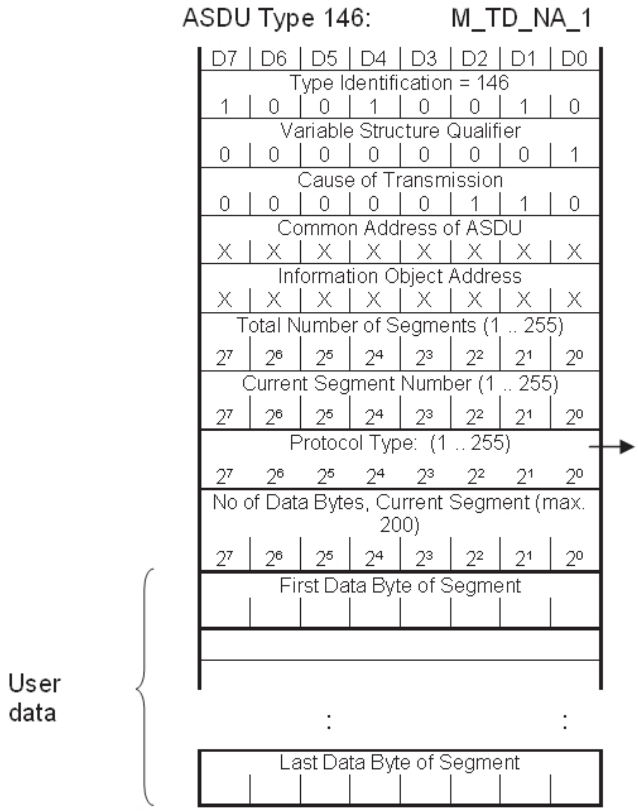
8.1.2 Monitoring direction

With the Transparent Data Response M_TD_NA_1, the RTU is able to transmit any data as transparent data to a Controlling Station.

The Type Ident is 146, the ASDU address and the Information object address must be configured by RTUtil500. They are equal to the one used in command direction.

The maximum amount of segments is 255, each of them contains up to 200 data bytes.

If all data can be sent in one message (data segmentation not necessary), the contents of both segmentation control fields are set to 1.



Protocol Type	Value in Protocol Type field
SPAbus	7
RP570/571	8*
Modbus	9
IEC 60870-5-101	101*
IEC 60870-5-102	102
IEC 60870-5-103	103*
IEC 60870-5-104	104*
IEC 62056-21	107

* : reserved for future use

Figure 2: ASDU Type 146

8.1.3 Request procedure

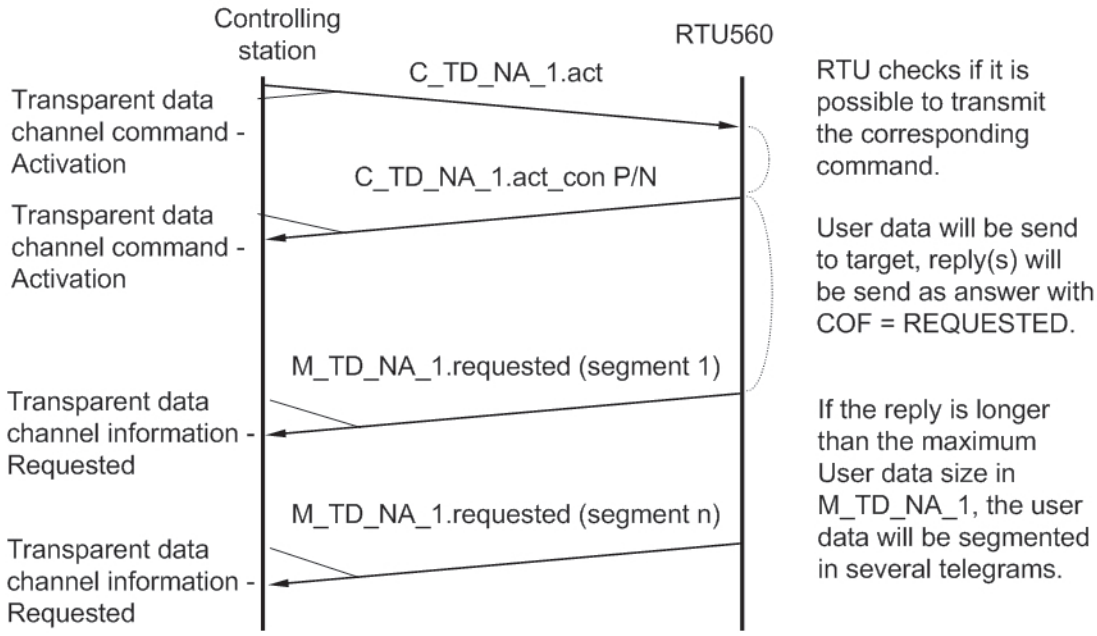


Figure 3: Request procedure

8.2 Encapsulated SPAbus messages

8.2.1 General

With the Transparent Data Message C_SB_NA_1 the Controlling Station is able to request data and execute commands of a SPAbus device connected to a subordinate device through the RTU560.

The Type Ident is 133, the ASDU address and the Information object address must be configured in RTUtil500.

The Transparent Data Message C_SB_NA_1 will be answered from RTU by sending the message back to Central System with Cause of Transmission 7 (activation confirmation).

When the message is accepted by the subordinate device (Device answers to the request message), the RTU sends a "positive confirmation" ACTCON with the reply data included, otherwise (message cannot be processed) the RTU sends a "negative confirmation" ACTCON.

Every transparent data command is checked on ASDU address, information object address and “No of Data Bytes in Current Segment“.

If the ASDU address, information object address or “No of Data Bytes” does not match to the configuration in RTUtil500, the command is confirmed negative.

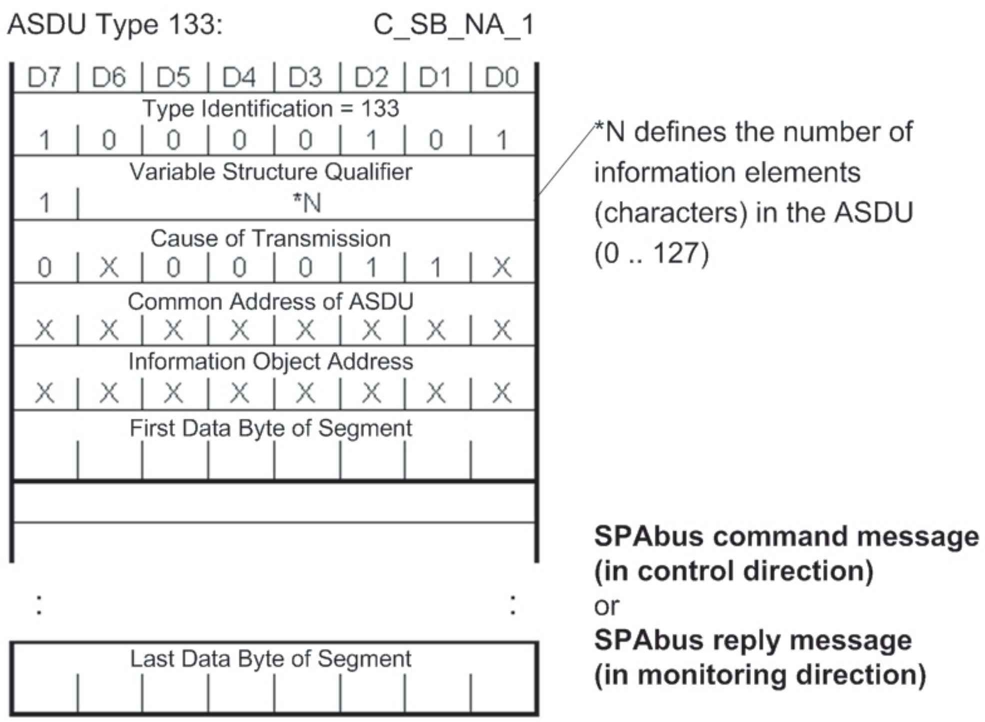


Figure 4: ASDU Type 133

8.2.2 Request procedure

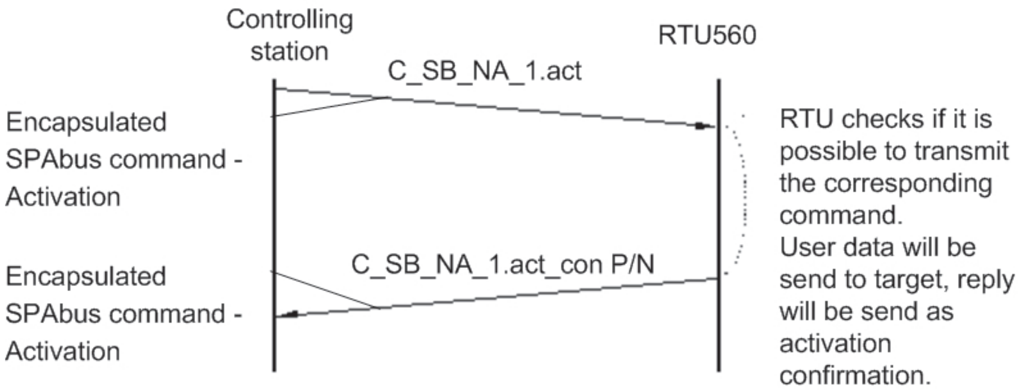


Figure 5: Request procedure

9 File Transfer

The file transfer is used for exchanging files between a control center and a RTU500 series or a subordinated device.

Before starting file transfer to an RTU, the control center can deactivate the RTU (stop periodic measurements), in order to have highest possible bandwidth for the file transfer. If no new configuration files are loaded into the RTU between deactivation and reset command, the RTU restarts with the same configuration data as before.

If a file transfer is started without preceding deactivation command, the RTU will continue its normal operation during the complete file transfer process. The downloaded configuration will become active only after a restart of the RTU.

The file name in the protocol is fixed for the following supported file types to 1 (transparent file).

Supported file types:

- RCD configuration file
- PRO configuration file (PLC boot project file)
- Disturbance recorder of various protocols and device types. See corresponding SCI description for details.
- UNDEF file not specified in greater detail

The name of file in the protocol for ‘Sequence of events’ is 3 and ‘Sequence of analog values’ is 4.

- Sequence of events file
- Sequence of recorded analog values file

9.1 Supported data types

IEC 60870-5-104			RTU		
ASDU	**Type identification**	**Data type property**	**Data type**	**Parameter name**	**Parameter location**
F_FR_NA_1	<120>				
F_SR_NA_1	<121>				
F_SC_NA_1	<122>				
F_LS_NA_1	<123>				
F_AF_NA_1	<124>				
F_SG_NA_1	<125>				
F_DR_TA_1	<126>				

Table 74: File transfer - Supported data types

9.2 Values

None.

9.3 Command Authority

None

9.4 Additional information

F_DR_TA_1 cannot be generated by RTU500 series, but routed to/from subordinated devices.

9.5 Conversion of causes of transmission

RTU		IEC 60870-5-104
Internal communication (short)	Internal communication (long)	Communication
T	Test	Ignored
P/N	Positive/negative confirmation	Relevant in monitor direction only
Cause	Spontaneous	3 – spontaneous (126)
	Requested	5 – requested (122, 126)
	File transfer	13 - file transfer

Table 75: File transfer - Conversion of causes of transmission

9.6 Download

The download of configuration files does not trigger any restarting mechanism in the RTU500 series. For activating the new configuration file, the control center has to issue a Reset Process Command (C_RP_NA_1, ASDU 105) after writing the files to the RTU500 series.

The RCD configuration file is distributed to every CMU board in the system concerned after download is completed. Configuration file distribution will only be done, if the file belongs to the RTU itself. Otherwise the file transfer will only be routed to the subordinated device it belongs to. In this case the file transfer handling is done by the subordinated device (e.g. a RTU of the RTU500 series).

PRO configuration file is only stored local these download is completed. This means, that PLC functions using this configuration file has to be located on the same CMU-board where the host communication interface handling the file transfer is located.

The distribution is done between the message F_LS_NA_1 and the message F_AF_NA_1 and may last a couple of seconds.

The message F_AF_NA_1 is only acknowledged positive, when file transfer and file distribution was successful. If a file transfer to a RTU500 series is confirmed negative, the downloaded file was not stored and the previous file is not deleted or overwritten.

9.7 Upload

All supported file types can also be uploaded from a RTU of the RTU500 series or an IED.

See documentation of the relevant subdevice communication interface for support of (disturbance) file upload.

9.8 Transmission of sequences of events

9.8.1 Scope of operation

Sequences of events (SOE) (for example single point information, double point information measured values, integrated totals) acquired in a controlled station are transmitted via the file transfer defined in IEC 60870-5-5 and IEC 60870-5-101.ed.2 (2003) (chapter 7.4.11.3) when onward transmission to the controlling station is required.

ASDUs with the following type identifications may be transmitted as spontaneous digital information:

<30>	Single-point information with time tag CP56Time2a	M_SP_TB_1
<31>	Double-point information with time tag CP56Time2a	M_DP_TB_1
<32>	Step position information with time tag CP56Time2a	M_ST_TB_1
<33>	Bitstring of 32 bit with time tag CP56Time2a	M_BO_TB_1
<34>	Measured value, normalized value with time tag CP56Time2a	M_ME_TD_1
<35>	Measured value, scaled value with time tag CP56Time2a	M_ME_TE_1
<36>	Measured value, short floating point value with time tag CP56Time2a	M_ME_TF_1
<37>	Integrated totals with time tag CP56Time2a	M_IT_TB_1
<38>	Event of protection equipment with time tag CP56Time2a	M_EP_TD_1

Table 76: Supported ASDUs

ASDUs with the following type identifications are not supported:

<39>	Packed start events of protection equipment with time tag CP56Time2a	M_EP_TE_1
<40>	Packed output circuit information of protection equipment with time tag CP56Time2a	M_EP_TF_1

Table 77: Not supported ASDUs

The variable structure qualifier is set to 1, i.e. only one information object is transmitted per ASDU.

9.8.2 Engineering in RTUtil500

Recording and transmission of sequences of events are only activated, if preconfigured in RTUtil500.

Transmission of sequences of events (spontaneous digital events) is activated by configuring one FTR object of file type 'Sequence of events' in the Hardware Tree. It is possible to configure a single FTR of file type 'Sequence of events' as child of an FDR object (file type 'UNDEF') but not as child of the RTU itself. By enabling the FTR of file type 'Sequence of events' (setting 'In use') for a HCI the FTR is activated.

The FTR object contains the parameters Max. contained ASDUs and Sections per file. The product of both parameters defines the number of recorded events buffered including the point of time at which they are acquired. If the predefined product is exceeded the RTU informs spontaneously the controlling station about an available file for transfer. The parameter Max. contained ASDUs has a value range from 1 to 5 000 and the default value is 1 000. The parameter Sections per file has a value range from 1 to 100 and the default value is 1.

RTU objects of type SPI, DPI, STI, BSIx, AMI, DMI, MFI, ITI, EPI, SEV offer the checkbox Include in sequence of event file. If enabled events will be recorded and transmitted to the controlling station via file transfer.

9.8.3 Runtime procedure

The structure of the record of sequences of events in a section of a file is composed according IEC 60870-5-101.ed.2 (2003) (chapter 7.4.11.3.1). The transmission procedures are performed according IEC 60870-5-101.ed.2 (2003) (chapter 7.4.11.3.2).

FTR of file type 'Sequence of events' is available as volatile file / memory area, i.e. after RTU restart the file is available for transfer after the above described buffer limit is exceeded.

FTR requests of file type 'Sequence of events' are supported only by one requester at the same time.

9.9 Transmission of sequences of recorded analog values

9.9.1 Scope of operation

Sequences of recorded analog values (for example, measured values, integrated totals) acquired in a controlled station are transmitted via the file transfer defined in IEC 60870-5-5 and IEC 60870-5-101.ed.2 (2003) (chapter 7.4.11.4) when onward transmission to the controlling station is required.

The following information elements may be transmitted as sequences of recorded analog values:

- binary counter reading (ITI)
- normalized value with quality descriptor (AMI and DMI).

9.9.2 Engineering in RTUtil500

Recording and transmission of sequences of analog values are only activated, if preconfigured in RTUtil500.

Transmission of sequences of recorded analog values is activated by configuring one FTR object of file type 'Sequence of recorded analog values' in the Hardware Tree. It is possible to configure a single FTR of file type 'Sequence of recorded analog values' as child of an FDR object (file type 'UNDEF') but not as child of the RTU itself. By enabling the FTR of file type 'Sequence of recorded analog values' (setting 'In use') for a HCI the FTR is activated.

The time interval between information elements is to be calculated as product of the factor <1..255> and the time base in <seconds, minutes or hours>. The result of this calculation has to be converted in seconds for configuration in RTUtil500. The FTR object contains the parameter Time interval for setting the time interval for data recording. The resolution of parameterTime interval is seconds and the value range is from 1 to 918 000 seconds (=255 hours). Default value of parameter Time interval is 10 seconds.

The FTR object contains the parameter Max. contained information elements of a record identifier. That parameter determines the number of buffered information elements. If this parameters is exceeded the RTU informs spontaneously the controlling station about an available file for transfer. The parameter has a value range from 1 to 3 600 and the default value is 300.

RTU objects of type AMI, DMI and ITI offer the checkbox Include in sequence of recorded analog value file. If enabled the values will be recorded and transmitted via file transfer. Enclosed is the parameter Record identifier defining a unique value for identifying the set of information elements (normalized values or counter readings), i.e. the address of the complete sequence of recorded analog values. Value range is from 1 to 65 535. The parameter Record identifier is sensitive only, if parameter Include in sequence of recorded analog value file is enabled.

9.9.3 Runtime procedure

The structure of data files containing sequences of recorded analog values is composed according IEC 60870-5-101.ed.2 (2003) (chapter 7.4.11.4.1). The transmission procedures are performed according IEC 60870-5-101.ed2003 (chapter 7.4.11.4.2).

FTR of file type 'Sequence of recorded analog values' is available as volatile file / memory area, i.e. after RTU restart the file is available for transfer after the above described buffer limit is exceeded.

FTR requests of file type 'Sequence of recorded analog value' are supported only by one requester at the same time.

10 Internal Functions

10.1 General Interrogation

The general interrogation includes single point information, double point information, step positions, measured values, bit strings and RTU system events, whereas integrated totals are excluded. The interrogation of a selected part of the process information by a group interrogation is supported. The process values transmitted in the course of the interrogation are marked with the cause of transmission 20 (General Interrogation) or 21 to 36.

When events occur during the general interrogation, the General Interrogation is interrupted, and the events are transmitted immediately.

10.1.1 Supported Data Types

IEC 60870-5-104			RTU		
ASDU	**Type identification**	**Data type property**	**Data type**	**Parameter name**	**Parameter location**
C_IC_NA_1	<100>				

Table 78: General Interrogation - Supported data types

10.1.2 Values

20, 21 … 36

10.1.3 Command Authority

None

10.1.4 Additional information

The general interrogation is responded from the HCI's process image.

10.1.5 Conversion of Quality Descriptors

RTU		IEC 60870-5-104
Internal communication (short)	**Internal communication (long)**	**Communication**
QOI	Qualifier of Interrogation	20 – General interrogation 21 – Interrogation Group 1 22 – Interrogation Group 2 … 36 – Interrogation Group 16

Table 79: General Interrogation - Conversion of quality descriptors

10.1.6 Conversion of Causes of Transmission

RTU		IEC 60870-5-104
Internal communication (short)	**Internal communication (long)**	**Communication**
T	Test	Ignored
P/N	Positive/negative confirmation	Relevant in monitor direction only
Cause	Activation	6 - Activation
	Activation Confirmation	7 - Activation Confirmation
	Activation Termination	10 - Activation Termination
	Negative Confirmation	45 … 47 - Unknown

Table 80: General Interrogation - Conversion of causes of transmission

A General Interrogation (with QOI=20) can be generated also by the Function Block GI_OUT of a PLC program. All process data points will be transmitted to the NCC with COT=20.

10.2 Counter Interrogation Command

Process command to interrogate a binary counter

10.2.1 Supported data types

IEC 60870-5-104			RTU		
ASDU	**Type identification**	**Data type property**	**Data type**	**Parameter name**	**Parameter location**
C_IC_NA_1	<101>				

Table 81: Counter Interrogation Command - Supported data types

10.2.2 Values

0 … 5

10.2.3 Command Authority

None

10.2.4 Additional information

The ASDU address must be same.

The information object address must be zero.

If ASDU or information object address does not match, the command is confirmed negative.

Only counter data of the local PDP is readable. The counter interrogation command for subordinated devices is not supported.

10.2.5 Conversion of quality descriptors

RTU		IEC 60870-5-104
Internal communication (short)	**Internal communication (long)**	**Communication**
RQT	No counter requested	0 - No counter requested
	request counter group 1	1 - request counter group 1
	request counter group 2	2 - request counter group 2
	request counter group 3	3 - request counter group 3
	request counter group 4	4 - request counter group 4
	general request counter	5 - general request counter
FRZ	No freeze or reset	0 - No freeze or reset
	counter freeze without reset	1 - counter freeze without reset
	counter freeze with reset	2 - counter freeze with reset
	counter reset	3 - counter reset

Table 82: Counter Interrogation Command - Conversion of quality descriptors

10.2.6 Conversion of causes of transmission

RTU		IEC 60870-5-104
Internal communication (short)	**Internal communication (long)**	**Communication**
T	Test	Ignored
P/N	Positive/negative confirmation	Relevant in monitor direction only
Cause	Activation	6 - Activation
	Activation Confirmation	7 - Activation Confirmation
	Activation Termination	10 - Activation Termination
	Negative Confirmation	45 … 47 - Unknown

Table 83: Counter Interrogation Command - Conversion of causes of transmission

10.3 Read Command

Process command to read a specific data point.

10.3.1 Supported data types

IEC 60870-5-104		RTU			
ASDU	**Type identification**	**Data type property**	**Data type**	**Parameter name**	**Parameter location**
C_RD_NA_1	<102>				

Table 84: Read Command - Supported data types

10.3.2 Values

None.

10.3.3 Command Authority

None

10.3.4 Additional information

The process data point with the ASDU and information object address of the C_RD_NA_1 command is read and send to NCC with cause of transmission requested.

The timestamp of the process data point is the actual time of the RTU.

10.3.5 Conversion of quality descriptors

RTU		IEC 60870-5-104
Internal communication (short)	Internal communication (long)	Communication
SE	Select / Execute	Only S/E = 0 (execute) supported

Table 85: Read Command - Conversion of quality descriptors

10.3.6 Conversion of causes of transmission

RTU		IEC 60870-5-104
Internal communication (short)	Internal communication (long)	Communication
T	Test	Ignored
P/N	Positive/negative confirmation	Relevant in monitor direction only
Cause	Request	5 - Request
	Negative Confirmation	45 … 47 - Unknown

Table 86: Read Command - Conversion of caused of transmission

10.4 Time Synchronization

The RTU500 series supports different methods of time synchronization. The time synchronization can be done via the communication line with the protocol IEC 60870-5-104.

The eight time masters have their own priority. If a higher prior master will fail, the time master with the lower priority will synchronize the RTU. If the higher prior time master is available again, he will continue synchronizing.

Parameter name	Default	Parameter location
Time administration	Not used	RTU Parameters
Primary device for time synchronization. This device is always allowed to synchronize the RTU if availble. If not, the next device is used.		

10.4.1 Supported Data Types

IEC 60870-5-104			RTU		
ASDU	**Type identification**	**Data type property**	**Data type**	**Parameter name**	**Parameter location**
C_CS_NA_1	<103>				

Table 87: Time Synchronization - Supported data types

10.4.2 Values

Complete time and date information in CP56Time2a format.

10.4.3 Command Authority

None

10.4.4 Additional information

Time synchronization with global address (broadcast, common address of ASDU 255 or 65 535) is supported by RTU500 series.

10.4.5 Conversion of Causes of Transmission

RTU		IEC 60870-5-104
Internal communication (short)	**Internal communication (long)**	**Communication**
T	Test	Ignored
P/N	Positive/negative confirmation	Relevant in monitor direction only
Cause	Activation	6 - Activation
	Activation Confirmation	7 - Activation Confirmation
	Negative Confirmation	45 … 47 - Unknown

Table 88: Time synchronization - Conversion of causes of transmission

10.5 Test Command

Process command to test a HCI of RTU500 series.

10.5.1 Supported data types

IEC 60870-5-104			RTU		
ASDU	**Type identification**	**Data type property**	**Data type**	**Parameter name**	**Parameter location**
C_TS_TA_1	<107>	with time tag CP56Time2a			

Table 89: Test Command - Supported data types

10.5.2 Values

0x55AA

10.5.3 Command Authority

None

10.5.4 Additional information

Time Tag CP56Time2a

10.5.5 Conversion of quality descriptors

RTU		IEC 60870-5-104
Internal communication (short)	**Internal communication (long)**	**Communication**
SE	Select / Execute	Only S/E = 0 (execute) supported

Table 90: Test Command - Conversion of quality descriptors

10.5.6 Conversion of causes of transmission

RTU		IEC 60870-5-104
Internal communication (short)	**Internal communication (long)**	**Communication**
T	Test	Ignored
P/N	Positive/negative confirmation	Relevant in monitor direction
Cause	Activation	6 - Activation
	Activation Confirmation	7 - Activation Confirmation
	Negative Confirmation	45 … 47 - Unknown

Table 91: Test Command - Conversion of causes of transmission

10.6 Reset Command

Process command to reset the RTU500 series RTU.

10.6.1 Supported data types

IEC 60870-5-104				RTU	
ASDU	**Type identification**	**Data type property**	**Data type**	**Parameter name**	**Parameter location**
C_RP_NA_1	<105>				

Table 92: Reset Command - Supported data types

10.6.2 Values

1

10.6.3 Command Authority

None

10.6.4 Additional information

The reset process command is not acknowledged.

The reset process command will be routed to a subdevice communication interface, if necessary.

10.6.5 Conversion of quality descriptors

RTU		IEC 60870-5-104
Internal communication (short)	**Internal communication (long)**	**Communication**
SE	Select / Execute	Only S/E = 0 (execute) supported

Table 93: Reset Command - Conversion of quality descriptors

10.6.6 Conversion of causes of transmission

RTU		IEC 60870-5-104
Internal communication (short)	**Internal communication (long)**	**Communication**
T	Test	Ignored
P/N	Not used	Not relevant
Cause	REMOTE_RESET	Not relevant

Table 94: Reset Command - Conversion of causes of transmission

10.7 Deactivate Command

Process command to deactivate the host communication interface of the RTU500 series.

10.7.1 Supported data types

IEC 60870-5-104		RTU			
ASDU	**Type identification**	**Data type property**	**Data type**	**Parameter name**	**Parameter location**
C_RP_NA_1	<105>				

Table 95: Deactivate Command - Supported data types

10.7.2 Values

128

10.7.3 Command Authority

None

10.7.4 Additional information

The Deactivate Command stops the transmission of periodic measurements, process commands are negative acknowledged (ACTCON neg).

Spontaneous informations (including Integrated Totals) are still sent.

10.7.5 Conversion of quality descriptors

RTU		IEC 60870-5-104
Internal communication (short)	**Internal communication (long)**	**Communication**
SE	Select / Execute	Only S/E = 0 (execute) supported

Table 96: Deactivate Command - Conversion of quality descriptors

10.7.6 Conversion of causes of transmission

RTU		IEC 60870-5-104
Internal communication (short)	**Internal communication (long)**	**Communication**
T	Test	Ignored
P/N	Not used	Not relevant
Cause	Activation	6 - Activation
	Activation Confirmation	7 - Activation Confirmation
	Negative Confirmation	45 … 47 - Unknown

Table 97: Deactivate Command - Conversion of causes of transmission

10.8 Parameter Loading

Parameter loading is used to change parameters of measured values, which are locally connected to the analog input boards of the RTU500 series. A routing to subordinated devices is not supported by RTU500 series.

Parameter loading is enabled per default. Deviating from standard in RTU500 the IOA used to carry information in control and monitor direction are the same for the parameter types.

Parameter name	Default	Parameter location
Parameter Loading	Enabled	Line T101/104
If enabled: Parameter loading requests are supported. If disabled: Parameter loading requests will be responded negative.		

To achieve full conformity with standard parameter loading can be disabled. If parameter loading is disabled request will be responded with negative activation confirmation.

10.8.1 Supported data types

IEC 60870-5-104			RTU		
ASDU	**Type identification**	**Data type property**	**Data type**	**Parameter name**	**Parameter location**
P_ME_NA_1	<110>	Parameter sent as a normalized value			
P_ME_NB_1	<111>	Parameter sent as a scaled value			
P_ME_NC_1	<112>	Parameter sent as a floating point value			

Table 98: Parameter Loading - Supported data types

10.8.2 Command Authority

None

10.8.3 Additional Information

None

10.8.4 Conversion of values for threshold

Range	RTU internal value	IEC 60870-5-101 value
Range min.	1 %	Normalized: 328 Scaled: 10 Floating point: 1.0
...	...	
Range max.	+12 %	Normalized: 3 933 Scaled: 120 Floating point: 12.0

Table 99: Parameter Loading - Conversion of values for threshold

10.8.5 Conversion of values for smoothing

Range	RTU internal value	IEC 60870-5-101 value
Range min.	1	Normalized: not available Scaled: 1

Table 100: Parameter Loading - Conversion of values for smoothing

Range	RTU internal value	IEC 60870-5-101 value
		Floating point: 1.0
...	...	
Range max.	128	Normalized: not available Scaled: 128 Floating point: 128.0

Table 100: Parameter Loading - Conversion of values for smoothing

The following values are processed: 1, 2, 4, 8, 16, 32, 64, 128

10.8.6 Conversion of qualifier of parameter of measured values

RTU		IEC 60870-5-104
Internal communication (short)	**Internal communication (long)**	**Communication**
QPM	Threshold Value	1 – Threshold value
	Smoothing factor	2 – Smoothing factor

Table 101: Parameter Loading - Conversion of qualifier of parameter of measured values

10.8.7 Conversion of causes of transmission

RTU		IEC 60870-5-104
Internal communication (short)	**Internal communication (long)**	**Communication**
P/N	Not used	Relevant in monitor direction only
Cause	Activation	6 - Activation
	Activation Confirmation	7 - Activation Confirmation
	Negative Confirmation	45 … 47 - Unknown

Table 102: Parameter Loading - Conversion of causes of transmission

10.9 System Events

The host interface manages internal status messages of the RTU500 series. These status messages can be created from the host itself or other activities of the RTU500 series. The system events of other activities are sent via internal communication and are processed by the HCI.

Parameter name	Default	Parameter location
Fix SEV address schema	enabled	SDI - line
Value range: enabled/ disabled if enabled: a base address for the whole block of system events is defined at the SDI node if disabled: individual addresses per SEV can be defined In order to avoid collisions, the addresses of the system events may not be used for other process objects.		
In use	enabled	SDI - line
Value range: enabled/ disabled if disabled: no SEVs will be transmitted on this line		

The following table shows the system events available for the host interface. System events send spontaneous as SPI with or without timestamp and contained in a general interrogation (without timestamp):

Description of system event	Address offset
At least one indication faulty	SEV#016
At least one analog value faulty	SEV#017
At least one digital value faulty	SEV#018
At least one integrated total faulty	SEV#019
At least one object or regulation command faulty	SEV#020
At least one analog output faulty	SEV#021
At least one digital output faulty	SEV#022
RTU is faulty	SEV#023
Device/ RTU active	SEV#024
RTU synchronized	SEV#025
External clock inoperable	SEV#026
Local printer offline	SEV#027
At least one indication oscillating	SEV#028
Battery voltage low (RTU560E only)	SEV#029
AC power supply failure (RTU560E only)	SEV#030
Test mode active	SEV#042
At least one data object simulated	SEV#043
At least one data communication equipment (DCE) faulty	SEV#044
Device connected	SEV#045
At least one PLC function not running	SEV#046
At least one PLC function cycle time exceeded	SEV#047
Device/ RTU inoperable	SEV#048
Device/ RTU is out of service	SEV#049
Power supply failure in RTU central sub-rack	SEV#059
Command supervision circuit x disconnected or faulty, 1 ≤ x ≤ 32	SEV#064 ... #095
SNTP client 1 is synchronized	SEV#096
SNTP client 2 is synchronized	SEV#097
Local control authority active	SEV#100
Host x Online, 1 ≤ x ≤ 16	SEV#101 ... #116
Host interface x: At least one change of information lost, 1 ≤ x ≤ 16	SEV#117 ... #132
Host interface x: At least one pulse counter lost, 1 ≤ x ≤ 16	SEV#133 ... #148
CMU x is inoperable, 1 ≤ x ≤ 16	SEV#149 … #164
Database identity tag	SEV#174
Device reachable on redundant line x, 1 ≤ x ≤ 4	SEV#180 … #183
Device active on redundant line x, 1 ≤ x ≤ 4	SEV#184 … #187
Device preferred on redundant line x, 1 ≤ x ≤ 4	#SEV188 … #191
Network element x is operable, 1 ≤ x ≤ 32	SEV#192 … #223
CMU x is active, 1 ≤ x ≤ 16	SEV#224 … #239
Process command collision with host x, 1 ≤ x ≤ 16	SEV#242 ... #257
Command collision with Integrated HMI	SEV#258

Table 103: Description of system events

Description of system event	Address offset
Command collision with web server	SEV#259
Command collision with PLC	SEV#260
HMI Client x online,1 ≤ x ≤ 16	SEV#261 ... #276
PRP interface x: Network interface E1 link on, 1 ≤ x ≤ 8	SEV#277 ... #284
PRP interface x: Network interface E2 link on, 1 ≤ x ≤ 8	SEV#285 ... #292
Host interface x: SOE buffer filling status is not reached, 1 ≤ x ≤ 16	SEV#293 ... #308
CAM Client x online, 1 ≤ x ≤ 4	SEV#309 ... #312
RTC battery voltage low[1]	SEV#313

Table 103: Description of system events

1 540CID01, 540CMD01 and 560CMR01/02

ADVICE

System event #174 "Database identity tag" is not sent spontaneous but send in a general interrogation with timestamp

10.10 System commands

System Single Commands (SSC) are accepted by the host communication interface with protocol IEC 60870-5-104. If the command is addressed to the RTU itself, the RTU performs the command. If the command is addressed to the connected subdevice, the SSC command is sent to the corresponding subinterface.

SSC supported	Description of SSC	Address offset
X	Set device out of service	#001
X	Reset device process	#002
X	Connect/disconnect device	#003
X	Set redundant line 1 / 2 as preferred line	#004, #005
	Set redundant line 3 / 4 as preferred line	#006, #007
X	Force global process image update, i.e. force process image update of all subdevices	#012
X	Request redundancy change over for the active CMU x, 1 ≤ x ≤ 16	#016 ... #031

Table 104: Description of system single commands (SSC)

10.10.1 Reset device process

The SSC command performs a reset for the addressed device. If the command is addressed to the RTU itself, the RTU performs a restart. If the command is addressed to the connected subdevice, the SSC command is sent to the corresponding sub-device interface.

RTU internal value	Status
off	<Ignored>
on	reset device process

Table 105: Conversion of values SSC#002

10.10.2 Force process image update

If the SSC command is addressed to the RTU itself, SSC commands "force process image update" are delegated to all sub-device interfaces. If the SSC command is addressed to the connected sub-device, the command is routed to the corresponding sub-device interface.

RTU internal value	Status
off	<Ignored>
on	Force process image update

Table 106: Conversion of values SSC#012

10.10.3 Request redundancy change over

The SSC command performs a switchover to the CMU specified by the command. If the command is addressed to the RTU itself, the RTU forces a CMU reset when the CMU is active and the standby partner is ok. If the command is addressed to the connected subdevice, the SSC command is sent to the corresponding subinterface.

RTU internal value	Status
off	<Ignored>
on	Request redundancy change over

Table 107: Conversion of values SSC#016 ... #031

11 Secure Communication according IEC 62351-3

11.1 Technology Overview

In general, the protocol IEC 60870-5-104 is a plaintext protocol. If not secured, one can read and change any communication between the control system and the RTU500. Using an open network, it is recommended to protect the communication with encryption and authentication of the transmitted data as requested in IEC 62351-3.

This chapter describes the implementation of secured IEC 60870-5-104 HCI communication with IEC 62351-3 in RTU500 as controlled station. RTU500 supports TLS (Transport Layer Security) encryption and authentication by means of X.509 certificates. This option is available with the license feature "Advanced Security".

11.2 TLS Version

RTU500 supports TLS version 1.2 as specified in RFC 5246:2008. TLS versions lower than TLS 1.2 are not supported.

11.3 TCP Ports

To differentiate between unsecured and secured communication different TCP ports are used to establish IEC60870-5-104 connections:

- 2404: Unsecured connections
- 19998: Secured connections

Availability of those ports can be restricted by configuration. Depending on the selected settings, the following scenarios are supported:

- Unsecured connections only
- Secured connections only
- Simultaneous secured and unsecured connections

The TCP port number to establish secure connections can be configured deviating from standard IEC/TS 60870-5-7:

Parameter name	Default	Parameter location
TCP port (TLS)	19998	RTU - Line T104
TCP port number to listen for connect (secure connection). Value Range: 1 to 65535 Default: 19998 as defined in IEC/TS 60870-5-7		

11.4 Supported Cipher Suites

The following cipher suites are supported by RTU500:

RFC Identifier	OpenSSL Name
TLS_DHE_DSS_WITH_AES_256_GCM_SHA384	DHE-DSS-AES256-GCM-SHA384
TLS_DHE_RSA_WITH_AES_256_GCM_SHA384	DHE-RSA-AES256-GCM-SHA384
TLS_DHE_RSA_WITH_AES_256_CBC_SHA256	DHE-RSA-AES256-SHA256

RFC Identifier	OpenSSL Name
TLS_DHE_DSS_WITH_AES_256_CBC_SHA256	DHE-DSS-AES256-SHA256
TLS_DHE_RSA_WITH_AES_256_CBC_SHA	DHE-RSA-AES256-SHA
TLS_DHE_DSS_WITH_AES_256_CBC_SHA	DHE-DSS-AES256-SHA
TLS_RSA_WITH_AES_256_GCM_SHA384	AES256-GCM-SHA384
TLS_RSA_WITH_AES_256_CBC_SHA256	AES256-SHA256
TLS_RSA_WITH_AES_256_CBC_SHA	AES256-SHA
TLS_DHE_DSS_WITH_AES_128_GCM_SHA256	DHE-DSS-AES128-GCM-SHA256
TLS_DHE_RSA_WITH_AES_128_GCM_SHA256	DHE-RSA-AES128-GCM-SHA256
TLS_DHE_RSA_WITH_AES_128_CBC_SHA256	DHE-RSA-AES128-SHA256
TLS_DHE_DSS_WITH_AES_128_CBC_SHA256	DHE-DSS-AES128-SHA256
TLS_DHE_RSA_WITH_AES_128_CBC_SHA	DHE-RSA-AES128-SHA
TLS_DHE_DSS_WITH_AES_128_CBC_SHA	DHE-DSS-AES128-SHA
TLS_RSA_WITH_AES_128_GCM_SHA256	AES128-GCM-SHA256
TLS_RSA_WITH_AES_128_CBC_SHA256	AES128-SHA256
TLS_RSA_WITH_AES_128_CBC_SHA	AES128-SHA

11.5 Certificates

For a secure TLS communication, it is essential to have a mutual authentication between the communication partners. For TLS in general, X.509 certificates are used. A digital certificate is used to prove that someone is who they say they are. In a TLS negotiation, RTU500 uses a server certificate to prove its identity to the control system. TLS requires that the control system prove its identity with a client certificate as well.

Certificates are a set of keys and information. A private and a public key are needed. The private key is a RSA key. RTU500 supports a key length of 2048 bits. The private key is used for signature and encryptions. A corresponding public key with the same length can be distributed to the public and is used for verifying the signature or for decrypting messages.

Version 3 of X.509 certificates are supported by RTU500 (RFC5280). One certificate per CMU module may be configured for IEC 62351-3. RTU500 supports up to two CAs (Certificate Authorities). RTU500 supports X.509 certificates with a size up to 8192 bytes. Certificate revocation list handling is not implemented.

11.6 RTUtil500 Engineering

The configuration parameters for IEC 62351-3 are defined for each IEC 60870-5-104 HCI line respectively within an RTU. For securing data traffic the following modes are selectable:

- Unsecured
- IEC 62351-3

The certificate used for authentication and encryption is selectable from a dropdown list. List items depend on certificate store configuration. That means prior to that list selection set an entry with descriptive text in the certificate store of the CMU module to upload external certificates for authentication.

11.7 Certificate Upload via the RTU500 Web Server

TLS requires an uploaded certificate in the certificate store of the CMU module. The web pages for certificate configuration require secure HTTPS web server access. It is not possible to open the web pages with standard HTTP access. For uploading the generated certificate must be stored in PKCS#12 format (.p12 file extension).

The upload of an external generated certificate is done via the RTU500 series Web server. In the Web server menu the link "Certificate Management" is the entry point for the certificate upload. This link can be found under the menu item "Management".

To upload a certificate the following steps have to be executed:

- Select the description of the certificate to upload in the column "Certificate description". In the selection all in RTUtil500 configured entries of the certificate store appear. The selection text is the descriptive name set in RTUtil500.
- Select a certificate file.
- Enter the password for the private key passphrase by pressing the lock symbol.

When all steps are finished the certificate can be uploaded by pressing the upload button. The upload button appears not before all required information are set.

12 Interoperability List

The selected parameters are marked in the white boxes as follows:

☐ Function or ASDU is not used
[X] 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

12.1 System or device

(system-specific parameter)

☐ System definition
☐ Controlling station definition (master)
☒ Controlled station definition (slave)

12.2 Network configuration

(network-specific parameter)

~~Point-to-point~~
~~Multiple point-to-point~~
~~Multipoint-party line~~
~~Multipoint-star~~

12.3 Physical Layer

(network-specific parameter)

12.3.1 Transmission speed (control direction)

Unbalanced interchange
Circuit V.24/V.28
Standard

~~100~~bit/s
~~200~~bit/s
~~300~~bit/s
~~600~~bit/s
~~1 200~~bit/s

Unbalanced interchange
Circuit V.24/V.28
Recommended if >1 200 bit/s

~~2 400~~bit/s
~~4 800~~bit/s

■ ~~9 600~~bit/s

Balanced interchange
Circuit X.24/X.27

■ ~~2 400~~bit/s

■ ~~4 800~~bit/s

■ ~~9 600~~bit/s

■ ~~19 200~~bit/s

■ ~~38 400~~bit/s

■ ~~56 000~~bit/s

■ ~~64 000~~bit/s

12.3.2 Transmission speed (monitor direction)

Unbalanced interchange
Circuit V.24/V.28
Standard

■ ~~100~~bit/s

■ ~~200~~bit/s

■ ~~300~~bit/s

■ ~~600~~bit/s

■ ~~1 200~~bit/s

Unbalanced interchange
Circuit V.24/V.28
Recommended if >1 200 bit/s

■ ~~2 400~~bit/s

■ ~~4 800~~bit/s

■ ~~9 600~~bit/s

Balanced interchange
Circuit X.24/X.27

■ ~~2 400~~bit/s

■ ~~4 800~~bit/s

■ ~~9 600~~bit/s

■ ~~19 200~~bit/s

■ ~~38 400~~bit/s

■ ~~56 000~~bit/s

■ ~~64 000~~bit/s

12.4 Link Layer

(network-specific parameter)

~~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~~

Frame length

■ ~~Maximum length L (number of octets)~~

Address field of the link

■ ~~Not present (balanced transmission only)~~

■ ~~One octet~~

■ ~~Two octets~~

■ ~~Structured~~

■ ~~Unstructured~~

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

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

Type identification	Cause of transmission

12.5 Application Layer

12.5.1 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.

12.5.2 Common Address of ASDU

(system-specific parameter)

■ ~~One octet~~

☒ Two octets

12.5.3 Information object address

(system-specific parameter)

■ ~~One octet~~

■ ~~Two octet~~

☒ Three octets

☒ Structured

☒ Unstructured

12.5.4 Cause of transmission

(system-specific parameter)

■ ~~One octet~~

☒ Two octets
(with originator address)

12.5.5 Length of APDU

(system-specific parameter)

The maximum length of APDU for both directions is 253. It is a fixed system parameter.

■ Maximum length of APDU per system in control direction

■ Maximum length of APDU per system in monitor direction

12.5.6 Selection of standard ASDUs

12.5.6.1 Process information in monitor direction

(station-specific parameter)

☒	<1>	:=	Single-point information	M_SP_NA_1
■	~~<2>~~	~~:=~~	~~Single-point information with time tag~~	~~M_SP_TA_1~~
☒	<3>	:=	Double-point information	M_DP_NA_1
■	~~<4>~~	~~:=~~	~~Double-point information with time tag~~	M_DP_TA_1
☒	<5>	:=	Step position information	M_ST_NA_1
■	~~<6>~~	~~:=~~	~~Step position information with time tag~~	M_ST_TA_1
☒	<7>	:=	Bitstring of 32 bit	M_BO_NA_1
■	~~<8>~~	~~:=~~	~~Bitstring of 32 bit with time tag~~	M_BO_TA_1
☒	<9>	:=	Measured value, normalized value	M_ME_NA_1
■	~~<10>~~	~~:=~~	~~Measured value, normalized value with time tag~~	M_ME_TA_1
☒	<11>	:=	Measured value, scaled value	M_ME_NB_1
■	~~<12>~~	~~:=~~	~~Measured value, scaled value with time tag~~	M_ME_TB_1
☒	<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
☒	<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
☐	<20>	:=	Packed single-point information with status change detection	M_PS_NA_1
☐	<21>	:=	Measured value, normalized value without quality descriptor	M_ME_ND_1
☒	<30>	:=	Single-point information with time tag CP56Time2a	M_SP_TB_1
☒	<31>	:=	Double-point information with time tag CP56Time2a	M_DP_TB_1
☒	<32>	:=	Step position information with time tag CP56Time2a	M_ST_TB_1
☒	<33>	:=	Bitstring of 32 bit with time tag CP56Time2a	M_BO_TB_1
☒	<34>	:=	Measured value, normalized value with time tag CP56Time2a	M_ME_TD_1
☒	<35>	:=	Measured value, scaled value with time tag CP56Time2a	M_ME_TE_1
☒	<36>	:=	Measured value, short floating point value with time tag CP56Time2a	M_ME_TF_1
☒	<37>	:=	Integrated totals with time tag CP56Time2a	M_IT_TB_1
☒	<38>	:=	Event of protection equipment with time tag CP56Time2a	M_EP_TD_1
☐	<39>	:=	Packed start events of protection equipment with time tag CP56Time2a	M_EP_TE_1
☐	<40>	:=	Packed output circuit information of protection equipment with time tag CP56Time2a	M_EP_TF_1

In this companion standard only the use of the set <30> – <40> for ASDUs with time tag is permitted.

12.5.6.2 Process information in control direction

(station-specific parameter)

☒	<45>	:=	Single command	C_SC_NA_1
☒	<46>	:=	Double command	C_DC_NA_1
☒	<47>	:=	Regulating step command	C_RC_NA_1
☒	<48>	:=	Set point command, normalized value	C_SE_NA_1
☒	<49>	:=	Set point command, scaled value	C_SE_NB_1
☒	<50>	:=	Set point command, short floating point value	C_SE_NC_1
☒	<51>	:=	Bitstring of 32 bit	C_BO_NA_1
☒	<58>	:=	Single command with time tag CP56Time2a	C_SC_TA_1
☒	<59>	:=	Double command with time tag CP56Time2a	C_DC_TA_1
☒	<60>	:=	Regulating step command with time tag CP56Time2a	C_RC_TA_1
☒	<61>	:=	Set point command, normalized value with time tag CP56Time2a	C_SE_TA_1
☒	<62>	:=	Set point command, scaled value with time tag CP56Time2a	C_SE_TB_1
☒	<63>	:=	Set point command, short floating point value with time tag CP56Time2a	C_SE_TC_1
☒	<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.

12.5.6.3 System information in monitor direction

(station-specific parameter)

X	<70>	:=	End of initialization	M_EI_NA_1

12.5.6.4 System information in control direction

(station-specific parameter)

X	<100>	:=	Interrogation command	C_IC_NA_1
X	<101>	:=	Counter interrogation command	C_CI_NA_1
X	<102>	:=	Read command	C_RD_NA_1
X	<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~~
X	<107>	:=	Test command with time tag CP56Time2a	C_TS_TA_1

12.5.6.5 Parameter in control direction

(station-specific parameter)

X[1]	<110>	:=	Parameter of measured value, normalized value	P_ME_NA_1
X[1]	<111>	:=	Parameter of measured value, scaled value	P_ME_NB_1
X[1]	<112>	:=	Parameter of measured value, short floating point value	P_ME_NC_1
	<113>	:=	Parameter activation	P_AC_NA_1

1 Deviation from standard explained in chapter "Parameter Loading" more detailed

12.5.6.6 File transfer

(station-specific parameter)

X	<120>	:=	File ready	F_FR_NA_1
X	<121>	:=	Section ready	F_SR_NA_1
X	<122>	:=	Call directory, select file, call file, call section	F_SC_NA_1
X	<123>	:=	Last section, last segment	F_LS_NA_1
X	<125>	:=	Segment	F_SG_NA_1
X	<126>	:=	Directory {blank or X, only available in monitor (standard) direction}	F_DR_TA_1
	<127>	:=	Query Log - Request archive file	F_SC_NB_1

12.5.6.7 Type identification and case of transmission assignments

(station-specific parameter)

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	X		X						(x)	(x)		X					
~~<2>~~	~~M_SP_TA_1~~																			

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
<3>	M_DP_NA_1		X	X		X						(x)	(x)		X					
~~<4>~~	~~M_DP_TA_1~~																			
<5>	M_ST_NA_1		X	X		X						(x)	(x)		X					
~~<6>~~	~~M_ST_TA_1~~																			
<7>	M_BO_NA_1		X	X		X									X					
~~<8>~~	~~M_BO_TA_1~~																			
<9>	M_ME_NA_1	X	X	X		X									X					
~~<10>~~	~~M_ME_TA_1~~																			
<11>	M_ME_NB_1	X	X	X		X									X					
~~<12>~~	~~M_ME_TB_1~~																			
<13>	M_ME_NC_1	X	X	X		X									X					
~~<14>~~	~~M_ME_TC_1~~																			
<15>	M_IT_NA_1			X		X										X				
~~<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																			
<21>	M_ME_ND_1																			
<30>	M_SP_TB_1			X		X						(x)	(x)							
<31>	M_DP_TB_1			X		X						(x)	(x)							
<32>	M_ST_TB_1			X		X						(x)	(x)							
<33>	M_BO_TB_1			X		X														
<34>	M_ME_TD_1	X		X		X														
<35>	M_ME_TE_1	X		X		X														
<36>	M_ME_TF_1	X		X		X														
<37>	M_IT_TB_1			X		X										X				
<38>	M_EP_TD_1			X																
<39>	M_EP_TE_1																			
<40>	M_EP_TF_1																			
<45>	C_SC_NA_1						X	X	X	X	X							X	X	X
<46>	C_DC_NA_1						X	X	X	X	X							X	X	X
<47>	C_RC_NA_1						X	X	X	X	X							X	X	X
<48>	C_SE_NA_1						X	X	X	X	X							X	X	X
<49>	C_SE_NB_1						X	X	X	X	X							X	X	X
<50>	C_SE_NC_1						X	X	X	X	X							X	X	X
<51>	C_BO_NA_1						X	X			X							X	X	X
<58>	C_SC_TA_1						X	X	X	X	X							X	X	X
<59>	C_DC_TA_1						X	X	X	X	X							X	X	X
<60>	C_RC_TA_1						X	X	X	X	X							X	X	X
<61>	C_SE_TA_1						X	X	X	X	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
<62>	C_SE_TB_1						X	X	X	X	X							X	X	X
<63>	C_SE_TC_1						X	X	X	X	X							X	X	X
<64>	C_BO_TA_1						X	X			X							X	X	X
<70>	M_EI_NA_1				X															
<100>	C_IC_NA_1						X	X			X							X	X	X
<101>	C_CI_NA_1						X	X			X							X	X	X
<102>	C_RD_NA_1					X												X	X	X
<103>	C_CS_NA_1						X	X										X	X	X
~~<104>~~	~~C_TS_NA_1~~																			
<105>	C_RP_NA_1						X	X										X	X	X
~~<106>~~	~~C_CD_NA_1~~																			
<107>	C_TS_TA_1						X	X										X	X	X
<110>	P_ME_NA_1						X	X										X	X	X
<111>	P_ME_NB_1						X	X									X			
<112>	P_ME_NC_1						X	X										X	X	X
<113>	P_AC_NA_1																X			
<120>	F_FR_NA_1													X				X	X	X
<121>	F_SR_NA_1													X				X	X	X
<122>	F_SC_NA_1					X								X				X	X	X
<123>	F_LS_NA_1													X				X	X	X
<124>	F_AF_NA_1													X				X	X	X
<125>	F_SG_NA_1													X				X	X	X
<126>	F_DR_TA_1[1]			X		X														
<127>	F_SC_NB_1[1]																X			

1 Blank or X only.

(x) Functionality 'Local' or 'Remote' can be assigned by PLC.

12.6 Basic application functions

12.6.1 Station initialization

(station-specific parameter)

☒ Remote initialization

12.6.2 Cyclic data transmission

(station-specific parameter)

☒ Cyclic data transmission

12.6.3 Read procedure

(station-specific parameter)

[X] Read procedure

12.6.4 Spontaneous transmission

(station-specific parameter)

[X] Spontaneous transmission

12.6.5 Double transmission of information objects with cause of transmission spontaneous

(station-specific parameter)

The following type identifications will 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
[ ] 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 number M_ME_NC_1, M_ME_TC_1 and M_ME_TF_1

12.6.6 Station interrogation

(station-specific parameter)

[X] global

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

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

12.6.7 Clock synchronization

(station-specific parameter)

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

12.6.8 Command transmission

(object-specific parameter)

- [X] Direct command transmission
- [X] Direct set point command transmission
- [X] Select and execute command
- [X] Select and execute set point command
- [X] C_SE ACTTERM used (configurable)
- [X] No additional definition
- [ ] Short-pulse duration (duration determined by a system parameter in the controlled station)
- [ ] Long-pulse duration (duration determined by a system parameter in the controlled station)
- [X] Persistent output
- [X] Supervision of maximum delay in command direction of commands and set point commands

65 535 sec Maximum allowable delay of commands and set point commands

12.6.9 Transmission of integrated totals

(station- or object-specific parameter)

- [X] Mode A: local freeze with spontaneous transmission
- [X] Mode B: local freeze with counter interrogation
- [X] Mode C: freeze and transmit by counter interrogation commands
- [X] Mode D: freeze by counter-interrogation command, frozen values reported spontaneously
- [X] Counter read
- [X] Counter freeze without reset
- [X] Counter freeze with reset

- [ ] Counter reset
- [X] General request counter
- [X] Request counter group 1
- [X] Request counter group 2
- [X] Request counter group 3
- [X] Request counter group 4

12.6.10 Parameter loading

(object-specific parameter)

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

12.6.11 Parameter activation

(object-specific parameter)

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

12.6.12 Test procedure

(station-specific parameter)

☒ Test procedure

12.6.13 File transfer

(station-specific parameter)

File transfer in monitor direction

☒ Transparent file
☒ Transmission of disturbance data of protection equipment
☒ Transmission of sequences of events
☒ Transmission of sequences of recorded analogue values

File transfer in control direction

☒ Transparent file

12.6.14 Background scan

(station-specific parameter)

☒ Background scan

12.6.15 Acquisition of transmission delay

(station-specific parameter)

■ ~~Acquisition of transmission delay~~

12.6.16 Definition of timeouts

Parameter	Default value	Remarks	Selected values
t_1	15 s	Time-out of send or test APDUs	1 … 255 s
t_2	10 s	Time-out for acknowledges in case of no data messages $t_2 < t_1$	1 … 255 s
t_3	20 s	Time-out for sending test frames in case of a long idle state	1 … 65 535 s

Maximum range for timeouts t_1 to t_2: 1 s to 255 s, accuracy 1 s.

Recommended range for timeout t_3: 1 s to 48 h, resolution 1 s.

Long timeouts for t_3 may be needed in special cases where satellite links or dialup connections are used (for instance to establish connection and collect values only once per day or week).

12.6.17 Maximum number of outstanding I format APDUs k and latest acknowledge APDUs (w)

Parameter	Default value	Remarks	Selected values
k	12 APDUs	Maximum difference receive sequence number to send state variable	1 … 32 767
w	8 APDUs	Latest acknowledge after receiving w I format APDUs	1 … 32 767

12.6.18 Port number

Parameter	Values	Remarks
Port number	2 404	In all cases, except for
	19 998	secure connection

12.6.19 Redundant connections

[8] Number N of redundancy group connections used

12.6.20 RFC 2200 suite

[X] Ethernet 802.3
[ ] Serial X.21 interface

[ ] Other selection from RFC 2200

13 Glossary

AC	Alternating Current
AMI	Analog Measured value Input
ASDU	Application Service Data Unit
ASO	Analog Setpoint command Output
BSI	Bit String Input
BSO	Bit String Output
CAM	Central User Account Management
CMU	Communication and Data Processing Unit
DCE	Data Communication Equipment
DCO	**D**ouble **C**ommand **O**utput
DMI	Digital Measured value Input (8, 16 bit)
DO	Digital Output
DPI	Double Point Input
DSO	Digital Setpoint command Output (8, 16 bit)
EPI	Event of Protection equipment Input (1 bit)
FDR	File transfer directory
FSO	Floating Setpoint Command Output
FTR	File transfer file
HCI	Human Maschine Interface (here Integrated HMI function of the RTU500 series)
IED	Intelligent Electronic Device
IOA	Information Object Address
ITI	Integrated Totals Input
MAX	Maximum
MFI	Analog Measured value Floating Input
Min	Minimum
MS	Microsoft
NCC	Network Control Center
PDP	Process Data Processing
PLC	Programmable Logic Control
PRP	Parallel Redundancy Protocol
RCD	RTU Configuration Data

RCO	Regulation step Command Output
RFC	Request for Comments
RTC	Real Time Clock
RTU	Remote Terminal Unit
SCI	Sub-Device Communication Interface
SCO	Single Command Output
SEV	System Event
SHA	Secure Hash Algorithms
SNTP	Simple Network Time Protocol (according to RFC 4330)
SOE	Sequence-of-Event Queue
SPI	Single Point Input or Single point information
SSC	System Single Command
STI	Step position Input
Tx	Transmit Direction

Note:

The specifications, data, design or other information contained in this document (the “Brochure”) - together: the “Information” - shall only be for information purposes and shall in no respect be binding. The Brochure does not claim to be exhaustive. Technical data in the Information are only approximate figures. We reserve the right at any time to make technical changes or modify the contents of this document without prior notice. The user shall be solely responsible for the use of any application example or information described within this document. The described examples and solutions are examples only and do not represent any comprehensive or complete solution. The user shall determine at its sole discretion, or as the case may be, customize, program or add value to the ABB products including software by creating solutions for the end customer and to assess whether and to what extent the products are suitable and need to be adjusted or customized.

This product is designed to be connected to and to communicate information and data via a network interface. It is the users sole responsibility to provide and continuously ensure a secure connection between the product and users or end customers network or any other network (as the case may be). The user shall establish and maintain any appropriate measures (such as but not limited to the installation of firewalls, application of authentication measures, encryption of data, installation of anti-virus programs, etc) to protect the product, the network, its system and the interface against any kind of security breaches, unauthorized access, interference, intrusion, leakage and/or theft of data or information. ABB AG is not liable for any damages and/or losses related to such security breaches, any unauthorized access, interference, intrusion, leakage and/or theft of data or information.

ABB AG shall be under no warranty whatsoever whether express or implied and assumes no responsibility for the information contained in this document or for any errors that may appear in this document. ABB AG's liability under or in connection with this Brochure or the files included within the Brochure, irrespective of the legal ground towards any person or entity, to which the Brochure has been made available, in view of any damages including costs or losses shall be excluded. In particular ABB AG shall in no event be liable for any indirect, consequential or special damages, such as – but not limited to – loss of profit, loss of production, loss of revenue, loss of data, loss of use, loss of earnings, cost of capital or cost connected with an interruption of business or operation, third party claims. The exclusion of liability shall not apply in the case of intention or gross negligence. The present declaration shall be governed by and construed in accordance with the laws of Switzerland under exclusion of its conflict of laws rules and of the Vienna Convention on the International Sale of Goods (CISG).

Visit us

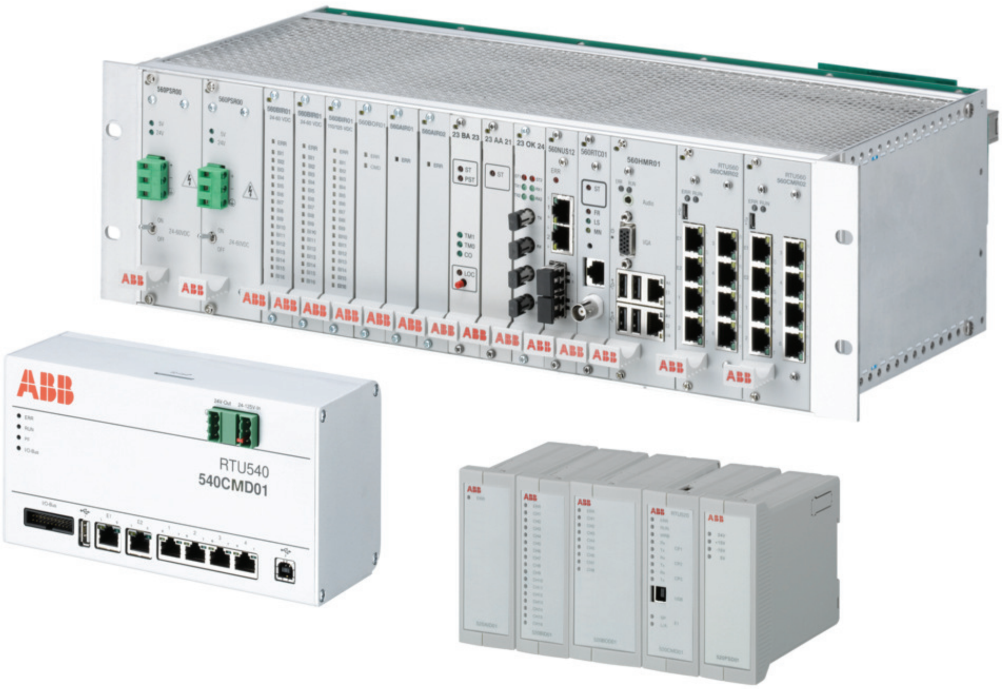
ABB AG
Power Grids
P.O. Box 10 03 51
68128 Mannheim, Germany

www.abb.com/remote-terminal-units

1KGT 150 482 V020 1

Power Grids

Remote Terminal Units
Subdevice Communication Interface with IEC 60870-5-104
Protocol description



Revision

Document identity:		1KGT 150 519 V012 1
Revision:	**Date:**	**Changes:**
0	2002-03-26	Basic document
1	2002-12-10	Chapter Filetransfer updated Chapter Transparent Data added (Available with firmware Release 6)
2	2006-06-28	Max. 32 subordinated devices (Supported from Release 7.1 Build 1
3	2007-08-10	Support of COT 44 … 47 Update Interoperability List C_RP_NA_1 will be accepted
4	06/2009	Chapter Physical Layer changed Transparent Data Modbus protocol Offline delay Test Command C_TS_TA_1 New ASDU: C_SE_NC_1
5	10/2009	System events updated Chapter Redundant Communication Lines added Chapter System Commands added
6	06/2010	Adaption of the document according to software improvements Line parameters added ASDUs in command direction added
7	03/2011	System Command #012 Process image update
8	03/2012	New Layout
9	09/2012	Threshold supervision for AMI and MFI added
10	05/2015	Support NT-Flag (PR#12254) More details on command qualifiers (PR#17056) ITI value range corrected (PR#22711) Correction: qualifier of command for BSO (PR#23928) Update chapter system events and system commands Update chapter system events and system commands New Layout
11	05/2016	Removed Link address from chapters 'Transparent data' (PR#28618)
	01/2017	Updated: Table "conversion of values" for DPI in monitoring direction (PR#33213)
12	07/2018	New layout

Document identity:		1KGT 150 519 V012 1
Revision:	**Date:**	**Changes:**
		Updated chapter 'Switch Over Handling' (PR#37151)

Contents

1 Introduction 7
- 1.1 Preface 7
- 1.2 References 7
- 1.3 Conventions 7

2 Physical Layer 9

3 Link Layer 11
- 3.1 General 11
- 3.2 Redundant communication lines 11
  - 3.2.1 General 11
  - 3.2.2 Switch Over Handling 14
  - 3.2.3 Limitations 14

4 Application Layer 15
- 4.1 General 15
- 4.2 ASDU Type identification 16
  - 4.2.1 ASDU in monitoring direction 16
  - 4.2.2 ASDU in control direction 17
  - 4.2.3 ASDU of system information in command direction 17
  - 4.2.4 ASDU for file transfer 18

5 Parameters and Addressing 19
- 5.1 Address elements 19
  - 5.1.1 Restrictions for the Common Address 19
  - 5.1.2 Restrictions for the information object address 19

6 Data Types - Monitoring Direction 21
- 6.1 AMI – Analog Measured Information 21
  - 6.1.1 Supported Data Types 21
  - 6.1.2 Additional information 21
  - 6.1.3 Conversion of Values 22
  - 6.1.4 Conversion of Quality Descriptors 22
  - 6.1.5 Conversion of Causes of Transmission 23
- 6.2 BSI – Bit String Information 23
  - 6.2.1 Supported Data Types 23
  - 6.2.2 Additional information 23
  - 6.2.3 Conversion of values 24
  - 6.2.4 Conversion of Quality Descriptors 24
  - 6.2.5 Conversion of Causes of Transmission 24
- 6.3 DMI – Digital Measured Information 25
  - 6.3.1 Supported Data Types 25
  - 6.3.2 Additional information 25
  - 6.3.3 Conversion of values 25
  - 6.3.4 Conversion of Quality Descriptors 25
  - 6.3.5 Conversion of Causes of Transmission 26

6.4 DPI – Double Point Information 26
6.4.1 Supported Data Types 26
6.4.2 Conversion of Values 26
6.4.3 Additional information 26
6.4.4 Conversion of Quality Descriptors 27
6.4.5 Conversion of Causes of Transmission 27
6.5 ITI – Integrated Totals Information 27
6.5.1 Supported Data Types 28
6.5.2 Additional information 28
6.5.3 Conversion of Values 28
6.5.4 Conversion of Quality Descriptors 28
6.5.5 Conversion of Causes of Transmission 28
6.6 MFI – Measured Float Information 29
6.6.1 Supported Data Types 29
6.6.2 Values 29
6.6.3 Additional information 29
6.6.4 Conversion of values 30
6.6.5 Conversion of Quality Descriptors 30
6.6.6 Conversion of Causes of Transmission 30
6.7 SPI – Single Point Information 31
6.7.1 Supported Data Types 31
6.7.2 Additional information 31
6.7.3 Conversion of values 31
6.7.4 Conversion of Quality Descriptors 31
6.7.5 Conversion of Causes of Transmission 32
6.8 STI – Step Position Information 32
6.8.1 Supported Data Types 32
6.8.2 Additional information 32
6.8.3 Conversion of values 33
6.8.4 Conversion of Quality Descriptors 33
6.8.5 Conversion of Causes of Transmission 33

7 Data Types - Controlling Direction 35
7.1 ASO – Analog Setpoint Output 35
7.1.1 Supported Data Types 35
7.1.2 Command Authority 35
7.1.3 Additional information 35
7.1.4 Conversion of values 35
7.1.5 Conversion of qualifier of command 36
7.1.6 Conversion of causes of transmission 36
7.2 BSO – Bit String Output 36
7.2.1 Supported Data Types 36
7.2.2 Command Authority 37
7.2.3 Additional information 37
7.2.4 Conversion of values 37
7.2.5 Conversion of qualifier of command 37
7.2.6 Conversion of causes of transmission 37

7.3 DCO – Double Command Output ... 38
7.3.1 Supported Data Types ... 38
7.3.2 Command Authority ... 38
7.3.3 Additional information ... 38
7.3.4 Conversion of Values ... 38
7.3.5 Conversion of qualifier of command ... 38
7.3.6 Conversion of causes of transmission ... 39
7.4 DSO – Digital Setpoint Output ... 39
7.4.1 Supported Data Types ... 39
7.4.2 Command Authority ... 39
7.4.3 Additional information ... 40
7.4.4 Conversion of values ... 40
7.4.5 Conversion of qualifier of command ... 40
7.4.6 Conversion of causes of transmission ... 40
7.5 FSO – Floating Point Setpoint Output ... 40
7.5.1 Supported Data Types ... 41
7.5.2 Command Authority ... 41
7.5.3 Additional information ... 41
7.5.4 Conversion of values ... 41
7.5.5 Conversion of qualifier of command ... 41
7.5.6 Conversion of causes of transmission ... 41
7.6 RCO – Regulation Command Output ... 42
7.6.1 Supported Data Types ... 42
7.6.2 Command Authority ... 42
7.6.3 Additional information ... 42
7.6.4 Conversion of values ... 42
7.6.5 Conversion of qualifier of command ... 43
7.6.6 Conversion of causes of transmission ... 43
7.7 SCO – Single Command Output ... 43
7.7.1 Supported Data Types ... 43
7.7.2 Command Authority ... 44
7.7.3 Additional information ... 44
7.7.4 Conversion of values ... 44
7.7.5 Conversion of qualifier of command ... 44
7.7.6 Conversion of causes of transmission ... 44

8 File Transfer ... 45
8.1 Supported data types ... 45
8.2 Values ... 45
8.3 Command Authority ... 45
8.4 Additional information ... 45
8.5 Conversion of causes of transmission ... 45
8.6 Download ... 46
8.7 Upload ... 46

9 Transparent Data ... 47
9.1 Command direction ... 47

9.2 Monitoring direction ... 48
9.3 Request procedure ... 49
9.4 Encapsulated SPAbus messages ... 50
9.4.1 General ... 50
9.4.2 Request procedure ... 51

10 Internal Functions ... 53
10.1 General Interrogation ... 53
10.1.1 Supported Data Types ... 53
10.1.2 Values ... 53
10.1.3 Command Authority ... 53
10.1.4 Additional information ... 53
10.1.5 Conversion of Quality Descriptors ... 53
10.1.6 Conversion of Causes of Transmission ... 54
10.2 Read Command ... 54
10.2.1 Supported data types ... 54
10.2.2 Values ... 54
10.2.3 Command Authority ... 54
10.2.4 Additional information ... 54
10.2.5 Conversion of quality descriptors ... 55
10.2.6 Conversion of causes of transmission ... 55
10.3 Time Synchronization ... 55
10.3.1 Supported Data Types ... 56
10.3.2 Values ... 56
10.3.3 Command Authority ... 56
10.3.4 Additional information ... 56
10.3.5 Conversion of Causes of Transmission ... 56
10.4 Test Command ... 56
10.4.1 Supported data types ... 56
10.4.2 Values ... 57
10.4.3 Command Authority ... 57
10.4.4 Additional information ... 57
10.4.5 Conversion of quality descriptors ... 57
10.4.6 Conversion of causes of transmission ... 57
10.5 Reset Command ... 57
10.5.1 Supported data types ... 58
10.5.2 Values ... 58
10.5.3 Command Authority ... 58
10.5.4 Additional information ... 58
10.5.5 Conversion of quality descriptors ... 58
10.5.6 Conversion of causes of transmission ... 58
10.6 System events ... 58
10.6.1 Status change device OFFLINE to device ONLINE ... 59
10.6.2 Status change device ONLINE to device OFFLINE ... 60
10.7 System commands ... 60
10.7.1 Set device out of service ... 60
10.7.2 Reset device process ... 61

10.7.3 Connect/disconnect device ... 61
10.7.4 Set redundant line as preferred line ... 61
10.7.5 Force process image update ... 61
10.7.6 Request redundancy change over ... 62

11 Interoperability List ... 63
11.1 System or device ... 63
11.2 Network configuration ... 63
11.3 Physical Layer ... 63
11.3.1 Transmission speed (control direction) ... 63
11.3.2 Transmission speed (monitor direction) ... 64
11.4 Link Layer ... 65
11.5 Application Layer ... 65
11.5.1 Transmission mode for application data ... 65
11.5.2 Common Address of ASDU ... 65
11.5.3 Information object address ... 66
11.5.4 Cause of transmission ... 66
11.5.5 Length of APDU ... 66
11.5.6 Selection of standard ASDUs ... 66
11.6 Basic application functions ... 70
11.6.1 Station initialization ... 70
11.6.2 Cyclic data transmission ... 70
11.6.3 Read procedure ... 71
11.6.4 Spontaneous transmission ... 71
11.6.5 Double transmission of information objects with cause of transmission spontaneous ... 71
11.6.6 Station interrogation ... 71
11.6.7 Clock synchronization ... 71
11.6.8 Command transmission ... 72
11.6.9 Transmission of integrated totals ... 72
11.6.10 Parameter loading ... 72
11.6.11 Parameter activation ... 72
11.6.12 Test procedure ... 73
11.6.13 File transfer ... 73
11.6.14 Background scan ... 73
11.6.15 Acquisition of transmission delay ... 73
11.6.16 Definition of timeouts ... 73
11.6.17 Maximum number of outstanding I format APDUs k and latest acknowledge APDUs (w) ... 74
11.6.18 Portnumber ... 74
11.6.19 Redundant connections ... 74
11.6.20 RFC 2200 suite ... 74

12 Glossary ... 75

1 Introduction

1.1 Preface

This document describes the functions of the subdevice communication interface in RTU500 series according to IEC 60870-5-104.

RTU500 series fulfills the requirements of IEC 60870-5-104 Edition 2. Detailed information can be found in the interoperability list (see Chapter 11).

1.2 References

[1] Telecontrol equipment and systems – Part 5-104

Transmission protocols –

Network access for IEC 60870-5-101

using standard transport profiles
Second edition 06-2006

[2] RTU500 series Interfaces and Protocols Release 12 (1KGT 150 939)

[3] User Manual RTUtil500 Release 12 (1KGT 150 950)

1.3 Conventions

In this document function codes of data types according to IEC 60870-5-104 are marked with square brackets: <Function code>

Bold fonts with the table heading "Parameter name" are references to configuration parameters in RTUtil500. The parameter is followed by the parameter location where to find this parameter in RTUtil500. The first element of the parameter location defines the node in the hardware tree on the left side (e. g. RTU, CMU, line, IED) and the second element defines selected header control tab in the parameter window on the right side (e. g. general, interfaces, protocol).

Example:

Parameter name	**Default**	**Parameter location**
In Use	Enabled	data point (e.g. SPI) - line T101/104
Value range: enabled / disabled		
If enabled: Object is processed by HCI.		

In this document references to elements of the standard and other references will be printed in brackets. Example: [2, 7.4]

The tables in the next chapters include lists of the functions, options and message types supported according to the protocol structure given in IEC 60870-5 (EPA three layer model) for

- the physical layer
- the link layer
- the application layer

This layered model is valid for the protocol IEC 60870-5-104.

2 Physical Layer

The protocol IEC 60870-5-104 is running on the Ethernet-Interfaces of the CMU. For more details see [2].

For each Ethernet interface following parameters can be configured:

Parameter name	Default	Parameter location
Interface mode	Auto-Negotiation	CMU - Network Interfaces
Interface Mode: • Auto-Negotiation • 100BaseT full duplex • 100BaseT half duplex • 10BaseT full duplex • 10BaseT half duplex		
Node name	none	CMU - Network Interfaces
IP Address	none	CMU - Network Interfaces
Subnet mask	0.0.0.0	CMU - Network Interfaces
Default Gateway IP	0.0.0.0	CMU - Network Interfaces

3 Link Layer

3.1 General

Protection against loss and duplication of message is handled as defined in [1, 5.1].

For each Ethernet connection a slave IP address is necessary.

Parameter name	Default	Parameter location
IP address 1 (slave)		IED/RTU - Line T104
Unique network address of the subdevice		
IP address 2 (slave)	disabled	IED/RTU - Line T104
If enabled: A second IP-Address for the subdevice can be configured to establish a redundant link. Second IP address of the subdevice or '-' to disable. As VPN is enabled at the 2nd network interface, you can select between ethernet IP address and VPN virtual IP address.		
Routing	Static assignment of IP addresses (E1-IP1, E2-IP2)	Line T104 - IEC 60870-5-104
Static or dynamic usage of network interfaces. Value range: • Static assignment of IP addresses (E1-IP1, E2-IP2) • Dynamic usage of configured network interfaces		

3.2 Redundant communication lines

3.2.1 General

The redundant link function of the RTU500 series is used to increase connection availability to the subordinated devices. Therefore, two independent connections have to be established and supervised between the RTU and the subordinated devices. A second IP address for subordinated devices can be configured to establish a redundant link. The redundant line is implemented according to the IEC 60870-5-104, edition 2 standard.

The following configurations are supported by the SCI:

- 1 IP address for RTU500 series SCI, 1 IP address for subordinated device (Non redundant)
- 1 IP address for RTU500 series SCI, 2 IP addresses for subordinated device
- 2 IP addresses for RTU500 series SCI on one CMU, 2 IP addresses for subordinated device
- 1 IP address for RTU500 series SCI on two redundant CMUs, 2 IP addresses for subordinated device
- 2 IP addresses for RTU500 series SCI on two redundant CMUs, 2 IP addresses for subordinated device

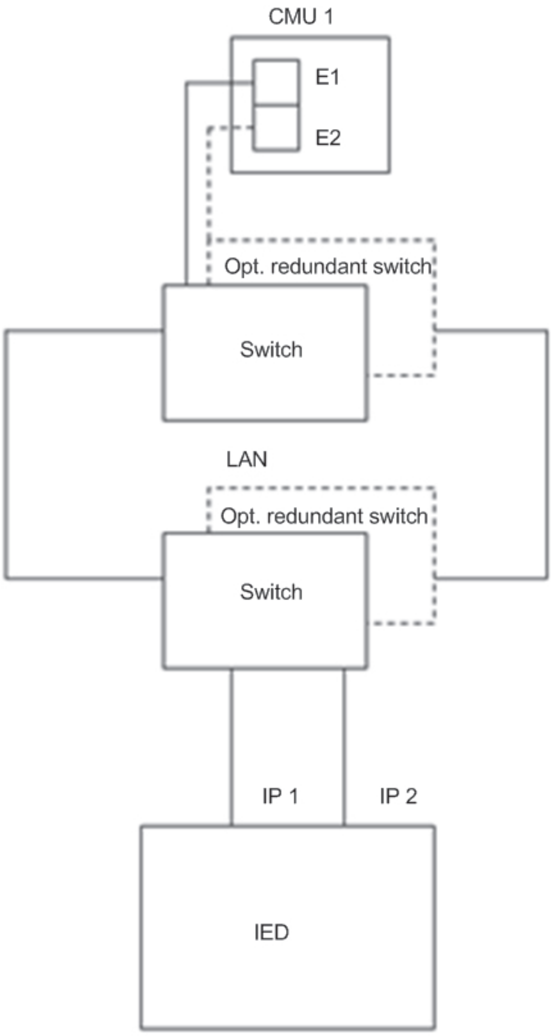


Figure 1: 1/2 IP addresses for RTU560 SCI on one CMU, 2 IP addresses for subordinated device

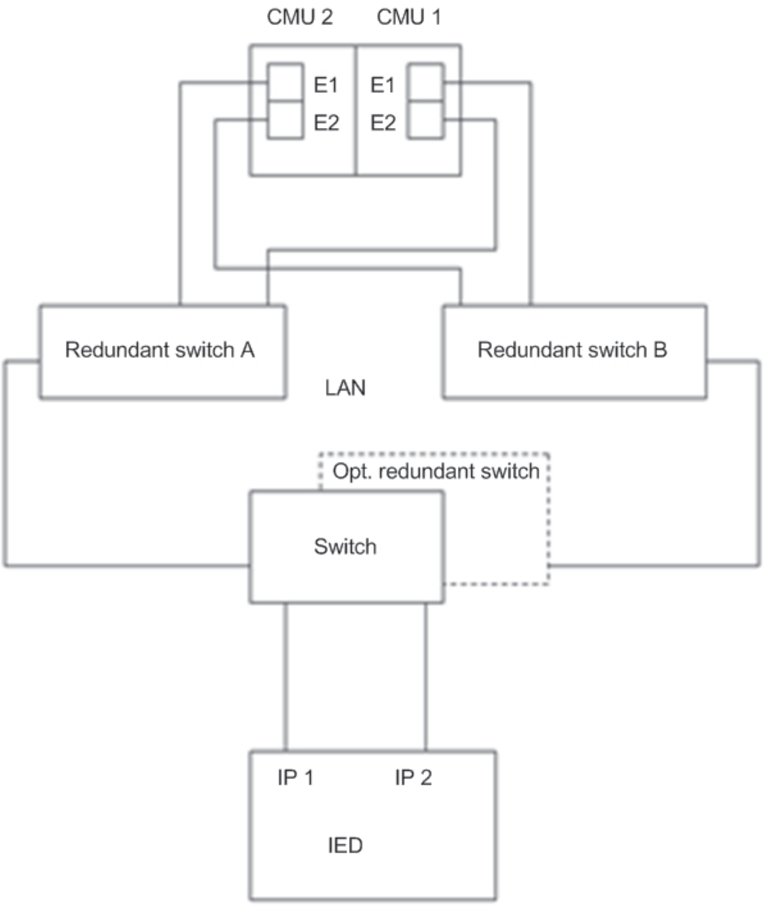


Figure 2: 2 IP addresses for RTU560 SCI on redundant CMU, 2 IP addresses for subordinated device

General functions:

- The IEC 60870-5-104 configuration including datapoint addresses have to be identical on both links of the subordinated device.
- The switching between the links is generally initiated by the RTU500 series SCI.
- After a redundancy switching a general interrogation is sent from the RTU500 series SCI.
- During the switchover between the redundant links the subordinated device has to secure that no data point information gets lost.
- Only one link is used for process information.

The configuration of redundant lines is part of the engineering tool for the RTU500 series, RTUtil500. One or two Ethernet ports of one CMU can be used for a redundant communication link, depending on the CMU type.

Redundant communication links can have different status for every subordinated device. Handling of status is done individually per subordinated device. A device can be reachable on a line. Reachable means that at least a link connection to a device is possible. The line used for process data communication is called the active line.

The priorities are derived from RTUtil500 IP address configuration. The first IP address has the highest priority. The link with the highest priority is the preferred line used for process communication.

To signalize the reachability of a subordinated device system event "Device reachable on redundant line 1/2" (SEV #180, SEV #181) is used. An active line is signalized with "Device active on redundant line 1/2" (SEV #184, SEV #185).

To control the behavior of redundant lines the preferred line can be modified using system single commands "Set redundant line 1/2 as preferred line" (SSC#004, SSC#005). At system startup the modifications get lost and the system will start up with the initial preferred line.

3.2.2 Switch Over Handling

As mentioned before, only one line is used for user data transfer. The other redundant link is cyclically supervised according to the IEC 60870-5-104, edition 2 standard.

The RTU500 series RTU switches the communication link if the active connection is closed (STOP DT). Switching of active links takes place only in this failure case. A switch back in case of recovery of the preferred link does not take place.

At initial state the preferred line of a subordinated device gets active if the device is reachable. If the communication link on the active link gets lost (STOP DT), the RTU switches the process communication over to the other reachable link. This link is now the active one.

3.2.3 Limitations

- Up to 32 subordinated devices can be configured on one Ethernet link (logical link in the Network Tree of RTUtil500).
- Up to 8 Ethernet links can be configured on one Ethernet device (Hardware).
- The number of subordinated devices within one RTU must be less than 120 (In addition the limitations on the total number of process data points must be considered).
- The RTU500 series RTU supports two IP addresses per connected RTU/ IED.

4 Application Layer

4.1 General

The selectable parameters have to be calculated regarding the real communication technology. All parameters preset to the default values from the IEC standard.

Parameter name	Default	Parameter location
Test command cycle time	disabled	IED/RTU - Line T101/T104
If enabled: The cycle time of the test command can be configured. Value range: 0 to 65535 or '-' to disable.		

Table 1: RTU parameters application layer

Parameter name	Default	Parameter location
Maximum difference receive sequence number (k)	12 APDUs	Line T104 - IEC 60870-5-104
k: maximum difference receive sequence number to send sequence count variable 1 to 32767 APDUs; default value: 12 APDUs		
Latest acknowledge after number of I format (w)	8 APDUs	Line T104 - IEC 60870-5-104
Latest acknowledge after receiving w I format APDUs 1 to 32767 APDUs; default value: 8 APDUs (w should not exceed two-thirds of k)		
ASDU address structure (16bit)	16 bit (2 octets)	Line T104 - IEC 60870-5-104
Length of Address fixed to 16 bit! Structured address with underscore as delimiter Example: 3_5_8 defines 16-bit address with 3 structure elements: 3 bit most significant 5 bit medium significant 8 bit least significant		
Information object address structure (24bit)	24 bit (3 octets)	Line T104 - IEC 60870-5-104
Length of Information Object Address fixed to 24 bit! Structured address with underscore as delimiter Example: 3_5_6_3_7 defines 24-bit address with 5 structure elements		
Maximum length of APDU	253 byte	Line T104 - IEC 60870-5-104
32 to 253 octets (byte) Default value: 253 octets		

Table 2: Parameters application layer IEC 60870-5-104: telegram framing

Parameter name	Default	Parameter location
Time out of connection establishment (t0)	30 sec	Line T104 - IEC 60870-5-104
t0: Time-out of connection establishment 1 to 255 seconds; default value: 30 seconds		
Send or test APDUs (t1)	15 sec	Line T104 - IEC 60870-5-104
t1: Time-out of send APDUs or test APDUs 1 to 255 seconds; default value: 15 seconds		

Table 3: Parameters application layer IEC 60870-5-104: timeouts

Parameter name	Default	Parameter location
Acknowledge no data message (t2)	10 sec	Line T104 - IEC 60870-5-104
t2: Time-out for acknowledges in case of no data messages 1 to 255 seconds; default value: 10 seconds t2 < t1		
Sending test frames (t3)	30 sec	Line T104 - IEC 60870-5-104
t3: Timeout for sending test frames in case of a long idle state. Value range: 1 to 65535 seconds.		

Table 3: Parameters application layer IEC 60870-5-104: timeouts

Parameter name	Default	Parameter location
Routed diagnosis support	enabled	Line T101/104 - IEC 60870-5-101/104
If enabled: Routed diagnosis is activated.		
Time interval of clock synchronization commands	disabled	Line T101/104 - IEC 60870-5-101/104
Specification whether Time Synchronization of the secondary station shall take place. Time period in seconds, Value range: 60 to 65000 or'-' to disable. Approved value for SPA-Bus devices is 60 seconds.		
Offline delay	disabled	Line T101/104 - IEC 60870-5-101/104
If enabled, connection failures of subordinated devices will be suppressed for the configured time. If the connection is available again within this time, no signalisation is done. Default value is 'disabled'. Delay time: 0..600 sec or '-' to disable.		
Send commands with time tag	disabled	Line T104 - IEC 60870-5-104
If enabled, all commands to sub devices get send with timestamp.		

Table 4: Line parameters application layer IEC 60870-5-104: other parameters

4.2 ASDU Type identification

Overview on type identifications for data elements of the application layer defined in [2].

The column "RTU data type" shows the type of data with must be configured in RTUtil500.

4.2.1 ASDU in monitoring direction

ASDU	Description	Type identification	RTU data type
M_SP_NA_1	Single-point information	<1>	SPI
M_SP_TB_1	Single-point information with time tag CP56Time2a	<30>	SPI
M_DP_NA_1	Double-Point information	<3>	DPI
M_DP_TB_1	Double-Point information with time tag CP56Time2a	<31>	DPI
M_ST_NA_1	Step position information	<5>	STI
M_ST_TB_1	Step position information with time tag CP56Time2a	<32>	STI
M_BO_NA_1	Bitstring of 32 bit	<7>	BSI8/16/32

Table 5: ASDU in monitoring direction

ASDU	Description	Type identification	RTU data type
M_BO_TB_1	Bitstring of 32 bit with time tag CP56Time2a	<33>	BSI8/16/32
M_ME_NA_1	Measured value, normalized value	<9>	AMI DMI8/16
M_ME_TD_1	Measured value, normalized value with time tag CP56Time2a	<34>	AMI DMI8/16
M_ME_NB_1	Measured value, scaled value	<11>	AMI
M_ME_TE_1	Measured value, scaled value with time tag CP56Time2a	<35>	AMI
M_ME_NC_1	Measured value, short floating point	<13>	MFI
M_ME_TF_1	Measured value, short floating point value with time tag CP56Time2a	<36>	MFI
M_IT_NA_1	Integrated totals	<15>	ITI
M_IT_TB_1	Integrated totals with time tag CP56Time2a	<37>	ITI

Table 5: ASDU in monitoring direction

4.2.2 ASDU in control direction

ASDU	Description	Type identification	RTU data type
C_SC_NA_1	Single command	<45>	SCO
C_DC_NA_1	Double command	<46>	DCO
C_RC_NA_1	Regulation step command	<47>	RCO
C_SE_NA_1	Set point command, normalized value	<48>	ASO DSO8/16
C_SE_NB_1	Set point command, scaled value	<49>	ASO DSO8/16
C_SE_NC_1	Set point command, short floating point	<50>	FSO
C_BO_NA_1	Bitstring of 32 bit	<51>	BSO1/2/8/16/32
C_SC_TA_1	Single command with time tag	<58>	SCO
C_DC_TA_1	Double command with time tag	<59>	DCO
C_RC_TA_1	Regulation step command with time tag	<60>	RCO
C_SE_TA_1	Setpoint command, normalized value with time tag	<61>	ASO DSO8/16
C_SE_TB_1	Setpoint command, scaled value with time tag	<62>	ASO DSO8/16
C_SE_TC_1	Setpoint command, short floating point, with time tag	<63>	FSO
C_BO_TA_1	Bitstring of 32 bit with time tag	<64>	BSO1/2/8/16/32

Table 6: ASDU in control direction

4.2.3 ASDU of system information in command direction

ASDU	Description	Type identification
C_IC_NA_1	Interrogation Command	<100>
C_RD_NA_1	Read command	<102>

Table 7: System information in command direction

ASDU	Description	Type identification
C_CS_NA_1	Clock synchronization command	<103>
C_RP_NA_1	Reset process command	<105>
C_TS_NA_1	Test command	<107>

Table 7: System information in command direction

4.2.4 ASDU for file transfer

ASDU	Description	Type identification
F_FR_NA_1	File ready	<120>
F_SR_NA_1	Section ready	<121>
F_SC_NA_1	Call directory, select file, …	<122>
F_LS_NA_1	Last section, last segment	<123>
F_AF_NA_1	Ack file, ack section	<124>
F_SG_NA_1	Segment	<125>
F_DR_TA_1	Directory	<126>

Table 8: ASDU for file transfer

5 Parameters and Addressing

5.1 Address elements

Selection according to [1]. The address fields have the following size:

Parameter name	Default	Parameter location
Common address ASDU length	2 octets (fixed)	
Information object address length	3 octets (fixed)	
Cause of transmission length	2 octets (fixed)	

5.1.1 Restrictions for the Common Address

The value 0 is not allowed.

The highest possible address value (255 for 1 octet common address length and 65 535 for 2 octet common address length) is reserved for broadcast calls in control direction and therefore must not be used as station address.

Parameter name	Default	Parameter location
ASDU address	1	data point - Line T104
Application Service Data Unit. The address may be unstructured or structured. Length: 2 octets.		

5.1.2 Restrictions for the information object address

All addresses must be unique within one station. The type of presentation (ASDU format) is not part of the identification of an object.

The value 0 is not allowed.

Parameter name	Default	Parameter location
Information object	1	data point - Line T104
Address of the Information Object. The address may be unstructured or structured. Length: 3 octets		

6 Data Types - Monitoring Direction

6.1 AMI – Analog Measured Information

Analog process information indicated by 16 bit used as a measured value from analog inputs in normalized or scaled format.

6.1.1 Supported Data Types

IEC 60870-5-104			RTU		
ASDU	Type identification	Data type property	Data type	Parameter name	Parameter location
M_ME_NA_1	<9>	normalized without timestamp	AMI	Transmission format: Normalized	AMI - line T101/T104/GP104
M_ME_NB_1	<11>	scaled without timestamp	AMI	Transmission format: Scaled	AMI - line T101/T104/GP104
M_ME_TD_1	<34>	normalized with timestamp CP56Time2a	AMI	Transmission format: Normalized	AMI - line T101/T104/GP104
M_ME_TE_1	<35>	scaled with timestamp CP56Time2a	AMI	Transmission format: Scaled	AMI - line T101/T104/GP104

Table 9: AMI - Supported data types

6.1.2 Additional information

Parameter name	Default	Parameter location
Transmission format	normalized	protocol and address parameters
value range: normalized / scaled normalized: value representation -100% (-1) to +100 % (+1); scaled: value representation: -32,767 to +32,768		
Maximum value	max. range	protocol and address parameters
Maximum value in the external protocol is converted to +100% on RTU internal communication (IC).		
Minimum value	max. range	protocol and address parameters
Minimum value in the external protocol is converted to -100% on RTU internal communication (IC).		

Parameter name	Default	Parameter location
Threshold supervision	disabled	data point - line (Sub parameter)
value range: enabled / disabled enabled: the object is supervised by the threshold supervision; disabled: every received value is transmitted.		
Type	disabled	data point - line (Sub parameter)
value range: absolute / integrated		
Threshold	5 %	data point - line (Sub parameter)
value range: 0… 100 % Dead-band value for threshold supervision.		

Readable by a read command (see Chapter 10.2, "Read Command").

Parameter name	Default	Parameter location
Read command status	no	data point (e.g. SPI) - line (Sub parameter)
value range: no, cyclic time, absolute time no: no read command enabled; cyclic time: cyclic read command enabled; absolute time: read command at abosute point of time once a day enabled		

6.1.3 Conversion of Values

Parameter name	Default	Parameter location
Transmission format	Normalized	AMI - line T101/104
Transmission format for this data point: Normalized: Value range -1.0 ... +1.0 Scaled: Value range -32768.0 ... +32767.0.		
Maximum value	1 (Normalized) 32767 (Scaled)	AMI - line T101/104
+100 % within RTU internal communication get converted to parameter 'Maximum value' in the external communication protocol. Normalized: Value range -1.0 ... +1.0. Scaled: Value range -32768.0 ... +32767.0.		
Minimum value	-1 (Normalized -32768 (Scaled)	AMI - line T101/104
-100 % within RTU internal communication get converted to parameter 'Minimum value' in the external communication protocol. Normalized: Value range -1.0 ... +1.0. Scaled: Value range -32768.0 ... +32767.0.		

Range	RTU internal value	IEC 60870-5-104
Range min.	-100 %	Minimum value
...	...	
Range max.	+100 %	Maximum value

Table 10: AMI - Conversion of values

6.1.4 Conversion of Quality Descriptors

RTU		IEC 60870-5-104
Internal communication (short)	**Internal communication (long)**	**Communication**
OV	Overflow	Overflow
BL	Blocked	Blocked
SB	Substituted	Substituted
NT	Not Topical	Not Topical
IV	Invalid	Invalid

Table 11: AMI - Conversion of quality descriptors

6.1.5 Conversion of Causes of Transmission

RTU		IEC 60870-5-104
Internal communication (short)	**Internal communication (long)**	**Communication**
T	Test	Test
P/N	Positive/negative confirmation	- Irrelevant -
Cause	Spontaneous	3 - spontaneous
	spontaneous (in case of a value change)	1 - periodic / cyclic
	spontaneous (in case of a value change)	2 - background scan
	spontaneous (in case of a value change)	5 - requested
	spontaneous (in case of a value change)	20, 21 ... 36 - interrogated

Table 12: AMI - Conversion of causes of transmission

6.2 BSI – Bit String Information

Binary process information is indicated by 8, 16 or 32 bit.

6.2.1 Supported Data Types

IEC 60870-5-104				RTU	
ASDU	**Type identification**	**Data type property**	**Data type**	**Parameter name**	**Parameter location**
M_BO_NA_1	<7>	without timestamp	BSI		
M_BO_TB_1	<33>	with timestamp CP56Time2a	BSI		

Table 13: BSI - Supported data types

6.2.2 Additional information

Readable by a read command (see Chapter 10.2, "Read Command").

Parameter name	Default	Parameter location
Read command status	no	data point (e.g. SPI) - line (Sub parameter)
value range: no, cyclic time, absolute time no: no read command enabled; cyclic time: cyclic read command enabled; absolute time: read command at abosute point of time once a day enabled		

6.2.3 Conversion of values

Range	RTU internal value	IEC 60870-5-104
Range min.	0	0
...	...	
Range max.	BSI8: Bit mask of 8 bit; range ... 255	255
	BSI16: Bit mask of 16 bit; range ... 65 535	65 535
	BSI32: Bit mask of 32 bit; range ... 4 294 967 295	4 294 967 295

Table 14: BSI - Conversion of values

6.2.4 Conversion of Quality Descriptors

RTU		IEC 60870-5-104
Internal communication (short)	**Internal communication (long)**	**Communication**
OV	Overflow	Overflow
BL	Blocked	Blocked
SB	Substituted	Substituted
NT	Not Topical	Not Topical
IV	Invalid	Invalid

Table 15: BSI - Conversion of quality descriptors

6.2.5 Conversion of Causes of Transmission

RTU		IEC 60870-5-104
Internal communication (short)	**Internal communication (long)**	**Communication**
T	Test	Test
P/N	Positive/negative confirmation	- Irrelevant -
Cause	Spontaneous	3 - spontaneous
	spontaneous (in case of a value change)	2 - background scan
	spontaneous (in case of a value change)	5 - requested
	spontaneous (in case of a value change)	20, 21 ... 36 - interrogated

Table 16: BSI - Conversion of causes of transmission

6.3 DMI – Digital Measured Information

Binary process information indicated by 8 or 16 bit is used as a measured value from digital inputs in normalized format.

6.3.1 Supported Data Types

IEC 60870-5-104				RTU	
ASDU	Type identification	Data type property	Data type	Parameter name	Parameter location
M_ME_NA_1	<9>	without timestamp	DMI		
M_ME_TD_1	<34>	with timestamp CP56Time2a	DMI		

Table 17: DMI - Supported data types

6.3.2 Additional information

Readable by a read command (see Chapter 10.2, "Read Command").

Parameter name	Default	Parameter location
Read command status	no	data point (e.g. SPI) - line (Sub parameter)

value range: no, cyclic time, absolute time
no: no read command enabled; cyclic time: cyclic read command enabled; absolute time: read command at abosute point of time once a day enabled

6.3.3 Conversion of values

Range	RTU internal value	IEC 60870-5-104
Range min.	-100 %	-1
...	...	
Range max.	+100 %	$+1-2e_{-15}$

Table 18: DMI - Conversion of values

6.3.4 Conversion of Quality Descriptors

RTU		IEC 60870-5-104
Internal communication (short)	Internal communication (long)	Communication
OV	Overflow	Overflow
BL	Blocked	Blocked
SB	Substituted	Substituted
NT	Not Topical	Not Topical
IV	Invalid	Invalid

Table 19: DMI - Conversion of quality descriptors

6.3.5 Conversion of Causes of Transmission

RTU		IEC 60870-5-104
Internal communication (short)	**Internal communication (long)**	**Communication**
T	Test	Test
P/N	Positive/negative confirmation	- Irrelevant -
Cause	Spontaneous	3 - spontaneous
	spontaneous (in case of a value change)	1 - periodic / cyclic
	spontaneous (in case of a value change)	2 - background scan
	spontaneous (in case of a value change)	5 - requested
	spontaneous (in case of a value change)	20, 21 ... 36 - interrogated

Table 20: DMI - Conversion of causes of transmission

6.4 DPI – Double Point Information

Binary process information is indicated by two bits.

6.4.1 Supported Data Types

IEC 60870-5-104				RTU	
ASDU	**Type identification**	**Data type property**	**Data type**	**Parameter name**	**Parameter location**
M_DP_NA_1	<3>	without timestamp	DPI		
M_DP_TB_1	<31>	with timestamp CP56Time2a	DPI		

Table 21: DPI - Supported data types

6.4.2 Conversion of Values

RTU internal value	IEC 60870-5-104
intermediate	11
off	01
on	10
indeterminate	00

Table 22: DPI – Conversion of values

6.4.3 Additional information

Readable by a read command (see Chapter 10.2, "Read Command").

	Parameter name	Default	Parameter location
	Read command status	no	data point (e.g. SPI) - line (Sub parameter)

value range: no, cyclic time, absolute time
no: no read command enabled; cyclic time: cyclic read command enabled; absolute time: read command at abosute point of time once a day enabled

6.4.4 Conversion of Quality Descriptors

RTU		IEC 60870-5-104
Internal communication (short)	**Internal communication (long)**	**Communication**
BL	Blocked	Blocked
SB	Substituted	Substituted
NT	Not Topical	Not Topical
IV	Invalid	Invalid

Table 23: DPI - Conversion of quality descriptors

6.4.5 Conversion of Causes of Transmission

RTU		IEC 60870-5-104
Internal communication (short)	**Internal communication (long)**	**Communication**
T	Test	Test
P/N	Positive/negative confirma-tion	- Irrelevant -
Cause	Spontaneous	3 - spontaneous
	spontaneous (in case of a value change)	2 - background scan
	spontaneous (in case of a value change)	5 - requested
	return information caused by a remote command	11 - return information caused by a remote command
	return information caused by a local command	12 - return information caused by a local command
	spontaneous (in case of a value change)	20, 21 ... 36 - interrogated

Table 24: DPI - Conversion of causes of transmission

6.5 ITI – Integrated Totals Information

Binary process information is indicated by 32 bits as a count value.

6.5.1 Supported Data Types

IEC 60870-5-104				RTU	
ASDU	Type identification	Data type property	Data type	Parameter name	Parameter location
M_IT_NA_1	<15>	without timestamp	ITI		
M_IT_TB_1	<37>	with timestamp CP56Time2a	ITI		

Table 25: ITI - Supported data types

6.5.2 Additional information

Readable by a read command (see Chapter 10.2, "Read Command").

Parameter name	Default	Parameter location
Read command status	no	data point (e.g. SPI) - line (Sub parameter)
value range: no, cyclic time, absolute time no: no read command enabled; cyclic time: cyclic read command enabled; absolute time: read command at abosute point of time once a day enabled		

6.5.3 Conversion of Values

Range	RTU internal value	IEC 60870-5-104
Range min.	- 2 147 483 648	- 2 147 483 648
...	...	
Range max.	2 147 483 647	2 147 483 647

Table 26: ITI - Conversion of values

6.5.4 Conversion of Quality Descriptors

RTU		IEC 60870-5-104
Internal communication (short)	Internal communication (long)	Communication
SEQ	Sequence number	Sequence number
CY	Carry	Carry
CA	Adjusted	Adjusted
IV	Invalid	Invalid

Table 27: ITI - Conversion of quality descriptors

6.5.5 Conversion of Causes of Transmission

RTU		IEC 60870-5-104
Internal communication (short)	Internal communication (long)	Communication
T	Test	Test

Table 28: ITI - Conversion of causes of transmission

RTU		IEC 60870-5-104
Internal communication (short)	**Internal communication (long)**	**Communication**
P/N	Positive/negative confirmation	- Irrelevant -
Cause	Spontaneous	3 - spontaneous
	spontaneous (in case of a value change)	5 - requested
	Interrogated	37, 38 … 41 - interrogated

Table 28: ITI - Conversion of causes of transmission

6.6 MFI – Measured Float Information

32 bit analog process information is used as a measured value in float format.

6.6.1 Supported Data Types

IEC 60870-5-104			RTU		
ASDU	**Type identification**	**Data type property**	**Data type**	**Parameter name**	**Parameter location**
M_ME_NC_1	<13>	without timestamp	MFI		
M_ME_TF_1	<36>	with timestamp CP56Time2a	MFI		

Table 29: MFI - Supported data types

6.6.2 Values

R32–IEEE STD 754

6.6.3 Additional information

Parameter name	Default	Parameter location
Threshold supervision	disabled	data point - line (Sub parameter)
value range: enabled / disabled enabled: the object is supervised by the threshold supervision; disabled: every received value is transmitted.		
Type	disabled	data point - line (Sub parameter)
value range: absolute / integrated		
Threshold	5 %	data point - line (Sub parameter)
value range: 0… 100 % Dead-band value for threshold supervision.		

Readable by a read command (see Chapter 10.2, "Read Command").

	Parameter name	Default	Parameter location
Read command status		no	data point (e.g. SPI) - line (Sub parameter)
value range: no, cyclic time, absolute time no: no read command enabled; cyclic time: cyclic read command enabled; absolute time: read command at abosute point of time once a day enabled			

6.6.4 Conversion of values

Range	RTU internal value	IEC 60870-5-104
Range min.	-3.4 x 10e38	-3.4 x 10e^{38}
...	...	
Range max.	+3.4 x 10e38	+3.4 x 10e^{38}

Table 30: MFI - Conversion of values

6.6.5 Conversion of Quality Descriptors

RTU		IEC 60870-5-104
Internal communication (short)	**Internal communication (long)**	**Communication**
OV	Overflow	Overflow
BL	Blocked	Blocked
SB	Substituted	Substituted
NT	Not Topical	Not Topical
IV	Invalid	Invalid

Table 31: MFI - Conversion of quality descriptors

6.6.6 Conversion of Causes of Transmission

RTU		IEC 60870-5-104
Internal communication (short)	**Internal communication (long)**	**Communication**
T	Test	Test
P/N	Positive/negative confirmation	- Irrelevant -
Cause	Spontaneous	3 - spontaneous
	spontaneous (in case of a value change)	1 - periodic / cyclic
	spontaneous (in case of a value change)	2 - background scan
	spontaneous (in case of a value change)	5 - requested
	spontaneous (in case of a value change)	20, 21 ... 36 - interrogated

Table 32: MFI - Conversion of causes of transmission

6.7 SPI – Single Point Information

Binary process information is indicated by one bit.

6.7.1 Supported Data Types

IEC 60870-5-104				RTU	
ASDU	**Type identification**	**Data type property**	**Data type**	**Parameter name**	**Parameter location**
M_SP_NA_1	<1>	without timestamp	SPI		
M_SP_TB_1	<30>	with timestamp CP56Time2a	SPI		

Table 33: SPI - Supported data types

6.7.2 Additional information

Readable by a read command (see Chapter 10.2, "Read Command").

Parameter name	Default	Parameter location
Read command status	no	data point (e.g. SPI) - line (Sub parameter)

value range: no, cyclic time, absolute time
no: no read command enabled; cyclic time: cyclic read command enabled; absolute time: read command at abosute point of time once a day enabled

6.7.3 Conversion of values

RTU internal value	IEC 60870-5-104
off	0
on	1

Table 34: SPI - Conversion of values

6.7.4 Conversion of Quality Descriptors

RTU		IEC 60870-5-104
Internal communication (short)	**Internal communication (long)**	**Communication**
BL	Blocked	Blocked
SB	Substituted	Substituted
NT	Not Topical	Not Topical
IV	Invalid	Invalid

Table 35: SPI - Conversion of quality descriptors

6.7.5 Conversion of Causes of Transmission

RTU		IEC 60870-5-104
Internal communication (short)	**Internal communication (long)**	**Communication**
T	Test	Test
P/N	Positive/negative confirmation	- Irrelevant -
Cause	Spontaneous	3 - spontaneous
	spontaneous (in case of a value change)	2 - background scan
	spontaneous (in case of a value change)	5 - requested
	return information caused by a remote command	11 - return information caused by a remote command
	return information caused by a local command	12 - return information caused by a local command
	spontaneous (in case of a value change)	20, 21 ... 36 - interrogated

Table 36: SPI - Conversion of causes of transmission

6.8 STI – Step Position Information

Binary process information is indicated by 8 bits.

6.8.1 Supported Data Types

IEC 60870-5-104				RTU	
ASDU	**Type identification**	**Data type property**	**Data type**	**Parameter name**	**Parameter location**
M_ST_NA_1	<5>	without timestamp	STI		
M_ST_TB_1	<32>	with timestamp CP56Time2a	STI		

Table 37: STI - Supported data types

6.8.2 Additional information

Readable by a read command (see Chapter 10.2, "Read Command").

Parameter name	**Default**	**Parameter location**
Read command status	no	data point (e.g. SPI) - line (Sub parameter)
value range: no, cyclic time, absolute time no: no read command enabled; cyclic time: cyclic read command enabled; absolute time: read command at abosute point of time once a day enabled		

6.8.3 Conversion of values

Range	RTU internal value	IEC 60870-5-104
Range min.	-63	-63
...	...	
Range max.	+63	+63

Table 38: STI - Conversion of values

6.8.4 Conversion of Quality Descriptors

RTU		IEC 60870-5-104
Internal communication (short)	**Internal communication (long)**	**Communication**
OV	Overflow	Overflow
BL	Blocked	Blocked
SB	Substituted	Substituted
NT	Not Topical	Not Topical
IV	Invalid	Invalid
T	Transient Bit	Transient Bit

Table 39: STI - Conversion of quality descriptors

6.8.5 Conversion of Causes of Transmission

RTU		IEC 60870-5-104
Internal communication (short)	**Internal communication (long)**	**Communication**
T	Test	Test
P/N	Positive/negative confirmation	- Irrelevant -
Cause	Spontaneous	3 - spontaneous
	spontaneous (in case of a value change)	2 - background scan
	spontaneous (in case of a value change)	5 - requested
	return information caused by a remote command	11 - return information caused by a remote command
	return information caused by a local command	12 - return information caused by a local command
	spontaneous (in case of a value change)	20, 21 ... 36 - interrogated

Table 40: STI - Conversion of causes of transmission

7 Data Types - Controlling Direction

7.1 ASO – Analog Setpoint Output

Analog process command (16 bit signed number).

7.1.1 Supported Data Types

IEC 60870-5-104			RTU		
ASDU	Type identification	Data type property	Data type	Parameter name	Parameter location
C_SE_NA_1	<48>	normalized, without time tag	ASO	Transmission format: Normalized	ASO - line T101/ T104/GP104
C_SE_TA_1	<61>	normalized, with time tag CP56Time2a	ASO	Transmission format: Normalized	ASO - line T104/ GP104
				Send commands with time tag	linie T104 - IEC 60870-5-104
C_SE_NB_1	<49>	scaled, without time tag	ASO	Transmission format: Scaled	ASO - line T101/ T104/GP104
C_SE_TB_1	<62>	scaled, with time tag CP56Time2a	ASO	Transmission format: Scaled	ASO - line T104/ GP104
				Send commands with time tag	linie T104 - IEC 60870-5-104

Table 41: ASO - Supported data types

7.1.2 Command Authority

None

7.1.3 Additional information

None

7.1.4 Conversion of values

Range	RTU internal value	IEC 60870-5-104
Range min.	-100 %	Normalized: -1 Scaled: -32 768
...	...	

Table 42: ASO - Conversion of values

Range	RTU internal value	IEC 60870-5-104
Range max.	+100 %	Normalized: $+1\text{-}2e^{-15}$ Scaled: +32 767

Table 42: ASO - Conversion of values

7.1.5 Conversion of qualifier of command

RTU		IEC 60870-5-104
Internal communication (short)	Internal communication (long)	Communication
SE	Select / Execute	Select / Execute (1 select, 0 execute)
QL	default	0 - default

Table 43: ASO - conversion of qualifier of command

7.1.6 Conversion of causes of transmission

RTU		IEC 60870-5-104
Internal communication (short)	Internal communication (long)	Communication
T	Test	Ignored
P/N	Positive/negative confirmation	Relevant in monitor direction only
Cause	Activation	6 - Activation
	Activation Confirmation	7 - Activation Confirmation
	Deactivation	8 - Deactivation
	Deactivation Confirmation	9 - Deactivation Confirmation
	Activation Termination	10 - Activation Termination
	Negative Confirmation	45 … 47 - Unknown

Table 44: ASO - Conversion of causes of transmission

7.2 BSO – Bit String Output

Binary process command (1, 2, 8, 16, 32 bit unsigned number).

7.2.1 Supported Data Types

IEC 60870-5-104			RTU		
ASDU	Type identification	Data type property	Data type	Parameter name	Parameter location
C_BO_NA_1	<51>	without time tag	BSO		

Table 45: BSO - Supported data types

IEC 60870-5-104				RTU	
ASDU	**Type identification**	**Data type property**	**Data type**	**Parameter name**	**Parameter location**
C_BO_TA_1	<64>	with time tag, CP56Time2a	BSO	Send commands with time tag	linie T104 - IEC60870-5-104

Table 45: BSO - Supported data types

7.2.2 Command Authority

None

7.2.3 Additional information

None

7.2.4 Conversion of values

Range	RTU internal value	IEC 60870-5-104
Range min.	0	0
...	...	
Range max.	65535	65535

Table 46: BSO - Conversion of values

7.2.5 Conversion of qualifier of command

RTU		IEC 60870-5-104
Internal communication (short)	**Internal communication (long)**	**Communication**
SE	only direct execute	only direct execute

Table 47: BSO - conversion of qualifier of command

7.2.6 Conversion of causes of transmission

RTU		IEC 60870-5-104
Internal communication (short)	**Internal communication (long)**	**Communication**
T	Test	Ignored
P/N	Positive/negative confirmation	Relevant in monitor direction only
Cause	Activation	6 - Activation
	Activation Confirmation	7 - Activation Confirmation
	Activation Termination	10 - Activation Termination
	Negative Confirmation	45 … 47 - Unknown

Table 48: BSO - Conversion of causes of transmission

7.3 DCO – Double Command Output

Binary process command (two bits).

7.3.1 Supported Data Types

IEC 60870-5-104				RTU	
ASDU	**Type identification**	**Data type property**	**Data type**	**Parameter name**	**Parameter location**
C_DC_NA_1	<46>	without timestamp	DCO		
C_DC_TA_1	<59>	with timestamp CP56Time2a	DCO	Send commands with time tag	linie T104 - IEC60870-5-104

Table 49: DCO - Supported data types

7.3.2 Command Authority

None

7.3.3 Additional information

None

7.3.4 Conversion of Values

RTU internal value	IEC 60870-5-104
off	01
on	10

Table 50: DCO - Conversion of values

7.3.5 Conversion of qualifier of command

RTU		IEC 60870-5-104
Internal communication (short)	**Internal communication (long)**	**Communication**
SE	Select / Execute	Select / Execute (1 select, 0 execute)
QU	default	0 - no additional definition

Table 51: DCO - conversion of qualifier of command

7.3.6 Conversion of causes of transmission

RTU		IEC 60870-5-104
Internal communication (short)	Internal communication (long)	Communication
T	Test	Ignored
P/N	Positive/negative confirmation	Relevant in monitor direction only
Cause	Activation	6 - Activation
	Activation Confirmation	7 - Activation Confirmation
	Deactivation	8 - Deactivation
	Deactivation Confirmation	9 - Deactivation Confirmation
	Activation Termination	10 - Activation Termination
	Negative Confirmation	45 … 47 - Unknown

Table 52: DCO - Conversion of causes of transmission

7.4 DSO – Digital Setpoint Output

Binary process command (8 or 16 bit signed number).

7.4.1 Supported Data Types

IEC 60870-5-104			RTU		
ASDU	Type identification	Data type property	Data type	Parameter name	Parameter location
C_SE_NA_1	<48>	normalized, without time tag	DSO	Transmission format: Normalized	DSO - line T101/T104/GP104
C_SE_TA_1	<61>	normalized, with time tag CP56Time2a	DSO	Transmission format: Normalized	DSO - line T104/GP104
				Send commands with time tag	line T104 - IEC 60870-5-104
C_SE_NB_1	<49>	scaled, without time tag	DSO	Transmission format: Scaled	DSO - line T101/T104/GP104
C_SE_TB_1	<62>	scaled, with time tag CP56Time2a	DSO	Transmission format: Scaled	DSO - line T104/GP104
				Send commands with time tag	line T104 - IEC 60870-5-104

Table 53: DSO - Supported data types

7.4.2 Command Authority

None

7.4.3 Additional information

None

7.4.4 Conversion of values

Range	RTU internal value	IEC 60870-5-104
Range min.	-100 %	-1
...	...	
Range max.	+100 %	+1-2e^{-15}

Table 54: DSO - Conversion of values

7.4.5 Conversion of qualifier of command

RTU		IEC 60870-5-104
Internal communication (short)	**Internal communication (long)**	**Communication**
SE	Select / Execute	Select / Execute (1 select, 0 execute)
QL	default	0 - default

Table 55: DSO - conversion of qualifier of command

7.4.6 Conversion of causes of transmission

RTU		IEC 60870-5-104
Internal communication (short)	**Internal communication (long)**	**Communication**
T	Test	Ignored
P/N	Positive/negative confirmation	Relevant in monitor direction only
Cause	Activation	6 - Activation
	Activation Confirmation	7 - Activation Confirmation
	Deactivation	8 - Deactivation
	Deactivation Confirmation	9 - Deactivation Confirmation
	Activation Termination	10 - Activation Termination
	Negative Confirmation	45 … 47 - Unknown

Table 56: DSO - Conversion of causes of transmission

7.5 FSO – Floating Point Setpoint Output

Floating point process command (32 bit short floating point number)

7.5.1 Supported Data Types

IEC 60870-5-104			RTU		
ASDU	**Type identification**	**Data type property**	**Data type**	**Parameter name**	**Parameter location**
C_SE_NC_1	<50>	without time tag	FSO		
C_SE_TC_1	<63>	with time tag CP56Time2a	FSO	Send commands with time tag	linie T104 - IEC60870-5-104

Table 57: FSO - Supported data types

7.5.2 Command Authority

None

7.5.3 Additional information

None

7.5.4 Conversion of values

Range	RTU internal value	IEC 60870-5-104
Range min.	-3.4 x 10e38	-3.4 x 10e38
...	...	
Range max.	+3.4 x 10e38	+3.4 x 10e38

Table 58: FSO - Conversion of values

7.5.5 Conversion of qualifier of command

RTU		IEC 60870-5-104
Internal communication (short)	**Internal communication (long)**	**Communication**
SE	Select / Execute	Select / Execute (1 select, 0 execute)
QL	default	0 - default

Table 59: FSO - conversion of qualifier of command

7.5.6 Conversion of causes of transmission

RTU		IEC 60870-5-104
Internal communication (short)	**Internal communication (long)**	**Communication**
T	Test	Ignored

Table 60: FSO - Conversion of causes of transmission

RTU		IEC 60870-5-104
Internal communication (short)	Internal communication (long)	Communication
P/N	Positive/negative confirmation	Relevant in monitor direction only
Cause	Activation	6 - Activation
	Activation Confirmation	7 - Activation Confirmation
	Deactivation	8 - Deactivation
	Deactivation Confirmation	9 - Deactivation Confirmation
	Activation Termination	10 - Activation Termination
	Negative Confirmation	45 … 47 - Unknown

Table 60: FSO - Conversion of causes of transmission

7.6 RCO – Regulation Command Output

Regulation step command (two bits).

7.6.1 Supported Data Types

IEC 60870-5-104			RTU		
ASDU	Type identification	Data type property	Data type	Parameter name	Parameter location
C_RC_NA_1	<47>	without time tag	RCO		
C_RC_TA_1	<60>	with time tag CP56Time2a	RCO	Send commands with time tag	linie T104 - IEC60870-5-104

Table 61: RCO - Supported data types

7.6.2 Command Authority

None

7.6.3 Additional information

None

7.6.4 Conversion of values

RTU internal value	IEC 60870-5-104
Lower	01
Higher	10

Table 62: RCO - Conversion of values

7.6.5 Conversion of qualifier of command

RTU		IEC 60870-5-104
Internal communication (short)	**Internal communication (long)**	**Communication**
SE	Select / Execute	Select / Execute (1 select, 0 execute)
QU	default	0 - no additional definition

Table 63: RCO - conversion of qualifier of command

7.6.6 Conversion of causes of transmission

RTU		IEC 60870-5-104
Internal communication (short)	**Internal communication (long)**	**Communication**
T	Test	Ignored
P/N	Positive/negative confirmation	Relevant in monitor direction only
Cause	Activation	6 - Activation
	Activation Confirmation	7 - Activation Confirmation
	Deactivation	8 - Deactivation
	Deactivation Confirmation	9 - Deactivation Confirmation
	Activation Termination	10 - Activation Termination
	Negative Confirmation	45 … 47 - Unknown

Table 64: RCO - Conversion of causes of transmission

7.7 SCO – Single Command Output

Binary process command (one bit).

7.7.1 Supported Data Types

IEC 60870-5-104			RTU		
ASDU	**Type identification**	**Data type property**	**Data type**	**Parameter name**	**Parameter location**
C_SC_NA_1	<45>	without timestamp	SCO		
C_SC_TA_1	<58>	with timestamp CP56Time2a	SCO	Send commands with time tag	line T104 - IEC 60870-5-104

Table 65: SCO - Supported data types

7.7.2 Command Authority

None

7.7.3 Additional information

None

7.7.4 Conversion of values

RTU internal value	IEC 60870-5-104
off	0
on	1

Table 66: SCO - Conversion of values

7.7.5 Conversion of qualifier of command

RTU		IEC 60870-5-104
Internal communication (short)	**Internal communication (long)**	**Communication**
SE	Select / Execute	Select / Execute (1 select, 0 execute)
QU	default	0 - no additional definition

Table 67: SCO - conversion of qualifier of command

7.7.6 Conversion of causes of transmission

RTU		IEC 60870-5-104
Internal communication (short)	**Internal communication (long)**	**Communication**
T	Test	Ignored
P/N	Positive/negative confirmation	Relevant in monitor direction only
Cause	Activation	6 - Activation
	Activation Confirmation	7 - Activation Confirmation
	Deactivation	8 - Deactivation
	Deactivation Confirmation	9 - Deactivation Confirmation
	Activation Termination	10 - Activation Termination
	Negative Confirmation	45 … 47 - Unknown

Table 68: SCO - Conversion of causes of transmission

8 File Transfer

The file transfer is used for exchanging files between a control center and a subordinated device connected to a RTU560.

The file name in the protocol is fixed for all supported file types to 1 (transparent file).

Supported file types:
- RCD configuration file
- PRO configuration file (PLC boot project file)
- Disturbance record file (various protocols and device types)
- UNDEF file not specified in detail

8.1 Supported data types

IEC 60870-5-104			RTU		
ASDU	Type identification	Data type property	Data type	Parameter name	Parameter location
F_FR_NA_1	<120>				
F_SR_NA_1	<121>				
F_SC_NA_1	<122>				
F_LS_NA_1	<123>				
F_AF_NA_1	<124>				
F_SG_NA_1	<125>				
F_DR_TA_1	<126>				

Table 69: File transfer - Supported data types

8.2 Values

None.

8.3 Command Authority

None

8.4 Additional information

None

8.5 Conversion of causes of transmission

RTU		IEC 60870-5-104
Internal communication (short)	Internal communication (long)	Communication
T	Test	Ignored

Table 70: File transfer - Conversion of causes of transmission

	RTU	IEC 60870-5-104
Internal communication (short)	**Internal communication (long)**	**Communication**
P/N	Positive/negative confirmation	Relevant in monitor direction only
Cause	Spontaneous	3 – spontaneous (126)
	Requested	5 – requested (122, 126)
	File transfer	13 - file transfer

Table 70: File transfer - Conversion of causes of transmission

8.6 Download

The download of configuration files does not trigger any restarting mechanism in the subordinated device. For activating the new configuration file, the control center has to issue a Reset Process Command (C_RP_NA_1, TI 105) after writing the files to the device.

The file transfer will only be routed to the subordinated device it belongs to. The distribution is done between the message F_LS_NA_1 and the message F_AF_NA_1 and may last a couple of seconds. The message F_AF_NA_1 is only acknowledged positively when file distribution were successful.

8.7 Upload

All supported file types can also be uploaded from a RTU of the RTU500 series or an IED.

See documentation of the relevant subdevice communication interface for support of (disturbance) file upload.

9 Transparent Data

In automation systems may be required information that is not mapped to the IEC 60870-5-104 protocol. This information includes several device specific parameters etc.

Several type identifications of the private range have been selected to enable transparent data transfer through the RTU500 series RTU to subordinated devices.

9.1 Command direction

With the Transparent Data Message C_TD_NA_1 the Controlling Station is able to request data from subordinate devices through the RTU500 series.

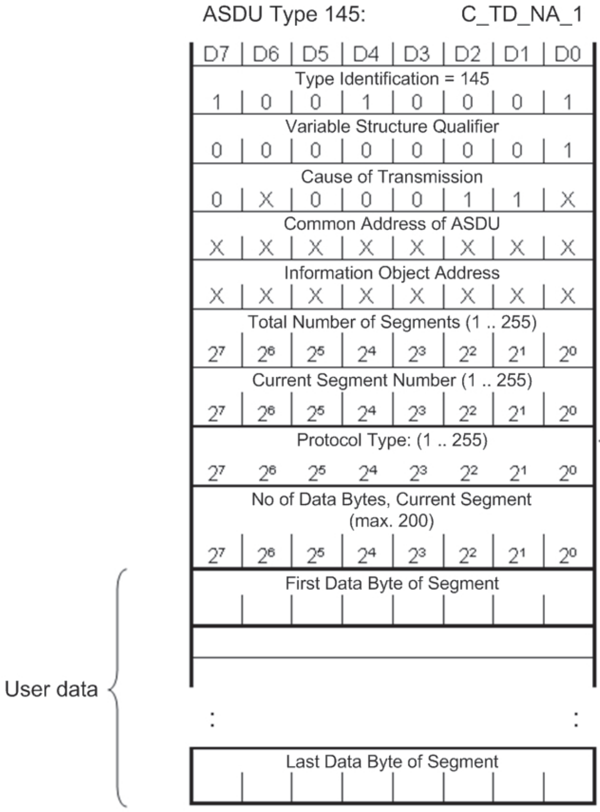
The Type Ident is 145, ASDU address and the Information object address must be configured in RTUtil500.

The Transparent Data Message C_TD_NA_1 will be answered from the RTU by sending the message back to Controlling Station with Cause of Transmission 7 (activation confirmation).

When the message is accepted by the RTU (message can be processed by the RTU and device answers to the request message), the RTU sends a “positive confirmation” ACTCON, otherwise (message cannot be processed by the RTU) the RTU sends a “negative confirmation” ACTCON.

Every transparent data command is checked on ASDU address, information object address and “No of Data Bytes in Current Segment“.

If the ASDU address or information object address does not match to the configuration in RTUtil500 or the “No of Data Bytes in Current Segment” is higher than 200, the command is confirmed negative.



Protocol Type	Value in Protocol Type field
SPAbus	7
RP570/571	8*
Modbus	9
IEC 60870-5-101	101*
IEC 60870-5-102	102
IEC 60870-5-103	103*
IEC 60870-5-104	104*
IEC 1107	107

* : reserved for future use

Figure 3: ASDU Type 145

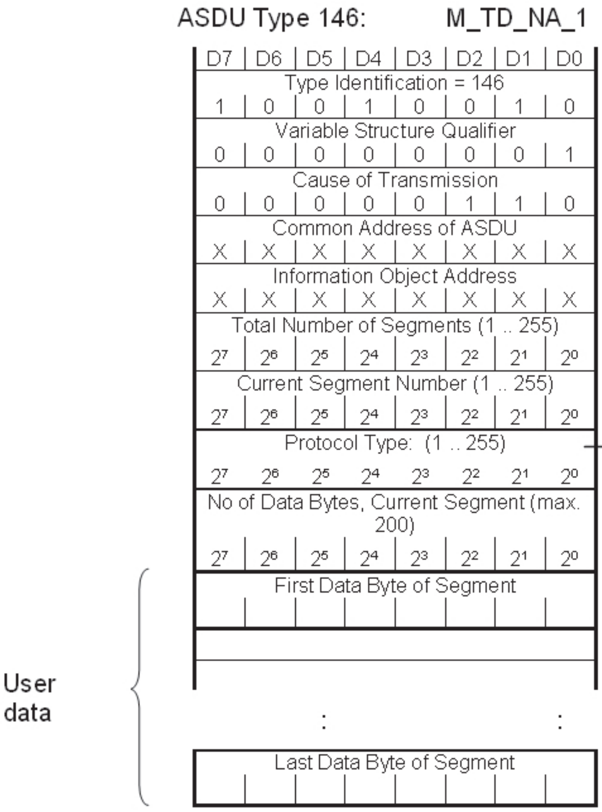
9.2 Monitoring direction

With the Transparent Data Response M_TD_NA_1, the RTU is able to receive any data as transparent data from subordinate devices.

The Type Ident is 146, the ASDU address and the Information object address must be configured by RTUtil500. They are equal to the one used in command direction.

The maximum amount of segments is 255, each of them contains up to 200 data bytes.

If all data can be sent in one message (data segmentation not necessary), the contents of both segmentation control fields are set to 1.



Protocol Type	Value in Protocol Type field
SPAbus	7
RP570/571	8*
Modbus	9
IEC 60870-5-101	101*
IEC 60870-5-102	102
IEC 60870-5-103	103*
IEC 60870-5-104	104*
IEC 62056-21	107

* : reserved for future use

Figure 4: ASDU Type 146

9.3 Request procedure

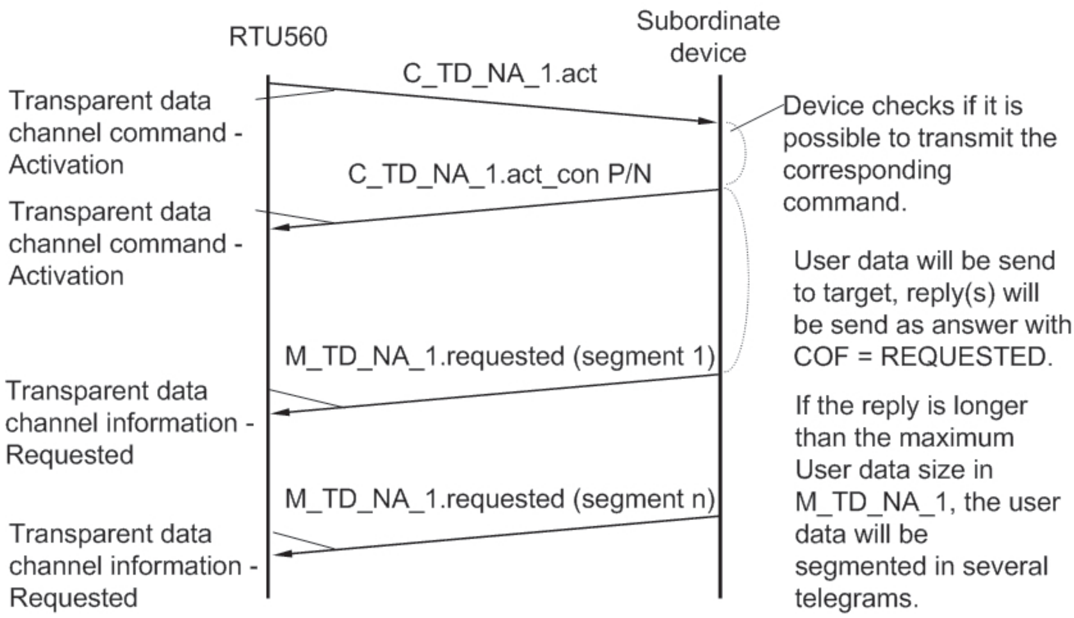


Figure 5: Request procedure

9.4 Encapsulated SPAbus messages

9.4.1 General

With the Transparent Data Message C_SB_NA_1 the Controlling Station is able to request data and execute commands of a SPAbus device connected to a subordinate device through the RTU560.

The Type Ident is 133, the ASDU address and the Information object address must be configured in RTUtil500.

The Transparent Data Message C_SB_NA_1 will be answered from RTU by sending the message back to Central System with Cause of Transmission 7 (activation confirmation).

When the message is accepted by the subordinate device (Device answers to the request message), the RTU sends a "positive confirmation" ACTCON with the reply data included, otherwise (message cannot be processed) the RTU sends a "negative confirmation" ACTCON.

Every transparent data command is checked on ASDU address, information object address and “No of Data Bytes in Current Segment“.

If the ASDU address, information object address or “No of Data Bytes” does not match to the configuration in RTUtil500, the command is confirmed negative.

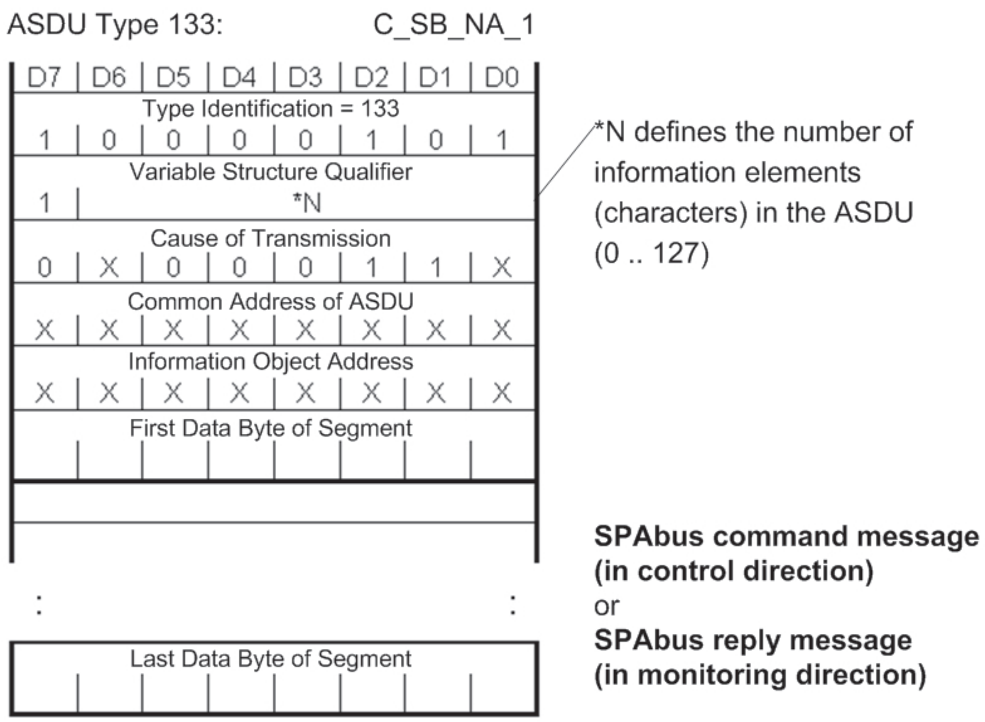


Figure 6: ASDU Type 133

9.4.2 Request procedure

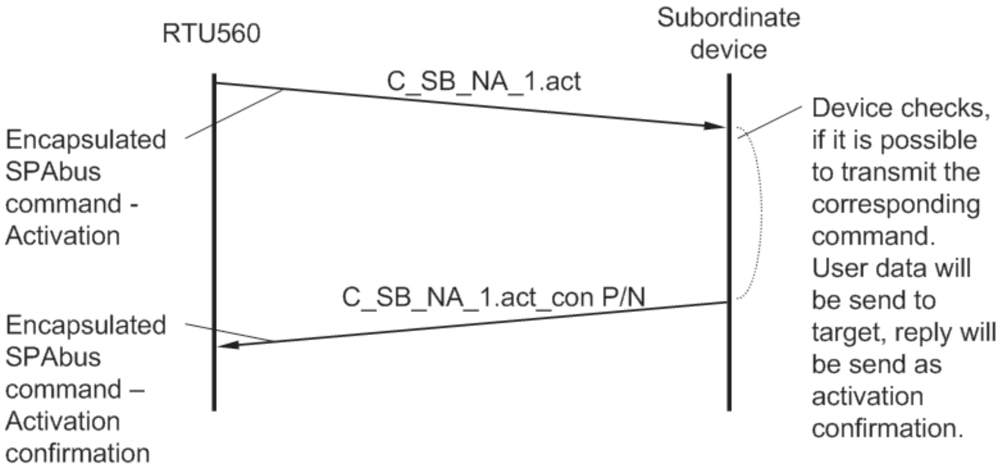


Figure 7: Request procedure

10 Internal Functions

10.1 General Interrogation

The general interrogation to the subordinated devices is send directly after the initialization of the RTU and on every change of the subordinated link from state OFFLINE to state ONLINE.

A redundancy switchover causes also a general interrogation if the subdevice interface is configured as non-redundant (CMU is an additional non-redundant board in a redundant station).

10.1.1 Supported Data Types

IEC 60870-5-104			RTU		
ASDU	**Type identification**	**Data type property**	**Data type**	**Parameter name**	**Parameter location**
C_IC_NA_1	<100>				

Table 71: General Interrogation - Supported data types

10.1.2 Values

20

10.1.3 Command Authority

None

10.1.4 Additional information

None

10.1.5 Conversion of Quality Descriptors

RTU		IEC 60870-5-104
Internal communication (short)	**Internal communication (long)**	**Communication**
QOI	Qualifier of Interrogation	20 – General interrogation

Table 72: General Interrogation - Conversion of quality descriptors

10.1.6 Conversion of Causes of Transmission

RTU		IEC 60870-5-104
Internal communication (short)	**Internal communication (long)**	**Communication**
T	Test	Ignored
P/N	Positive/negative confirmation	Relevant in monitor direction only
Cause	Activation	6 - Activation
	Activation Confirmation	7 - Activation Confirmation
	Activation Termination	10 - Activation Termination
	Negative Confirmation	45 … 47 - Unknown

Table 73: General Interrogation - Conversion of causes of transmission

10.2 Read Command

Process command to read a specific data point.

10.2.1 Supported data types

IEC 60870-5-104				RTU	
ASDU	**Type identification**	**Data type property**	**Data type**	**Parameter name**	**Parameter location**
C_RD_NA_1	<102>				

Table 74: Read Command - Supported data types

10.2.2 Values

None.

10.2.3 Command Authority

None

10.2.4 Additional information

A read command can be configured for every data point of the monitoring direction.

The read command can be configured in two modes:

- Absolute time
  The read command for the specific data point is send at the configured time within a day. It is send only once per day.
- Cyclic time
  The read command for the specific data point is send cyclic. The time period must be configured. The time period is configured in minutes. Possible values are 1 to 1 440 minutes.

	Parameter name	Default	Parameter location
Read command status		no	data point (e.g. SPI) - line (Sub parameter)

value range: no, cyclic time, absolute time
no: no read command enabled; cyclic time: cyclic read command enabled; absolute time: read command at abosute point of time once a day enabled

10.2.5 Conversion of quality descriptors

RTU		IEC 60870-5-104
Internal communication (short)	**Internal communication (long)**	**Communication**
SE	Select / Execute	Only S/E = 0 (execute) supported

Table 75: Read Command - Conversion of quality descriptors

10.2.6 Conversion of causes of transmission

RTU		IEC 60870-5-104
Internal communication (short)	**Internal communication (long)**	**Communication**
T	Test	Ignored
P/N	Positive/negative confirmation	Relevant in monitor direction only
Cause	Request	5 - Request
	Negative Confirmation	44 … 47 - Unknown

Table 76: Read Command - Conversion of caused of transmission

10.3 Time Synchronization

If the RTU500 series should synchronize subordinated devices, it must be configured.

	Parameter name	Default	Parameter location
Time interval of clock synchronization commands		Disabled	Line T101/104 - IEC 60870-5-101/104

Value range: disabled, 60 ... 65000 s

Specification whether time synchronization of the secondary station shall take place. Approved value for RTU500 series secondary stations: 300 s

ADVICE

The time synchronization command is only send to subordinated devices which are in state ONLINE, and only if the time tag of the own RTU is valid (synchronized).

10.3.1 Supported Data Types

IEC 60870-5-104				RTU	
ASDU	Type identification	Data type property	Data type	Parameter name	Parameter location
C_CS_NA_1	<103>				

Table 77: Time Synchronization - Supported data types

10.3.2 Values

Complete time and date information in CP56Time2a format.

10.3.3 Command Authority

None

10.3.4 Additional information

None

10.3.5 Conversion of Causes of Transmission

RTU		IEC 60870-5-104
Internal communication (short)	Internal communication (long)	Communication
T	Test	Ignored
P/N	Positive/negative confirmation	Relevant in monitor direction only
Cause	Activation	6 - Activation
	Activation Confirmation	7 - Activation Confirmation
	Negative Confirmation	45 … 47 - Unknown

Table 78: Time synchronization - Conversion of causes of transmission

10.4 Test Command

10.4.1 Supported data types

IEC 60870-5-104				RTU	
ASDU	Type identification	Data type property	Data type	Parameter name	Parameter location
C_TS_TA_1	<107>	with time tag CP56Time2a			

Table 79: Test Command - Supported data types

10.4.2 Values

0x55AA

10.4.3 Command Authority

None

10.4.4 Additional information

Parameter name	Default	Parameter location
Test command cycle		IED Parameter
The cycle time of the test command can be configured. Value range: 0 … 65.535 s		

10.4.5 Conversion of quality descriptors

RTU		IEC 60870-5-104
Internal communication (short)	**Internal communication (long)**	**Communication**
SE	Select / Execute	Only S/E = 0 (execute) supported

Table 80: Test Command - Conversion of quality descriptors

10.4.6 Conversion of causes of transmission

RTU		IEC 60870-5-104
Internal communication (short)	**Internal communication (long)**	**Communication**
T	Test	Ignored
P/N	Positive/negative confirmation	Relevant in monitor direction
Cause	Activation	6 - Activation
	Activation Confirmation	7 - Activation Confirmation
	Negative Confirmation	45 … 47 - Unknown

Table 81: Test Command - Conversion of causes of transmission

10.5 Reset Command

Command to reset a subordinated RTU.

10.5.1 Supported data types

IEC 60870-5-104			RTU		
ASDU	Type identification	Data type property	Data type	Parameter name	Parameter location
C_RP_NA_1	<105>				

Table 82: Reset Command - Supported data types

10.5.2 Values

1

10.5.3 Command Authority

None

10.5.4 Additional information

The subdevice communication interface will not generate this command, but it will route this command, received from a host communication interface.

10.5.5 Conversion of quality descriptors

RTU		IEC 60870-5-104
Internal communication (short)	Internal communication (long)	Communication
SE	Select / Execute	Only S/E = 0 (execute) supported

Table 83: Reset Command - Conversion of quality descriptors

10.5.6 Conversion of causes of transmission

RTU		IEC 60870-5-104
Internal communication (short)	Internal communication (long)	Communication
T	Test	Ignored
P/N	Not used	Not relevant
Cause	REMOTE_RESET	Not relevant

Table 84: Reset Command - Conversion of causes of transmission

10.6 System events

The subdevice communication interface manages internal status messages for every device connected to this line. These status messages are created from the subdevice communication interface itself for every connected device.

Parameter name	Default	Parameter location
Fix SEV address schema	enabled	SDI - line
Value range: enabled/ disabled if enabled: a base address for the whole block of system events is defined at the SDI node if disabled: individual addresses per SEV can be defined In order to avoid collisions, the addresses of the system events may not be used for other process objects.		
In use	enabled	SDI - line
Value range: enabled/ disabled if disabled: no SEVs will be transmitted on this line		

The subdevice communication interface generates the following system events:

IED SEVs influ-enced by the SCI	Description of system event	Address offset
X	Device is active While initialization the value of SEV#024 is set to ON. On a running system this system event does not change anymore.	#024
	At least one DCE (data communication equipment) faulty	#044
X	Device connected (controled by SSC#003)	#045
X	Device inoperable The SEV#048 is set in dependency of the state of the subordinated device.	#048
X	Device out of service (controled by SSC#001)	#049
X	Device reachable on redundant line 1 / 2	#180, #181
	Device reachable on redundant line 3 / 4	#182, #183
X	Device active on redundant line 1 / 2	#184, #185
	Device active on redundant line 3 / 4	#186, #187
X	Device preferred on redundant line 1 / 2	#188, #189
	Device preferred on redundant line 3 / 4	#190, #191
X[1)]	Process command collision with host x, 1 ≤ x ≤ 16	#242 ... #257
X[1)]	Process command collision with Integrated HMI	#258
X[1)]	Process command collision with webserver	#259
X[1)]	Process command collision with PLC	#260

Table 85: Description of system events

1) The process command collision will be signalized as 1ms impulse in two following system events.

10.6.1 Status change device OFFLINE to device ONLINE

If the state of a subordinated device or line changes from OFFLINE to ONLINE, a general interrogation command is send to the concerning device(s).

The system event "device inoperable" (SEV#048) with value 0 is sent as SPI to the internal communication for every device that changed its state to ONLINE.

10.6.2 Status change device ONLINE to device OFFLINE

If the state of a subordinated device or line changes from ONLINE to OFFLINE all configured data points connected to these devices are sent to the internal communication with the actual state, marked as INVALID (IV) or NOT TOPICAL (NT) and with the timestamp of the own RTU. INVALID or NOT TOPICAL is set depending on the configuration parameter Information object qualifier.

Parameter name	Default	Parameter location
Information object qualifier (usage for disconnected subordinated devices)	Mark as invalid (IV)	RTU - Parameter
Value range: Mark as invalid (IV) / Mark as not topical (NT)		

ADVICE

Also in not topical (NT) configuration are data points which have not been updated since RTU startup marked as invalid (IV).

The system event DEVICE_INOPERABLE (48) with value 1 is sent as SPI to the internal communication for every device that changed its state to OFFLINE.

10.7 System commands

The behavior of subordinated devices connected to a sub-device communication interface with protocol IEC 60870-5-104 can be modified with system single commands (SSC).

If system commands are configured to a subordinated device not directly connected to the sub-device communication interface they are send as single command with the protocol address configured for this SSC in RTUtil500 to the next subordinated device. Devices directly connected to a sub-device communication interface are processed by the sub-device communication interface itself.

The following system single commands are supported:

SSC supported	Description of SSC	Address offset
X	Set device out of service	#001
X	Reset device process	#002
X	Connect/disconnect device	#003
X	Set redundant line 1 / 2 as preferred line	#004, #005
	Set redundant line 3 / 4 as preferred line	#006, #007
X	Force global process image update, i.e. force process image update of all subdevices	#012
X	Request redundancy change over for the active CMU x, $1 \le x \le 16$	#016 ... #031

Table 86: Description of system single commands (SSC)

10.7.1 Set device out of service

The processing of a subordinated device can be stopped using the system single command Set device out of service. The current status is signalized with the system event SEV#048 "Device out of service". Initial status is in service. If a device is taken out of service no communication at all will be done. Process information referencing to this device will be send spontaneously as invalid and received process commands to this device will be confirmed negative.

If the device is set in service again, a general interrogation is done to get the current process status of the subordinated device.

RTU internal value	Status
off	Set device in service
on	Set device out of service

Table 87: Conversion of values SSC#001

10.7.2 Reset device process

The SSC command ‘Reset device process’ will be send as reset command (C_RP) to subordinated devices of type IED. If the subordinated device is of type RTU500 series it will be send as single command (C_SC) with the protocol address configured for this system single command. Depending on the device, a command confirmation of the reset process command will not be received.

RTU internal value	Status
off	<Ignored>
on	reset device process

Table 88: Conversion of values SSC#002

10.7.3 Connect/disconnect device

In case of a dial up connection it is possible to force a connection to a specified device with system single command Connect device.

RTU internal value	Status
off	disconnect a dial up connection of device
on	connect a dial up connection to device

Table 89: Conversion of values

10.7.4 Set redundant line as preferred line

To modify the preferred redundant line in case of configured redundant communication lines the system single command "Set redundant line x as preferred line" is used.

RTU internal value	Status
off	<ignored>
on	set redundant line as preferred line

Table 90: Conversion of values

10.7.5 Force process image update

If the command is addressed to a subordinated device and this device is an RTU of RTU500 series and for this RTU the SSC#12 "force process image update" is also defined, the SSC command is delegated to the connected sub-RTU. If not, a general interogation command (GI) is performed to the connected device.

RTU internal value	Status
off	<Ignored>
on	Force process image update

Table 91: Conversion of values SSC#012

10.7.6 Request redundancy change over

The SSC command will only be send to a subordinated device of the type RTU500 series. It will be send as single command (C_SC) with the protocol address configured for this SSC.

RTU internal value	Status
off	<Ignored>
on	Request redundancy change over

Table 92: Conversion of values SSC#016 ... #031

11 Interoperability List

The selected parameters are marked in the white boxes as follows:

☐ Function or ASDU is not used
[X] 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

11.1 System or device

(system-specific parameter)

☐ System definition
☒ Controlling station definition (master)
☐ Controlled station definition (slave)

11.2 Network configuration

(network-specific parameter)

■ ~~Point-to-point~~
■ ~~Multiple point-to-point~~
■ ~~Multipoint-party line~~
■ ~~Multipoint-star~~

11.3 Physical Layer

(network-specific parameter)

11.3.1 Transmission speed (control direction)

Unbalanced interchange
Circuit V.24/V.28
Standard

■ ~~100~~bit/s
■ ~~200~~bit/s
■ ~~300~~bit/s
■ ~~600~~bit/s
■ ~~1 200~~bit/s

Unbalanced interchange
Circuit V.24/V.28
Recommended if >1 200 bit/s

■ ~~2 400~~bit/s
■ ~~4 800~~bit/s

■ ~~9 600~~bit/s

Balanced interchange
Circuit X.24/X.27

■ ~~2 400~~bit/s

■ ~~4 800~~bit/s

■ ~~9 600~~bit/s

■ ~~19 200~~bit/s

■ ~~38 400~~bit/s

■ ~~56 000~~bit/s

■ ~~64 000~~bit/s

11.3.2 Transmission speed (monitor direction)

Unbalanced interchange
Circuit V.24/V.28
Standard

■ ~~100~~bit/s

■ ~~200~~bit/s

■ ~~300~~bit/s

■ ~~600~~bit/s

■ ~~1 200~~bit/s

Unbalanced interchange
Circuit V.24/V.28
Recommended if >1 200 bit/s

■ ~~2 400~~bit/s

■ ~~4 800~~bit/s

■ ~~9 600~~bit/s

Balanced interchange
Circuit X.24/X.27

■ ~~2 400~~bit/s

■ ~~4 800~~bit/s

■ ~~9 600~~bit/s

■ ~~19 200~~bit/s

■ ~~38 400~~bit/s

■ ~~56 000~~bit/s

■ ~~64 000~~bit/s

11.4 Link Layer

(network-specific parameter)

~~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~~

Frame length

■ ~~Maximum length L (number of octets)~~

Address field of the link

■ ~~Not present (balanced transmission only)~~

■ ~~One octet~~

■ ~~Two octets~~

■ ~~Structured~~

■ ~~Unstructured~~

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

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

Type identification	Cause of transmission

11.5 Application Layer

11.5.1 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.

11.5.2 Common Address of ASDU

(system-specific parameter)

■ ~~One octet~~ ☒ Two octets

11.5.3 Information object address

(system-specific parameter)

■ ~~One octet~~

■ ~~Two octet~~

☒ Three octets

☒ Structured

☒ Unstructured

11.5.4 Cause of transmission

(system-specific parameter)

■ ~~One octet~~

☒ Two octets
(with originator address)

11.5.5 Length of APDU

(system-specific parameter)

The maximum length of APDU for both directions is 253. It is a fixed system parameter.

■ Maximum length of APDU per system in control direction

■ Maximum length of APDU per system in monitor direction

11.5.6 Selection of standard ASDUs

11.5.6.1 Process information in monitor direction

(station-specific parameter)

☒	<1>	:=	Single-point information	M_SP_NA_1
■	~~<2>~~	~~:=~~	~~Single-point information with time tag~~	~~M_SP_TA_1~~
☒	<3>	:=	Double-point information	M_DP_NA_1
■	~~<4>~~	~~:=~~	~~Double-point information with time tag~~	M_DP_TA_1
☒	<5>	:=	Step position information	M_ST_NA_1
■	~~<6>~~	~~:=~~	~~Step position information with time tag~~	M_ST_TA_1
☒	<7>	:=	Bitstring of 32 bit	M_BO_NA_1
■	~~<8>~~	~~:=~~	~~Bitstring of 32 bit with time tag~~	M_BO_TA_1
☒	<9>	:=	Measured value, normalized value	M_ME_NA_1
■	~~<10>~~	~~:=~~	~~Measured value, normalized value with time tag~~	M_ME_TA_1
☒	<11>	:=	Measured value, scaled value	M_ME_NB_1
■	~~<12>~~	~~:=~~	~~Measured value, scaled value with time tag~~	M_ME_TB_1
☒	<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
☒	<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
☐	<20>	:=	Packed single-point information with status change detection	M_PS_NA_1
☐	<21>	:=	Measured value, normalized value without quality descriptor	M_ME_ND_1
☒	<30>	:=	Single-point information with time tag CP56Time2a	M_SP_TB_1
☒	<31>	:=	Double-point information with time tag CP56Time2a	M_DP_TB_1
☒	<32>	:=	Step position information with time tag CP56Time2a	M_ST_TB_1
☒	<33>	:=	Bitstring of 32 bit with time tag CP56Time2a	M_BO_TB_1
☒	<34>	:=	Measured value, normalized value with time tag CP56Time2a	M_ME_TD_1
☒	<35>	:=	Measured value, scaled value with time tag CP56Time2a	M_ME_TE_1
☒	<36>	:=	Measured value, short floating point value with time tag CP56Time2a	M_ME_TF_1
☒	<37>	:=	Integrated totals with time tag CP56Time2a	M_IT_TB_1
☐	<38>	:=	Event of protection equipment with time tag CP56Time2a	M_EP_TD_1
☐	<39>	:=	Packed start events of protection equipment with time tag CP56Time2a	M_EP_TE_1
☐	<40>	:=	Packed output circuit information of protection equipment with time tag CP56Time2a	M_EP_TF_1

In this companion standard only the use of the set <30> – <40> for ASDUs with time tag is permitted.

11.5.6.2 Process information in control direction

(station-specific parameter)

☒	<45>	:=	Single command	C_SC_NA_1
☒	<46>	:=	Double command	C_DC_NA_1
☒	<47>	:=	Regulating step command	C_RC_NA_1
☒	<48>	:=	Set point command, normalized value	C_SE_NA_1
☒	<49>	:=	Set point command, scaled value	C_SE_NB_1
☒	<50>	:=	Set point command, short floating point value	C_SE_NC_1
☒	<51>	:=	Bitstring of 32 bit	C_BO_NA_1
☒	<58>	:=	Single command with time tag CP56Time2a	C_SC_TA_1
☒	<59>	:=	Double command with time tag CP56Time2a	C_DC_TA_1
☒	<60>	:=	Regulating step command with time tag CP56Time2a	C_RC_TA_1
☒	<61>	:=	Set point command, normalized value with time tag CP56Time2a	C_SE_TA_1
☒	<62>	:=	Set point command, scaled value with time tag CP56Time2a	C_SE_TB_1
☒	<63>	:=	Set point command, short floating point value with time tag CP56Time2a	C_SE_TC_1
☒	<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.

11.5.6.3 System information in monitor direction

(station-specific parameter)

[X] <70> := End of initialization M_EI_NA_1

11.5.6.4 System information in control direction

(station-specific parameter)

[X] <100> := Interrogation command C_IC_NA_1
[ ] <101> := Counter interrogation command C_CI_NA_1
[X] <102> := Read command C_RD_NA_1
[X] <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~~
[X] <107> := Test command with time tag CP56Time2a C_TS_TA_1

11.5.6.5 Parameter in control direction

(station-specific parameter)

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

11.5.6.6 File transfer

(station-specific parameter)

[X] <120> := File ready F_FR_NA_1
[X] <121> := Section ready F_SR_NA_1
[X] <122> := Call directory, select file, call file, call section F_SC_NA_1
[X] <123> := Last section, last segment F_LS_NA_1
[X] <124> := Ack file, ack section F_AF_NA_1
[X] <125> := Segment F_SG_NA_1
[X] <126> := Directory {blank or X, only available in monitor (standard) direction} F_DR_TA_1
[ ] <127> := Query Log - Request archive file F_SC_NB_1

11.5.6.7 Type identification and case of transmission assignments

(station-specific parameter)

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	X		X						X	X		X					
~~<2>~~	~~M_SP_TA_1~~																			
<3>	M_DP_NA_1		X	X		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
~~<4>~~	~~M_DP_TA_1~~																			
<5>	M_ST_NA_1		X	X		X						X	X		X					
~~<6>~~	~~M_ST_TA_1~~																			
<7>	M_BO_NA_1		X	X		X									X					
~~<8>~~	~~M_BO_TA_1~~																			
<9>	M_ME_NA_1	X	X	X		X									X					
~~<10>~~	~~M_ME_TA_1~~																			
<11>	M_ME_NB_1	X	X	X		X									X					
~~<12>~~	~~M_ME_TB_1~~																			
<13>	M_ME_NC_1	X	X	X		X									X					
~~<14>~~	~~M_ME_TC_1~~																			
<15>	M_IT_NA_1			X		X														
~~<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																			
<21>	M_ME_ND_1																			
<30>	M_SP_TB_1			X		X						X	X							
<31>	M_DP_TB_1			X		X						X	X							
<32>	M_ST_TB_1			X		X						X	X							
<33>	M_BO_TB_1			X		X														
<34>	M_ME_TD_1	X		X		X														
<35>	M_ME_TE_1	X		X		X														
<36>	M_ME_TF_1	X		X		X														
<37>	M_IT_TB_1			X		X														
<38>	M_EP_TD_1			X																
<39>	M_EP_TE_1																			
<40>	M_EP_TF_1																			
<45>	C_SC_NA_1						X	X	X	X	X						X	X	X	X
<46>	C_DC_NA_1						X	X	X	X	X						X	X	X	X
<47>	C_RC_NA_1						X	X	X	X	X						X	X	X	X
<48>	C_SE_NA_1						X	X	X	X	X						X	X	X	X
<49>	C_SE_NB_1						X	X	X	X	X						X	X	X	X
<50>	C_SE_NC_1						X	X	X	X	X						X	X	X	X
<51>	C_BO_NA_1						X	X			X						X	X	X	X
<58>	C_SC_TA_1						X	X	X	X	X						X	X	X	X
<59>	C_DC_TA_1						X	X	X	X	X						X	X	X	X
<60>	C_RC_TA_1						X	X	X	X	X						X	X	X	X
<61>	C_SE_TA_1						X	X	X	X	X						X	X	X	X
<62>	C_SE_TB_1						X	X	X	X	X						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
<63>	C_SE_TC_1						X	X	X	X	X						X	X	X	X
<64>	C_BO_TA_1						X	X			X						X	X	X	X
<70>	M_EI_NA_1				X															
<100>	C_IC_NA_1						X	X			X						X	X	X	X
<101>	C_CI_NA_1																X			
<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~~																			
<105>	C_RP_NA_1						X	X									X	X	X	X
~~<106>~~	~~C_CD_NA_1~~																			
<107>	C_TS_TA_1						X	X									X	X	X	X
<110>	P_ME_NA_1																X			
<111>	P_ME_NB_1																X			
<112>	P_ME_NC_1																X			
<113>	P_AC_NA_1																X			
<120>	F_FR_NA_1													X			X	X	X	X
<121>	F_SR_NA_1													X			X	X	X	X
<122>	F_SC_NA_1					X								X			X	X	X	X
<123>	F_LS_NA_1													X			X	X	X	X
<124>	F_AF_NA_1													X			X	X	X	X
<125>	F_SG_NA_1													X			X	X	X	X
<126>	F_DR_TA_1[1]			X		X														
<127>	F_SC_NB_1[1]																X			

1 Blank or X only.

(x) Functionality 'Local' or 'Remote' can be assigned by PLC.

11.6 Basic application functions

11.6.1 Station initialization

(station-specific parameter)

☒ Remote initialization

11.6.2 Cyclic data transmission

(station-specific parameter)

☒ Cyclic data transmission

11.6.3 Read procedure

(station-specific parameter)

☒ Read procedure

11.6.4 Spontaneous transmission

(station-specific parameter)

☒ Spontaneous transmission

11.6.5 Double transmission of information objects with cause of transmission spontaneous

(station-specific parameter)

The following type identifications will 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
☐ 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 number M_ME_NC_1, M_ME_TC_1 and M_ME_TF_1

11.6.6 Station interrogation

(station-specific parameter)

☒ global

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

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

11.6.7 Clock synchronization

(station-specific parameter)

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

11.6.8 Command transmission

(object-specific parameter)

☒ Direct command transmission
☒ Direct set point command transmission
☒ Select and execute command
☒ Select and execute set point command
☒ C_SE ACTTERM used
☒ No additional definition
☐ Short-pulse duration (duration determined by a system parameter in the controlled station)
☐ Long-pulse duration (duration determined by a system parameter in the controlled station)
☒ Persistent output
☐ Supervision of maximum delay in command direction of commands and set point commands

Maximum allowable delay of commands and set point commands

11.6.9 Transmission of integrated totals

(station- or object-specific parameter)

☒ Mode A: local freeze with spontaneous transmission
☐ Mode B: local freeze with counter interrogation
☐ Mode C: freeze and transmit by counter interrogation commands
☐ Mode D: freeze by counter-interrogation command, frozen values reported spontaneously
☒ Counter read
☐ Counter freeze without reset
☐ Counter freeze with reset
☐ Counter reset
☐ General request counter
☐ Request counter group 1
☐ Request counter group 2
☐ Request counter group 3
☐ Request counter group 4

11.6.10 Parameter loading

(object-specific parameter)

☐ Threshold value
☐ Smoothing factor
☐ Low limit for transmission of measured value
☐ High limit for transmission of measured values value

11.6.11 Parameter activation

(object-specific parameter)

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

11.6.12 Test procedure

(station-specific parameter)

☒ Test procedure

11.6.13 File transfer

(station-specific parameter)

File transfer in monitor direction

☒ Transparent file
☒ Transmission of disturbance data of protection equipment
☐ Transmission of sequences of events
☐ Transmission of sequences of recorded analogue values

File transfer in control direction

☒ Transparent file

11.6.14 Background scan

(station-specific parameter)

☐ Background scan

11.6.15 Acquisition of transmission delay

(station-specific parameter)

■ ~~Acquisition of transmission delay~~

11.6.16 Definition of timeouts

Parameter	Default value	Remarks	Selected values
t_0	30 s	Time-out of connection establishment	30 s
t_1	15 s	Time-out of send or test APDUs	1 … 255 s
t_2	10 s	Time-out for acknowledges in case of no data messages $t_2 < t_1$	1 … 255 s
t_3	20 s	Time-out for sending test frames in case of a long idle state	1 … 65 535 s

Maximum range for timeouts t_0 to t_2: 1 s to 255 s, accuracy 1 s.

Recommended range for timeout t_3: 1 s to 48 h, resolution 1 s.

Long timeouts for t_3 may be needed in special cases where satellite links or dialup connections are used (for instance to establish connection and collect values only once per day or week).

11.6.17 Maximum number of outstanding I format APDUs k and latest acknowledge APDUs (w)

Parameter	Default value	Remarks	Selected values
k	12 APDUs	Maximum difference receive sequence number to send state variable	1 … 32 767
w	8 APDUs	Latest acknowledge after receiving w I format APDUs	1 … 32 767

11.6.18 Portnumber

Parameter	Values	Remarks
Port number	2 404	In all cases

11.6.19 Redundant connections

[2] Number N of redundancy group connections used

11.6.20 RFC 2200 suite

[X] Ethernet 802.3
[ ] Serial X.21 interface

[ ] Other selection from RFC 2200

12 Glossary

AMI	Analog Measured value Input
ASDU	Application Service Data Unit
ASO	Analog Setpoint command Output
BSI	Bit String Input
BSO	Bit String Output
CMU	Communication and Data Processing Unit
DCE	Data Communication Equipment
DCO	**D**ouble **C**ommand **O**utput
DMI	Digital Measured value Input (8, 16 bit)
DO	Digital Output
DPI	Double Point Input
DSO	Digital Setpoint command Output (8, 16 bit)
FSO	Floating Setpoint Command Output
HCI	Human Maschine Interface (here Integrated HMI function of the RTU500 series)
IED	Intelligent Electronic Device
ITI	Integrated Totals Input
MAX	Maximum
MFI	Analog Measured value Floating Input
Min	Minimum
PLC	Programmable Logic Control
RCD	RTU Configuration Data
RCO	Regulation step Command Output
RFC	Request for Comments
RTU	Remote Terminal Unit
SCI	Sub-Device Communication Interface
SCO	Single Command Output
SEV	System Event
SPI	Single Point Input or Single point information
SSC	System Single Command
STI	Step position Input
VPN	Virtual Private Network

Note:

The specifications, data, design or other information contained in this document (the "Brochure") - together: the "Information" - shall only be for information purposes and shall in no respect be binding. The Brochure does not claim to be exhaustive. Technical data in the Information are only approximate figures. We reserve the right at any time to make technical changes or modify the contents of this document without prior notice. The user shall be solely responsible for the use of any application example or information described within this document. The described examples and solutions are examples only and do not represent any comprehensive or complete solution. The user shall determine at its sole discretion, or as the case may be, customize, program or add value to the ABB products including software by creating solutions for the end customer and to assess whether and to what extent the products are suitable and need to be adjusted or customized.

This product is designed to be connected to and to communicate information and data via a network interface. It is the users sole responsibility to provide and continuously ensure a secure connection between the product and users or end customers network or any other network (as the case may be). The user shall establish and maintain any appropriate measures (such as but not limited to the installation of firewalls, application of authentication measures, encryption of data, installation of anti-virus programs, etc) to protect the product, the network, its system and the interface against any kind of security breaches, unauthorized access, interference, intrusion, leakage and/or theft of data or information. ABB AG is not liable for any damages and/or losses related to such security breaches, any unauthorized access, interference, intrusion, leakage and/or theft of data or information.

ABB AG shall be under no warranty whatsoever whether express or implied and assumes no responsibility for the information contained in this document or for any errors that may appear in this document. ABB AG's liability under or in connection with this Brochure or the files included within the Brochure, irrespective of the legal ground towards any person or entity, to which the Brochure has been made available, in view of any damages including costs or losses shall be excluded. In particular ABB AG shall in no event be liable for any indirect, consequential or special damages, such as – but not limited to – loss of profit, loss of production, loss of revenue, loss of data, loss of use, loss of earnings, cost of capital or cost connected with an interruption of business or operation, third party claims. The exclusion of liability shall not apply in the case of intention or gross negligence. The present declaration shall be governed by and construed in accordance with the laws of Switzerland under exclusion of its conflict of laws rules and of the Vienna Convention on the International Sale of Goods (CISG).

Visit us

ABB AG
Power Grids
P.O. Box 10 03 51
68128 Mannheim, Germany

www.abb.com/remote-terminal-units

1KGT 150 519 V012 1

RTU500 series

RTU500 series Remote Terminal Unit
Protocol description
Subdevice Communication Interface with IEC 60870-5-103

Power and productivity
for a better world™

Revision

Document identity:		1KGT 150 485 V008 1
Revision:	Date:	Changes:
0	03/2001	Base version
1	08/2002	Several details updated
2	10/2003	Chapter 7: File transfer updated
3	01/2006	Chapter 12: Basic Functions extended
		New functionality for information number 73
4	01/2008	Type Ident 3 and 9: Parameter Position defined
		New communication units (CMU) included
5	06/2009	Chapter 10.5.6 modified
		Chapter ‘Physical Layer’ corrected
		New: Monitor Direction blocked.
6	03/2011	System Command #012 “Process image update”
7	07/2012	New Layout
8	05/2017	New Layout
		Added new chapter 'Generic Services' (PR#24364)

Contents

1 Introduction.......... 1-1
1.1 Preface.......... 1-1
1.2 References.......... 1-1
1.3 Conventions.......... 1-1

2 Physical Layer.......... 2-1

3 Link Layer.......... 3-1
3.1 General.......... 3-1
3.2 Unbalanced Mode.......... 3-2

4 Application Layer.......... 4-1
4.1 Data Types.......... 4-1

5 Parameters and addressing.......... 5-1
5.1 Address elements.......... 5-1
5.1.1 Restrictions for the Link Address.......... 5-1
5.1.2 Restrictions for the Common Address of ASDU.......... 5-1
5.1.3 Restrictions for the Function Type.......... 5-1
5.1.4 Restrictions for the Information Number.......... 5-1

6 Data Types - Monitoring Direction.......... 6-1
6.1 AMI – Analog Measured Information.......... 6-1
6.1.1 Supported Data Types.......... 6-1
6.1.2 Additional Configuration Parameters.......... 6-1
6.1.3 Additional Information.......... 6-1
6.1.4 Conversion of Values.......... 6-2
6.1.5 Conversion of Quality Descriptors.......... 6-2
6.1.6 Conversion of Causes of Transmission.......... 6-2
6.2 DPI – Double Point Information.......... 6-2
6.2.1 Supported Data Types.......... 6-3
6.2.2 Additional Configuration Parameters.......... 6-3
6.2.3 Additional Information.......... 6-3
6.2.4 Conversion of Values.......... 6-3
6.2.5 Conversion of Quality Descriptors.......... 6-3
6.2.6 Conversion of Causes of Transmission.......... 6-4
6.3 EPI – Protection Event Information.......... 6-4
6.3.1 Supported Data Types.......... 6-4
6.3.2 Values.......... 6-4
6.3.3 Additional Configuration Parameters.......... 6-4
6.3.4 Additional Information.......... 6-5
6.3.5 Conversion of Values.......... 6-5
6.3.6 Conversion of Quality Descriptors.......... 6-5
6.3.7 Conversion of Causes of Transmission.......... 6-5

6.4 MFI – Measured Float Information.................... 6-5
6.4.1 Supported Data Types.................... 6-6
6.4.2 Additional Configuration Parameters.................... 6-6
6.4.3 Additional Information.................... 6-6
6.4.4 Conversion of Values.................... 6-6
6.4.5 Conversion of Quality Descriptors.................... 6-7
6.4.6 Conversion of Causes of Transmission.................... 6-7
6.5 SPI – Single Point Information.................... 6-7
6.5.1 Supported Data Types.................... 6-7
6.5.2 Additional Configuration Parameters.................... 6-7
6.5.3 Additional Information.................... 6-8
6.5.4 Conversion of Values.................... 6-8
6.5.5 Conversion of Quality Descriptors.................... 6-8
6.5.6 Conversion of Causes of Transmission.................... 6-8

7 Data Types - Controlling Direction.................... 7-1
7.1 DCO – Double Command Output.................... 7-1
7.1.1 Supported Data Types.................... 7-1
7.1.2 Command Authorities.................... 7-1
7.1.3 Conversion of Values.................... 7-1
7.1.4 Conversion of Quality Descriptors.................... 7-1
7.1.5 Conversion of Cause of Transmission.................... 7-1

8 File Transfer.................... 8-1
8.1 Transfer of Disturbance Data Files.................... 8-1
8.2 Parameters.................... 8-2

9 Internal Functions.................... 9-1
9.1 General Interrogation.................... 9-1
9.1.1 Values.................... 9-1
9.1.2 Command Authority.................... 9-1
9.1.3 Additional Information.................... 9-1
9.1.4 Conversion of Quality Descriptors.................... 9-1
9.1.5 Conversion of Cause of Transmission.................... 9-1
9.2 Time Synchronization.................... 9-1
9.2.1 Supported Data Types.................... 9-2
9.2.2 Values.................... 9-2
9.2.3 Command Authority.................... 9-2
9.2.4 Additional Information.................... 9-2
9.2.5 Conversion of Causes of Transmission.................... 9-2
9.3 System Events.................... 9-2
9.3.1 Status Change OFFLINE to ONLINE.................... 9-3
9.3.2 Status Change ONLINE to OFFLINE.................... 9-3
9.4 System Commands.................... 9-3
9.4.1 Force Process Image Update.................... 9-3

9.4.2 Conversion of Values ... 9-4
9.5 Blocking of Monitoring Direction ... 9-4
9.5.1 Protection Equipment ... 9-4
9.5.2 Controlling Station RTU560 ... 9-4

10 Generic Services ... 10-1
10.1 Overview of Generic Services ... 10-1
10.2 Supported Type Identifications ... 10-1
10.2.1 Generic Data in Monitoring Direction ... 10-1
10.2.2 Generic Data in Control Direction ... 10-2
10.2.3 General Interrogation of Generic Data (GGI) ... 10-2

11 Interoperability List ... 11-1
11.1 Interoperability Definitions ... 11-1
11.2 Supported and Selectable Parameters ... 11-1
11.3 Physical Layer ... 11-1
11.3.1 Electrical Interface ... 11-1
11.3.2 Optical Interface ... 11-1
11.3.3 Transmission Speed ... 11-1
11.3.4 Link Layer ... 11-1
11.3.5 Application Layer ... 11-2
11.3.6 Selection of Standard Information Numbers in Control Direction ... 11-7

12 Glossary ... 12-1

1 Introduction

1.1 Preface

This document describes the functions of the subdevice communication interface in RTU500 series according to IEC60870-5-103.

1.2 References

[1] IEC 60870-5-103 Telecontrol equipment and systems
Part 5: Transmission protocols
Section 103: Companion standard for informative interface of protection equipment
First Edition, December 1997

[2] IEC 60870-5-101 Telecontrol equipment and systems
Part 5: Transmission protocols
Section 101: Companion standard for basic telecontrol tasks
Second Edition, 2003-02

[3] Interfaces and Protocols
1KGT 150 714

1.3 Conventions

In this document function codes of data types according to IEC60870-5-103 are marked with square brackets: <Function code>

Bold fonts with the table heading "Parameter name" are references to configuration parameters in RTUtil500. The parameter is followed by the parameter location where to find this parameter in RTUtil500. The first element of the parameter location defines the node in the hardware tree on the left side (e. g. RTU, CMU, line, IED) and the second element defines selected header control tab in the parameter window on the right side (e. g. general, interfaces, protocol).

Example:

	Parameter name	Default	Parameter location
In use		Enabled	data point (e.g. SPI) - line T101/104
If enabled, the data point is transmitted to the host communication interface. This setting refers to data in monitoring and command direction.			

In this document references to elements of the standard and other references will be printed in brackets. Example: [2, 7.4]

The tables in the next chapters include lists of the functions, options and message types supported according to the protocol structure given in IEC 60870-5 (EPA three layer model) for

- the physical layer
- the link layer
- the application layer

This layered model is valid for the protocol IEC60870-5-103.

2 Physical Layer

The protocol IEC 60870-5-103 is a serial protocol, running on a serial communication line of a CMU. For more details see the documentation [3].

3 Link Layer

3.1 General

A link address model is used for all RTU560 subdevice interfaces. The basic procedures for data transfer, protection against loss and duplication and flow control are described in [1].

Communication primitives like framing of messages, parity checks or retransmissions are handled by the telecontrol protocol. These tasks are executed in the link layer that connects RTUs and control systems or other RTUs.

The selectable parameters have to be calculated regarding the real communication technology.

Parameter name	Default	Parameter location
Maximum telegram length	255 bytes	Line T103 - IEC60870-5-103
32 ... 1024 byte length of the complete message (incl. Start character, checksum, etc.)		
Single character for acknowledgements	Enabled	Line T103 - IEC60870-5-103
Enable / disable		
Timeout for acknowledgements	1 s	Line T103 - IEC60870-5-103
0.1...600.0 s (only used in balanced mode)		
Time interval of clock synchronization commands	Enabled 60 s	Line T103 - IEC60870-5-103
Enable / disable If enabled: 60...65000 s		
Communication retry	Enabled 7	Line T103 - IEC60870-5-103
Enable / disable If enabled: 1...255 times (only used in balanced mode)		
Gap supervision time	Disabled 1 t_0	Line T103 - IEC60870-5-103
Enable / disable If enabled: 1...255 t_0 (t_0 = time of one bit; depends on the baud rate)		
Send status change "ON" to "OFF"	Enabled	Line T103 - IEC60870-5-103
Enable / disable If enabled: If the information number is not included in GI, the status change ON to OFF is generated by the RTU560 subdevice interface.		

Line parameters – IEC 60870-5-103

3.2 Unbalanced Mode

- The controlling station is primary station, controlled station (IED) is secondary station
- The controlling station uses SEND/CONFIRM or SEND/NO REPLY services for transmission of messages to the IED
- The controlling station uses REQUEST/RESPOND services for the polling procedure and during establishment of the link

4 Application Layer

4.1 Data Types

Overview on type identifications for data elements of the application layer defined in [1].

The column RTU data type shows the type of data which must be configured in RTUtil500.

Type identification	Description	RTU data type
<1>	Time-tagged message CP32Time2a	SPI, DPI
<2>	Time-tagged message with relative time	EPI
<3>	Measurement I	AMI
<4>	Time-tagged measurement with relative time	MFI
<5>	Identification	-
<9>	Measurement II	AMI
<10>	Generic data	AMI, MFI, STI, BSI
<11>	Generic identification	-
<23>	List of recorded disturbances	-
<26>	Ready for transmission of disturbance data	-
<27>	Ready for transmission of channel	-
<28>	Ready for transmission of tags	-
<29>	Transmission of tags	-
<30>	Transmission of disturbance values	-
<31>	End of transmission	-

Table 1: of ASDU in monitoring direction

Type identification	Description	RTU data type
<10>	Generic data	ASO, FSO, BSO
<20>	General command	DCO
<21>	Generic command	SSC # 012
<24>	Order of disturbance data transmission	-
<25>	Acknowledgement for disturbance data transmission	-

Table 2: of ASDU in control direction

5 Parameters and addressing

5.1 Address elements

Selection according to [1]. The size of the addressing fields is defined in [1, 7.1], as shown in the following table:

Information field	Size
Link address length	1 octet
Common address of ASDU	1 octet
Function type length	1 octet
Information number length	1 octet
Cause of transmission length	1 octet

Table 3: Adress elements

5.1.1 Restrictions for the Link Address

The value 0 is not allowed.

5.1.2 Restrictions for the Common Address of ASDU

The common address of ASDU shall be identical to the address used in link address.

All addresses must be unique on one communication line.

Value 255 is reserved for broadcast calls in control direction and therefore should not be used as station address.

5.1.3 Restrictions for the Function Type

None

5.1.4 Restrictions for the Information Number

None

6 Data Types - Monitoring Direction

6.1 AMI – Analog Measured Information

Analog process information indicated by 16 bit used as a measured value from analog inputs in normalized or scaled format.

6.1.1 Supported Data Types

IEC 60870-5-103			RTU		
ASDU	**Type identification**	**Data type property**	**Data type**	**Parameter name**	**Parameter location**
	<3>	Measurement I	AMI		
	<9>	Measurement II	AMI		

Table 4: AMI – Supported data types

ADVICE
Use always the parameter Deadband supervision, in order to reduce the load in the RTU.

6.1.2 Additional Configuration Parameters

Parameter name	Default	Parameter location
Data point is included in general interrogation		AMI – Protocol address and parameters
If this feature is disabled, this data point is not included in general interrogation of subdevice and therefore also not included in general interrogation of host interfaces.		
Deadband function		AMI – Protocol address and parameters
Enabled / Disabled		
Deadband supervision		AMI – Protocol address and parameters
Integrated / Absolute If Deadband function is disabled: Integrated		
Deadband value		AMI – Protocol address and parameters
0..100 % If Deadband function is disabled: 10 %		

6.1.3 Additional Information

If the information number is not included in GI and the parameter Send status change "ON" to "OFF" is enabled, see chapter General (page 3-1), the RTU560 subdevice interface will generate the status change ON to OFF.

6.1.4 Conversion of Values

Range	RTU internal value	IEC 60870-5-103 value
Range min.	-100 %	-4 096
...	...	
Range max.	+100 %	+4 096

Table 5: AMI – Conversion of values

6.1.5 Conversion of Quality Descriptors

RTU		IEC 60870-5-103
Internal communication (short)	**Internal communication (long)**	**Communication**
OV	Overflow	Overflow
BL	Blocked	-
SB	Substituted	-
NT	Not Topical	-
IV	Invalid	MVAL invalid

Table 6: AMI – Conversion of quality descriptors

6.1.6 Conversion of Causes of Transmission

RTU		IEC 60870-5-103
Internal communication (short)	**Internal communication (long)**	**Communication**
T	Test	Test
P/N	Positive/negative confirmation	- Irrelevant -
Cause	Spontaneous	1 – spontaneous
	Periodic	2 – cyclic
	Interrogated	9 – general interrogation

Table 7: AMI – Conversion of causes of transmission

6.2 DPI – Double Point Information

Binary process information is indicated by two bits.

6.2.1 Supported Data Types

IEC 60870-5-103			RTU		
ASDU	Type identification	Data type property	Data type	Parameter name	Parameter location
	<1>	Time-tagged message CP32Time2a	DPI		

Table 8: DPI – Supported data types

6.2.2 Additional Configuration Parameters

None

6.2.3 Additional Information

If the information number is not included in GI and the parameter Send status change "ON" to "OFF" is enabled, see chapter General (page 3-1), the RTU560 subdevice interface will generate the status change ON to OFF.

6.2.4 Conversion of Values

RTU internal value	IEC 60870-5-103 value
intermediate	0
off	1
on	2
indeterminate	3

Table 9: DPI – Conversion of values

6.2.5 Conversion of Quality Descriptors

RTU		IEC 60870-5-103
Internal communication (short)	Internal communication (long)	Communication
BL	Blocked	-
SB	Substituted	-
NT	Not Topical	-
IV	Invalid	-

Table 10: DPI – Conversion of quality descriptors

6.2.6 Conversion of Causes of Transmission

RTU		IEC 60870-5-103
Internal communication (short)	**Internal communication (long)**	**Communication**
T	Test	7 – Test mode
P/N	Positive/negative confirmation	- Irrelevant -
Cause	Spontaneous	1 – spontaneous
	Periodic	2 – cyclic
	Interrogated	9 – general interrogation
	Returned by local command	11 – local operation
	Returned by remote command	12 – remote operation

Table 11: DPI – Conversion of causes of transmission

6.3 EPI – Protection Event Information

Binary process information is indicated by two bits and relative timetag (used by protection relays).

6.3.1 Supported Data Types

IEC 60870-5-103			RTU		
ASDU	**Type identification**	**Data type property**	**Data type**	**Parameter name**	**Parameter location**
	<2>	Time-tagged message CP32Time2a with relative time	EPI		

Table 12: EPI – Supported data types

ADVICE
Fault-number (FAN) is not supported in EPI data type.

6.3.2 Values

Relative-time

Format: CP16Time2a

6.3.3 Additional Configuration Parameters

	Parameter name	Default	Parameter location
Data point is included in general interrogation			EPI – Protocol address and parameters
If this feature is disabled, this data point is not included in general interrogation of subdevice and therefore also not included in general interrogation of host interfaces.			

6.3.4 Additional Information

If the information number is not included in GI and the parameter Send status change "ON" to "OFF" is enabled, see chapter General (page 3-1), the RTU560 subdevice interface will generate the status change ON to OFF.

6.3.5 Conversion of Values

RTU internal value	IEC60870-5-103
intermediate	0
off	1
on	2
indeterminate	3

Table 13: EPI - Conversion of values

6.3.6 Conversion of Quality Descriptors

RTU		IEC 60870-5-103
Internal communication (short)	Internal communication (long)	Communication
BL	Blocked	-
SB	Substituted	-
NT	Not Topical	-
IV	Invalid	-

Table 14: EPI – Conversion of quality descriptors

6.3.7 Conversion of Causes of Transmission

RTU		IEC 60870-5-103
Internal communication (short)	Internal communication (long)	Communication
T	Test	7 - Test mode
P/N	Positive/negative confirmation	- Irrelevant -
Cause	Spontaneous	1 – spontaneous
	Periodic	2 – cyclic
	Interrogated	9 – general interrogation
	Returned by local command	11 – local operation
	Returned by remote command	12 – remote operation

Table 15: EPI – Conversion of causes of transmission

6.4 MFI – Measured Float Information

32 bit analog process information is used as a measured value in float format.

6.4.1 Supported Data Types

IEC 60870-5-103			RTU		
ASDU	**Type identification**	**Data type property**	**Data type**	**Parameter name**	**Parameter location**
	<4>	Time-tagged measurement with relative time	MFI		

Table 16: MFI – Supported data types

ADVICE
Fault-number (FAN) and relative time (RET) are not supported in MFI data type.

6.4.2 Additional Configuration Parameters

	Parameter name	Default	Parameter location
Data point is included in general interrogation			MFI – Protocol address and parameters
If this feature is disabled, this data point is not included in general interrogation of subdevice and therefore also not included in general interrogation of host interfaces.			

6.4.3 Additional Information

If the information number is not included in GI and the parameter Send status change "ON" to "OFF" is enabled, see chapter General (page "3-1"), the RTU560 subdevice interface will generate the status change ON to OFF.

If this feature is enabled in RTUtil500, the information number 73 (fault location x in Ohms) will be transmitted with value 0 in a general interrogation (GI) at IEC 60870-5-101/104 host communication interfaces.

6.4.4 Conversion of Values

Range	RTU internal value	IEC60870-5-103
Range min.	-3.4 x 10e38	-3.4 x 10e38
...	...	
Range max.	+3.4 x 10e38	+3.4 x 10e38

Table 17: MFI - Conversion of values

6.4.5 Conversion of Quality Descriptors

RTU		IEC 60870-5-103
Internal communication (short)	**Internal communication (long)**	**Communication**
OV	Overflow	-
BL	Blocked	-
SB	Substituted	-
NT	Not Topical	-
IV	Invalid	-

Table 18: MFI – Conversion of quality descriptors

6.4.6 Conversion of Causes of Transmission

RTU		IEC 60870-5-103
Internal communication (short)	**Internal communication (long)**	**Communication**
T	Test	Test
P/N	Positive/negative confirmation	- Irrelevant -
Cause	Spontaneous	1 – spontaneous
	Periodic	2 – cyclic
	Interrogated	9 – general interrogation

Table 19: MFI – Conversion of causes of transmission

6.5 SPI – Single Point Information

Binary process information is indicated by one bit.

6.5.1 Supported Data Types

IEC 60870-5-103			RTU		
ASDU	**Type identification**	**Data type property**	**Data type**	**Parameter name**	**Parameter location**
	<1>	Time-tagged message CP32Time2a	SPI		

Table 20: SPI – Supported data types

6.5.2 Additional Configuration Parameters

Parameter name	Default	Parameter location
Data point is included in general interrogation		SPI – Protocol address and parameters
If this feature is disabled, this data point is not included in general interrogation of subdevice and therefore also not included in general interrogation of host interfaces.		

6.5.3 Additional Information

If the information number is not included in GI and the parameter Send status change "ON" to "OFF" is enabled, see chapter General (page 3-1), the RTU560 subdevice interface will generate the status change ON to OFF.

6.5.4 Conversion of Values

RTU internal value	IEC 60870-5-103 value
off (IV)	0
off	1
on	2
on (IV)	3

Table 21: SPI – Conversion of values

6.5.5 Conversion of Quality Descriptors

RTU		IEC 60870-5-103
Internal communication (short)	**Internal communication (long)**	**Communication**
BL	Blocked	-
SB	Substituted	-
NT	Not Topical	-
IV	Invalid	Value conversion faulty, see Additional information (page " 6-1 ")

Table 22: SPI – Conversion of quality descriptors

6.5.6 Conversion of Causes of Transmission

RTU		IEC 60870-5-103
Internal communication (short)	**Internal communication (long)**	**Communication**
T	Test	7 – Test mode
P/N	Positive/negative confirmation	- Irrelevant -
Cause	Spontaneous	1 – spontaneous
	Periodic	2 – cyclic
	Interrogated	9 – general interrogation
	Returned by local command	11 – local operation
	Returned by remote command	12 – remote operation

Table 23: SPI – Conversion of causes of transmission

7 Data Types - Controlling Direction

7.1 DCO – Double Command Output

Binary process command (two bits).

7.1.1 Supported Data Types

IEC 60870-5-103			RTU		
ASDU	Type identification	Data type property	Data type	Parameter name	Parameter location
	<20>	General command	DCO		

Table 24: DCO – Supported data types

7.1.2 Command Authorities

None

7.1.3 Conversion of Values

RTU internal value	IEC 60870-5-103 value
off	1
on	2

Table 25: DCO – Conversion of values

7.1.4 Conversion of Quality Descriptors

RTU		IEC 60870-5-103
Internal communication (short)	Internal communication (long)	Communication
SE	Select / Execute	-

Table 26: DCO – Conversion of quality descriptors

7.1.5 Conversion of Cause of Transmission

RTU		IEC 60870-5-103
Internal communication (short)	Internal communication (long)	Communication
T	Test	Ignored
P/N	Positive/negative confirmation	Type identification <1>, Cause of transmission 20/21 (pos./neg.)
Cause	Activation	20 – general command

Table 27: DCO – Conversion of causes of transmission

RTU		IEC 60870-5-103
Internal communication (short)	**Internal communication (long)**	**Communication**
	Activation Confirmation	-
	Deactivation	-
	Deactivation Confirmation	

Table 27: DCO – Conversion of causes of transmission

8 File Transfer

The file transfer is used for exchanging files between a control center and a subordinated device connected to a RTU560.

The file name in the protocol is fixed for all supported file types to 1 (transparent file).

Supported file types:
– RCD configuration file
– PRO configuration file (PLC boot project file)
– Disturbance record file (various protocols and device types)
– UNDEF file not specified in detail

8.1 Transfer of Disturbance Data Files

The subdevice communication interface with protocol IEC 60870-5-103 is capable to read disturbance data files from a protection device, and to store them on the memory card file system of the RTU560. The user is able to access them via the internal web server. The web server is also used to transfer these files to a workspace PC. The transmission of disturbance data files is according to [1], the supported ASDUs are described in the two following tables.

ASDU	Description
23	List of recorded disturbances
26	Ready for transmission of disturbance data
27	Ready for transmission of channel
28	Ready for transmission of tags
29	Transmission of tags
30	Transmission of disturbance values
31	End of transmission

Table 28: List of ASDUs in monitoring direction

ASDU	Description
24	Order for disturbance data transmission
25	Acknowledgement for disturbance data transmission

Table 29: List of ASDUs in command direction

Within the ASDUs in command direction, the following information elements are supported (see the following table):

ASDU	Information element / Explanation	Information value	Description
24	TOO Type of order	<1>	selection of fault
		<2, 3>	request for disturbance data
		<8, 9>	request for channel

Table 30: Contents of information elements

ASDU	Information element / Explanation	Information value	Description
		<16, 17>	request for tags
25	TOO Type of order	<64, 65>	disturbance data transmitted
		<66, 67>	channel transmitted
		<68, 69>	tags transmitted
24, 25	TOV Type of disturbance	<1>	instantaneous values
24, 25	FAN Fault number	<0 ... 65535>	
24, 25	ACC Actual channel	<1 ... 255>	

Table 30: Contents of information elements

8.2 Parameters

The file archive is running on any CMU in the system. In configurations with redundant CMUs the file archive must be configured on a non-redundant CMU (Group C), see the following figure. It is also possible to have several file archives in a system.

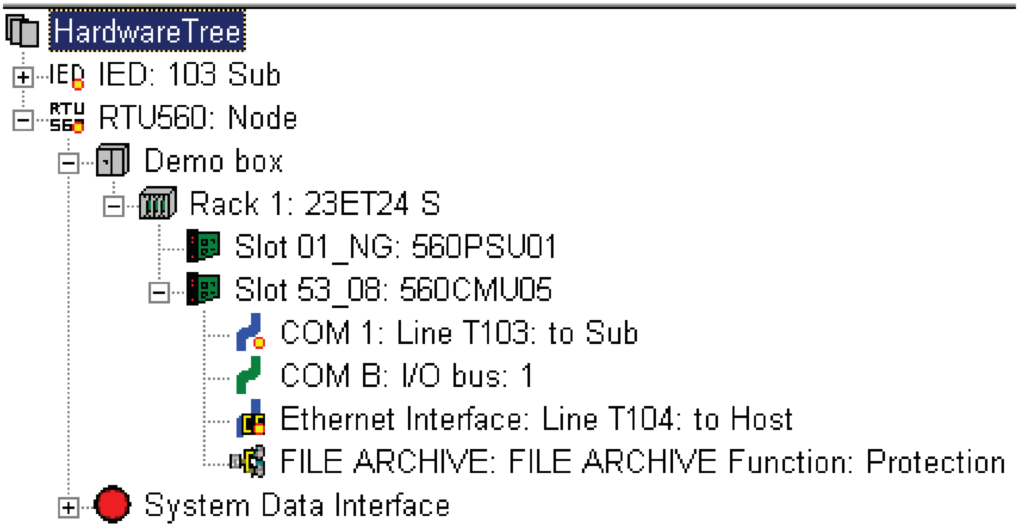


Figure 1: Configuration of file archives function

The file transfer function is configured on an IEC 60870-5-103 subdevice communication line. At least two elements are necessary for this function, see the following figure:

- The File transfer directory (FDR) with the name of the directory on the memory card
- At least one File transfer file (FTR)

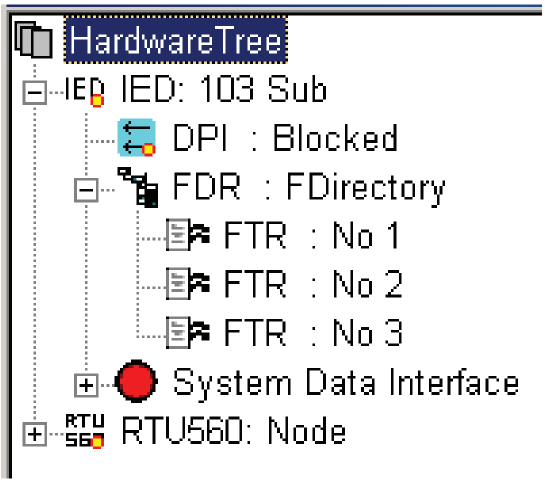


Figure 2: Configuration of file archive function

1. Set the parameter for the File Archive according to the following table.

Parameter name	Default	Parameter location
File type	-	
Disturbance recorder – IEC103		
Max. size of directory storage	Enabled 15	
Enable / Disable If enabled: Number of files in a FTR [1 ... 255] If disabled: 1 file within FTR		
Max. number of days for directory storage	Enabled 30	
Enable / Disable If enabled: Delete file after number of days automatically [1 ... 365] If disabled: Overwrite the oldest file, if archive is full.		

9 Internal Functions

9.1 General Interrogation

The general interrogation to the subordinated devices is send directly after the initialization of the RTU and on every change of the subordinated link from state OFFLINE to state ONLINE

9.1.1 Values

0

9.1.2 Command Authority

None

9.1.3 Additional Information

None

9.1.4 Conversion of Quality Descriptors

RTU		IEC 60870-5-103
Internal communication (short)	**Internal communication (long)**	**Communication**
QOI	Qualifier of Interrogation	Ignored

Table 31: General Interrogation – Conversion of quality descriptors

9.1.5 Conversion of Cause of Transmission

RTU		IEC 60870-5-103
Internal communication (short)	**Internal communication (long)**	**Communication**
T	Test	Ignored
P/N	Positive/negative confirmation	Relevant in monitor direction only
Cause	Activation	9 – initiation of general interrogation
	Activation Confirmation	-
	Activation Termination	Type identification <8>

Table 32: General Interrogation – Conversion of causes of transmission

9.2 Time Synchronization

If the RTU560 shall synchronize subordinated devices the configuration parameter Time interval of clock synchronization commands has to be defined, see chapter General (page "3-1").

ADVICE

The time synchronization command is only send to subordinated devices which are in state ONLINE, and only if the time tag of the own RTU is valid (synchronized).

9.2.1 Supported Data Types

IEC60870-5-103			RTU		
ASDU	Type identification	Data type property	Data type	Parameter name	Parameter location
C_CS_NA_1	<103>				

Table 33: Time Synchronization - Supported data types

9.2.2 Values

Complete time and date information in CP56Time2a format.

9.2.3 Command Authority

None

9.2.4 Additional Information

None

9.2.5 Conversion of Causes of Transmission

RTU		IEC 60870-5-103
Internal communication (short)	Internal communication (long)	Communication
T	Test	Ignored
P/N	Positive/negative confirmation	Relevant in monitor direction only
Cause	Activation	-
	Activation Confirmation	Type identification <6>

Table 34: Time synchronization – Conversion of causes of transmission

9.3 System Events

The subdevice interface manages internal status messages for every device connected to these lines. These status messages are created from the subdevice interface itself for every connected device.

The subdevice communication interface supports two system events:

Description of system event	Address offset
RTU is active	24

Table 35: Description of system events

Description of system event	Address offset
RTU inoperable	48

Table 35: Description of system events

While initialization the system event RTU_IS_ACTIVE (24) is sent as SPI with value 1 to the internal communication. On a running system this system event will not change anymore.

The system event RTU_INOPERABLE (48) is sent as SPI to the internal communication in dependency of the state of the subordinated device:

State of subordinated device	Value of system event 48
OFFLINE	1
ONLINE	0

Table 36: State of subordinated device

9.3.1 Status Change OFFLINE to ONLINE

If the status of a subordinated device or line changes from OFFLINE to ONLINE, a general interrogation command is sent to the concerning device(s).

The system event RTU_INOPERABLE (48) with value 0 is sent as SPI to the internal communication for every device separately that changed its status. If the parameter in use is enabled, this SPI is also sent to the connected hosts.

9.3.2 Status Change ONLINE to OFFLINE

If the status of a subordinated device or line changes from ONLINE to OFFLINE, all configured data points connected to these devices are send to the internal communication with the actual status, marked as INVALID and with the timestamp of the own RTU when the device or line is detected as OFFLINE.

The system event RTU_INOPERABLE (48) with value 1 is sent as SPI to the internal communication for every device separately that changed its status. If the parameter in use is enabled, this SPI is also sent to the connected hosts.

9.4 System Commands

The behavior of subordinated devices connected to a subdevice communication interface can be modified with system commands. The following system command is supported:

Description of system single command	Address offset
Force process image update	012

Table 37: Description of system single command

9.4.1 Force Process Image Update

The command performs a GI for the addressed device. If the device is an RTU560 and for this RTU the system command Force process image update is also defined, the request is delegated to the connected RTU. If not, a GI is performed for the given device.

If the command is addressed to the RTU itself, it is delegated to all connected devices.

9.4.2 Conversion of Values

RTU internal value	Status
off	<Ignored>
on	Force process image update

Table 38: Conversion of values

9.5 Blocking of Monitoring Direction

9.5.1 Protection Equipment

If the blocking of the monitoring direction located in the protection equipment is switched on, a double indication with information number 20 and value on is transferred.

In case of blocking of the monitoring direction activation in the protection equipment, no indications and measurements are transmitted from the protection equipment anymore. A GI command received by the protection equipment is answered by a GI termination message. Any general interrogation in progress is aborted by the protection equipment, using a General Interrogation termination message. A disturbance data transmission in progress is aborted, too. Generic commands associated with disturbance data transmission will not be responded by the application layer level.

General commands received, in spite of the blocking of the monitor direction, will be rejected with negative acknowledgement of command as CAUSE OF TRANSMISSION. Blocking of the monitor direction has no impact on transmission of messages indicating system functions. Time synchronization continues to operate. With regard to compatible interconnections, the blocking facility can only be activated locally, as no remote instruction is intended to be used for this purpose.

If the blocking of the monitoring direction is switched off, the protection equipment transfers the double indication with information number 20 with the value off.

9.5.2 Controlling Station RTU560

If the RTU560 receives that indication, it will send all measurements and indications with the common address of ASDU and the function type received to all relaying communication channels with the qualifier blocked.

If the global function type (255) is received within the blocking indication message, all measurements and indications of the common address of ASDU received are sent with the qualifier blocked independent of the function type.

Precondition for the function blocking of monitoring direction is that the blocking indication is configured with RTUtil560. This is also valid for the global function type.

The RTU560 suppresses no commands as well as general interrogation. That requests are sent to the protection equipment as usual.

If the RTU560 receives an indication with information number 20 with the value Off, the RTU560 sends a general interrogation to the protection equipment, and all measurements and indications not included in the general interrogation with the qualifier ‘blocked’ reset to all relaying communication channels. The other measurements and indications are sent with qualifier not blocked, if received as answer to the general interrogation.

10 Generic Services

10.1 Overview of Generic Services

Generic services have been introduced for future extensions of protection equipment in order to provide a mechanism to transmit data of any type and format, and without having to constantly define new explicit ASDUs. These services provide the ability to identify data, including their type, format, and description, and the ability to read and write the values of data. The term ‘generic’ implies that all data accessible through the generic services can be accessed in the same way. The data are therefore structured in a consistent manner across all protection equipments. The structure shall therefore be suitable for use with various data types in many different protection equipments.

10.2 Supported Type Identifications

10.2.1 Generic Data in Monitoring Direction

Generic data (type identification <10>) is supported for the following RTU data types in monitoring direction: AMI, MFI, STI, BSI08, BSI16, BSI32.

Function Type	Description
<254>	GEN (generic function typ)

INF	Semantics
<244>	Read value of a single entry
<245>	End of general interrogation of generic data
<249>	Write entry with confirmation
<250>	Write entry with execution
<251>	Write entry aborted

Table 39: Information Number in Monitoring Direction

GIN	Description
<0..255>	group
<0..255>	entry

Table 40: Generic Identification Number

KOD	Description
<1>	Actual value

Table 41: Kind of Description

GDD	Description
<4>	Signed integer
<7>	R32.23 IEEE754 short float

Table 42: Generic Data Description - Datatype

10.2.2 Generic Data in Control Direction

Generic data (type identification <10>) is supported for the following RTU data types in control direction: ASO, FSO, BSO01, BSO02, BSO08 and BSO16.

Function Type	Description
<254>	GEN (generic function typ)

INF	Semantics
<245>	General interrogation of generic data
<248>	Write entryneric
<249>	Write entry with confirmation
<250>	Write entry with execution
<251>	Write entry abort

Table 43: Information Number in Control Direction

GIN	Description
<0..255>	group
<0..255>	entry

Table 44: Generic Identification Number

KOD	Description
<1>	Actual value

Table 45: Kind of Description

GDD	Description
<4>	Signed integer
<7>	R32.23 IEEE754 short float

Table 46: Generic Data Description - Datatype

10.2.3 General Interrogation of Generic Data (GGI)

In the control direction, general interrogation of generic data is initiated by means of a generic command (type identification <21>).
If generic data are configured for the protection equipment the GGI initiation message is always sent after subdevice gets operable. GGI could also be initiated by sending system single command (SSC#012) to the RTU. This means to ask to update process image.

11 Interoperability List

11.1 Interoperability Definitions

The following interoperability definitions are copied from IEC 60870-5-103, clause 8; the original numbering and layout is maintained.

11.2 Supported and Selectable Parameters

In this document parameter settings and selections of the Modbus protocol that are supported by RTU500 series are marked by squares with a tick [X].

Functions and parameters with filled (black) squares ■ are not supported by RTU500 series!

11.3 Physical Layer

11.3.1 Electrical Interface

[X] EIA RS-485

Number of unit loads: max. 32 slave devices

ADVICE
EIA RS-485 standard defines unit loads so that 32 of them can be operated on one line. For detailed information, refer to clause 3 of EIA RS-485 standard.

11.3.2 Optical Interface

[X]	Glass fiber (23OK24)	
[X]	Plastic fiber	
[X]	F-SMA type connector	(for plastic fiber interface)
[X]	BFOC/2,5 type connector	(for glass fiber interface) (23OK24)

11.3.3 Transmission Speed

[X] 9 600 bit/s

[X] 19 200 bit/s

11.3.4 Link Layer

There are no choices for the link layer.

11.3.5 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

X One COMMON ADDRESS OF ASDU (identical with station address)

■ More than one COMMON ADDRESS OF ASDU

Selection of Standard Information Numbers in Monitor Direction

The standard information numbers are valid for the following relay types (IEDs):

- **D**istance **P**rotection Relays, **D**P
- **L**ine Differential **P**rotection Relays, **L**P
- **O**vercurrent **P**rotection Relays, **O**P
- **T**ransformer Differential **P**rotection Relays, **T**P

If a general protection relay is used, all other information numbers are possible, too.

System Functions in Monitor Direction

	INF	Semantics	Type of relay
X	<0>	End of general interrogation	< D L O T >
X	<0>	Time synchronization	< D L O T >
X	<2>	Reset FCB	< D L O T >
X	<3>	Reset CU	< D L O T >
X	<4>	Start/restart	< D L O T >
X	<5>	Power on	< D L O T >

System Indications in Monitor Direction

	INF	Semantics	Type of relay
X	<16>	Auto-recloser active	< D L O >
X	<17>	Tele-protection active	< D O >
X	<18>	Protection active	< D L O T >
X	<19>	LED reset	< D L O T >

	INF	Semantics	Type of relay
X	<20>	Monitor direction blocked See also chapter System commands (page "10-5")	< D L O T >
X	<21>	Test mode	< D L O T >
X	<22>	Local parameter setting	< D L O T >
X	<23>	Characteristic 1	< D >
X	<24>	Characteristic 2	< D >
X	<25>	Characteristic 3	< D >
X	<26>	Characteristic 4	< D >
X	<27>	Auxiliary input 1	< D L O T >
X	<28>	Auxiliary input 2	< D L O T >
X	<29>	Auxiliary input 3	< D L O T >
X	<30>	Auxiliary input 4	< D L O T >

Supervision Indications in Monitor Direction

	INF	Semantics	Type of relay
X	<32>	Measurement supervision I	< D O >
X	<33>	Measurement supervision V	< D O >
X	<35>	Phase sequence supervision	< D O >
X	<36>	Trip circuit supervision	< D L O T >
X	<37>	I>> back-up operation	< D >
X	<38>	VT fuse failure	< D O >
X	<39>	Tele-protection disturbed	< D L O >
X	<46>	Group warning	< D L O T >
X	<47>	Group alarm	< D L O T >

Earth Fault Indications in Monitor Direction

	INF	Semantics	Type of relay
X	<48>	Earth fault L_1	< D O >
X	<49>	Earth fault L_2	< D O >
X	<50>	Earth fault L_3	< D O >
X	<51>	Earth fault forward, i.e. line	< D O >
X	<52>	Earth fault reverse, i.e. bus bar	< D O >

Fault Indications in Monitor Direction

	INF	Semantics	Type of relay
X	<64>	Start /pick-up L_1	< D L O >
X	<65>	Start /pick-up L_2	< D L O >
X	<66>	Start /pick-up L_3	< D L O >
X	<67>	Start /pick-up N	< D L O >
X	<68>	General trip	< D L O T >
X	<69>	Trip L_1	< D L O T >
X	<70>	Trip L_2	< D L O T >
X	<71>	Trip L_3	< D L O T >
X	<72>	Trip I>> (back-up operation)	< D >
X	<73>	Fault location X in ohms	< D O > (*)
X	<74>	Fault forward/line	< D O >
X	<75>	Fault reverse/bus bar	< D O >
X	<76>	Tele-protection signal transmitted	< D O >
X	<77>	Tele-protection signal received	< D O >
X	<78>	Zone 1	< D >
X	<79>	Zone 2	< D >

	INF	Semantics	Type of relay
X	<80>	Zone 3	< D >
X	<81>	Zone 4	< D >
X	<82>	Zone 5	< D >
X	<83>	Zone 6	< D >
X	<84>	General start/pick-up	< D L O T >
X	<85>	Breaker failure	< D O >
X	<86>	Trip measuring system L_1	< T >
X	<87>	Trip measuring system L_2	< T >
X	<88>	Trip measuring system L_3	< T >
X	<89>	Trip measuring system E	< T >
X	<90>	Trip I>	< O >
X	<91>	Trip I>>	< O >
X	<92>	Trip IN>	< O >
X	<93>	Trip IN>>	< O >

* **If enabled in RTUtil500, the information number 73 will be transmitted with value 0 in a general interrogation (GI) by IEC 60870-5-101 and IEC 60870-5-104 host communication interfaces.**

Auto-reclosure Indications in Monitor Direction

	INF	Semantics	Type of relay
X	<128>	CB on by AR	< D L O >
X	<129>	CB on by long-time AR	< D L O >
X	<130>	AR blocked	< D L O >

Measurements in Monitor Direction

	INF	Semantics	Type of relay
X	<144>	Measurement I	< D O >
X	<145>	Measurement I, V	< D O >

	INF	Semantics	Type of relay
X	<146>	Measurement I, V, P, Q	< D >
X	<147>	Measurement I_N, V_{EN}	< D O >
X	<148>	Measurement $I_{L1,2,3}$, $V_{L1,2,3}$, P, Q, f	< D >

General Functions in Monitor Direction

	INF	Semantics	Type of relay
■	<240>	Read headings of all defined groups	
■	<241>	Read values or attributes of all entries of one group	
■	<243>	Read directory of a single entry	
X	<244>	Read value or attribute of a single entry	
X	<245>	End of general interrogation of generic data	
X	<249>	Write entry with confirmation	
X	<250>	Write entry with execution	
X	<251>	Write entry aborted	

Basic Application Functions

	Application functions
X	Test mode
X	Blocking of monitor direction
X	Disturbance data
X	Generic services
□	Private data [1]

1 **Type Identifications:**
- **1 and 2 monitor direction**
- **20 in control direction**

ADVICE
Private data with other Type Identifications are not supported.

11.3.6 Selection of Standard Information Numbers in Control Direction

System Functions in Control Direction

	INF	Semantics	Type of relay
X	<0>	Initiation of general interrogation	< D L O T >
X	<0>	Time synchronization	< D L O T >

General Commands in Control Direction

	INF	Semantics	Type of relay
X	<16>	Auto-recloser on/off	< D L O >
X	<17>	Tele-protection on/off	< D O >
X	<18>	Protection on/off	< D L O T >
X	<19>	LED reset	< D L O T >
X	<23>	Activate characteristic 1	< D >
X	<24>	Activate characteristic 2	< D >
X	<25>	Activate characteristic 3	< D >
X	<26>	Activate characteristic 4	< D >

General Functions in Control Direction INF Semantics

	INF	Semantics	Type of relay
■	<240>	Read headings of all defined groups	
■	<241>	Read values or attributes of all entries of one group	
■	<243>	Read directory of a single entry	
■	<244>	Read value or attribute of a single entry	
X	<245>	General interrogation of generic data	
X	<248>	Write entry	
X	<249>	Write entry with confirmation	
X	<250>	Write entry with execution	
X	<251>	Write entry aborted	

Basic Application Functions

	Application functions
X	Test mode
X	Blocking of monitor direction
X	Disturbance data
X	Generic services
□	Private data [1]

1 **Type Identifications:**
- **1 and 2 monitor direction**
- **20 in control direction**

ADVICE
Private data with other Type Identifications are not supported.

Miscellaneous

The maximum value of a measurand with quality descriptor (ASDU 3 or 9) can either be ±1.2 or ±2.4 times the rated value. This factor must be the same for all measurand types in all ASDUs.

Measurement	Max. Value = rated value times		
	1.2	or	2.4
Current L1	□		□
Current L2	□		□
Current L3	□		□
Voltage L1-E	□		□
Voltage L2-E	□		□
Voltage L3-E	□		□
Active power P	□		□
Reactive power Q	□		□
Frequency f	□		□
Voltage L1 – L2	□		□

ADVICE
Values are not relevant for primary system (RTU)!

12 Glossary

AMI	Analog Measured value Input
ASO	Analog Setpoint command Output
BSI	Bit String Input
BSO	Bit String Output
CMU	Communication and Data Processing Unit
DCO	**D**ouble **C**ommand **O**utput
DPI	Double Point Input
EPI	Event of Protection equipment Input (1 bit)
FSO	Floating Setpoint Command Output
IED	Intelligent Electronic Device
MFI	Analog Measured value Floating Input
PLC	Programmable Logic Control
RCD	RTU Configuration Data
RTU	Remote Terminal Unit
SPI	Single Point Input or Single point information
SSC	System Single Command
STI	Step position Input

Note:

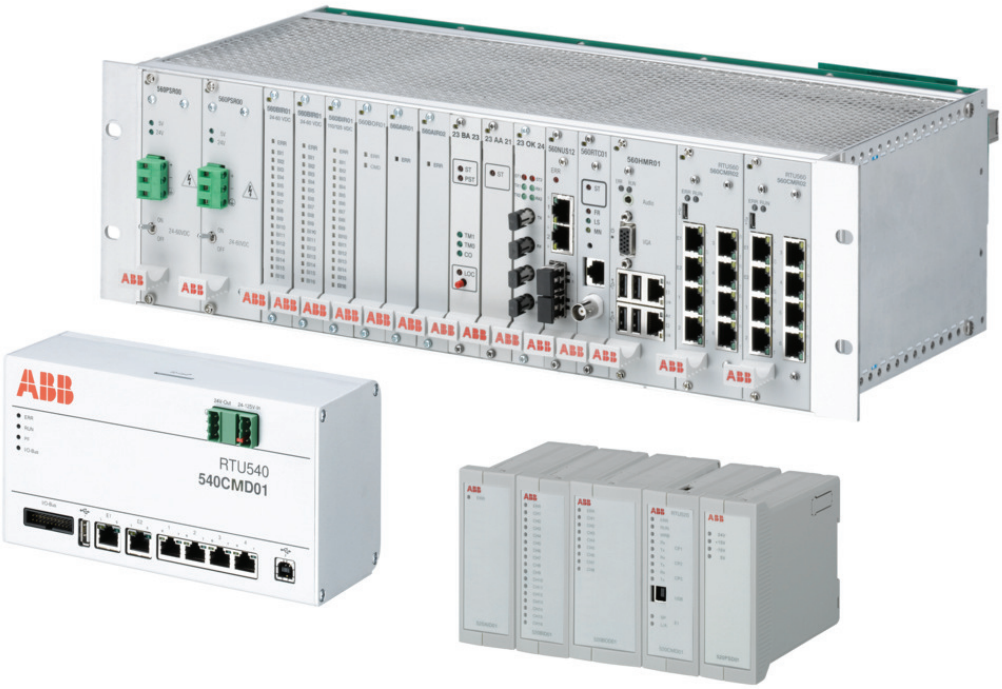
The specifications, data, design or other information contained in this document (the “Brochure”) - together: the “Information” - shall only be for information purposes and shall in no respect be binding. The Brochure does not claim to be exhaustive. Technical data in the Information are only approximate figures. We reserve the right at any time to make technical changes or modify the contents of this document without prior notice. The user shall be solely responsible for the use of any application example or information described within this document. The described examples and solutions are examples only and do not represent any comprehensive or complete solution. The user shall determine at its sole discretion, or as the case may be, customize, program or add value to the ABB products including software by creating solutions for the end customer and to assess whether and to what extent the products are suitable and need to be adjusted or customized.

This product is designed to be connected to and to communicate information and data via a network interface. It is the users sole responsibility to provide and continuously ensure a secure connection between the product and users or end customers network or any other network (as the case may be). The user shall establish and maintain any appropriate measures (such as but not limited to the installation of firewalls, application of authentication measures, encryption of data, installation of anti-virus programs, etc) to protect the product, the network, its system and the interface against any kind of security breaches, unauthorized access, interference, intrusion, leakage and/or theft of data or information. ABB AG is not liable for any damages and/or losses related to such security breaches, any unauthorized access, interference, intrusion, leakage and/or theft of data or information.

ABB AG shall be under no warranty whatsoever whether express or implied and assumes no responsibility for the information contained in this document or for any errors that may appear in this document. ABB AG's liability under or in connection with this Brochure or the files included within the Brochure, irrespective of the legal ground towards any person or entity, to which the Brochure has been made available, in view of any damages including costs or losses shall be excluded. In particular ABB AG shall in no event be liable for any indirect, consequential or special damages, such as – but not limited to – loss of profit, loss of production, loss of revenue, loss of data, loss of use, loss of earnings, cost of capital or cost connected with an interruption of business or operation, third party claims. The exclusion of liability shall not apply in the case of intention or gross negligence. The present declaration shall be governed by and construed in accordance with the laws of Switzerland under exclusion of its conflict of laws rules and of the Vienna Convention on the International Sale of Goods (CISG).

Power Grids

Remote Terminal Units
Host Communication Interface with Mod-bus
Protocol description



Revision

Document identity:		1KGT 150 487 V019 1
Revision:	**Date:**	**Changes:**
0	05/2001	Base version
1	08/2001	Transmission settings introduced Texts of address parameters changed Explanations for address parameters added Additional data type parameters changed Interoperability list updated RCO added
2	03/2002	
3	05/2002	New Line Parameter added
4	10/2002	New Line Parameter
5	11/2004	Chapter Link Layer corrected Chapter System events updated
6	06/2007	Expansion new definitions for Modbus TCP
7	05/2011	Configurable bit position for DPI and SPI Support function code 8 Support MFI and FSO Support of AMI, ASO Format conversion
8	06/2011	32 bit value support for function code 3 & 4 Format conversion
9	12/2011	New layout
10	12/2011	Configurable bit position for DPI in a register Support function code 1& 2 Value format
	04/2012	Value format for DPI object was added
11	09/2012	SSCs added. Added restrictions in using function codes <15> and <16>
12	02/2013	Host Interface Parameters updated Updated range for Offline Timeout
13	01/2014	Updated parameters for AMI, ASO, MFI, FSO
14	11/2014	Details added on maximum message size in monitoring direction New layout
15	11/2014	Explained exception code 6
		Update chapter system events and system commands
16	04/2017	Updated chapter 'Addressing' for BSI08 and DMI08 (PR #29816)
17	03/2018	Function code 23 added (PR#36581)

Document identity:		1KGT 150 487 V019 1
Revision:	**Date:**	**Changes:**
	04/2018	New layout
18	06/2018	Increased baudrate up to 115,2 kB/s (PR#38055)
	10/2018	Updated chapter 'Monitoring Direction' (PR#37734)
		Updated description of 'Index' parameter (PR#39667)
19	10/2018	Updated chapter 'Slave address' due to broadcast functionality (PR#37918)

Contents

1 Introduction.....5
1.1 Preface.....5
1.2 References.....5
1.3 Conventions.....5

2 Physical Layer.....7
2.1 Serial line-based communication.....7
2.2 IP based Communication.....8
2.3 Host interface.....8

3 Link Layer.....11
3.1 General.....11
3.2 Serial Link Layer.....11
3.3 TCP Link Layer.....12
3.3.1 Multi-host connection.....12
3.4 Check of links.....12
3.5 Monitoring Direction.....12
3.5.1 Treatment of DMI8 and BSI8 data types.....12
3.6 Command direction.....13

4 Application Layer.....15
4.1 Restrictions for function codes.....15

5 Addressing.....17
5.1 Slave address.....17
5.2 Data point parameters.....17
5.2.1 Restrictions for function codes.....17
5.2.2 Restrictions for index.....17

6 Data types - monitoring direction.....19
6.1 AMI – Analog Measured Information.....19
6.1.1 Supported Function Codes.....19
6.1.2 Additional configuration parameters.....19
6.1.3 Conversion of values.....20
6.1.4 Conversion of quality descriptors.....20
6.1.5 Conversion of causes of transmission.....21
6.2 BSI – Bit String Information.....21
6.2.1 Supported Function Codes.....21
6.2.2 Additional configuration parameters.....21
6.2.3 Conversion of values.....22
6.2.4 Conversion of quality descriptors.....22
6.2.5 Conversion of causes of transmission.....22
6.3 DMI – Digital Measured Information.....23
6.3.1 Supported Function Codes.....23
6.3.2 Additional Information.....23
6.3.3 Conversion of values.....23

6.3.4 Conversion of quality descriptors....23
6.3.5 Conversion of causes of transmission....24
6.4 DPI – Double Point Information....24
6.4.1 Supported Function Codes....24
6.4.2 Additional information....26
6.4.3 Conversion of values....26
6.4.4 Conversion of quality descriptors....27
6.4.5 Conversion of causes of transmission....27
6.5 EPI – Protection Event Information....27
6.6 ITI – Integrated Totals Information....28
6.6.1 Supported Function Codes....28
6.6.2 Additional configuration parameters....28
6.6.3 Conversion of values....28
6.6.4 Conversion of quality descriptors....29
6.6.5 Conversion of causes of transmission....29
6.7 MFI – Measured Float Information....29
6.7.1 Supported Function Codes....29
6.7.2 Value types....30
6.7.3 Additional configuration parameters....30
6.7.4 Conversion of values....31
6.7.5 Conversion of quality descriptors....31
6.7.6 Conversion of causes of transmission....31
6.8 SPI – Single Point Information....32
6.8.1 Supported Function Codes....32
6.8.2 Additional information....33
6.8.3 Conversion of Values....33
6.8.4 Conversion of quality descriptors....33
6.8.5 Conversion of causes of transmission....33
6.9 STI – Step Position Information....34
6.9.1 Supported Function Codes....34
6.9.2 Additional information....34
6.9.3 Conversion of values....34
6.9.4 Conversion of quality descriptors....34
6.9.5 Conversion of causes of transmission....35

7 Data types - controlling direction....37
7.1 ASO – Analog Setpoint Output....37
7.1.1 Supported Function Codes....37
7.1.2 Command Authority....37
7.1.3 Additional configuration parameters....38
7.1.4 Conversion of values....38
7.1.5 Conversion of quality descriptors....39
7.1.6 Conversion of causes of transmission....39
7.2 BSO – Bit String Output....39
7.2.1 Supported Function Codes....39
7.2.2 Command Authority....40
7.2.3 Additional Information....40

7.2.4 Conversion of values....40
7.2.5 Conversion of quality descriptors.... 40
7.2.6 Conversion of causes of transmission.... 41
7.3 DCO – Double Command Output....41
7.3.1 Supported Function Codes....41
7.3.2 Command Authority....42
7.3.3 Additional Information.... 42
7.3.4 Conversion of values....42
7.3.5 Conversion of quality descriptors....42
7.3.6 Conversion of causes of transmission....42
7.4 DSO – Digital Setpoint Output.... 43
7.4.1 Supported Function Codes....43
7.4.2 Command Authority.... 44
7.4.3 Additional Information....44
7.4.4 Conversion of values....44
7.4.5 Conversion of quality descriptors.... 44
7.4.6 Conversion of causes of transmission....44
7.5 FSO – Floating Point Setpoint Output.... 45
7.5.1 Supported Function Codes.... 45
7.5.2 Command Authority.... 46
7.5.3 Additional configuration parameters.... 46
7.5.4 Conversion of values....46
7.5.5 Conversion of quality descriptors....47
7.5.6 Conversion of causes of transmission....47
7.6 RCO – Regulation Command Output.... 47
7.6.1 Supported Function Codes....47
7.6.2 Command Authority.... 48
7.6.3 Additional information....48
7.6.4 Conversion of values....48
7.6.5 Conversion of quality descriptors.... 48
7.6.6 Conversion of causes of transmission....49
7.7 SCO – Single Command Output.... 49
7.7.1 Supported Function Codes.... 49
7.7.2 Command Authority.... 50
7.7.3 Additional Information....50
7.7.4 Conversion of values....50
7.7.5 Conversion of quality descriptors.... 50
7.7.6 Conversion of causes of transmission....50

8 File Transfer....51

9 Internal Functions....53
9.1 General Interrogation.... 53
9.1.1 Supported data types....53
9.1.2 Values....53
9.1.3 Command authority.... 53
9.1.4 Additional information.... 53

9.1.5 Conversion of quality descriptors 53
9.1.6 Conversion of causes of transmission 53
9.2 Time synchronization 54
9.3 System Events 54
9.4 System commands 55
9.4.1 Reset device process 56
9.4.2 Force process image update 56
9.4.3 Request redundancy change over 56

10 Parameter loading 57

11 Interoperability list 59
11.1 Supported and selectable parameters 59
11.2 Network configuration 59
11.3 Physical Layer 59
11.3.1 Electrical interface 59
11.3.2 Transmission speed 59
11.3.3 Transmission settings (only serial) 59
11.4 Link Layer 60
11.5 Application Layer 60
11.5.1 Function codes 60
11.5.2 Basic application functions 60

12 Glossary 61

1 Introduction

1.1 Preface

This document describes the functions of the host communication interface in the RTU500 series according to Modbus communication protocol for serial line and Ethernet based communication.

1.2 References

[1]	Modicon	Revision Y	June 1996
	Modbus Protocol Reference Guide,		
[2]	Modicon	Version 1.1a	June 2004
	Modbus Application Protocol Specification		
[3]	Modicon	Version 1.0a	June 2004
	Modbus Messaging on TCP/IP Guideline		

1.3 Conventions

The Modbus communication protocol is called Modbus or Modbus protocol in this document.

This convention encloses Modbus TCP.

In this document function codes of data types according to Modbus are marked with square brackets: <Function code>

Bold fonts with the table heading "Parameter name" are references to configuration parameters in RTUtil500. The parameter is followed by the parameter location where to find this parameter in RTUtil500. The first element of the parameter location defines the node in the hardware tree on the left side (e. g. RTU, CMU, line, IED) and the second element defines selected header control tab in the parameter window on the right side (e. g. general, interfaces, protocol).

Example:

Parameter name	Default	Parameter location
In use	Enabled	data point (e.g. SPI) - line T101/104
If enabled, the data point is transmitted to the host communication interface. This setting refers to data in monitoring and command direction.		

In this document references to elements of the standard and other references will be printed in brackets. Example: [2, 7.4]

The tables in the next chapters include lists of the functions, options and message types supported according to the protocol structure given in IEC 60870-5 (EPA three layer model) for

- the physical layer
- the link layer
- the application layer

This layered model does not exactly apply to the Modbus protocol [1], but is adapted because of the structure of the host communication interface of RTU500 series.

2 Physical Layer

2.1 Serial line-based communication

The protocol Modbus is running on the serial communication interfaces of the CMUs. For more details see RTU500 series Interfaces and Protocols Release 12 (1KGT 150 939).

Set the communication parameters according to the following table:

Parameter name	Default	Parameter location
Interface type	RS232C	CMU - serial interfaces
Type of physical interface. Select from list. Value range: RS232C, RS485 or fix if selection is not supported		
Baud rate	9600 bits/sec	CMU - serial interfaces
Value range: 50, 75, 100, 110, 150, 200, 300, 600, 1200, 1500, 2400, 4800, 9600, 19200, 38400, 57600, 115200 bits/sec; 50-600 bits/sec only on selected interfaces		
Modem control	Direct link (TxD/RxD only)	CMU - serial interfaces
Value range: • Direct link (TxD/RxD only) • WT link full duplex (no handshake) • WT link half duplex (RTS/CTS handshake) • WT link half duplex (RTS/DCD handshake) • Dial up (external modem DCD handshake) • Loop switch unit (DSTC 3002), RP570/71 Host interface only • Link with collision avoidance (DCD handshake), DNP 3 only Usage of the controls for this interface. Direct Link: No modem controls. Loop Switch Unit: RP570/71 Host Interface only. Collision Avoidance: DNP3.0 Host/Sub-Interface only		
Transmit delay time	disabled	CMU - serial interfaces
If 'Transmit Delay Time' is enabled: Delay time in Milliseconds. Value range: 1 to 10000 ms. Recommended value for WT modems in half-duplex mode: 30 ms		

Parameter name	Default	Parameter location
Allow non-standard UART mode	disabled, usage as specified in standard	CMU - serial interfaces
If enabled, it will be possible to select a non IEC 60870-5-101/Modbus conform UART mode (parity). Value range: • disabled • 1 stop bit, no parity • 1 stop bit, even parity • 1 stop bit, odd parity • 2 stop bits, no parity		

ADVICE

The possibility to use different transmission speeds in control and in monitor direction is not supported by RTU500 series.

2.2 IP based Communication

The protocol Modbus is running on the Ethernet-Interfaces of the CMU. For more details see RTU500 series Interfaces and Protocols Release 12 (1KGT 150 939).

For each Ethernet interface following parameters can be configured:

Parameter name	Default	Parameter location
Interface mode	Auto-negotiation	CMU - Network Interfaces
Transmisssion rate and duplex modes. Possible values are: - 100BaseTx half duplex - 100BaseTx full duplex - 10BaseT half duplex - 10BaseT full duplex - Auto-negotiation Default value: Auto-negotiation		
Node name	none	CMU - Network Interfaces
Node name of RTU at this ethernet interface		
IP Address	0.0.0.0	CMU - Network Interfaces
IP Address of this RTU interface		
Subnet mask	0.0.0.0	CMU - Network Interfaces
Subnet mask of IP address		
Default gateway IP	0.0.0.0	CMU - Network Interfaces
IP address of default gateway		

Following Ethernet line parameters can be configured for the master:

Parameter name	Default	Parameter location
Master IP Address	0.0.0.0 (only one host, all master IP addresses accepted)	Line Tx - Modbus
IP Address of the controlling station. Simultaneous communication with up to 8 hosts from the same message queues.		
Master IP Address 2 to 8	disabled	Line Tx - Modbus
If enabled: An additional IP address can be configured to establish a redundant link. Additional IP address or '-' to disable.		
Port number	502	Line Tx - Modbus
TCP port number on which the RTU expects the connection requests of the 8 possible masters. For all masters the same. Value range: 1 to 65535		

2.3 Host interface

All host interfaces will be configured according to the following table.

Parameter name	Default	Parameter location
Host number	1	CMU - all interfaces
Logical number of this host interface. Value range: 1 to 16. The Host Number has to be unique in a system, and will point to the data in the system event block		

	Parameter name	Default	Parameter location
Interlock with local control authority		disabled	CMU - all interfaces
If enabled: No commands are accepted from the host, as long as a user has successfully requested the 'Command Authority' in the 'Integrated HMI'			

3 Link Layer

3.1 General

Modbus does not define a Link Layer, but the Link Layer depends on the different implementations of the protocol. Therefore, a separated description of this is given for serial- and IP-based communication.

3.2 Serial Link Layer

Modbus defines no special link layer. Therefore, only global parameters have to be configured for the communication lines.

These parameters can be configured in the line folder of RTUtil500 separately for every line. Parameter: General parameter (RTU – General parameter)

Communication primitives like the framing of messages and parity checks are handled by the telecontrol protocol. Data polling and retransmissions are handled by the host communication interface of RTU500 series. These tasks are executed in the link layer that connects RTUs and Modbus-IEDs.

The selectable parameters have to be calculated regarding the real communication technology. All parameters are preset to the default values.

Parameter name	Parameter range / Explanation	Default
Modbus Mode	RTU / ASCII	RTU
UART Mode	1 stop bit, even parity 1 stop bit, odd parity 1 stop bit, no parity 2 stop bits, no parity (CP1 / CP1 only)	1 stop bit, even parity
Offline Timeout	1 ... 65 535 sec Timeout to indicate that the Host is offline	30
Exception response on invalid data points	TRUE / FALSE (Firmware Releases ≥ 5 only)	TRUE
Exception response on unconfigured data points	TRUE / FALSE (Firmware Releases ≥ 5 only)	TRUE
Acknowledge commands on reception	TRUE / FALSE (Firmware Releases ≥ 5 only) (see also chapter Command direction (page "3-3"))	FALSE

Table 1: Line parameters – Modbus

- ASCII mode
  1 start bit, 7 data bits, 1/2 stop bit(s) and 1 parity bit (even / odd) or no parity.
- RTU mode
  1 start bit, 8 data bits, 1/2 stop bit(s) and 1 parity bit (even / odd) or no parity.

The difference between these two framing modes is that in the RTU mode 8 bits are represented by one 8 bit character and in the ASCII mode by two 7 bit ASCII character. The start characters and error checking are different in both modes as described in [1].

3.3 TCP Link Layer

The IP-based communication is based in part upon reference RFC1122. One of the main functions of the messaging service is to manage communication establishment and ending, and to manage the data flow on established TCP connections.

No parameters are required for this implementation since the TCP/IP stack is responsible of the management of communication. (speed, duplex, time-to-live, number of hops, time-outs, window-size, three-way-handshaking, etc).

3.3.1 Multi-host connection

Up to 8 hosts (NCC) can be connected to one RTU500 series system. In this case the RTU500 series needs the IP addresses of the NCCs in order to distinguish the logical connections.

Every host IP address could be linked to one different host number or to same host number in order to provide redundancy.

3.4 Check of links

With every correctly received Modbus request, the timeout timer for marking a Host in RTU500 series offline is retriggered.

If a Host is marked offline, the system events 101 ... 108 are reset according to the host interface number configured in RTUtil500.

3.5 Monitoring Direction

All data in monitoring direction are sent as response to a query from a Modbus host system. Registers can be read also by querying the start register and an offset of registers.

In the Modbus host communication interface it is also possible to read the value of RTU500 series command data types like SCO, DCO, ASO, etc.

The payload of Modbus Protocol Telegrams is organized in 16 bit width data blocks (exception: function codes <1> and <2>), therefore some data types must be treated especially. A maximum of 125 registers can be requested in a single Modbus query.

3.5.1 Treatment of DMI8 and BSI8 data types

Two DMI8 or BSI8 data points can be referenced by one Modbus register in RTU500 series. If this register is requested by a host, the values of both 8 bit data points will be combined in the Modbus response to a 16 bit data word.

The Byte order information is given by parameter Position high byte for both data types configured in RTUtil500.

If an 8 bit data point is referenced by its own unique Modbus address, the Modbus response telegram contains a 16 bit data word which MSByte is set to zero.

3.6 Command direction

Modbus does not support a mechanism for selecting and executing a command. This mechanism is therefore handled by HCI RTU500 series-internally for the data types SCO and DCO without configuration work needed.

All other data types in command direction are executed directly.

The reaction to a command, which is in Modbus the echo of the command query, is first sent to the Modbus Host, when the action is terminated, if parameter Acknowledge Commands on reception is set to FALSE (see chapter General (page "3-1")). If this parameter is set to TRUE, commands are acknowledged immediately.

If the command results in a command collision, exception code 6 (SERVER BUSY) is generated.

4 Application Layer

Overview of the function codes of the application layer defined in [1].

The column RTU data type shows the type of data which must be configured in RTUtil500.

Modbus		RTU
Function code	**Description**	**Data type**
<01>	Read Coil Status	SPI, DPI, SCO, SEV
<02>	Read Input Status	SPI, DPI, SCO, SEV
<03>	Read Holding Registers	SPI, DPI, ITI, STI, DMI8/16, AMI, BSI8/16 DCO, RCO, ASO, DSO, BSO
<04>	Read Input Registers	SPI, DPI, ITI, STI, DMI8/16, AMI, BSI8/16 DCO, RCO, ASO, DSO, BSO
<08>	Diagnostics Only sub function 0x00 is supported	-

Table 2: Function codes in monitoring direction

Modbus		RTU
Function code	**Description**	**Data type**
<05>	Force Single Coil	SCO, SSC
<06>	Preset Single Register	DCO, RCO, ASO, DSO, BSO
<15>	Force Multiple Coils	SCO, SSC
<16>	Preset Multiple Registers	DCO, RCO, ASO, DSO, BSO

Table 3: Function codes in control direction

Modbus		RTU
Function code	**Description**	**Data type**
<23>	Read/Write Multiple Registers	SPI, DPI, ITI, STI, DMI8/16, AMI, BSI8/16, MFI, DCO, RCO, ASO, DSO, BSO, FSO

Table 4: Function codes in control and monitoring direction

4.1 Restrictions for function codes

The function codes <15> and <16> can be used for operating on only one RTU data object. If multiple objects are received in these commands, an exception response is generated and no command will be executed.

5 Addressing

Selection according to [1]. The sizes of the addressing fields cannot be configured.

5.1 Slave address

The Modbus slave address must be the same for the System event block and all data points of this IED.

Received queries with slave address '0' (broadcast address) are ignored. RTU500 doesn't accept the broadcast for writing function.

Parameter name	Default	Parameter location
Slave address	1	IED/RTU line parameters
Range: 1 ... 255		
Function code	02	SDI line parameters
01: Read Coil Status 02: Read Input Status 03: Read Holding Registers 04: Read Input Registers		
Index	0	SDI line parameters
Range: 0 .. 65 535		

5.2 Data point parameters

Parameter name	Default	Parameter location
Function code	Depends on data point type	Data point parameters
Value range: 1 .. 255 Modbus function code		
Index	0	Data point parameters
Modbus address index corresponds to Modbus PDU address. The index can be identical for different function codes. Range: 0 to 65535 Depending on device typ: Index for On/Raise (DCO, SCO, RCO).		
Bit position	1	BSI08, DMI08 parameters
Value range: 1 or 8 Bit position of the data point.		

5.2.1 Restrictions for function codes

Only function codes listed in chapter Application Layer (page "4-1") are supported.

5.2.2 Restrictions for index

The register index of every function code starts with 0.

6 Data types - monitoring direction

6.1 AMI – Analog Measured Information

Analog process information is used as a measured value from the analog inputs in normalized or scaled format.

6.1.1 Supported Function Codes

Modbus		RTU				
Function code	**Function code property**	**Data type**	**Parameter name**	**Parameter location**	**Parameter range / Explanation**	**Default**
<03>	Read Holding Registers	AMI	Address	AMI - Protocol address and parameters		
<04>	Read Input Registers	AMI	Address	AMI - Protocol address and parameters		
<23>	Read/Write Multiple Registers	AMI	Address	AMI - Protocol address and parameters		

Table 5: AMI - Supported function codes

6.1.2 Additional configuration parameters

Parameter name	Default	Parameter location
Scaling limit mapping	Bipolar	AMI - Protocol address and parameters
Bipolar Unipolar		
Value format	16 bit signed scaled value	AMI - Protocol address and parameters
Supported value formats are: 32 bit floating value (High word in first register) 32 bit floating value (High word in second register) 16 bit signed scaled value 32 bit signed scaled value (High word in first register) 32 bit signed scaled value (High word in second register) 16 bit unsigned scaled value 32 bit unsigned scaled value (High word in first register) 32 bit unsigned scaled value (High word in second register)		

Parameter name	Default	Parameter location
Min. value	-32768	AMI - Protocol address and parameters
16bit signed scaled value formats -32768 ... +32767 16bit unsigned scaled value formats 0 ... +65535 32bit signed scaled value formats -231 ... +231 -1 32bit unsigned scaled value formats 0 ... +232 – 1 Minimum raw value in the telegram, to be converted to -100 % (internal communication)		
Max. value	+32767	AMI - Protocol address and parameters
16bit signed scaled value formats -32768 ... +32767 16bit unsigned scaled value formats 0 ... +65535 32bit signed scaled value formats -231 ... +231 -1 32bit unsigned scaled value formats 0 ... +232 – 1 Maximum raw value in the telegram, to be converted to 100 % (internal communication)		
Min. float value	0	AMI - Protocol address and parameters
-3.4e38 … +3.4e38 (32 bit float formats) Minimum float value in the telegram, to be converted to -100 % (internal communication)		
Max. float value	65 535	AMI - Protocol address and parameters
-3.4e38 … +3.4e38 (32 bit float formats) Maximum float value in the telegram, to be converted to 100 % (internal communication)		

6.1.3 Conversion of values

Range	RTU internal value	Modbus value
Range min.	-100 %	Min. value / Min. float value
...	...	
Range max.	+100 %	Max. value / Max. float value

Table 6: AMI - Conversion of values

6.1.4 Conversion of quality descriptors

RTU		Modbus
Internal communication (short)	**Internal communication (long)**	**Communication**
OV	Overflow	-
BL	Blocked	-
SB	Substituted	-
NT	Not Topical	-
IV	Invalid	Exception response (code 3)

Table 7: AMI - Conversion of quality descriptors

6.1.5 Conversion of causes of transmission

RTU		Modbus
Internal communication (short)	**Internal communication (long)**	**Communication**
T	Test	-
P/N	Positive/negative confirmation	- Irrelevant -
Cause	Periodic / Cyclic	-
	Spontaneous	-
	Requested	-
	Interrogated	-

Table 8: AMI - Conversion of causes of transmission

6.2 BSI – Bit String Information

Binary process information is indicated by 8, 16 or 32 bits.

6.2.1 Supported Function Codes

Modbus		RTU				
Function code	**Function code property**	**Data type**	**Parameter name**	**Parameter location**	**Parameter range / Explanation**	**Default**
<03>	Read Holding Registers	BSI	Index	BSI - Protocol address and parameters		
<04>	Read Input Registers	BSI	Index	BSI - Protocol address and parameters		
<23>	Read/Write Multiple Registers	BSI	Index	BSI - Protocol address and parameters		

Table 9: BSI - Supported function codes

6.2.2 Additional configuration parameters

Parameter name	Default	Parameter location
Value format	32 bit binary (High word in first register)	BSI32 - Protocol address and parameters

32 bit binary (High word in first register)

32 bit binary (High word in second register)

The 32 bit value is transmitted in two consecutive registers.

6.2.3 Conversion of values

Range	RTU internal value	Modbus value
Range min.	0	0
...	...	
Range max.	BSI8: Bit mask of 8 bit; range 0 ... 255	255
	BSI16: Bit mask of 16 bit; range 0 ... 65 535	65 535
	BSI32: Bit mask of 32 bits, range 0 … 4 294 967 295	4 294 967 295

Table 10: BSI - Conversion of values

6.2.4 Conversion of quality descriptors

RTU		Modbus
Internal communication (short)	Internal communication (long)	Communication
OV	Overflow	-
BL	Blocked	-
SB	Substituted	-
NT	Not Topical	-
IV	Invalid	Exception response (code 3)

Table 11: BSI - Conversion of quality descriptors

6.2.5 Conversion of causes of transmission

RTU		Modbus
Internal communication (short)	Internal communication (long)	Communication
T	Test	-
P/N	Positive/negative confirmation	- Irrelevant -
Cause	Spontaneous	-
	Requested	-
	Interrogated	-

Table 12: BSI - Conversion of causes of transmission

6.3 DMI – Digital Measured Information

Binary process information indicated by 8 or 16 bits is used as a measured value from digital inputs in normalized format.

6.3.1 Supported Function Codes

Modbus		RTU				
Function code	**Function code property**	**Data type**	**Parameter name**	**Parameter location**	**Parameter range / Explanation**	**Default**
<03>	Read Holding Registers	DMI	Address	DMI - Protocol address and parameters		
<04>	Read Input Registers	DMI	Address	DMI - Protocol address and parameters		
<23>	Read/Write Multiple Registers	DMI	Address	DMI - Protocol address and parameters		

Table 13: DMI - Supported function codes

6.3.2 Additional Information

None

6.3.3 Conversion of values

Range	RTU internal value	Modbus value
Range min.	-100 %	-32 768
...	...	
Range max.	+100 %	+32 767

Table 14: DMI - Conversion of values

6.3.4 Conversion of quality descriptors

RTU		Modbus
Internal communication (short)	**Internal communication (long)**	**Communication**
OV	Overflow	-
BL	Blocked	-

Table 15: DMI - Conversion of quality descriptors

RTU		Modbus
Internal communication (short)	Internal communication (long)	Communication
SB	Substituted	-
NT	Not Topical	-
IV	Invalid	Exception response (code 3)

Table 15: DMI - Conversion of quality descriptors

6.3.5 Conversion of causes of transmission

RTU		Modbus
Internal communication (short)	Internal communication (long)	Communication
T	Test	-
P/N	Positive/negative confirmation	- Irrelevant -
Cause	Spontaneous	-
	Requested	-
	Interrogated	-

Table 16: DMI - Conversion of causes of transmission

6.4 DPI – Double Point Information

Binary process information is indicated by single bit or double bits.

6.4.1 Supported Function Codes

Modbus			RTU			
Function code	Function code property	Data type	Parameter name	Parameter location	Parameter range / Explanation	Default
<01>	Read Coil Status	DPI	Index	DPI - Protocol address and parameters		
			Value format	DPI - Protocol address and parameters	Single bit indication Single bit indication reversed	
<02>	Read Input Status	DPI	Index	DPI - Protocol address and parameters	Single bit indication Single bit indication reversed	

Table 17: DPI - Supported function codes

Modbus		RTU				
Function code	**Function code property**	**Data type**	**Parameter name**	**Parameter location**	**Parameter range / Explanation**	**Default**
			Value format	DPI - Protocol address and parameters		
<03>	Read Holding Registers	DPI	Index	DPI - Protocol address and parameters		
			Bit position	DPI - Protocol address and parameters	0 to 14	
			Value format	DPI - Protocol address and parameters	Double bit indication Double bit indication reversed Single bit indication Single bit indication reversed	
<04>	Read Input Registers	DPI	Index	DPI - Protocol address and parameters		
			Bit position	DPI - Protocol address and parameters	0 to 14	
			Value format	DPI - Protocol address and parameters	Double bit indication Double bit indication reversed Single bit indication Single bit indication reversed	

Table 17: DPI - Supported function codes

Modbus			RTU			
Function code	Function code property	Data type	Parameter name	Parameter location	Parameter range / Explanation	Default
<23>	Read/Write Multiple Registers	DPI	Index	DPI - Protocol address and parameters		
			Bit position	DPI - Protocol address and parameters	0 to 14	
			Value format	DPI - Protocol address and parameters	Double bit indication Double bit indication reversed Single bit indication Single bit indication reversed	

Table 17: DPI - Supported function codes

6.4.2 Additional information

Combination of function code, index and bit position should be unique.

6.4.3 Conversion of values

Conversion value as per configured Value format Double Bit Indication:

RTU internal value	Modbus value
intermediate	00
off	01
on	10
indeterminate	11

Table 18: DPI - Conversion of values for Double Bit Indication

Conversion value as per configured Value format Double Bit Indication Reverse:

RTU internal value	Modbus value
intermediate	00
on	01
off	10

Table 19: DPI - Conversion of values for Double Bit Indication Reverse

RTU internal value	Modbus value
indeterminate	11

Table 19: DPI - Conversion of values for Double Bit Indication Reverse

Conversion value as per configured Value format Single Bit Indication:

RTU internal value	Modbus value
off	0
on	1

Table 20: DPI - Conversion of values for Single Bit Indication

Conversion value as per configured Value format Single Bit Indication Reverse:

RTU internal value	Modbus value
off	1
on	0

Table 21: DPI - Conversion of values for Single Bit Indication Reverse

6.4.4 Conversion of quality descriptors

RTU		Modbus
Internal communication (short)	**Internal communication (long)**	**Communication**
BL	Blocked	-
SB	Substituted	-
NT	Not Topical	-
IV	Invalid	Exception response (code 3)

Table 22: DPI - Conversion of quality descriptors

6.4.5 Conversion of causes of transmission

RTU		Modbus
Internal communication (short)	**Internal communication (long)**	**Communication**
T	Test	-
P/N	Positive/negative confirmation	- Irrelevant -
Cause	Spontaneous	-
	Interrogated	-

Table 23: DPI - Conversion of causes of transmission

6.5 EPI – Protection Event Information

Binary process information is indicated by two bits and a relative time tag (used by protection relays).

The EPI is not supported in the Modbus Host Communication Interface.

6.6 ITI – Integrated Totals Information

Binary process information is indicated by 16 or 32 bits as a count value.

6.6.1 Supported Function Codes

Modbus		RTU				
Function code	**Function code property**	**Data type**	**Parameter name**	**Parameter location**	**Parameter range / Explanation**	**Default**
<03>	Read Holding Registers	ITI	Address	ITI - Protocol address and parameters		
<04>	Read Input Registers	ITI	Address	ITI - Protocol address and parameters		
<23>	Read/Write Multiple Registers	ITI	Address	ITI - Protocol address and parameters		

Table 24: ITI - Supported function codes

6.6.2 Additional configuration parameters

Parameter name	Default	Parameter location
Value format	16 bit unsigned integer	ITI - Protocol address and parameters
16 bit unsigned integer		
16 bit signed integer		
32 bit unsigned integer (High word in first register)		
32 bit unsigned integer (High word in second register)		
32 bit signed integer (High word in first register)		
32 bit signed integer (High word in second register)		

6.6.3 Conversion of values

Range	RTU internal value	Modbus value
Range min.	0 (16/31 bit unsigned)	0
	-2 147 483 648 (32 bit signed)	-2 147 483 648
...	...	
Range max.	+65 535 (16 bit unsigned)	+65 535

Table 25: ITI - Conversion of values

Range	RTU internal value	Modbus value
	+2 147 483 647 (31 bit unsigned, 32 bit signed)	+2 147 483 647

Table 25: ITI - Conversion of values

6.6.4 Conversion of quality descriptors

RTU		Modbus
Internal communication (short)	Internal communication (long)	Communication
SEQ	Sequence number	-
CY	Carry	-
CA	Adjusted	-
IV	Invalid	Exception response (code 3)

Table 26: ITI - Conversion of quality descriptors

6.6.5 Conversion of causes of transmission

RTU		Modbus
Internal communication (short)	Internal communication (long)	Communication
T	Test	-
P/N	Positive/negative confirmation	- Irrelevant -
Cause	Spontaneous	-
	Requested	-
	Interrogated	-

Table 27: ITI - Conversion of causes of transmission

6.7 MFI – Measured Float Information

Analog process information indicated by 16 or 32 bits is used as a measured value from the analog inputs in floating point format.

6.7.1 Supported Function Codes

Modbus		RTU				
Function code	Function code property	Data type	Parameter name	Parameter location	Parameter range / Explanation	Default
<03>	Read Holding Registers	MFI	Address	MFI - Protocol address and parameters		

Table 28: MFI - Supported function codes

Modbus				RTU		
Function code	**Function code property**	**Data type**	**Parameter name**	**Parameter location**	**Parameter range / Explanation**	**Default**
<04>	Read Input Registers	MFI	Address	MFI - Protocol address and parameters		
<23>	Read/Write Multiple Registers	MFI	Address	MFI - Protocol address and parameters		

Table 28: MFI - Supported function codes

6.7.2 Value types

R32-IEEE STD 754; range –3.4 x 10e38 ... +3.4 x 10e38

6.7.3 Additional configuration parameters

Parameter name	Default	Parameter location
Value format	32 bit floating value (High word in first register)	MFI - Protocol address and parameters
Supported value formats are: 32 bit floating value (High word in first register) 32 bit floating value (High word in second register) 16 bit signed scaled value 32 bit signed scaled value (High word in first register) 32 bit signed scaled value (High word in second register) 16 bit unsigned scaled value 32 bit unsigned scaled value (High word in first register) 32 bit unsigned scaled value (High word in second register)		
Min. value	-32768	MFI - Protocol address and parameters
16bit signed scaled value formats 32768 ... +32767 16bit unsigned scaled value formats 0 ... +65535 32bit signed scaled value formats -231 ... +231-1 32bit unsigned scaled value formats 0 ... +232 – 1		
Min. float value	0	MFI -Protocol address and parameters
-3.4 x 10e38 ... +3.4 x 10e38		
Max. value	32767	MFI - Protocol address and parameters
16bit signed scaled value formats 32768 ... +32767 16bit unsigned scaled value formats 0 ... +65535 32bit signed scaled value formats -231 ... +231 -1 32bit unsigned scaled value formats 0 ... +232 – 1		
Max. float value	65 535	MFI - Protocol address and parameters
-3.4 x 10e38 ... +3.4 x 10e38		

6.7.4 Conversion of values

Range	RTU internal value	Modbus value
Range min.	-3.4 x 10e38 Min. float value	-3.4 x 10e38 (float value) Min. value (16/32 bit scaled value)
...	...	
Range max.	+3.4 x 10e38 Max. float value	+3.4 x 10e38 (float value) Max. value (16/32 bit scaled value)

Table 29: MFI - Conversion of values

6.7.5 Conversion of quality descriptors

RTU		Modbus
Internal commu-nication (short)	**Internal commu-nication (long)**	**Communication**
OV	Overflow	-
BL	Blocked	-
SB	Substituted	-
NT	Not Topical	-
IV	Invalid	Exception response (code 3)

Table 30: MFI - Conversion of quality descriptors

6.7.6 Conversion of causes of transmission

RTU		Modbus
Internal commu-nication (short)	**Internal commu-nication (long)**	**Communication**
T	Test	-
P/N	Positive/negative confir-mation	- Irrelevant -
Cause	Periodic / Cyclic	-
	Spontaneous	-
	Requested	-
	Interrogated	-

Table 31: MFI - Conversion of causes of transmission

Transmission of 32 bit float value in the Modbus protocol

-> Sequence of transmission

Byte 1								Byte 2								Byte 3								Byte 4							
8	7	6	5	4	3	2	1	8	7	6	5	4	3	2	1	8	7	6	5	4	3	2	1	8	7	6	5	4	3	2	1
s	exponent								fraction high							fraction low															

Table 32: Value format with high word in first register

-> Sequence of transmission

Byte 1								Byte 2								Byte 3								Byte 4							
8	7	6	5	4	3	2	1	8	7	6	5	4	3	2	1	8	7	6	5	4	3	2	1	8	7	6	5	4	3	2	1
fraction low																s	exponent							fraction high							

Table 33: Value format with high word in second register

6.8 SPI – Single Point Information

Binary process information is indicated by one bit.

6.8.1 Supported Function Codes

Modbus			RTU			
Function code	**Function code property**	**Data type**	**Parameter name**	**Parameter location**	**Parameter range / Explanation**	**Default**
<01>	Read Coil Status	SPI	Index	SPI - Protocol address and parameters		
<02>	Read Input Status	SPI	Index	SPI - Protocol address and parameters		
<03>	Read Holding Registers	SPI	Index	SPI - Protocol address and parameters		
			Bit position	SPI - Protocol address and parameters	0 to 15	
<04>	Read Input Registers	SPI	Index	SPI - Protocol address and parameters		
			Bit position	SPI - Protocol address and parameters	0 to 15	
<23>	Read/Write Multiple Registers	SPI	Index	SPI - Protocol address and parameters		

Table 34: SPI - Supported function codes

Modbus			RTU			
Function code	Function code property	Data type	Parameter name	Parameter location	Parameter range / Explanation	Default
			Bit position	SPI - Protocol address and parameters	0 to 15	

Table 34: SPI - Supported function codes

6.8.2 Additional information

Combination of function code, index and bit position should be unique.

6.8.3 Conversion of Values

RTU internal value	Modbus
off	0
on	1

Table 35: SPI - Conversion of values

6.8.4 Conversion of quality descriptors

RTU		Modbus
Internal communication (short)	Internal communication (long)	Communication
BL	Blocked	-
SB	Substituted	-
NT	Not Topical	-
IV	Invalid	Exception response (code 3)

Table 36: SPI - Conversion of quality descriptors

6.8.5 Conversion of causes of transmission

RTU		Modbus
Internal communication (short)	Internal communication (long)	Communication
T	Test	-
P/N	Positive/negative confirmation	- Irrelevant -
Cause	Spontaneous	-
	Interrogated	-

Table 37: SPI - Conversion of causes of transmission

6.9 STI – Step Position Information

Binary process information is indicated by 8 bits.

6.9.1 Supported Function Codes

Modbus		RTU				
Function code	**Function code property**	**Data type**	**Parameter name**	**Parameter location**	**Parameter range / Explanation**	**Default**
<03>	Read Holding Registers	STI	Address	STI - Protocol address and parameters		
<04>	Read Input Registers	STI	Address	STI - Protocol address and parameters		
<23>	Read/Write Multiple Registers	STI	Address	STI - Protocol address and parameters		

Table 38: STI - Supported function codes

6.9.2 Additional information

None

6.9.3 Conversion of values

Range	RTU internal value	Modbus value
Range min.	-64	-64
...	...	
Range max.	+63	+63

Table 39: STI - Conversion of values

6.9.4 Conversion of quality descriptors

RTU		Modbus
Internal communication (short)	**Internal communication (long)**	**Communication**
OV	Overflow	-
BL	Blocked	-
SB	Substituted	-

Table 40: STI - Conversion of quality descriptors

RTU		Modbus
Internal communication (short)	**Internal communication (long)**	**Communication**
NT	Not Topical	-
IV	Invalid	Exception response (code 3)
T	Transient Bit	-

Table 40: STI - Conversion of quality descriptors

6.9.5 Conversion of causes of transmission

RTU		Modbus
Internal communication (short)	**Internal communication (long)**	**Communication**
T	Test	-
P/N	Positive/negative confirmation	- Irrelevant -
Cause	Spontaneous	-
	Requested	-
	Interrogated	-

Table 41: STI - Conversion of causes of transmission

7 Data types - controlling direction

7.1 ASO – Analog Setpoint Output

Analog process command (16 or 32 bit for signed or unsigned numbers)

7.1.1 Supported Function Codes

Modbus		RTU				
Function code	**Function code property**	**Data type**	**Parameter name**	**Parameter location**	**Parameter range / Explanation**	**Default**
<03>	Read Holding Registers (read only)	ASO	Address	ASO - Protocol address and parameters		
<04>	Read Input Registers (read only)	ASO	Address	ASO - Protocol address and parameters		
<06>	Preset Single Registers (write only)	ASO	Address	ASO - Protocol address and parameters		
<16>	Preset Multiple Registers (write only)	ASO	Address	ASO - Protocol address and parameters	For restrictions on the usage of the function code see chapter Application Layer (page "4-1")	
<23>	Read/Write Multiple Registers	ASO	Address	ASO - Protocol address and parameters	For restrictions on the usage of the function code see chapter Application Layer (page "4-1")	

Table 42: ASO - Supported function codes

7.1.2 Command Authority

See also parameter Interlock with local control authority

7.1.3 Additional configuration parameters

Parameter name	Default	Parameter location
Scaling limit mapping	Bipolar	ASO - Protocol address and parameters
Bipolar Unipolar		
Value format	16 bit signed scaled value	ASO - Protocol address and parameters
Value format is used for transmitting the ASO information. Supported value formats are: 32 bit floating value (High word in first register) 32 bit floating value (High word in second register) 16 bit signed scaled value 32 bit signed scaled value (High word in first register) 32 bit signed scaled value (High word in second register) 16 bit unsigned scaled value 32 bit unsigned scaled value (High word in first register) 32 bit unsigned scaled value (High word in second register)		
Min. raw value	-32768	ASO - Protocol address and parameters
16bit signed scaled value formats 32768 ... +32767 16bit unsigned scaled value formats 0 ... +65535 32bit signed scaled value formats -231 ... +231 -1 32bit unsigned scaled value formats 0 ... +232 – 1 Minimum value in the telegram, to be converted to -100 % (internal communication)		
Max. raw value	32767	ASO - Protocol address and parameters
16bit signed scaled value formats 32768 ... +32767 16bit unsigned scaled value formats 0 ... +65535 32bit signed scaled value formats -231 ... +231 -1 32bit unsigned scaled value formats 0 ... +232 – 1 Maximum value in the telegram, to be converted to 100 % (internal communication)		
Min. float value	0	ASO - Protocol address and parameters
Minimum float value in the telegram, to be converted to -100 % (internal communication)		
Max. float value	65535	ASO - Protocol address and parameters
Maximum float value in the telegram, to be converted to +100 % (internal communication)		

7.1.4 Conversion of values

Range	RTU internal value	Modbus value
Range min.	-100 %	Min. raw value Min. float value
...	...	
Range max.	+100 %	Max. raw value Max. float value

Table 43: ASO - Conversion of values

7.1.5 Conversion of quality descriptors

RTU		Modbus
Internal commu-nication (short)	Internal commu-nication (long)	Communication
SE	Select / Execute	-

Table 44: ASO - Conversion of quality descriptors

7.1.6 Conversion of causes of transmission

RTU		Modbus
Internal commu-nication (short)	Internal commu-nication (long)	Communication
T	Test	-
P/N	Positive/negative confir-mation	Relevant in monitoring direction only
Cause	Activation	-
	Activation Confirmation	-
	Deactivation	-
	Deactivation Confirmation	-
	Activation Termination	Echo of Write Query

Table 45: ASO - Conversion of causes of transmission

7.2 BSO – Bit String Output

Binary process command (1, 2, 8, 16 bit unsigned number)

7.2.1 Supported Function Codes

Modbus		RTU				
Function code	Function code property	Data type	Parame-ter name	Parameter location	Parameter range / Explanation	Default
<03>	Read Holding Registers (read only)	BSO	Address	BSO - Protocol address and para-meters		
<04>	Read Input Registers (read only)	BSO	Address	BSO - Protocol address and para-meters		
<06>	Preset Sin-gle Registers (write only)	BSO	Address	BSO - Protocol address		

Table 46: BSO - Supported function codes

Modbus		RTU				
Function code	**Function code property**	**Data type**	**Parameter name**	**Parameter location**	**Parameter range / Explanation**	**Default**
				and parameters		
<16>	Preset Multiple Registers (write only)	BSO	Address	BSO - Protocol address and parameters	For restrictions on the usage of the function code see chapter Application Layer (page "4-1")	
<23>	Read/Write Multiple Registers	BSO	Address	BSO - Protocol address and parameters	For restrictions on the usage of the function code see chapter Application Layer (page "4-1")	

Table 46: BSO - Supported function codes

7.2.2 Command Authority

See also parameter Interlock with local control authority

7.2.3 Additional Information

None

7.2.4 Conversion of values

Range	RTU internal value	Modbus value
Range min.	0	0
...	...	
Range max.	65 535	65 535

Table 47: BSO - Conversion of values

7.2.5 Conversion of quality descriptors

RTU		Modbus
Internal communication (short)	**Internal communication (long)**	**Communication**
SE	Select / Execute	-

Table 48: BSO - Conversion of quality descriptors

7.2.6 Conversion of causes of transmission

RTU		Modbus
Internal communication (short)	**Internal communication (long)**	**Communication**
T	Test	Ignored
P/N	Positive/negative confirmation	Relevant in monitoring direction only
Cause	Activation	-
	Activation Confirmation	-
	Deactivation	-
	Deactivation Confirmation	-
	Activation Termination	Echo of Write Query

Table 49: BSO - Conversion of causes of transmission

7.3 DCO – Double Command Output

Binary process command (two bits)

7.3.1 Supported Function Codes

Modbus		RTU				
Function code	**Function code property**	**Data type**	**Parameter name**	**Parameter location**	**Parameter range / Explanation**	**Default**
<03>	Read Holding Registers (read only)	DCO	Address	DCO - Protocol address and parameters		
<04>	Read Input Registers (read only)	DCO	Address	DCO - Protocol address and parameters		
<06>	Preset Single Registers (write only)	DCO	Address	DCO - Protocol address and parameters		
<16>	Preset Multiple Registers (write only)	DCO	Address	DCO - Protocol address and parameters	For restrictions on the usage of the function code see chapter Application Layer (page "4-1")	

Table 50: DCO - Supported function codes

Modbus		RTU				
Function code	Function code property	Data type	Parameter name	Parameter location	Parameter range / Explanation	Default
<23>	Read/Write Multiple Registers	DCO	Address	DCO - Protocol address and parameters	For restrictions on the usage of the function code see chapter Application Layer (page "4-1")	

Table 50: DCO - Supported function codes

7.3.2 Command Authority

See also parameter Interlock with local control authority

7.3.3 Additional Information

None

7.3.4 Conversion of values

RTU internal value	Modbus value
off	01
on	10

Table 51: DCO - Conversion of values

7.3.5 Conversion of quality descriptors

RTU		Modbus
Internal communication (short)	Internal communication (long)	Communication
SE	Select / Execute	-

Table 52: DCO - Conversion of quality descriptors

7.3.6 Conversion of causes of transmission

RTU		Modbus
Internal communication (short)	Internal communication (long)	Communication
T	Test	-
P/N	Positive/negative confirmation	Relevant in monitoring direction only

Table 53: DCO - Conversion of causes of transmission

RTU		Modbus
Internal communication (short)	Internal communication (long)	Communication
Cause	Activation	-
	Activation Confirmation	-
	Deactivation	-
	Deactivation Confirmation	-
	Activation Termination	Echo of Write Query

Table 53: DCO - Conversion of causes of transmission

7.4 DSO – Digital Setpoint Output

Binary process command (8 or 16 bit signed number)

7.4.1 Supported Function Codes

Modbus		RTU				
Function code	Function code property	Data type	Parameter name	Parameter location	Parameter range / Explanation	Default
<03>	Read Holding Registers (read only)	DSO	Address	DSO - Protocol address and parameters		
<04>	Read Input Registers (read only)	DSO	Address	DSO - Protocol address and parameters		
<06>	Preset Single Registers (write only)	DSO	Address	DSO - Protocol address and parameters		
<16>	Preset Multiple Registers (write only)	DSO	Address	DSO - Protocol address and parameters	For restrictions on the usage of the function code see chapter Application Layer (page "4-1")	
<23>	Read/Write Multiple Registers	DSO	Address	DSO - Protocol address and parameters	For restrictions on the usage of the function code see chapter	

Table 54: DSO - Supported function codes

Modbus		RTU				
Function code	**Function code property**	**Data type**	**Parameter name**	**Parameter location**	**Parameter range / Explanation**	**Default**
					Application Layer (page "4-1")	

Table 54: DSO - Supported function codes

7.4.2 Command Authority

See also parameter Interlock with local control authority

7.4.3 Additional Information

None

7.4.4 Conversion of values

Range	RTU internal value	Modbus value
Range min.	-100 %	-32 768
...	...	
Range max.	+100 %	+32 767

Table 55: DCO - Conversion of values

7.4.5 Conversion of quality descriptors

RTU		Modbus
Internal communication (short)	**Internal communication (long)**	**Communication**
SE	Select / Execute	-

Table 56: DSO - Conversion of quality descriptors

7.4.6 Conversion of causes of transmission

RTU		Modbus
Internal communication (short)	**Internal communication (long)**	**Communication**
T	Test	-
P/N	Positive/negative confirmation	Relevant in monitoring direction only
Cause	Activation	-
	Activation Confirmation	-
	Deactivation	-
	Deactivation Confirmation	-

Table 57: DSO - Conversion of causes of transmission

RTU		Modbus
Internal communication (short)	**Internal communication (long)**	**Communication**
	Activation Termination	Echo of Write Query

Table 57: DSO - Conversion of causes of transmission

7.5 FSO – Floating Point Setpoint Output

Analog process command (16 or 32 bit number)

7.5.1 Supported Function Codes

Modbus		RTU				
Function code	**Function code property**	**Data type**	**Parameter name**	**Parameter location**	**Parameter range / Explanation**	**Default**
<03>	Read Holding Registers (read only)	FSO	Address	FSO - Protocol address and parameters		
<04>	Read Input Registers (read only)	FSO	Address	FSO - Protocol address and parameters		
<06>	Preset Single Registers (write only)	FSO	Address	FSO - Protocol address and parameters		
<16>	Preset Multiple Registers (write only)	FSO	Address	FSO - Protocol address and parameters	For restrictions on the usage of the function code see chapter Application Layer (page "4-1")	
<23>	Read/Write Multiple Register	FSO	Address	FSO - Protocol address and parameters	For restrictions on the usage of the function code see chapter Application Layer (page "4-1")	

Table 58: FSO - Supported function codes

7.5.2 Command Authority

See also parameter Interlock with local control authority

7.5.3 Additional configuration parameters

Parameter name	Default	Parameter location
Value format	32 bit floating value (High word in first register)	FSO - Protocol address and parameters
Supported value formats are: 32 bit floating value (High word in first register) 32 bit floating value (High word in second register) 16 bit signed scaled value 32 bit signed scaled value (High word in first register) 32 bit signed scaled value (High word in second register) 16 bit unsigned scaled value 32 bit unsigned scaled value (High word in first register) 32 bit unsigned scaled value (High word in second register)		
Min. value	-32768	FSO - Protocol address and parameters
16bit signed scaled value format -32768 … +32767 16bit unsigned scaled value format 0 … +65535 32bit signed scaled value format -231 … +231 -1 32bit unsigned scaled value format 0 … +232 – 1		
Min. float value	0	FSO - Protocol address and parameters
-3.4 x 10e38 … +3.4 x 10e38		
Max. value	32767	FSO - Protocol address and parameters
16bit signed scaled value format -32768 … +32767 16bit unsigned scaled value format 0 … +65535 32bit signed scaled value format -231 … +231 -1 32bit unsigned scaled value format 0 … +232 – 1		
Max. float value	65 535	FSO - Protocol address and parameters
-3.4 x 10e38 … +3.4 x 10e38		

7.5.4 Conversion of values

Range	RTU internal value	Modbus value
Range min.	-3.4 x 10e38 Min. float value	-3.4 x 10e38 (float value) Min. value (16/32 bit scaled value)
…	…	
Range max.	+3.4 x 10e38 Max. float value	+3.4 x 10e38 (float value) Max. value (16/32 bit scaled value)

Table 59: FSO - Conversion of values

7.5.5 Conversion of quality descriptors

RTU		Modbus
Internal communication (short)	**Internal communication (long)**	**Communication**
SE	Select / Execute	-

Table 60: FSO - Conversion of quality descriptors

7.5.6 Conversion of causes of transmission

RTU		Modbus
Internal communication (short)	**Internal communication (long)**	**Communication**
T	Test	-
P/N	Positive/negative confirmation	Relevant in monitoring direction only
Cause	Activation	-
	Activation Confirmation	-
	Deactivation	-
	Deactivation Confirmation	-
	Activation Termination	Echo of Write Query

Table 61: FSO - Conversion of causes of transmission

7.6 RCO – Regulation Command Output

Regulation process command (two bits)

7.6.1 Supported Function Codes

Modbus		RTU				
Function code	**Function code property**	**Data type**	**Parameter name**	**Parameter location**	**Parameter range / Explanation**	**Default**
<03>	Read Holding Registers (read only)	RCO	Address	RCO - Protocol address and parameters		
<04>	Read Input Registers (read only)	RCO	Address	RCO - Protocol address and parameters		
<06>	Preset Single Registers (write only)	RCO	Address	RCO - Protocol address		

Table 62: RCO - Supported function codes

Modbus		RTU				
Function code	**Function code property**	**Data type**	**Parameter name**	**Parameter location**	**Parameter range / Explanation**	**Default**
				and parameters		
<16>	Preset Multiple Registers (write only)	RCO	Address	RCO - Protocol address and parameters	For restrictions on the usage of the function code see chapter Application Layer (page "4-1")	
<23>	Read/Write Multiple Registers	RCO	Address	RCO - Protocol address and parameters	For restrictions on the usage of the function code see chapter Application Layer (page "4-1"	

Table 62: RCO - Supported function codes

7.6.2 Command Authority

See also parameter Interlock with local control authority

7.6.3 Additional information

Regulation step commands are in principle retriggerable commands.

7.6.4 Conversion of values

RTU internal value	Modbus value
Lower	01
Higher	10

Table 63: RCO - Conversion of values

7.6.5 Conversion of quality descriptors

RTU		Modbus
Internal communication (short)	**Internal communication (long)**	**Communication**
SE	Select / Execute	-

Table 64: RCO - Conversion of quality descriptors

7.6.6 Conversion of causes of transmission

RTU		Modbus
Internal commu-nication (short)	**Internal commu-nication (long)**	**Communication**
T	Test	-
P/N	Positive/negative confir-mation	Relevant in monitoring direction only
Cause	Activation	-
	Activation Confirmation	-
	Deactivation	-
	Deactivation Confirmation	-
	Activation Termination	Echo of Write Query

Table 65: RCO - Conversion of causes of transmission

7.7 SCO – Single Command Output

Binary process command (one bit)

7.7.1 Supported Function Codes

Modbus		RTU				
Function code	**Function code property**	**Data type**	**Parame-ter name**	**Parameter location**	**Parameter range / Explanation**	**Default**
<01>	Read Coil Sta-tus (read only)	SCO	Address	SCO - Protocol address and para-meters		
<02>	Read Input Status (read only)	SCO	Address	SCO - Protocol address and para-meters		
<05>	Force single coil (write only)	SCO	Address	SCO - Protocol address and para-meters		
<15>	Force Multi-ple Coils (write only)	SCO	Address	SCO - Protocol address and para-meters	For restric-tions on the usage of the func-tion code see chapter Application Layer (page "4-1")	

Table 66: SCO - Supported function codes

7.7.2 Command Authority

See also parameter Interlock with local control authority

7.7.3 Additional Information

None

7.7.4 Conversion of values

RTU internal value	Modbus value
off	0
on	1

Table 67: SCO - Conversion of values

7.7.5 Conversion of quality descriptors

RTU		Modbus
Internal communication (short)	Internal communication (long)	Communication
SE	Select / Execute	-

Table 68: SCO - Conversion of quality descriptors

7.7.6 Conversion of causes of transmission

RTU		Modbus
Internal communication (short)	Internal communication (long)	Communication
T	Test	-
P/N	Positive/negative confirmation	Relevant in monitoring direction only
Cause	Activation	-
	Activation Confirmation	-
	Deactivation	-
	Deactivation Confirmation	-
	Activation Termination	-

Table 69: SCO - Conversion of causes of transmission

8 File Transfer

Not defined in the Modbus protocol.

9 Internal Functions

9.1 General Interrogation

In Modbus protocol, no special general interrogation command is defined. All data in monitoring direction have to be polled by the host system using the query/response mechanism. This must be initiated by the host system.

All data configured for monitoring direction can be queried.

9.1.1 Supported data types

None

9.1.2 Values

None

9.1.3 Command authority

None

9.1.4 Additional information

None

9.1.5 Conversion of quality descriptors

RTU		Modbus
Internal communication (short)	**Internal communication (long)**	**Communication**
QOI	Qualifier of Interrogation	-

Table 70: General Interrogation - Conversion of quality descriptors

9.1.6 Conversion of causes of transmission

RTU		Modbus
Internal communication (short)	**Internal communication (long)**	**Communication**
T	Test	-
P/N	Positive/negative confirmation	Relevant in monitoring direction only
Cause	Activation	-
	Activation Confirmation	-

Table 71: General Interrogation - Conversion of causes of transmission

RTU		Modbus
Internal commu-nication (short)	Internal commu-nication (long)	Communication
	Activation Termination	-

Table 71: General Interrogation - Conversion of causes of transmission

9.2 Time synchronization

Not defined in the Modbus protocol.

9.3 System Events

The host interface manages internal status messages of the RTU500 series. These status messages can be created from the host itself or other activities of the RTU500 series. The system events of other activities are sent via internal communication and are processed by the HCI.

Parameter name	Default	Parameter location
Fix SEV address schema	enabled	SDI - line
Value range: enabled/ disabled if enabled: a base address for the whole block of system events is defined at the SDI node if disabled: individual addresses per SEV can be defined In order to avoid collisions, the addresses of the system events may not be used for other process objects.		
In use	enabled	SDI - line
Value range: enabled/ disabled if disabled: no SEVs will be transmitted on this line		

The following table shows the system events available for the host interface:

Description of system event	Address offset
At least one indication faulty	SEV#016
At least one analog value faulty	SEV#017
At least one digital value faulty	SEV#018
At least one integrated total faulty	SEV#019
At least one object or regulation command faulty	SEV#020
At least one analog output faulty	SEV#021
At least one digital output faulty	SEV#022
RTU is faulty	SEV#023
Device/ RTU active	SEV#024
RTU synchronized	SEV#025
External clock inoperable	SEV#026
Local printer offline	SEV#027
At least one indication oscillating	SEV#028
Battery voltage low (RTU560E only)	SEV#029
AC power supply failure (RTU560E only)	SEV#030
Test mode active	SEV#042

Table 72: Description of system events

Description of system event	Address offset
At least one data object simulated	SEV#043
At least one data communication equipment (DCE) faulty	SEV#044
Device connected	SEV#045
At least one PLC function not running	SEV#046
At least one PLC function cycle time exceeded	SEV#047
Device/ RTU inoperable	SEV#048
Device/ RTU is out of service	SEV#049
Power supply failure in RTU central sub-rack	SEV#059
Command supervision circuit x disconnected or faulty, 1 ≤ x ≤ 32	SEV#064 ... #095
SNTP client 1 is synchronized	SEV#096
SNTP client 2 is synchronized	SEV#097
Local control authority active	SEV#100
Host x Online, 1 ≤ x ≤ 16	SEV#101 ... #116
Host interface x: At least one change of information lost, 1 ≤ x ≤ 16	SEV#117 ... #132
Host interface x: At least one pulse counter lost, 1 ≤ x ≤ 16	SEV#133 ... #148
CMU x is inoperable, 1 ≤ x ≤ 16	SEV#149 … #164
Database identity tag	SEV#174
Device reachable on redundant line x, 1 ≤ x ≤ 4	SEV#180 … #183
Device active on redundant line x, 1 ≤ x ≤ 4	SEV#184 … #187
Device preferred on redundant line x, 1 ≤ x ≤ 4	#SEV188 … #191
Network element x is operable, 1 ≤ x ≤ 32	SEV#192 … #223
CMU x is active, 1 ≤ x ≤ 16	SEV#224 … #239
Process command collision with host x, 1 ≤ x ≤ 16	SEV#242 ... #257
Command collision with Integrated HMI	SEV#258
Command collision with web server	SEV#259
Command collision with PLC	SEV#260
HMI Client x online,1 ≤ x ≤ 16	SEV#261 ... #276
PRP interface x: Network interface E1 link on, 1 ≤ x ≤ 8	SEV#277 ... #284
PRP interface x: Network interface E2 link on, 1 ≤ x ≤ 8	SEV#285 ... #292
Host interface x: SOE buffer filling status is not reached, 1 ≤ x ≤ 16	SEV#293 ... #308
CAM Client x online, 1 ≤ x ≤ 4	SEV#309 ... #312
RTC battery voltage low[1]	SEV#313

Table 72: Description of system events

1 540CID01, 540CMD01 and 560CMR01/02

9.4 System commands

System Single Commands (SSC) are accepted by the host communication interface with protocol Modbus. If the command is addressed to the RTU itself, the RTU performs the command. If the command is addressed to the connected subdevice, the SSC command is sent to the corresponding subinterface.

SSC supported	Description of SSC	Address offset
X	Set device out of service	#001
X	Reset device process	#002
X	Connect/disconnect device	#003
	Set redundant line 1 / 2 as preferred line	#004, #005
	Set redundant line 3 / 4 as preferred line	#006, #007
X	Force global process image update, i.e. force process image update of all subdevices	#012
X	Request redundancy change over for the active CMU x, 1 ≤ x ≤ 16	#016 ... #031

Table 73: Description of system single commands (SSC)

9.4.1 Reset device process

The SSC command performs a reset for the addressed device. If the command is addressed to the RTU itself, the RTU performs a restart. If the command is addressed to the connected subdevice, the SSC command is sent to the corresponding sub-device interface.

RTU internal value	Status
off	<Ignored>
on	reset device process

Table 74: Conversion of values SSC#002

9.4.2 Force process image update

If the SSC command is addressed to the RTU itself, SSC commands "force process image update" are delegated to all sub-device interfaces. If the SSC command is addressed to the connected sub-device, the command is routed to the corresponding sub-device interface.

RTU internal value	Status
off	<Ignored>
on	Force process image update

Table 75: Conversion of values SSC#012

9.4.3 Request redundancy change over

The SSC command performs a switchover to the CMU specified by the command. If the command is addressed to the RTU itself, the RTU forces a CMU reset when the CMU is active and the standby partner is ok. If the command is addressed to the connected subdevice, the SSC command is sent to the corresponding subinterface.

RTU internal value	Status
off	<Ignored>
on	Request redundancy change over

Table 76: Conversion of values SSC#016 ... #031

10 Parameter loading

Parameter loading is not supported by RTU500 series.

11 Interoperability list

11.1 Supported and selectable parameters

In this document parameter settings and selections of the Modbus protocol that are supported by RTU500 series are marked by squares with a tick ✓

Functions and parameters with filled (black) squares ■ are not supported by RTU500 series!

11.2 Network configuration

(network-specific parameter)

✓	Point-to-point	✓	Multipoint star

11.3 Physical Layer

11.3.1 Electrical interface

✓ RS-232
✓ EIA RS-485 (CPA / CPB only)
✓ Ethernet (up to 8 host devices)

Number of unit loads: max. 31 slave devices

ADVICE
EIA RS-485 standard defines unit loads so that 32 of them can be operated on one line. For detailed information refer to clause 3 of EIA RS-485 standard.

11.3.2 Transmission speed

Transmission settings are defined according to the chosen framing type. (serial only)

✓	300 bit/s	✓	600 bit/s	✓	1 200 bit/s
✓	2 400 bit/s	✓	4 800 bit/s	✓	9 600 bit/s
✓	19 200 bit/s				

Transmission on Ethernet networks

✓ 10 MBit/s
✓ 100 MBit/s

11.3.3 Transmission settings (only serial)

✓ even parity, 1 stop bit
✓ odd parity, 1 stop bit
✓ none parity, 1 stop bit
✓ none parity, 2 stop bits (CP1 / CP2 only)

11.4 Link Layer

Framing types (only serial)

✓ ASCII framing (7 bit ASCII characters)
✓ RTU framing (8 bit characters)

Message length

≤ 255 Maximum length L (number of characters)

11.5 Application Layer

11.5.1 Function codes

✓	<01>	Read Coil Status	✓	<02>	Read Input Status
✓	<03>	Read Holding Registers	✓	<04>	Read Input Registers
✓	<05>	Force Single Coil	✓	<06>	Preset Single Register
■	<07>	Read Exception Status	■	<08>	Diagnostics
■	<09>	Program 484	■	<10>	Poll 484
■	<11>	Fetch Communication Event Counter	■	<12>	Fetch Communication Event Log
■	<13>	Program Controller	■	<14>	Poll Controller
✓	<15>	Force Multiple Coils	✓	<16>	Preset Multiple Registers
■	<17>	Report Slave ID	■	<18>	Program 884/M84
■	<19>	Reset Communication Link	■	<20>	Read General Reference
■	<21>	Write General Reference	■	<22>	Mask Write 4X Register
■	<23>	Read/Write 4X Registers	■	<24>	Read FIFO Queue

11.5.2 Basic application functions

Clock synchronization

✓ Clock synchronization

Command transmission

✓ Direct command transmission
□ Select and execute command (Note: Select is internally simulated by RTU500 series-HCI)

✓ Direct set point command transmission
□ Select and execute set point command

12 Glossary

AC	Alternating Current
AMI	Analog Measured value Input
ASO	Analog Setpoint command Output
BSI	Bit String Input
BSO	Bit String Output
CAM	Central User Account Management
CMU	Communication and Data Processing Unit
CTS	Clear to Send
DCD	Data Carrier Detect
DCE	Data Communication Equipment
DCO	**D**ouble **C**ommand **O**utput
DMI	Digital Measured value Input (8, 16 bit)
DO	Digital Output
DPI	Double Point Input
DSO	Digital Setpoint command Output (8, 16 bit)
EPI	Event of Protection equipment Input (1 bit)
FSO	Floating Setpoint Command Output
HCI	Human Maschine Interface (here Integrated HMI function of the RTU500 series)
IED	Intelligent Electronic Device
ITI	Integrated Totals Input
MAX	Maximum
MFI	Analog Measured value Floating Input
Min	Minimum
MS	Microsoft
NCC	Network Control Center
PDU	Protocol Data Unit
PLC	Programmable Logic Control
PRP	Parallel Redundancy Protocol
RCO	Regulation step Command Output
RTC	Real Time Clock
RTS	Request to Send

RTU	Remote Terminal Unit
SCO	Single Command Output
SEV	System Event
SNTP	Simple Network Time Protocol (according to RFC 4330)
SOE	Sequence-of-Event Queue
SPI	Single Point Input or Single point information
SSC	System Single Command
STI	Step position Input
TCP/IP	Transmission Control Protocol / Internet Protocol
Tx	Transmit Direction
UART	Universal Asynchronous Receiver-transmitter

Visit us

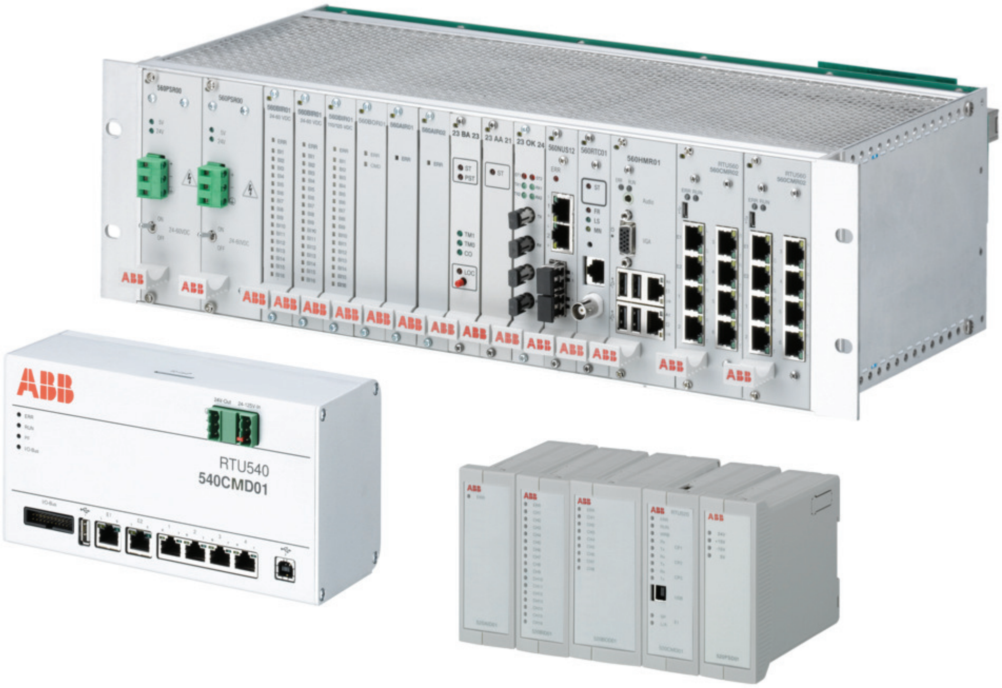
ABB AG
Power Grids
P.O. Box 10 03 51
68128 Mannheim, Germany

www.abb.com/remote-terminal-units

1KGT 150 487 V019 1

Power Grids

Remote Terminal Units
Subdevice Communication Interface with Modbus
Protocol description



Revision

Document identity:		1KGT 150 486 V022 1
Revision:	**Date:**	**Changes:**
0	05/2001	First version
1	10/2001	Transmission settings introduced Texts of address parameters changed Explanations for address parameters added Additional data type parameters changed Interoperability list updated RCO added Scaling of ASO and DSO added Parameter Block start changed into Query range Query auto-packing mode introduced
2	03/2001	
3	06/2002	Chapter General Information updated Range of STI corrected
4	07/2004	New data type MFI introduced (Transmitted in 2 consecutive Modbus register) Available with FW Release 6.1
5	11/2004	Chapter Link Layer, UART-Mode corrected
6	02/2005	Query auto-packing Mode explained
7	06/2007	Expansion new, chapter: Modbus TCP/IP based communication Threshold supervision for MFI's added (Available with FW Release 8.1 Build 0)
8	03/2008	Chapter SCO – Single Command Output Value of Force Single Coil corrected
9	06/2009	Deadband/Value Range MFI corrected Transparent Data Telegrams added Chapter Physical Layer extended.
10	07/2009	Added parameter format at data type ITI Chapter Time Synchronization extended Chapter Event handling added Added parameters for time synchronization and event handling
11	02/2010	Transparent data channel included Chapter Physical Layer updated Value range ITI and BSI corrected
12	05/2010	Added/changed parameter value format for data types BSI, ITI, AMI and MFI
13	05/2011	Included FSO data type Added Command handling for ABB SACE devices

Document identity:		1KGT 150 486 V022 1
Revision:	**Date:**	**Changes:**
		Corrected unipolar and bipolar DMI and AMI value ranges. Configurable bit position for SPI and DPI
14	11/2011	Time synchronization ABB SACE PR12x/33x
15	04/2012	Extension of FC 15 (Force Multiple Coils) for SCO object type Supporting Unit Identifier Configurable bit position for DPI in a register Time synchronization of 560CVT10, 560CVD03 and 560CVD11 Exception codes were added Line redundancy configuration added and explained Value format for DPI object was added
16	02/2013	OV flag for STI was added
17	01/2014	Updated value format information for AMI, MFI, ASO, FSO, ITI
18	08/2014	Support NT-Flag added New Layout
19	10/2014	Updated details on Unit identifier and Routing based on unit ID Updated conversion of values for SCO
		Updated chapter System events and System commands
20	04/2017	Updated chapter Ethernet communication (PR#33262)
		Updated chapter 'Addressing' for BSI08 and DMI08 (PR #29816)
21	10/2017	Updated chapter 'Switch over handling' (PR#24827)
	11/2017	Updated table 'Function codes' (PR#18792)
	03/2018	Updated chapter 'Station specific items', introduced new option multiple parallel queries per polling cycle (PR#36853)
	04/2018	New layout
22	06/2018	Increased baudrate up to 115,2 kB/s (PR#38055)
		Updated value range of parameter 'Cycle time for line 1/2' (PR#33996)
	09/2018	Added parameter 'Communication retries' to chapter "Ethernet communication" (PR#38337)
	10/2018	Updated description of 'Index' parameter in chapter 'Addressing' (PR#39667)
		Introduced broadcast functionality (PR#37918)

Contents

1 Introduction **7**
1.1 Preface 7
1.2 References 7
1.3 Conventions 8

2 Physical Layer **9**
2.1 General information 9
2.2 Serial line-based communication 9
2.3 IP based Communication 10
2.3.1 Unit identifier 11

3 Link Layer **13**
3.1 General 13
3.2 Serial Communication 13
3.2.1 Station specific items 14
3.2.2 Response times 14
3.3 Ethernet communication 14
3.3.1 Ethernet link 15
3.3.2 Station specific items 15
3.4 Check of links 16
3.5 Monitoring direction 17
3.6 Command direction 17
3.7 Restrictions 17

4 Redundant communication **19**
4.1 Redundant serial communication lines 19
4.1.1 General 19
4.1.2 Switch over handling 19
4.2 Redundant Ethernet Communication Links 20
4.2.1 General 20
4.2.2 Switch over handling 23

5 Application Layer **25**
5.1 Table of function codes in monitoring direction 25
5.2 Table of function codes in control direction 25
5.3 Table of exception codes 25

6 Addressing **27**
6.1 Restrictions for function codes 27
6.2 Restrictions for index 27
6.3 Restrictions for query range 27

7 Data types - monitoring direction **29**
7.1 AMI – Analog Measured Information 29
7.1.1 Supported function codes 29
7.1.2 Value types 30

7.1.3 Additional configuration parameters....30
7.1.4 Conversion of values.... 31
7.1.5 Conversion of quality descriptors.... 31
7.1.6 Conversion of causes of transmission.... 31
7.2 BSI – Bit String Information.... 31
7.2.1 Supported function codes....32
7.2.2 Additional configuration parameters....32
7.2.3 Conversion of values.... 33
7.2.4 Conversion of quality descriptors....33
7.2.5 Conversion of causes of transmission.... 33
7.3 DMI – Digital Measured Information....34
7.3.1 Supported function codes....34
7.3.2 Value types....34
7.3.3 Additional configuration parameters....35
7.3.4 Conversion of values.... 35
7.3.5 Conversion of quality descriptors....35
7.3.6 Conversion of causes of transmission.... 35
7.4 DPI – Double Point Information.... 36
7.4.1 Supported function codes....36
7.4.2 Additional information.... 38
7.4.3 Conversion of values....38
7.4.4 Conversion of quality descriptors....39
7.4.5 Conversion of causes of transmission....39
7.5 EPI – Protection Event Information.... 40
7.6 ITI – Integrated Totals Information....40
7.6.1 Supported function codes.... 40
7.6.2 Additional configuration parameters.... 41
7.6.3 Conversion of values.... 41
7.6.4 Conversion of quality descriptors.... 41
7.6.5 Conversion of causes of transmission.... 41
7.7 MFI – Measured Float Information.... 42
7.7.1 Supported function codes....42
7.7.2 Value types.... 43
7.7.3 Additional configuration parameters....43
7.7.4 Conversion of values....44
7.7.5 Conversion of quality descriptors.... 44
7.7.6 Conversion of causes of transmission....44
7.8 SPI – Single Point Information.... 45
7.8.1 Supported function codes....45
7.8.2 Additional information.... 46
7.8.3 Conversion of values.... 47
7.8.4 Conversion of quality descriptors....47
7.8.5 Conversion of causes of transmission.... 47
7.9 STI – Step Position Information....47
7.9.1 Supported function codes.... 47
7.9.2 Additional information.... 48

7.9.3 Conversion of values....48
7.9.4 Conversion of quality descriptors....49
7.9.5 Conversion of causes of transmission....49

8 Data types - controlling direction....51

8.1 ASO – Analog Setpoint Output....51
8.1.1 Supported function codes....51
8.1.2 Value types....52
8.1.3 Command authority....52
8.1.4 Additional configuration parameters....52
8.1.5 Conversion of values....52
8.1.6 Conversion of quality descriptors....53
8.1.7 Conversion of causes of transmission....53
8.2 BSO – Bit String Output....53
8.2.1 Supported function codes....53
8.2.2 Command authority....54
8.2.3 Additional information....54
8.2.4 Conversion of values....54
8.2.5 Conversion of quality descriptors....54
8.2.6 Conversion of causes of transmission....54
8.3 DCO – Double Command Output....55
8.3.1 Supported function codes....55
8.3.2 Command authority....55
8.3.3 Additional information....55
8.3.4 Supported function code for ABB SACE PR12x/33x....56
8.3.5 Command authority....56
8.3.6 Additional configuration parameters....56
8.3.7 Additional information....56
8.3.8 Supported function codes for ABB SACE PR 223DS/223EF devices....57
8.3.9 Command authority....57
8.3.10 Additional information....58
8.3.11 Conversion of values....58
8.3.12 Conversion of quality descriptors....58
8.3.13 Conversion of causes of transmission....58
8.4 DSO – Digital Setpoint Output....58
8.4.1 Supported function codes....59
8.4.2 Value types....59
8.4.3 Command authority....59
8.4.4 Additional configuration parameters....59
8.4.5 Conversion of values....59
8.4.6 Conversion of quality descriptors....60
8.4.7 Conversion of causes of transmission....60
8.5 FSO – Floating point Setpoint Output....60
8.5.1 Supported function codes....60
8.5.2 Value types....61
8.5.3 Command authority....61
8.5.4 Additional configuration parameters....62

8.5.5 Conversion of values ... 62
8.5.6 Conversion of quality descriptors ... 62
8.5.7 Conversion of causes of transmission ... 63
8.6 RCO – Regulation Command Output ... 63
8.6.1 Supported function codes ... 63
8.6.2 Command authority ... 63
8.6.3 Additional information ... 64
8.6.4 Supported function code for ABB SACE PR12x/33x ... 64
8.6.5 Command authority ... 64
8.6.6 Additional configuration parameters ... 64
8.6.7 Additional information ... 64
8.6.8 Supported function codes for ABB SACE PR 223DS/223EF devices ... 65
8.6.9 Command authority ... 65
8.6.10 Additional information ... 66
8.6.11 Conversion of values ... 66
8.6.12 Conversion of quality descriptors ... 66
8.6.13 Conversion of causes of transmission ... 66
8.7 SCO – Single Command Output ... 66
8.7.1 Supported function code ... 67
8.7.2 Command authority ... 67
8.7.3 Additional information ... 67
8.7.4 Supported function code for ABB SACE PR12x/33x ... 68
8.7.5 Command authority ... 68
8.7.6 Additional configuration parameters ... 68
8.7.7 Additional information ... 68
8.7.8 Supported function codes for ABB SACE PR 223DS/223EF devices ... 69
8.7.9 Command authority ... 70
8.7.10 Additional information ... 70
8.7.11 Conversion of values ... 70
8.7.12 Conversion of quality descriptors ... 70
8.7.13 Conversion of causes of transmission ... 70

9 Transparent Data Messages ... 71
9.1 Modbus ASCII mode ... 71
9.2 Modbus RTU mode ... 71
9.3 Modbus TCP/IP ... 72
9.4 Configuration ... 72

10 File transfer ... 75

11 Internal functions ... 77
11.1 General Interrogation ... 77
11.2 Time synchronization ... 77
11.2.1 Sepam ... 77
11.2.2 MiCOM ... 78
11.2.3 REF 542plus ... 79
11.2.4 ABB SACE PR12x/33x ... 80

11.2.5 560CVD03 ... 81
11.2.6 560CVD11 ... 81
11.3 Event handling ... 82
11.3.1 General ... 83
11.3.2 Sepam ... 83
11.3.3 MiCOM ... 83
11.3.4 REF 542plus ... 84
11.4 System events ... 85
11.4.1 Status Change Device OFFLINE to Device ONLINE ... 86
11.4.2 Status Change Device ONLINE to Device OFFLINE ... 86
11.5 System commands ... 87
11.5.1 Set redundant line as preferred line ... 87

12 Interoperability list ... 89
12.1 Supported and Selectable Parameters ... 89
12.2 Network configuration ... 89
12.3 Physical Layer ... 89
12.3.1 Electrical Interface ... 89
12.3.2 Transmission speed ... 89
12.3.3 Transmission settings (only serial) ... 89
12.3.4 Link Layer ... 90
12.3.5 Application Layer ... 90

13 Glossary ... 91

1 Introduction

1.1 Preface

This document describes the functions of the subdevice interface in the RTU500 series according to Modbus communication protocol for serial line, and Ethernet based communication.

1.2 References

[1]	Modicon	Revision Y	June 1996
	Modbus Protocol Reference Guide		
[2]	Modicon	Version 1.1a	June 2004
	Modbus Application Protocol Specification		
[3]	Modicon	Version 1.0a	June 2004
	Modbus Messaging on TCP/IP Guideline		

[4] Jbus / Sepam

Protection and control - Sepam 2000 - Jbus / Modbus communication

3140751A-G, December 1999, Schneider Electric

[5] MiCOM

MiCOM P127 Directional / Non-Directional Overcurrent & Earth Fault Relay

Technical Instructions, Alstom

[6] REF 542plus

Modbus RTU REF 542plus, Technical Reference, 1MRS755868, 2006, ABB Oy

[7] Interfaces and Protocols

ABB AG, 1KGT 150 714

[8] Instruction manual for ABB SACE devices

PR122-3/P + PR120/D-M

PR332-3/P + PR330/D-M

PR222DS/PD

PR223EF

PR223DS

[9] Instruction manual CT/VT devices

560CVT10

560CVD03

560CVD11

1.3 Conventions

The Modbus communication protocol is called Modbus or Modbus protocol in this document.

This convention encloses Modbus TCP.

In this document function codes of data types according to Modbus are marked with brackets: <Function code>

Bold fonts with the table heading "Parameter name" are references to configuration parameters in RTUtil500. The parameter is followed by the parameter location where to find this parameter in RTUtil500. The first element of the parameter location defines the node in the hardware tree on the left side (e. g. RTU, CMU, line, IED) and the second element defines selected header control tab in the parameter window on the right side (e. g. general, interfaces, protocol).

Example:

	Parameter name	**Default**	**Parameter location**
In use		enabled	data point (e.g. SPI) - line MODBUS
If enabled, the data point is transmitted to the host communication interface. This setting refers to data in monitoring and command direction.			

In this document references to elements of the standard and other references will be printed in brackets. Example: [2, 7.4]

The tables in the next chapters include lists of the functions, options and message types supported according to the protocol structure given in IEC 60870-5 (EPA three layer model) for

- the physical layer
- the link layer
- the application layer

This layered model does not exactly apply to the Modbus protocol [1], but is adapted because of the structure of the host communication interface of RTU500 series.

2 Physical Layer

2.1 General information

The protocol Modbus serial is a serial protocol, running on a serial communication line of a communication unit (CMU). For the protocol Modbus TCP/IP, a communication unit (CMU) with Ethernet Interface(s) is needed. For more details, see the documentation [7].

2.2 Serial line-based communication

The protocol Modbus is running on the serial communication interfaces of the CMUs. For more details see RTU500 series Interfaces and Protocols Release 12 (1KGT 150 939).

Set the communication parameters according to the following table:

Parameter name	Default	Parameter location
Interface type	RS232C	CMU - serial interfaces
Type of physical interface. Select from list. Value range: RS232C, RS485 or fix if selection is not supported		
Baud rate	9600 bits/sec	CMU - serial interfaces
Value range: 50, 75, 100, 110, 150, 200, 300, 600, 1200, 1500, 2400, 4800, 9600, 19200, 38400, 57600, 115200 bits/sec; 50-600 bits/sec only on selected interfaces		
Modem control	Direct link (TxD/RxD only)	CMU - serial interfaces
Value range: • Direct link (TxD/RxD only) • WT link full duplex (no handshake) • WT link half duplex (RTS/CTS handshake) • WT link half duplex (RTS/DCD handshake) • Dial up (external modem DCD handshake) • Loop switch unit (DSTC 3002), RP570/71 Host interface only • Link with collision avoidance (DCD handshake), DNP 3 only Usage of the controls for this interface. Direct Link: No modem controls. Loop Switch Unit: RP570/71 Host Interface only. Collision Avoidance: DNP3.0 Host/Sub-Interface only		
Transmit delay time	disabled	CMU - serial interfaces
If 'Transmit Delay Time' is enabled: Delay time in Milliseconds. Value range: 1 to 10000 ms. Recommended value for WT modems in half-duplex mode: 30 ms		

Parameter name	Default	Parameter location
Allow non-standard UART mode	disabled, usage as specified in standard	CMU - serial interfaces

If enabled, it will be possible to select a non IEC 60870-5-101/Modbus conform UART mode (parity).

Value range:
- disabled
- 1 stop bit, no parity
- 1 stop bit, even parity
- 1 stop bit, odd parity
- 2 stop bits, no parity

ADVICE

The possibility to use different transmission speeds in control and in monitor direction is not supported by RTU500 series.

2.3 IP based Communication

The protocol Modbus is running on the Ethernet-Interfaces of the CMU. For more details see RTU500 series Interfaces and Protocols Release 12 (1KGT 150 939).

For each Ethernet interface following parameters can be configured:

Parameter name	Default	Parameter location
Interface mode	Auto-negotiation	CMU - Network Interfaces
Transmisssion rate and duplex modes. Possible values are: - 100BaseTx half duplex - 100BaseTx full duplex - 10BaseT half duplex - 10BaseT full duplex - Auto-negotiation Default value: Auto-negotiation		
Node name	none	CMU - Network Interfaces
Node name of RTU at this ethernet interface		
IP Address	0.0.0.0	CMU - Network Interfaces
IP Address of this RTU interface		
Subnet mask	0.0.0.0	CMU - Network Interfaces
Subnet mask of IP address		
Default gateway IP	0.0.0.0	CMU - Network Interfaces
IP address of default gateway		

The subdevice interface supports up to 32 stations/IEDs per line. The parameters for the connected IEDs are shown in the following table:

Parameter name	Default	Parameter location
IP Address 1		IED/RTU - Line TMODBUS TCP
IP address of the controlled station		
IP Address 2	disabled	IED/RTU - Line TMODBUS TCP
If enabled: A second IP address for subdevice can be configured to establish a redundant link.		

Parameter name	Default	Parameter location
TCP Port 1	502	IED/RTU - Line TMODBUS TCP
TCP Port number of the controlled station. Value range: %1 to %2.		
TCP Port 2	disabled	IED/RTU - Line TMODBUS TCP
TCP Port number of the controlled substation. Value range: 0 to 65535		

2.3.1 Unit identifier

Parameter name	Default	Parameter location
Unit Identifier	255	IED parameter - Master Modbus
Unit identifier. Value range: %1 to %2		
Routing based on 'Unit identifier'	enabled	Line Tx - Modbus
If enabled: IP-Address of substations can be identical, if 'Unit identifier' is different.		

3 Link Layer

3.1 General

Modbus does not define a Link Layer, but the Link Layer depends on the different implementations of the protocol. Therefore, a separated description of this Layer is given for serial- and IP-based communication.

3.2 Serial Communication

For serial communication, only global parameters have to be configured for the communication lines.

Communication primitives like the framing of messages and parity checks are handled by the telecontrol protocol. Data polling and retransmissions are handled by the subdevice communication interface of RTU500 series. These tasks are executed in the link layer that connects RTUs and Modbus-IEDs.

The selectable parameters have to be calculated regarding the real communication technology.

Parameter name	Default	Parameter location
Modbus Mode	RTU	Line TMODBUS - Modbus
RTU Mode: 1 start bit, 8 data bits, 1/2 stop bits, 0/1 parity bit(s). ASCII mode: 1 start bit, 7/8 data bits, 1/2 stop bits, 0/1 parity bits The difference between these two framing modes is that in the RTU mode 8 bits are represented by one 8 bit character and in the ASCII mode by two 7 or 8 bit ASCII character. The start characters and error checking are different in both modes (see Chapter 2.2, "Serial line-based communication").		
Number of data bits	RTU Mode: 8 (fix) ASCII Mode: 7	Line TMODBUS - Modbus
Number of data bits. Value range: 7 to 8.		
Offline cycle time	5 sec	Line TMODBUS - Modbus
Time, a slave device offline marked is not polled. Value range: 0 to 255 sec		
Communication retries	5	Line TMODBUS - Modbus
Number of queries before a subdevice is marked 'Offline'. Value range: 0 ... 255		
Timeout acknowledgement	1 000 ms	Line TMODBUS - Modbus
Within this timeout time a response of a query have to be received, otherwise the query is repeated. Value range: 10 to 65535 milliseconds.		
Cycle time standby lines	100 ms	Line TMODBUS - Modbus
Polling cycle time for stand by lines. (Applicable for line redundancy) Value range: 10 to 10 000 ms		

Parameter name	Default	Parameter location
Time interval clock synchronization commands	disabled	Line TMODBUS - Modbus
If enabled, clock synchronization command will be send cyclically to all IEDs on this line. Clock synchronization command. Value range: 1 to 300 seconds		

3.2.1 Station specific items

These parameters can be configured in the IED folder of RTUtil500 separately for each IED.

Parameter name	Default	Parameter location
Slave address	1	IED parameter – Modbus
Integer Range 1 ... 255 Modbus slave address for RTU500 series		
Query auto-packing mode	Enabled	IED parameter – Modbus
Enabled / disabled If Query auto-packing mode is enabled, registers with the same function code will be queried within one query, if there is no gap in their address index. The query range of the address parameter is not used if the Query auto-packing mode is enabled. Maximum size of a packed query is 20 registers in one query.		
Type	Generic device (no time sync and event handling)	IED parameter – Modbus
Generic device / Sepam / MiCOM / REF 542plus / 560CVD03 / 560CVD11 This parameter describes the device type, according to it the methods of time synchronization and event handling are chosen.		

3.2.1.1 Broadcast Mode

In broadcast mode, the RTU500 as master will send command requests to all slaves. No response is expected to broadcast requests sent by the RTU500. The slave address '0' is reserved to identify a broadcast exchange. To use the broadcast mode node type 'IED Modbus Broadcast' has to be added to the Modbus serial line in RTUtil500. The broadcast requests are necessarily writing commands: SCO, DCO, RCO, ASO, DSO, BSO, FSO and TDC.

3.2.2 Response times

Because of the fact that all data of Modbus devices is polled, the response time of data changes in a slave device depends on the following factors:

- Value of offline cycle
- Value of communication retries
- Transmission rate
- Framing type
- Number of slave devices on physical link
- Number of configured data to poll per physical link

3.3 Ethernet communication

The IP-based communication is based in part upon reference RFC1122. One of the main functions of the messaging service is to manage communication establishment and ending, and to manage the data flow on established TCP connections.

No communication parameters are required for this implementation since the TCP/IP stack is responsible of the management of communication (speed, duplex, time-to-live, number of hops, time-outs, window-size, three-way-handshaking, etc).

Parameter name	Default	Parameter location
Time interval of clock synchronization commands	Disabled 60 s	Line parameter
Enabled / Disabled This parameter enables / disables the mechanism of time synchronization for all IEDs on this line If enabled: 1 …300 s Interval the IEDs on this line are time synchronized		
Routing based on 'Unit identifier'	Disabled	Line parameter
Enabled / Disabled If the parameter is enabled, the IP address of all the IEDs on the line can be identical. The IEDs are identified based on the Unit identifier.		
Allow only one query simultaneously	Disabled	Line parameter
Enabled / Disabled If the parameter is enabled, a limitation to send out only one query at once per Modbus TCP Line will be activated. RTU500 will send the Modbus TCP queries in order, such that no queries will be sent before the previous query is responded or timed out. The limitation to send out only one query for one Modbus TCP line is required for using special external hardware (Modbus bridges - converter Modbus TCP/IP to Modbus serial).		
Communication retries	3	Line parameter
Value Range: 0 to 255 If option 'Allow only one query simultaneously' on Modbus TCP line is activated a configurable number of communication retries will be done before subdevice is marked inoperable. In case of disconnection or query timeout the RTU performs the configured number of queries before the subordinated IED is set offline.		

3.3.1 Ethernet link

The Link in Ethernet communication is based on the TCP/IP stack. Once the stack connects a target device, the connection is monitored by the stack and remains connected until a reset or a close request is received.

In Ethernet networks, the time of a reset could take up to 2 hours. Therefore, the activity sends permanent queries in order to monitor the connection with the device.

3.3.2 Station specific items

These parameters can be configured in the IED folder of RTUtil500 separately for each IED.

Parameter name	Default	Parameter location
IP address 1	0.0.0.0	IED Parameter Modbus
String Range 0.0.0.0 to 255.255.255.255 Modbus IP address for RTU500 series		
TCP Port 1	502	IED Parameter Modbus
Integer Range 1…65 535 Destination TCP Port Number to connect Modbus Server.		
Cycle time for line 1	30 ms	IED Parameter Modbus
Integer Range 30...10 000 ms 10...10 000 ms for CMUs 560CMR0x and 540CxD01 Polling time to request monitoring information in ms.		
IP address 2	-	IED Parameter Modbus
String Range 0.0.0.0 to 255.255.255.255 Modbus IP address for RTU500 series(Applicable for line redundancy)		
TCP Port 2	502	IED Parameter Modbus
Integer Range 1...65 535 Destination TCP Port Number to connect Modbus Server.(Applicable for line redundancy)		

Parameter name	Default	Parameter location
Cycle time for line 2	30 ms	IED Parameter Modbus
Integer Range 30...10 000 ms 10...10 000 ms for CMUs 560CMR0x and 540CxD01 Polling time to request monitoring information in ms.(Applicable for line redundancy)		
Size of Tx Buffer	1	IED Parameter Modbus
Integer Range 1…16 Quantity of queries allowed to transmit without waiting for a response.		
Timeout	10	IED Parameter Modbus
Integer Range 1…50 Time (in seconds) before a query that has not been replied is discarded.		
Unit Identifier	255	IED Parameter Modbus
Integer Range 0…255 The unit identifier identifies the Modbus slave devices through Modbus TCP.		
Max. polling queries per cycle time[1]	1	IED Parameter Modbus
Maximal number of queries that are sent in parallel per polling cycle time. Value range: 1 to 16		
Query auto-packing mode	Enabled	IED Parameter Modbus
Enabled / disabled See serial mode		
Type	Generic devices (no time sync and event handling)	IED Parameter Modbus
Generic device / Sepam / MiCOM / REF 542plus This parameter describes the device type; according to the device type, the methods of time synchronization and event handling are chosen.		

Device standard:

- Sepam: The Jbus protocol used by Sepam 2000 devices (Schneider Electric) is a compatible sub-group of the Modbus protocol. [4]
- MiCOM: The MiCOM devices (Alstom) are using the standard Modbus implementation.
- REF 542plus: The REF 542plus devices are using the standard Modbus implementation.
- ABB SACE devices: The ABB SACE devices such as PR12x/33x/222DS/223DS/223EF are using the standard Modbus implementation.
- 560CVD03 / 560CVD11 are using the standard Modbus implementation.

Station setup can cause a high CPU usage. To avoid this, consistency check uses following formula to calculate if the settings are viable:

(IEDs * Parallel Queries (Tx Buffer) * 100/Cycle time) < 50

3.4 Check of links

Modbus does not support a defined link handling. Therefore, the link is checked by sending a query for a configured data point. If query auto-packing mode is enabled, only the data point with the lowest function code and the lowest address index of a slave/server device is polled. Otherwise, if disabled, the complete query range configured for that data point is polled.

If a response is received, the slave device is marked online and all data points of this slave device will be polled in the next polling cycle.

[1] **The number of polling queries to be performed in parallel per cycle time could could not exceed the limit set by 'Size of TX Buffer'. With each polling cycle SCI Modbus TCP will continue after the last requested query of the previous polling cycle. Sequence of polling queries is handled indepedently per IED. If default value 1 is configured one single query per polling cycle time is sent to the IED connected via Modbus TCP.**

3.5 Monitoring direction

All data in monitoring direction is polled by the subdevice communication interface.

3.6 Command direction

Data in command direction is written directly into the registers or coils of the slave devices.

Modbus does not support select before operate mechanisms, therefore this is handled in the subdevice communication interface. If a select command is received, the subdevice communication interface will check, if the corresponding slave device is offline or online and select will be confirmed according to the result of this check, negative or positive.

3.7 Restrictions

A maximum number of 32 slave devices are supported per line.

4 Redundant communication

4.1 Redundant serial communication lines

4.1.1 General

The redundant line function of RTU500 series is used to establish the connection availability to controlled stations.

General function:

- Addressing have to be the same for all lines
- The switching between the lines is generally initiated by the RTU500 series.
- During the switchover between redundant lines the subordinated device has to secure that no data point information get lost.
- After a disruption the connection have to establish again.
- Active line is used for process communication.

The configuration of redundant lines is part of the engineering tool for the RTU500 series RTUtil500. Up to four lines of one CMU can be used for a redundant communication line, depending on the CMU type. The interfaces could be configured with different physical parameters.

Redundant communication lines can have different status for every subordinated device. Handling of status is done individually per subordinated device. A device can be reachable on a line. Reachable means that at least a link connection to a device is possible. The line used for process data communication is called the active line.

The priorities are derived from the interface used for a redundant communication line. Interface CP1 has highest priority followed by CP2, CPA and CPB. The line index used for signalization and controlling is increased by one according to the lines priority starting with one. During initialization the line with the highest priority is the preferred line used for process communication.

To signalize the reachability of a subordinated device system event Device reachable on redundant line 1/2/3/4 (SEV #180, SEV #181, SEV #182 and SEV #183) are used. An active line is signalized with Device active on redundant line 1/2/3/4 (SEV #184, SEV #185, SEV #186 and SEV #187). The preferred line is signalized with Device preferred on redundant line 1/2/3/4 (SEV #188, SEV #189, SEV #190 and SEV #191).

To control the behavior of redundant lines the preferred line can be modified using system single commands Set redundant line 1/2/3/4 as preferred line (SEV #04, SEV #005, SEV #006 and SEV #007). At system startup the modifications get lost and the system will start up with the initial preferred line.

4.1.2 Switch over handling

As already described one line is used for process communication. All other redundant communication lines are standby lines. Check for reachability is performed by polling as an active line, but without evaluating the responses.

At initial state the preferred line of a subordinated device gets active if the device is reachable. If the communication link on the active line gets lost, RTU500 series switches the process communication over to the reachable line and this line is now the active one.

A switch over to another line will only be done if the subordinated device is no more reachable on the active line or the preferred line to the device gets reachable again.

4.2 Redundant Ethernet Communication Links

The assignment of links to an Ethernet interface is generally defined by the routing configuration. That means, the TCP/IP subnet configuration defines which link is assigned to which Ethernet interface.

If a CMU with two Ethernet interfaces is used and both interfaces are in the same subnet, the assignment between links and interfaces is fixed. In non-redundant configurations the link is assigned to the Ethernet interface E1. In redundant configurations the first link is assigned to the Ethernet interfaces E1 and the second link to interface E2.

4.2.1 General

The redundant link function of the RTU500 series is used to increase connection availability to the subordinated devices. Therefore, two independent connections have to be established and supervised between the RTU500 series and the subordinated devices. A second IP address for subordinated devices can be configured to establish a redundant link. The redundant line is implemented according to the polling mechanism.

The following configurations are supported by the SCI:

- 1 IP address for RTU500 series SCI, 2 IP addresses for subordinated device
- 2 IP addresses for RTU500 series SCI on one CMU, 2 IP addresses for subordinated device
- 1 IP address for RTU500 series SCI on two redundant CMUs, 2 IP addresses for subordinated device
- 2 IP addresses for RTU500 series SCI on two redundant CMUs, 2 IP addresses for subordinated device

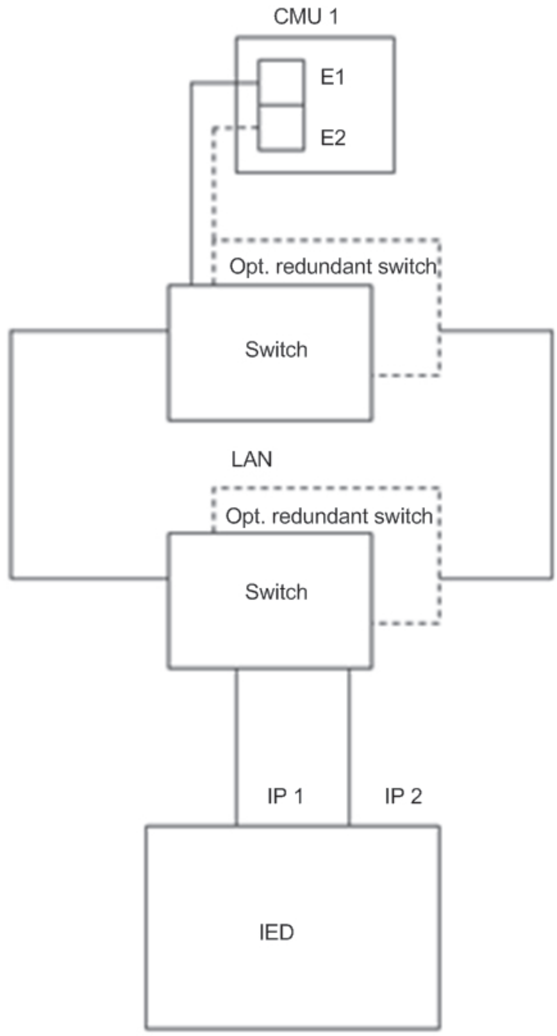


Figure 1: 1/2 IP addresses for RTU500 series SCI on one CMU, 2 IP addresses for subordinated device

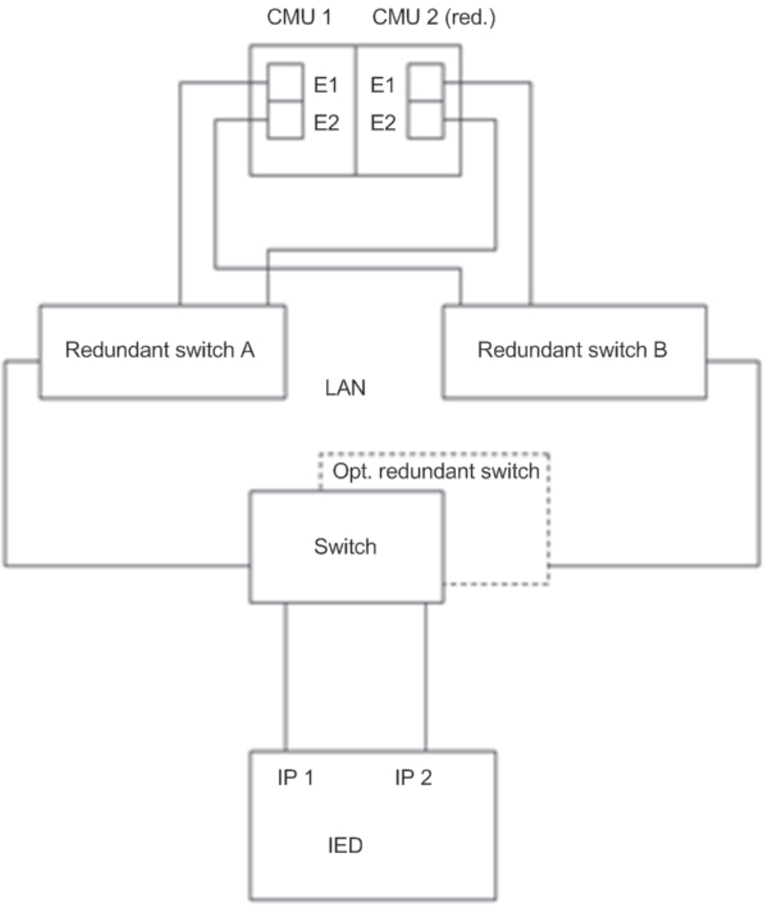


Figure 2: 2 IP addresses for RTU500 series SCI on redundant CMU, 2 IP addresses for subordinated device

General functions:

- The redundancy configuration including datapoint addresses have to be identical on both links of the subordinated device.
- The switching between the links is generally initiated by the RTU500 series SCI.
- After a redundancy switching a polling request is sent from the RTU500 series SCI.
- During the switchover between the redundant links the subordinated device has to secure that no data point information gets lost.
- Only one link is used for process information.

The configuration of redundant lines is part of the engineering tool for the RTU500 series, RTUtil500. One or two Ethernet ports of one CMU can be used for a redundant communication link, depending on the CMU type.

Redundant communication links can have different status for every subordinated device. Handling of status is done individually per subordinated device. A device can be reachable on a line. Reachable means that at least a link connection to a device is possible. The line used for process data communication is called the active line.

The priorities are derived from RTUtil500 IP address configuration. The first IP address has the highest priority. The link with the highest priority is the preferred line used for process communication.

To signalize the reachability of a subordinated device system event Device reachable on redundant line 1/2 (SEV #180, SEV #181) is used. An active line is signalized with Device active on redundant line 1/2 (SEV #184, SEV #185). The preferred line is signalized with Device active on redundant line 1/2 (SEV #188, SEV #189).

To control the behavior of redundant lines the preferred line can be modified using system single commands Set redundant line 1/2 as preferred line (SEV #004, SEV #005). At system startup the modifications get lost and the system will start up with the initial preferred line.

4.2.2 Switch over handling

As mentioned before, only one line is used for user data transfer. The other redundant link is cyclically supervised by polling the device.

The RTU500 series switches the communication link if the active connection is closed. Switching of active links takes place only in this failure case.

At initial state the preferred line of a subordinated device gets active if the device is reachable. If the communication link on the active link gets lost, the RTU500 series switches the process communication over to the other reachable link. This link is now the active one.

A switch over to another link will only be done if the subordinated device is no more reachable on the active line or the preferred link to the device gets reachable again.

5 Application Layer

Overview of function codes of the application layer defined in [1].

The column RTU Data type shows the type of data which can be configured in RTUtil500.

5.1 Table of function codes in monitoring direction

Modbus		RTU
Function code	**Description**	**Data type**
<01>	Read Coil Status	SPI, DPI
<02>	Read Input Status	
<03>	Read Holding Registers	SPI, DPI, ITI, STI, DMI8/16, BSI8/16/32, AMI, MFI
<04>	Read Input Registers	

Table 1: Function codes in monitoring direction

5.2 Table of function codes in control direction

Modbus		RTU
Function code	**Description**	**Data type**
<05>	Force Single Coil	SCO
<06>	Preset Single Registers	DCO, RCO, ASO, DSO8/16, BSO1/2/8/16
<15>	Force Multiple Coils	SCO
<16>	Preset Multiple Registers	FSO,ASO

Table 2: Function codes in control direction

5.3 Table of exception codes

Modbus		RTU
Exception code	**Description**	**Data type**
<01>	Illegal Function Code	
<02>	Illegal Data Address	SPI, DPI, ITI, STI, DMI8/16
<03>	Illegal Data Value	BSI8/16/32, AMI
<04>	Slave Device Failure	MFI
<0A>	Gateway Problem (Gateway path not available)	SCO, DCO, RCO, ASO, DSO8/16
<0B>	Gateway Problem (target device failed to respond)	BSO1/2/8/16

Table 3: Exception codes

6 Addressing

Selection according to [1][2]. The sizes of the addressing fields are fixed.

Parameter name	Default	Parameter location
Function code	1	Data point parameter – Modbus
Integer Range: 1 ... 255 Modbus function code		
Index	0	Data point parameter – Modbus
Modbus address index corresponds to Modbus PDU address. The index can be identical for different function codes. Range: 0 to 65535 Depending on device typ: Index for On/Raise (DCO, SCO, RCO).		
Query range	1	Data point parameter – Modbus
Integer Range: 1 ... 32		
Bit position	1	BSI08, DMI08 parameters
Value range: 1 or 8 Bit position of the data point		

ADVICE

Parameter Query range will be ignored, if the IED-parameter query auto-packing mode is enabled (see chapter Ethernet communication (page "3-3")).
1 ... 20: Range of registers requested in one query started with this index.
If two ranges overlap, the range of the one started first will be decreased.

6.1 Restrictions for function codes

Only function codes listed in chapter Application Layer (page "5-1") are supported.

6.2 Restrictions for index

The register index of every function code starts with 0.

6.3 Restrictions for query range

A value of 16 is recommended.

7 Data types - monitoring direction

7.1 AMI – Analog Measured Information

Analog process information is used as a measured value from the analog inputs in normalized or scaled format.

7.1.1 Supported function codes

Modbus			RTU			
Function code	**Function code property**	**Data type**	**Parameter name**	**Parameter location**	**Parameter range / Explanation**	**Default**
<03>	Read Holding Registers	AMI	Function code	AMI - Protocol address and parameters		
			Index	AMI - Protocol address and parameters		
			Query range	AMI - Protocol address and parameters (if auto-packing mode is disabled)		
<04>	Read Input Registers	AMI	Function code	AMI - Protocol address and parameters		
			Index	AMI - Protocol address and parameters		
			Query range	AMI - Protocol address and parameters (if auto-packing mode is disabled)		

Table 4: AMI - Supported function codes

7.1.2 Value types

Signed normalized (F16)

7.1.3 Additional configuration parameters

Parameter name	Default	Parameter location
Threshold supervision	Yes	AMI - Protocol address and parameters
Yes / No		
Threshold supervision type	Absolute	AMI - Protocol address and parameters
Integrated / Absolute		
Deadband in %	20 %	AMI - Protocol address and parameters
0 ... 100 % Deadband value for threshold supervision[1]		
Scaling limit mapping	Bipolar	AMI - Protocol address and parameters
Bipolar Unipolar		
Value format	16 bit signed scaled value	AMI - Protocol address and parameters
Supported value formats are: 32 bit floating value (High word in first register) 32 bit floating value (High word in second register) 16 bit signed scaled value 32 bit signed scaled value (High word in first register) 32 bit signed scaled value (High word in second register) 16 bit unsigned scaled value 32 bit unsigned scaled value (High word in first register) 32 bit unsigned scaled value (High word in second register)		
Min. value	-32768	AMI - Protocol address and parameters
16bit signed scaled value formats -32768 ... +32767 16bit unsigned scaled value formats 0 ... +65535 32bit signed scaled value formats -2**31 ... +2**31 -1 32bit unsigned scaled value formats 0 ... +2**32 – 1 Minimum raw value in the telegram, to be converted to -100 % (internal communication)		
Max. value	+32767	AMI - Protocol address and parameters
16bit signed scaled value formats -32768 ... +32767 16bit unsigned scaled value formats 0 ... +65535 32bit signed scaled value formats -2**31 ... +2**31 -1 32bit unsigned scaled value formats 0 ... +2**32 – 1 Maximum raw value in the telegram, to be converted to 100 % (internal communication)		
Min. float value	0	AMI - Protocol address and parameters
-3.4e38 … +3.4e38 (32 bit float formats) Minimum float value in the telegram, to be converted to -100 % (internal communication)		
Max. float value	65 535	AMI - Protocol address and parameters
-3.4e38 … +3.4e38 (32 bit float formats) Maximum float value in the telegram, to be converted to 100 % (internal communication)		

ADVICE

[1]0 means that every change is transmitted.

7.1.4 Conversion of values

Range	RTU internal value	Modbus value
Range min.	-100 %	Min. value / Min. float value
...	...	
Range max.	+100 %	Max. value / Max. float value

Table 5: AMI - Conversion of values

7.1.5 Conversion of quality descriptors

RTU		Modbus
Internal communication (short)	**Internal communication (long)**	**Communication**
OV	Overflow	-
BL	Blocked	-
SB	Substituted	-
NT	Not Topical	-
IV	Invalid	Exception response (all codes)
TIV	Time invalid	-

Table 6: AMI - Conversion of quality descriptors

7.1.6 Conversion of causes of transmission

RTU		Modbus
Internal communication (short)	**Internal communication (long)**	**Communication**
T	Test	-
P/N	Positive/negative confirmation	- Irrelevant -
Cause	Periodic / Cyclic	-
	Spontaneous	Received query response
	Requested	-
	Interrogated	-

Table 7: AMI - Conversion of causes of transmission

7.2 BSI – Bit String Information

Binary process information is indicated by 8, 16 or 32 bits.

7.2.1 Supported function codes

Modbus			RTU			
Function code	**Function code property**	**Data type**	**Parameter name**	**Parameter location**	**Parameter range / Explanation**	**Default**
<03>	Read Holding Registers	BSI	Function code	BSI - Protocol address and parameters		
			Index	BSI - Protocol address and parameters		
			Query range	BSI - Protocol address and parameters (if auto-packing mode is disabled)		
<04>	Read Input Registers	BSI	Function code	BSI - Protocol address and parameters		
			Index	BSI - Protocol address and parameters		
			Query range	BSI - Protocol address and parameters (if auto-packing mode is disabled)		

Table 8: BSI - Supported function codes

7.2.2 Additional configuration parameters

Parameter name	Default	Parameter location
Query rangeQuery range		BSI - Protocol address and parameters
The parameter Query range (see also chapter Addressing (page 6-16-1)) is automatically set to min. 2. The 32 bit value is transmitted in two consecutive registers.		
Value format		BSI - Protocol address and parameters
32 bit binary (High word in first register) 32 bit binary (High word in second register) The 32 bit value is transmitted in two consecutive registers.		

7.2.3 Conversion of values

Range	RTU internal value	Modbus value
Range min.	0	0
...	...	
Range max.	BSI08: Bit mask of 8 bits; range ... 255	255
	BSI16: Bit mask of 16 bits; range ... 65 535	65 535
	BSI32: Bit mask of 32 bits; range … 4 294 967 295	4 294 967 295

Table 9: BSI - Conversion of values

7.2.4 Conversion of quality descriptors

RTU		Modbus
Internal communication (short)	Internal communication (long)	Communication
OV	Overflow	-
BL	Blocked	-
SB	Substituted	-
NT	Not Topical	-
IV	Invalid	Exception response (all codes)
TIV	Time invalid	-

Table 10: BSI - Conversion of quality descriptors

7.2.5 Conversion of causes of transmission

RTU		Modbus
Internal communication (short)	Internal communication (long)	Communication
T	Test	-
P/N	Positive/negative confirmation	- Irrelevant -
Cause	Spontaneous	Received query response
	Requested	-
	Interrogated	-

Table 11: BSI - Conversion of causes of transmission

7.3 DMI – Digital Measured Information

Binary process information indicated by 8 or 16 bits is used as a measured value from the digital inputs in normalized format.

7.3.1 Supported function codes

Modbus			RTU			
Function code	**Function code property**	**Data type**	**Parameter name**	**Parameter location**	**Parameter range / Explanation**	**Default**
<03>	Read Holding Registers	DMI	Function code	DMI - Protocol address and parameters		
			Index	DMI - Protocol address and parameters		
			Query range	DMI - Protocol address and parameters		
<04>	Read Input Registers	DMI	Function code	DMI - Protocol address and parameters		
			Index	DMI - Protocol address and parameters		
			Query range	DMI - Protocol address and parameters		

Table 12: DMI - Supported function codes

7.3.2 Value types

Signed normalized (F16)

7.3.3 Additional configuration parameters

Parameter name	Default	Parameter location
Maximum value	127	DMI - Protocol address and parameters
0 … 255 (unipolar) -128 … 127 (bipolar)		
Maximum value	32 767	DMI - Protocol address and parameters
0 … 65 535 (unipolar) -32 768 … 32 767 (bipolar)		
Measurand value	bipolar	DMI - Protocol address and parameters
unipolar / bipolar		

ADVICE

Maximum value 32 767 (DMI8: 255) unipolar means that the value is expected to be in normalized format without scaling (see value range above).
All other values outside the ranges will be marked as invalid.

7.3.4 Conversion of values

Range	RTU internal value	Modbus value
Range min.	-100 %	- Maximum value +1
…	…	
Range max.	+100 %	+ Maximum value

Table 13: DMI - Conversion of values

7.3.5 Conversion of quality descriptors

RTU		Modbus
Internal communication (short)	**Internal communication (long)**	**Communication**
OV	Overflow	-
BL	Blocked	-
SB	Substituted	-
NT	Not Topical	-
IV	Invalid	Exception response (all codes)
TIV	Time invalid	-

Table 14: DMI - Conversion of quality descriptors

7.3.6 Conversion of causes of transmission

RTU		Modbus
Internal communication (short)	**Internal communication (long)**	**Communication**
T	Test	-

Table 15: DMI - Conversion of causes of transmission

RTU		Modbus
Internal communication (short)	Internal communication (long)	Communication
P/N	Positive/negative confirmation	- Irrelevant -
Cause	Spontaneous	Received query response
	Requested	-
	Interrogated	-

Table 15: DMI - Conversion of causes of transmission

7.4 DPI – Double Point Information

Binary process information is indicated by Single bit or Double bits.

7.4.1 Supported function codes

Modbus		RTU				
Function code	Function code property	Data type	Parameter name	Parameter location	Parameter range / Explanation	Default
<01>	Read Coil Status	DPI	Index	DPI – Protocol address and parameters		
			Value format	DPI – Protocol address and parameters	Double bit indication Double bit indication reversed Single bit indication Single bit indication reversed	
<02>	Read Input Status	DPI	Index	DPI – Protocol address and parameters		
			Value format	DPI – Protocol address and parameters	Double bit indication Double bit indication reversed Single bit indication	

Table 16: DPI – Supported function codes

Modbus		RTU				
Function code	**Function code property**	**Data type**	**Parameter name**	**Parameter location**	**Parameter range / Explanation**	**Default**
					Single bit indication reversed	
<03>	Read Holding Registers	DPI	Function code	DPI – Protocol address and parameters		
			Index	DPI – Protocol address and parameters		
			Query range	DPI – Protocol address and parameters (if auto-packing mode is disabled)		
			Bit position	DPI – Protocol address and parameters	0 … 14	
			Value format	DPI – Protocol address and parameters	Double bit indication Double bit indication reversed Single bit indication Single bit indication reversed	
<04>	Read Input Registers	DPI	Function code	DPI – Protocol address and parameters		
			Index	DPI – Protocol address and parameters		

Table 16: DPI – Supported function codes

Modbus			RTU			
Function code	**Function code property**	**Data type**	**Parameter name**	**Parameter location**	**Parameter range / Explanation**	**Default**
			Query range	DPI – Protocol address and parameters (if auto-packing mode is disabled)		
			Bit position	DPI – Protocol address and parameters	0 … 14	
			Value format	DPI – Protocol address and parameters	Double bit indication Double bit indication reversed Single bit indication Single bit indication reversed	

Table 16: DPI – Supported function codes

7.4.2 Additional information

Combination of function code, index and bit position should be unique.

Event messages with time tag see chapter Internal functions (page "11-1").

7.4.3 Conversion of values

Conversion value as per configured Value format Double Bit Indication:

RTU internal value	Modbus value
intermediate	00
off	01
on	10
indeterminate	11

Table 17: DPI - Conversion of values for Double Bit Indication

Conversion value as per configured Value format Double Bit Indication Reverse:

RTU internal value	Modbus value
intermediate	00
on	01
off	10
indeterminate	11

Table 18: DPI - Conversion of values for Double Bit Indication Reverse

Conversion value as per configured Value format Single Bit Indication:

RTU internal value	Modbus value
off	0
on	1

Table 19: DPI - Conversion of values for Single Bit Indication

Conversion value as per configured Value format Single Bit Indication Reverse:

RTU internal value	Modbus value
off	1
on	0

Table 20: DPI - Conversion of values for Single Bit Indication Reverse

7.4.4 Conversion of quality descriptors

RTU		Modbus
Internal communication (short)	**Internal communication (long)**	**Communication**
BL	Blocked	-
SB	Substituted	-
NT	Not Topical	-
IV	Invalid	Exception response (all codes)
TIV	Time invalid	-

Table 21: DPI - Conversion of quality descriptors

7.4.5 Conversion of causes of transmission

RTU		Modbus
Internal communication (short)	**Internal communication (long)**	**Communication**
T	Test	-
P/N	Positive/negative confirmation	- Irrelevant -
Cause	Spontaneous	Received query response
	Interrogated	-

Table 22: DPI - Conversion of causes of transmission

7.5 EPI – Protection Event Information

Binary process information is indicated by two bits and a relative time tag (used by protection relays).

EPI is not supported.

7.6 ITI – Integrated Totals Information

Binary process information is indicated by 32 bits as a count value.

7.6.1 Supported function codes

Modbus			RTU			
Function code	**Function code property**	**Data type**	**Parameter name**	**Parameter location**	**Parameter range / Explanation**	**Default**
<03>	Read Holding Registers	ITI	Function code	ITI - Protocol address and parameters		
			Index	ITI - Protocol address and parameters		
			Query range	ITI - Protocol address and parameters (if auto-packing mode is disabled)		
<04>	Read Input Registers	ITI	Function code	ITI - Protocol address and parameters		
			Index	ITI - Protocol address and parameters		
			Query range	ITI - Protocol address and parameters (if auto-packing mode is disabled)		

Table 23: ITI - Supported function codes

7.6.2 Additional configuration parameters

Parameter name	Default	Parameter location
Value format		ITI - Protocol address and parameters
16 bit unsigned integer value 16 bit signed integer value 32 bit unsigned integer (High word in first register) 32 bit unsigned integer (High word in second register) 32 bit signed integer (High word in first register) 32 bit signed integer (High word in second register)		
Query rangeQuery range		ITI - Protocol address and parameters
The parameter Query range (see also chapter Addressing (page 6-16-1)) is automatically set to min. 2.		

7.6.3 Conversion of values

Range	RTU internal value	Modbus value
Range min.	0 (16/32 bit unsigned)	0
	-32768 (16 bit signed)	-32768
	-2 147 483 648 (32 bit signed)	-2 147 483 648
...	...	
Range max.	+65 535 (16 bit unsigned)	+65 535
	+32767 (16 bit signed)	+32767
	+2 147 483 647 (31 bit unsigned, 32 bit signed)	+2 147 483 647

Table 24: ITI - Conversion of values

7.6.4 Conversion of quality descriptors

RTU		Modbus
Internal communication (short)	**Internal communication (long)**	**Communication**
SEQ	Sequence number	-
CY	Carry	-
CA	Adjusted	-
IV	Invalid	Exception response (all codes)
TIV	Time invalid	-

Table 25: ITI - Conversion of quality descriptors

7.6.5 Conversion of causes of transmission

RTU		Modbus
Internal communication (short)	**Internal communication (long)**	**Communication**
T	Test	-

Table 26: ITI - Conversion of causes of transmission

RTU		Modbus
Internal communication (short)	**Internal communication (long)**	**Communication**
P/N	Positive/negative confirmation	- Irrelevant -
Cause	Spontaneous	Received query response
	Requested	-
	Interrogated	-

Table 26: ITI - Conversion of causes of transmission

7.7 MFI – Measured Float Information

32 bit analog process information is used as a measured value in float format.

7.7.1 Supported function codes

Modbus			RTU			
Function code	**Function code property**	**Data type**	**Parameter name**	**Parameter location**	**Parameter range / Explanation**	**Default**
<03>	Read Holding Registers	MFI	Function code	MFI - Protocol address and parameters		
			Index	MFI -Protocol address and parameters		
			Query range[1]	MFI - Protocol address and parameters (if auto-packing mode is disabled)		
<04>	Read Input Registers	MFI	Function code	MFI - Protocol address and parameters		
			Index	MFI - Protocol address and parameters		
			Query range[1]	MFI - Protocol address		

Table 27: MFI - Supported function codes

Modbus		RTU				
Function code	**Function code property**	**Data type**	**Parameter name**	**Parameter location**	**Parameter range / Explanation**	**Default**
				and parameters (if auto-packing mode is disabled)		

Table 27: MFI - Supported function codes

1 The parameter Query range (see also chapter Addressing (page "6-1")) is automatically set to min. 2 by RTU500 series firmware.

7.7.2 Value types

R32-IEEE STD 754; range -3.4 x 10e38 ... +3.4 x 10e38

7.7.3 Additional configuration parameters

Parameter name	Default	Parameter location
Threshold supervision	Yes	MFI - Protocol address and parameters
Yes / No		
Threshold supervision type	Absolute	MFI - Protocol address and parameters
Integrated / Absolute		
Deadband	0.5	MFI - Protocol address and parameters
0 ... +3.4 x 10e38 Deadband value for threshold supervision1		
Value format	32 bit floating value (High word in first register)	MFI - Protocol address and parameters
Supported value formats are: 32 bit floating value (High word in first register) 32 bit floating value (High word in second register) 16 bit signed scaled value 32 bit signed scaled value (High word in first register) 32 bit signed scaled value (High word in second register) 16 bit unsigned scaled value 32 bit unsigned scaled value (High word in first register) 32 bit unsigned scaled value (High word in second register)		
Min. value	-32768	MFI - Protocol address and parameters
16bit signed scaled value formats -32768 ... +32767 16bit unsigned scaled value formats 0 ... +65535 32bit signed scaled value formats -2**31 ... +2**31 -1 32bit unsigned scaled value formats 0 ... +2**32 – 1-32768		
Min. float value	0	MFI - Protocol address and parameters
-3.4 x 10e38 ... +3.4 x 10e38		
Max. value	32767	MFI - Protocol address and parameters
16bit signed scaled value formats -32768 ... +32767 16bit unsigned scaled value formats 0 ... +6553532bit signed scaled value formats -2**31 ... +2**31 -1 32bit unsigned scaled value formats 0 ... +2**32 – 1		
Max. float value	65 535	MFI - Protocol address and parameters
-3.4 x 10e38 ... +3.4 x 10e38		

ADVICE
[1]0 means that every change is transmitted.

7.7.4 Conversion of values

Range	RTU internal value	Modbus value
Range min.	-3.4 x 10e38 Min. float value	-3.4 x 10e38 (float value) Min. value (16/32 bit scaled value)
...	...	
Range max.	+3.4 x 10e38 Max. float value	+3.4 x 10e38 Max. value (16/32 bit scaled value)

Table 28: MFI - Conversion of values

7.7.5 Conversion of quality descriptors

RTU		Modbus
Internal commu-nication (short)	Internal commu-nication (long)	Communication
OV	Overflow	-
BL	Blocked	-
SB	Substituted	-
NT	Not Topical	-
IV	Invalid	Exception response (all codes)
TIV	Time invalid	-

Table 29: MFI - Conversion of quality descriptors

7.7.6 Conversion of causes of transmission

RTU		Modbus
Internal commu-nication (short)	Internal commu-nication (long)	Communication
T	Test	-
P/N	Positive/negative confir-mation	- Irrelevant -
Cause	Periodic / Cyclic	-
	Spontaneous	Received query response
	Requested	-
	Interrogated	-

Table 30: MFI - Conversion of causes of transmission

Transmission of 32 bit float value in the Modbus protocol

-> Sequence of transmission

Byte 1								Byte 2								Byte 3								Byte 4							
8	7	6	5	4	3	2	1	8	7	6	5	4	3	2	1	8	7	6	5	4	3	2	1	8	7	6	5	4	3	2	1
s	exponent								fraction high							fraction low															

Table 31: Value format with high word in first register

-> Sequence of transmission

Byte 1								Byte 2								Byte 3								Byte 4							
8	7	6	5	4	3	2	1	8	7	6	5	4	3	2	1	8	7	6	5	4	3	2	1	8	7	6	5	4	3	2	1
fraction low																s	exponent								fraction high						

Table 32: Value format with high word in second register

7.8 SPI – Single Point Information

Binary process information is indicated by one bit.

7.8.1 Supported function codes

Modbus			RTU			
Function code	**Function code property**	**Data type**	**Parameter name**	**Parameter location**	**Parameter range / Explanation**	**Default**
<01>	Read Coil Status	SPI	Function code	SPI - Protocol address and parameters		
			Index	SPI - Protocol address and parameters		
			Query range	SPI - Protocol address and parameters (if auto-packing mode is disabled)		
<02>	Read Input Status	SPI	Function code	SPI - Protocol address and parameters		
			Index	SPI - Protocol address and parameters		
			Query range	SPI - Protocol address and parameters (if auto-pack-		

Table 33: SPI - Supported function codes

Modbus			RTU			
Function code	Function code property	Data type	Parameter name	Parameter location	Parameter range / Explanation	Default
				ing mode is disabled)		
<03>	Read Holding Registers	SPI	Function code	SPI - Protocol address and parameters		
			Index	SPI - Protocol address and parameters		
			Query range	SPI - Protocol address and parameters (if auto-packing mode is disabled)		
			Bit position	SPI - Protocol address and parameters	0 … 15	
<04>	Read Input Registers	SPI	Function code	SPI - Protocol address and parameters		
			Index	SPI - Protocol address and parameters		
			Query range	SPI - Protocol address and parameters (if auto-packing mode is disabled)		
			Bit position	SPI - Protocol address and parameters	0 … 15	

Table 33: SPI - Supported function codes

7.8.2 Additional information

Combination of function code, index and bit position should be unique.

Event messages with time tag see chapter Internal functions (page "11-1").

7.8.3 Conversion of values

RTU internal value	Modbus value
off	0
on	1

Table 34: SPI - Conversion of values

7.8.4 Conversion of quality descriptors

RTU		Modbus
Internal communication (short)	Internal communication (long)	Communication
BL	Blocked	-
SB	Substituted	-
NT	Not Topical	-
IV	Invalid	Exception response (all codes)
TIV	Time invalid	-

Table 35: SPI - Conversion of quality descriptors

7.8.5 Conversion of causes of transmission

RTU		Modbus
Internal communication (short)	Internal communication (long)	Communication
T	Test	-
P/N	Positive/negative confirmation	- Irrelevant -
Cause	Spontaneous	Received query response
	Interrogated	-

Table 36: SPI - Conversion of causes of transmission

7.9 STI – Step Position Information

Binary process information is indicated by 8 bits.

7.9.1 Supported function codes

Modbus		RTU				
Function code	Function code property	Data type	Parameter name	Parameter location	Parameter range / Explanation	Default
<03>	Read Holding Registers	STI	Function code	STI - Protocol address and parameters		

Table 37: STI - Supported function codes

Modbus			RTU			
Function code	**Function code property**	**Data type**	**Parameter name**	**Parameter location**	**Parameter range / Explanation**	**Default**
			Index	STI - Protocol address and parameters		
			Query range	STI - Protocol address and parameters (if auto-packing mode is disabled)		
<04>	Read Input Registers	STI	Function code	STI - Protocol address and parameters		
			Index	STI - Protocol address and parameters		
			Query range	STI - Protocol address and parameters (if auto-packing mode is disabled)		

Table 37: STI - Supported function codes

7.9.2 Additional information

None

7.9.3 Conversion of values

Range	RTU internal value	Modbus value
Range min.	-63	-63
...	...	
Range max.	+63	+63

Table 38: STI - Conversion of values

7.9.4 Conversion of quality descriptors

RTU		Modbus
Internal communication (short)	Internal communication (long)	Communication
OV	Overflow	The received value is outside the allowed range.
BL	Blocked	-
SB	Substituted	-
NT	Not Topical	-
IV	Invalid	Exception response (all codes)
T	Transient Bit	-
TIV	Time invalid	-

Table 39: STI - Conversion of quality descriptors

7.9.5 Conversion of causes of transmission

RTU		Modbus
Internal communication (short)	Internal communication (long)	Communication
T	Test	-
P/N	Positive/negative confirmation	- Irrelevant -
Cause	Spontaneous	Received query response
	Requested	-
	Interrogated	-

Table 40: STI - Conversion of causes of transmission

8 Data types - controlling direction

8.1 ASO – Analog Setpoint Output

Analog process command (16 bit signed number)

8.1.1 Supported function codes

Modbus			RTU			
Function code	**Function code property**	**Data type**	**Parameter name**	**Parameter location**	**Parameter range / Explanation**	**Default**
<06>	Preset Single Registers	ASO	Function code	ASO - Protocol address and parameters		
			Index	ASO - Protocol address and parameters		
			Query range	ASO - Protocol address and parameters (if auto-packing mode is disabled)		
<16>	Preset Multiple Registers	ASO	Function code	ASO - Protocol address and parameters		
			Index	ASO - Protocol address and parameters		
			Query range	ASO - Protocol address and parameters (if auto-packing mode is disabled)		

Table 41: ASO - Supported function codes

8.1.2 Value types

Signed normalized (F16)

8.1.3 Command authority

None

8.1.4 Additional configuration parameters

Parameter name	Default	Parameter location
Scaling limit mapping	Bipolar	ASO - Protocol address and parameters
Bipolar Unipolar		
Value format	16 bit signed scaled value	ASO - Protocol address and parameters
Supported value formats are: 32 bit floating value (High word in first register) 32 bit floating value (High word in second register) 16 bit signed scaled value 32 bit signed scaled value (High word in first register) 32 bit signed scaled value (High word in second register) 16 bit unsigned scaled value 32 bit unsigned scaled value (High word in first register) 32 bit unsigned scaled value (High word in second register)		
Min. value	-32768	ASO - Protocol address and parameters
16bit signed scaled value formats -32768 ... +32767 16bit unsigned scaled value formats 0 ... +65535 32bit signed scaled value formats -2**31 ... +2**31 -1 32bit unsigned scaled value formats 0 ... +2**32 – 1		
Min. float value	0	ASO - Protocol address and parameters
-3.4 x 10e38 ... +3.4 x 10e38		
Max. value	32767	ASO - Protocol address and parameters
16bit signed scaled value formats -32768 ... +32767 16bit unsigned scaled value formats 0 ... +65535 32bit signed scaled value formats -2**31 ... +2**31 -1 32bit unsigned scaled value formats 0 ... +2**32 – 1		
Max. float value	65 535	ASO - Protocol address and parameters
-3.4 x 10e38 ... +3.4 x 10e38		

8.1.5 Conversion of values

Range	RTU internal value	Modbus value
Range min.	-100 %	Min. value / Min. float value
...	...	
Range max.	+100 %	Max. value / Max. float value

Table 42: ASO - Conversion of values

8.1.6 Conversion of quality descriptors

RTU		Modbus
Internal communication (short)	**Internal communication (long)**	**Communication**
SE	Select / Execute	-

Table 43: ASO - Conversion of quality descriptors

8.1.7 Conversion of causes of transmission

RTU		Modbus
Internal communication (short)	**Internal communication (long)**	**Communication**
T	Test	-
P/N	Positive/negative confirmation	Received exception response / Relevant for activation confirmation only
Cause	Activation	-
	Activation Confirmation	Received echo of write query
	Deactivation	-
	Deactivation Confirmation	-
	Activation Termination	-

Table 44: ASO - Conversion of causes of transmission

8.2 BSO – Bit String Output

Binary process command (1, 2, 8, 16 bit unsigned number)

8.2.1 Supported function codes

Modbus		RTU				
Function code	**Function code property**	**Data type**	**Parameter name**	**Parameter location**	**Parameter range / Explanation**	**Default**
<06>	Preset Single Registers	BSO	Function code	BSO - Protocol address and parameters		
			Index	BSO - Protocol address and parameters		
			Query range	BSO - Protocol address		

Table 45: BSO - Supported function codes

Modbus		RTU				
Function code	Function code property	Data type	Parameter name	Parameter location	Parameter range / Explanation	Default
				and parameters (if auto-packing mode is disabled)		

Table 45: BSO - Supported function codes

8.2.2 Command authority

None

8.2.3 Additional information

None

8.2.4 Conversion of values

Range	RTU internal value	Modbus value
Range min.	0	0
...	...	
Range max.	65 535	65 535

Table 46: BSO - Conversion of values

8.2.5 Conversion of quality descriptors

RTU		Modbus
Internal communication (short)	Internal communication (long)	Communication
SE	Select / Execute	-

Table 47: BSO - Conversion of quality descriptors

8.2.6 Conversion of causes of transmission

RTU		Modbus
Internal communication (short)	Internal communication (long)	Communication
T	Test	Ignored
P/N	Positive/negative confirmation	Received exception response / Relevant for activation confirmation only
Cause	Activation	-
	Activation Confirmation	Received echo of write query

Table 48: BSO - Conversion of causes of transmission

RTU		Modbus
Internal communication (short)	**Internal communication (long)**	**Communication**
	Deactivation	-
	Deactivation Confirmation	-
	Activation Termination	-

Table 48: BSO - Conversion of causes of transmission

8.3 DCO – Double Command Output

Binary process command (two bits)

8.3.1 Supported function codes

Modbus		RTU				
Function code	**Function code property**	**Data type**	**Parameter name**	**Parameter location**	**Parameter range / Explanation**	**Default**
<06>	Preset Single Registers	DCO	Function code	DCO - Protocol address and parameters		
			Index	DCO - Protocol address and parameters		
			Query range	DCO - Protocol address and parameters (if auto-packing mode is disabled)		

Table 49: DCO - Supported function codes

8.3.2 Command authority

None

8.3.3 Additional information

None

8.3.4 Supported function code for ABB SACE PR12x/33x

Modbus			RTU			
Function code	**Function code property**	**Data type**	**Parameter name**	**Parameter location**	**Parameter range / Explanation**	**Default**
<16>	Preset Multiple Registers	DCO	Function code	DCO - Protocol address and parameters		
			Index	DCO - Protocol address and parameters		
			Query range	DCO - Protocol address and parameters (if auto-packing mode is disabled)		

Table 50: DCO - Supported function code for ABB SACE PR12x/33x

8.3.5 Command authority

None

8.3.6 Additional configuration parameters

Parameter name	Default	Parameter location
Value for On/Raise	0	DCO - Protocol address and parameters
0 … 15		
Value for Off/Lower	0	DCO - Protocol address and parameters
0 … 15		

8.3.7 Additional information

Index is always fixed at 40 001 and 40 002.

8.3.8 Supported function codes for ABB SACE PR 223DS/223EF devices

Modbus			RTU			
Function code	Function code property	Data type	Parameter name	Parameter location	Parameter range / Explanation	Default
<06>	Preset Single Registers	DCO	Function code	DCO - Protocol address and parameters		
			Index for On/Raise	DCO - Protocol address and parameters		
			Index for Off/Lower	DCO - Protocol address and parameters		
			Query range	DCO - Protocol address and parameters (if auto-packing mode is disabled)		
<16>	Preset Multiple Registers	DCO	Function code	DCO - Protocol address and parameters		
			Index for On/Raise	DCO - Protocol address and parameters		
			Index for Off/Lower	DCO - Protocol address and parameters		
			Query range	DCO - Protocol address and parameters (if auto-packing mode is disabled)		

Table 51: DCO - Supported function codes for ABB SACE PR 223DS/223EF devices

8.3.9 Command authority

None

8.3.10 Additional information

None

8.3.11 Conversion of values

RTU internal value	Modbus value
off	01
on	10

Table 52: DCO - Conversion of values

8.3.12 Conversion of quality descriptors

RTU		Modbus
Internal communication (short)	Internal communication (long)	Communication
SE	Select / Execute	Simulated by SCI

Table 53: DCO - Conversion of quality descriptors

8.3.13 Conversion of causes of transmission

RTU		Modbus
Internal communication (short)	Internal communication (long)	Communication
T	Test	-
P/N	Positive/negative confirmation	Relevant for activation confirmation only
Cause	Activation	-
	Activation Confirmation	Simulated by SCI
	Deactivation	-
	Deactivation Confirmation	Simulated by SCI
	Activation Termination	Received echo of write query

Table 54: DCO - Conversion of causes of transmission

8.4 DSO – Digital Setpoint Output

Binary process command (8 or 16 bit signed number)

8.4.1 Supported function codes

Modbus			RTU			
Function code	Function code property	Data type	Parameter name	Parameter location	Parameter range / Explanation	Default
<06>	Preset Single Registers	DSO	Function code	DSO - Protocol address and parameters		
			Index	DSO - Protocol address and parameters		
			Query range	DSO - Protocol address and parameters (if auto-packing mode is disabled)		

Table 55: DSO - Supported function codes

8.4.2 Value types

Signed normalized (F16)

8.4.3 Command authority

None

8.4.4 Additional configuration parameters

Parameter name	Default	Parameter location
Maximum value		DSO - Protocol address and parameters
0 ... 32 7671		

ADVICE

1Value 32 767 means that the value is sent in normalized format without scaling (see value range above).

8.4.5 Conversion of values

Range	RTU internal value	Modbus value
Range min.	-100 %	-32 768

Table 56: DCO - Conversion of values

Range	RTU internal value	Modbus value
...	...	
Range max.	+100 %	+32 767

Table 56: DCO - Conversion of values

8.4.6 Conversion of quality descriptors

RTU		Modbus
Internal communication (short)	Internal communication (long)	Communication
SE	Select / Execute	-

Table 57: DSO - Conversion of quality descriptors

8.4.7 Conversion of causes of transmission

RTU		Modbus
Internal communication (short)	Internal communication (long)	Communication
T	Test	-
P/N	Positive/negative confirmation	Received exception response / Relevant for activation confirmation only
Cause	Activation	-
	Activation Confirmation	Received echo of write query
	Deactivation	-
	Deactivation Confirmation	-
	Activation Termination	-

Table 58: DSO - Conversion of causes of transmission

8.5 FSO – Floating point Setpoint Output

Floating point process command

8.5.1 Supported function codes

Modbus		RTU				
Function code	Function code property	Data type	Parameter name	Parameter location	Parameter range / Explanation	Default
<06>	Preset Single Registers	FSO	Function code	FSO - Protocol address and parameters		

Table 59: FSO - Supported function codes

Modbus			RTU			
Function code	**Function code property**	**Data type**	**Parameter name**	**Parameter location**	**Parameter range / Explanation**	**Default**
			Index	FSO - Protocol address and parameters		
			Query range	FSO - Protocol address and parameters (if auto-packing mode is disabled)		
<16>	Preset Multiple Registers	FSO	Function code	FSO - Protocol address and parameters		
			Index	FSO - Protocol address and parameters		
			Query range	FSO - Protocol address and parameters (if auto-packing mode is disabled)		

Table 59: FSO - Supported function codes

8.5.2 Value types

None

8.5.3 Command authority

None

8.5.4 Additional configuration parameters

Parameter name	Default	Parameter location
Value format	32 bit floating value (High word in first register)	FSO - Protocol address and parameters
Supported value formats are: 32 bit floating value (High word in first register) 32 bit floating value (High word in second register) 16 bit signed scaled value 32 bit signed scaled value (High word in first register) 32 bit signed scaled value (High word in second register) 16 bit unsigned scaled value 32 bit unsigned scaled value (High word in first register) 32 bit unsigned scaled value (High word in second register)		
Value format	16/32 bit scaled	FSO - Protocol address and parameters
Sub parameters: FSO - Protocol address and parameters 16bit signed scaled value formats -32768 ... +32767 16bit unsigned scaled value formats 0 ... +65535 32bit signed scaled value formats -2**31 ... +2**31 -1 32bit unsigned scaled value formats 0 ... +2**32 – 1		
Min. value	-32768	FSO - Protocol address and parameters
16bit signed scaled value formats -32768 ... +32767 16bit unsigned scaled value formats 0 ... +65535 32bit signed scaled value formats -2**31 ... +2**31 -1 32bit unsigned scaled value formats 0 ... +2**32 – 1-32768		
Min. float value	0	FSO - Protocol address and parameters
-3.4 x 10e38 ... +3.4 x 10e38		
Max. value	32767	FSO - Protocol address and parameters
16bit signed scaled value formats -32768 ... +32767 16bit unsigned scaled value formats 0 ... +65535 32bit signed scaled value formats -2**31 ... +2**31 -1 32bit unsigned scaled value formats 0 ... +2**32 – 1		
Max. float value	65 535	FSO - Protocol address and parameters
-3.4 x 10e38 ... +3.4 x 10e38		

8.5.5 Conversion of values

Range	RTU internal value	Modbus value
Range min.	-3.4 x 10e38	-3.4 x 10e38 (float value)
	Min. float value	Min. value (16/32 bit scaled value)
...	...	
Range max.	+3.4 x 10e38	+3.4 x 10e38 (float value)
	Max. float value	Max. value (16/32 bit scaled value)

Table 60: FSO - Conversion of values

8.5.6 Conversion of quality descriptors

RTU		Modbus
Internal communication (short)	**Internal communication (long)**	**Communication**
SE	Select / Execute	-

Table 61: FSO - Conversion of quality descriptors

8.5.7 Conversion of causes of transmission

RTU		Modbus
Internal communication (short)	Internal communication (long)	Communication
T	Test	-
P/N	Positive/negative confirmation	Received exception response / Relevant for activation confirmation only
Cause	Activation	-
	Activation Confirmation	Received echo of write query
	Deactivation	-
	Deactivation Confirmation	-
	Activation Termination	-

Table 62: FSO - Conversion of causes of transmission

8.6 RCO – Regulation Command Output

Regulation process command (two bits)

8.6.1 Supported function codes

Modbus		RTU				
Function code	Function code property	Data type	Parameter name	Parameter location	Parameter range / Explanation	Default
<06>	Preset Single Registers	RCO	Function code	RCO - Protocol address and parameters		
			Index	RCO - Protocol address and parameters		
			Query range	RCO - Protocol address and parameters (if auto-packing mode is disabled)		

Table 63: RCO - Supported function codes

8.6.2 Command authority

None

8.6.3 Additional information

Regulation step commands are in principle retriggerable commands.

8.6.4 Supported function code for ABB SACE PR12x/33x

Modbus			RTU			
Function code	**Function code property**	**Data type**	**Parameter name**	**Parameter location**	**Parameter range / Explanation**	**Default**
<16>	Preset Multiple Registers	RCO	Function code	RCO - Protocol address and parameters		
			Index	RCO - Protocol address and parameters		
			Query range	RCO - Protocol address and parameters (if auto-packing mode is disabled)		

Table 64: RCO - Supported function code for ABB SACE PR12x/33x

8.6.5 Command authority

None

8.6.6 Additional configuration parameters

Parameter name	Default	Parameter location
Value for On/Raise		RCO - Protocol address and parameters
0 – 15		
Value for Off/Lower		RCO - Protocol address and parameters
0 – 15		

8.6.7 Additional information

Index is always fixed at 40 001 and 40 002.

8.6.8 Supported function codes for ABB SACE PR 223DS/223EF devices

Modbus			RTU			
Function code	**Function code property**	**Data type**	**Parameter name**	**Parameter location**	**Parameter range / Explanation**	**Default**
<06>	Preset Single Registers	RCO	Function code	RCO - Protocol address and parameters		
			Index for On/Raise	RCO - Protocol address and parameters		
			Index for Off/Lower	RCO - Protocol address and parameters		
			Query range	RCO - Protocol address and parameters (if auto-packing mode is disabled)		
<16>	Preset Multiple Registers	RCO	Function code	RCO - Protocol address and parameters		
			Index for On/Raise	RCO - Protocol address and parameters		
			Index for Off/Lower	RCO - Protocol address and parameters		
			Query range	RCO - Protocol address and parameters (if auto-packing mode is disabled)		

Table 65: RCO - Supported function codes for ABB SACE PR 223DS/223EF devices

8.6.9 Command authority

None

8.6.10 Additional information

None

8.6.11 Conversion of values

RTU internal value	Modbus value
Lower	01
Higher	10

Table 66: RCO - Conversion of values

8.6.12 Conversion of quality descriptors

RTU		Modbus
Internal communication (short)	Internal communication (long)	Communication
SE	Select / Execute	-

Table 67: RCO - Conversion of quality descriptors

8.6.13 Conversion of causes of transmission

RTU		Modbus
Internal communication (short)	Internal communication (long)	Communication
T	Test	-
P/N	Positive/negative confirmation	Relevant for activation confirmation only
Cause	Activation	-
	Activation Confirmation	Simulated by SCI
	Deactivation	-
	Deactivation Confirmation	Simulated by SCI
	Activation Termination	Echo of write query

Table 68: RCO - Conversion of causes of transmission

8.7 SCO – Single Command Output

Binary process command (one bit)

8.7.1 Supported function code

Modbus			RTU			
Function code	**Function code property**	**Data type**	**Parame-ter name**	**Parameter location**	**Parame-ter range / Explanation**	**Default**
<05>	Force Single Coil	SCO	Function code	SCO - Protocol address and para-meters		
			Index	SCO - Protocol address and para-meters		
			Query range	SCO - Protocol address and para-meters (if auto-pack-ing mode is disabled)		
<15>	Force Multiple Coils	SCO	Function code	SCO - Protocol address and para-meters		
			Index	SCO - Protocol address and para-meters		
			Query range	SCO - Protocol address and para-meters (if auto-pack-ing mode is disabled)		

Table 69: SCO - Supported function code

8.7.2 Command authority

None

8.7.3 Additional information

None

8.7.4 Supported function code for ABB SACE PR12x/33x

Modbus			RTU			
Function code	**Function code property**	**Data type**	**Parameter name**	**Parameter location**	**Parameter range / Explanation**	**Default**
<16>	Preset Multiple Registers	SCO	Function code	SCO - Protocol address and parameters		
			Index	SCO - Protocol address and parameters		
			Query range	SCO - Protocol address and parameters (if auto-packing mode is disabled)		

Table 70: SCO - Supported function code for ABB SACE PR12x/33x

8.7.5 Command authority

None

8.7.6 Additional configuration parameters

Parameter name	Default	Parameter location
Value for On/Raise	0	SCO - Protocol address and parameters
0 … 15		
Value for Off/Lower	0	SCO - Protocol address and parameters
0 … 15		

8.7.7 Additional information

Index is always fixed at 40 001 and 40 002.

8.7.8 Supported function codes for ABB SACE PR 223DS/223EF devices

Modbus			RTU			
Function code	**Function code property**	**Data type**	**Parameter name**	**Parameter location**	**Parameter range / Explanation**	**Default**
<06>	Preset Single Registers	SCO	Function code	SCO - Protocol address and parameters		
			Index for On/Raise	SCO - Protocol address and parameters		
			Index for Off/Lower	SCO - Protocol address and parameters		
			Query range	SCO - Protocol address and parameters (if auto-packing mode is disabled)		
<16>	Preset Multiple Registers	SCO	Function code	SCO - Protocol address and parameters		
			Index for On/Raise	SCO - Protocol address and parameters		
			Index for Off/Lower	SCO - Protocol address and parameters		
			Query range	SCO - Protocol address and parameters (if auto-packing mode is disabled)		

Table 71: SCO - Supported function codes for ABB SACE PR 223DS/223EF devices

8.7.9 Command authority

None

8.7.10 Additional information

None

8.7.11 Conversion of values

RTU internal value	Modbus value
off	0x0000 for function code 05. 0 for function code 15
on	0xFF00 for function code 05. 1 for function code 15

Table 72: SCO - Conversion of values

8.7.12 Conversion of quality descriptors

RTU		Modbus
Internal communication (short)	Internal communication (long)	Communication
SE	Select / Execute	Simulated by SCI

Table 73: SCO - Conversion of quality descriptors

8.7.13 Conversion of causes of transmission

RTU		Modbus
Internal communication (short)	Internal communication (long)	Communication
T	Test	-
P/N	Positive/negative confirmation	Relevant for activation confirmation only
Cause	Activation	-
	Activation Confirmation	Simulated by SCI
	Deactivation	-
	Deactivation Confirmation	Simulated by SCI
	Activation Termination	Received echo of write query

Table 74: SCO - Conversion of causes of transmission

9 Transparent Data Messages

With the Transparent Data Messages, the RTU500 series is able to transmit any data of a foreign protocol from/to the Controlling Station on the active line. The RTU500 series supports the encapsulation of Modbus messages in a transparent data channel.

A Modbus message is encapsulated with Modbus frame and checksum. This frame is not included in the transparent data message.

9.1 Modbus ASCII mode

Start character (:), slave address, LRC check sum and end character (CR, LF) are not included in the transparent data message.

9.2 Modbus RTU mode

Slave address information and CRC check sum are not included in the transparent data message.

Example: Read register 8 from slave device 17.

	Data bytes Transparent Data	Data bytes Modbus message RTU mode	Data bytes Modbus message ASCII mode
Slave address		0x11	0x31 and 0x31
Function	0x04	0x04	0x30 and 0x34
Starting address high	0x00	0x00	0x30 and 0x30
Starting address low	0x08	0x08	0x30 and 0x38
Number of points high	0x00	0x00	0x30 and 0x30
Number of points low	0x01	0x01	0x30 and 0x31
CRC high		0xB2	0x42 and 0x32
CRC low		0x98	0x39 and 0x38

Table 75: Transparent Data - Modbus message RTU mode

The response from the IED is transmitted as follows:

	Data bytes Modbus message RTU mode	Data bytes Modbus message ASCII mode		Data bytes Transparent Data
Slave address	0x11	0x31	0x31	
Function	0x04	0x30	0x34	0x04
Byte Count	0x02	0x30	0x30	0x02
Data byte high	0x00	0x30	0x30	0x00
Data byte low	0x0A	0x30	0x41	0x0A
CRC high	0xF8	0x46	0x38	
CRC low	0xF4	0x46	0x34	

Table 76: Modbus message RTU mode - Transparent Data - Response

9.3 Modbus TCP/IP

In TCP/IP mode the telegram header (MBAP = Modbus Application Protocol) is not included in the transparent data message.

Example: Read register 8 from slave device:

	Data bytes Transparent Data	Data bytes Modbus message TCP/IP mode
Transaction ID high		0x15
Transaction ID low		0x01
Protocol ID high		0x00
Protocol ID low		0x00
Length high		0x00
Length low		0x06
Unit ID		0xFF
Function	0x04	0x04
Starting address high	0x00	0x00
Starting address low	0x08	0x08
Number of points high	0x00	0x00
Number of points low	0x01	0x01

Table 77: Transparent Data - Modbus message TCP/IP mode

The response is as follows:

	Data bytes Modbus message TCP/IP mode	Data bytes Transparent Data
Transaction ID high	0x15	
Transaction ID low	0x01	
Protocol ID high	0x00	
Protocol ID low	0x00	
Length high	0x00	
Length low	0x05	
Unit ID	0xFF	
Function	0x04	0x04
Byte count	0x02	0x02
Data byte high	0x00	0x00
Data byte low	0x0A	0x0A

Table 78: Modbus message TCI/IP mode - Transparent Data - Response

9.4 Configuration

The transparent data channel must be configured for each IED by adding a TDC node to the Hardware Tree of the configuration tool RTUtil500.

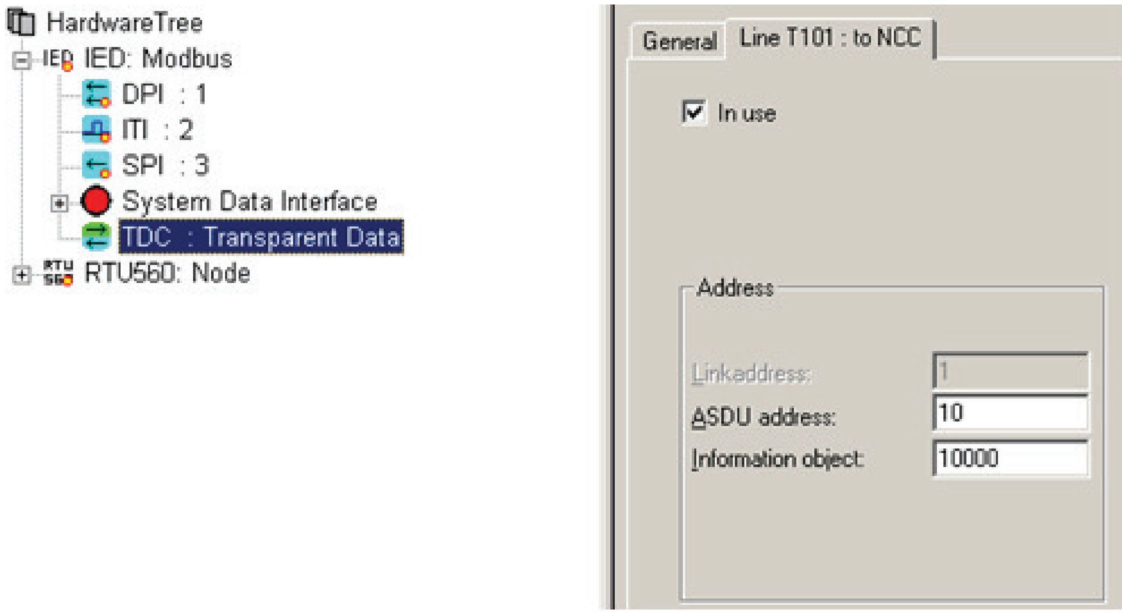


Figure 3: TDC node in Hardware Tree of configuration tool RTUtil500

10 File transfer

Not defined in the Modbus protocol.

11 Internal functions

11.1 General Interrogation

The general interrogation of the subordinated devices is done directly after the initialization of the RTU500 series and on every change of the subordinated link from state OFFLINE to state ONLINE.

A general interrogation is done by polling all data configured for one subordinated device. If this polling cycle is finished, the general interrogation is considered to be terminated.

11.2 Time synchronization

There are four different device types handled by the RTU500 series concerning the time synchronization via Modbus protocol (see parameter Type, chapter Station specific items (page "3-2") and Station specific items (page "3-4"). According to the device type, different specific methods are used.

The time synchronization command is only send to subordinated devices which are in state ONLINE (Active Line) and only if the time of the own RTU is valid (synchronized).

Those device types are:

- Generic device (no time synchronization performed)
- Sepam (Schneider Electric)
- MiCOM (Alstom)
- REF 542plus (ABB)
- ABB SACE PR12x/33x device
- 560CVD03 (ABB)
- 560CVD11 (ABB)

11.2.1 Sepam

The synchronization zone is a table which contains the absolute date and time for the time tagging function. Time messages should be written in a single block containing 4 words, using the Jbus n° 16 function word writing.[4]

Date and Time format:

15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00	
0	0	0	0	0	0	0	0	0	Y	Y	Y	Y	Y	Y	Y	1
0	0	0	0	M	M	M	M	0	0	0	D	D	D	D	D	2
0	0	0	H	H	H	H	H	0	0	mn	mn	mn	mn	mn	mn	3
ms	ms	ms	ms	ms	ms	ms	ms	ms	ms	ms	ms	ms	ms	ms	ms	4

Table 79: Date and Time format

Y: 1 byte for years: 0 to 99 years.

The remote monitoring and control system must ensure that the year 00 is greater than 99.

M: 1 byte for months: varies from 1 to 12.

D: 1 byte for days: varies from 1 to 31.

H: 1 byte for hours: varies from 0 to 23.

Mn: 1 byte for minutes: varies from 0 to 59.

Ms: 2 bytes for milliseconds: varies from 0 to 59 999.

11.2.1.1 Procedure

Function code	<0x16> (Write multiple registers)
Start address	0x0002 (called synchronization table)
Quantity of registers	0x04
Registers	Date and Time (8 bytes)

Table 80: Sepam procedure

11.2.2 MiCOM

Access in writing for n words (function 16). The time synchronization format is based on 8 bytes (4 words). [5]

Date and Time format:

15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00	
0	0	0	0	0	0	0	0	0	Y	Y	Y	Y	Y	Y	Y	1
0	0	0	0	M	M	M	M	0	0	0	D	D	D	D	D	2
0	0	0	H	H	H	H	H	0	0	mn	mn	mn	mn	mn	mn	3
ms	ms	ms	ms	ms	ms	ms	ms	ms	ms	ms	ms	ms	ms	ms	ms	4

Table 81: Date and Time format

Y: 1 byte for years: 0 to 99 years.

The remote monitoring and control system must ensure that the year 00 is greater than 99.

M: 1 byte for months: varies from 1 to 12.

D: 1 byte for days: varies from 1 to 31.

H: 1 byte for hours: varies from 0 to 23.

Mn: 1 byte for minutes: varies from 0 to 59.

Ms: 2 bytes for milliseconds: varies from 0 to 59 999.

11.2.2.1 Procedure

Function code	<0x16> (Write multiple registers)
Start address	0x0800 (called Page 8)
Quantity of registers	0x04
Registers	Date and Time (8 bytes)

Table 82: MiCOM procedure

11.2.3 REF 542plus

The absolute time may be sent from the control system to the communication board by using the extended file 7. The time format is based on the structure CP56Time2a (see IEC 870-5-4).

Each time the communication board receives a writing message on file 7, it forwards the entire AbsoluteTime field to the main board that applies the time. That means the entire file must be filled with a single function 21 message, otherwise a corrupted time value may be transferred to the main board. [6]

Date and Time format:

07	06	05	04	03	02	01	00	Byte
0	Y	Y	Y	Y	Y	Y	Y	1
0	0	0	0	M	M	M	M	2
DOW	DOW	DOW	DOM	DOM	DOM	DOM	DOM	3
SU	0	0	H	H	H	H	H	4
IV	0	mn	mn	mn	mn	mn	mn	5
Ms	ms	ms	ms	ms	ms	ms	ms	6
Ms	ms	ms	ms	ms	ms	ms	ms	7

Table 83: Date and Time format

Y: years: varies from 0 to 99

M: months: varies from 1 to 12

DOM: day of month: varies from 1 to 31

DOW: day of week: varies from 1 to 7 //unused

H: hours: varies from 0 to 23

SU: summer time: 0 = standard time, 1 = summer time //unused

mn: minutes: varies from 0 to 59

IV: invalid: 0 = valid, 1 = invalid

ms: milliseconds: varies from 0 to 59 999 (7=high byte, 8=low byte)

Format: CP56time2a (56 byte) according IEC standard

11.2.3.1 Procedure

Function code	<0x21> (Write file record)
Reference type	0x06
File number	0x0007 (called extended file 7)
Record number	0x00
Record length	0x04
Records	Date and Time (7 Bytes) and 0x00 (1 byte)

Table 84: REF 542plus procedure

11.2.4 ABB SACE PR12x/33x

The synchronization zone is a table which contains the absolute date and time for the time tagging function. Time messages should be written in a single block containing 4 words, using the Modbus FC 16.

Date and Time format:

15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00	
D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	1
0	0	0	H	H	H	H	H	0	0	mn	mn	mn	mn	mn	mn	2
0	0	0	0	0	0	0	0	0	0	s	s	s	s	s	s	3
0	0	0	0	0	0	ms	ms	ms	ms	ms	ms	ms	ms	ms	ms	4

Table 85: Date and Time format

Y: 1 byte for years: 0 to 99 years.

M: 1 byte for months: varies from 1 to 12.

D: 1 byte for days: varies from 1 to 31.

H: 1 byte for hours: varies from 0 to 23.

mn: minutes: varies from 0 to 59

S: 1 byte for minutes: varies from 0 to 59.

ms: 1 byte for milliseconds: varies from 0 to 999.

IV: invalid: 0 = valid, 1 = invalid

11.2.4.1 Procedure

Field	Value	Description
	Step1: Start Programming	
Function code	0x10	Function code 16, Write multiple registers
40001	5	Start programming session
40002	0	Command parameter. Not valid for this command
	Step2: Write time data	
Function code	0x10	Function code 16, Write multiple registers
Reg 40101	Day	Number of days from 31/12/1999
Reg 40102	Hour & Minute	Hour (High Byte), Minute (Low Byte)
Reg 40103	Second	0-59
Reg 40104	Millisecond	0-999
	Step3: Stop Programming	
Function code	0x10	Function code 16, Write multiple registers
40001	7	Stop programming session
40002	0	Command parameter. Not valid for this command

Table 86: ABB SACE PR12x/33x Synchronization command sequence

11.2.5 560CVD03

The synchronization zone is a table which contains the absolute date and time for the time tagging function. Time messages should be written in a single block containing 4 words, using the Modbus FC 16.

Date and Time format:

15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00	
0	0	mn	mn	mn	mn	mn	mn	0	0	s	s	s	s	s	s	1
0	0	0	D	D	D	D	D	0	0	0	H	H	H	H	H	2
Y	Y	Y	Y	Y	Y	Y	Y	0	0	0	0	M	M	M	M	3

Table 87: Date and Time format

mn: High byte for minutes: varies from 0 to 59

s: Low byte for milliseconds: varies from 0 to 59

D: High byte for days: varies from 1 to 31.

H: Low byte for hours: varies from 0 to 23.

Y: High byte for days: varies from 1 to 99.

M: Low byte for hours: varies from 1 to 12.

IV: invalid: 0 = valid, 1 = invalid

11.2.5.1 Procedure

Field	Value	Description
Device address	Configured device address	Specific Device address
Function code	0x10	Function code 16, Write multiple registers
Reg 0x30	Minutes/seconds	High Byte = minutes (0 to 59) Low Byte = seconds (0 to 59)
Reg 0x31	Day/Hours	High Byte = Day (1 to 31) Low Byte = Hours (0 to 23) 0 = 12 am, 1 = 1 am, …, 23 = 11 pm
Reg 0x32	Year/Month	High Byte = Year (01=2001,02=2002) Low Byte = Month (1 to 12) 1=January, 2=February, …, 12=December

Table 88: 560CVD03 procedure

11.2.6 560CVD11

The synchronization zone is a table which contains the absolute date and time for the time tagging function. Time messages should be written in a single block containing 4 words, using the Modbus FC 16.

Date and Time format:

15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00	
0	0	0	0	0	0	0	0	0	Y	Y	Y	Y	Y	Y	Y	1
0	0	0	0	M	M	M	M	0	0	0	D	D	D	D	D	2
0	0	0	H	H	H	H	H	0	0	mn	mn	mn	mn	mn	mn	3
ms	ms	ms	ms	ms	ms	ms	ms	ms	ms	ms	ms	ms	ms	ms	ms	4

Table 89: Date and Time format

Y: 1 byte for years: 0 to 99 years.

M: High byte for months: varies from 1 to 12.

D: Low byte for days: varies from 1 to 31.

H: High byte for hours: varies from 0 to 23.

mn: Low byte for minutes: varies from 0 to 59.

ms: 1 byte for milliseconds: varies from 0 to 59 999.

Written with 1 ms resolution

IV: invalid: 0 = valid, 1 = invalid

11.2.6.1 Procedure

Field	Value	Description
Device address	Configured device address	Specific Device address
Function code	0x10	Function code 16, Write multiple registers
Reg 0x38	Year	Value 0 to 99. (01=2001,02=2002)
Reg 0x39	Month/Day	High Byte = Month (1 to 12) 1=January, 2=February, …, 12=December Low Byte = Day (1 to 31)
Reg 0x3A	Hours/Minutes	High Byte = Hours (0 to 23) 0 = 12 am, 1 = 1 am, …, 23 = 11 pm Low Byte = minutes (0 to 59)
Reg 0x3B	Seconds	0 to 59 999 To be written with 1 ms resolution

Table 90: 560CVD11 procedure

11.3 Event handling

After establishing a connection to a device, all objects with Modbus register addresses are polled with their Modbus register address on Active line. Objects with configured and enabled event addresses will afterwards only be updated via events.

It is important that the event handling mechanism requires a prior time synchronization of the RTU500 series and the device itself.

11.3.1 General

There are four different device types handled by the RTU500 series concerning the reading of time tagged events via Modbus protocol. According to the device type, different specific methods are used for event handling.

Those device types are:

- Generic device (no reading of time tagged events performed)
- Sepam 2000 (Schneider Electric)
- MiCOM (Alstom)
- REF 542plus (ABB)

ABB SACE and 560CVDs devices do not support event-handling mechanism.

11.3.2 Sepam

On Sepam devices a "zone" describes a logical group of registers used for a specific purpose.

The event zones are two tables which contain a maximum of 4 time tagged events. Events should be read in a single block containing 33 words using FC 3. The exchange word can be written using FC 6 or 16, and read individually using FC 3..[4]. Only the first event table is evaluated by RTU500 series.

Events 1 zone / Events 2 zone:

Word address	Size	Access	
0x0040 / 0x0070	1 Word	R / W	Exchange word
0x0041 / 0x0071	8 Words	R	Event 1
0x0049 / 0x0079	8 Words	R	Event 2
0x0051 / 0x0081	8 Words	R	Event 3
0x0059 / 0x0089	8 Words	R	Event 4

Table 91: Events 1 zone / Events 2 zone

These parameters can be configured in the line folder of RTUtil500 separately for each datapoint.

Device Type: Sepam, Datapoint Type: SPI

Parameter name	Default	Parameter location
Event handling enabled	Disabled	Line parameter
Enabled / Disabled This parameter enables / disables the mechanism of event handling for this IED.		

11.3.3 MiCOM

To upload the event records two requests are allowed. The first method for uploading is to request an event record without acknowledgement of this event by using FC 3 with address 0x3500. The second one is to upload the oldest stored non-acknowledged event record by using FC 3 with address 0x3600. The automatic acknowledgment depends on the state of bit 12 of remote control word 1 at address 0x0400 (0 = automatic mode, 1 = manual mode). In automatic mode, reading of the event does also acknowledge it. For event reading, the RTU500 series uses the second method with automatic mode.

Event format:

Information	Size	Word
Event meaning	1 Word	1
Modbus assoc. value	1 Word	2
Modbus address	1 Word	3
Reserved	1 Word	4
Event date (s)	2 Words	5 / 6
Event date (ms)	2 Words	7 / 8
Acknowledgement	1 Word	9

Table 92: Event format

These parameters can be configured in the line folder of RTUtil500 separately for each datapoint.

Device Type: MiCOM, Datapoint type: SPI

Parameter name	Default	Parameter location
Event handling enabled	Disabled	Line parameter
Enabled / Disabled This parameter enables / disables the mechanism of event handling for this IED.		
Code	0	Line parameter
Integer Range 0 ... 67 Code of the event meaning		

11.3.4 REF 542plus

The REF 542plus records up to 100 of the last events. As the master unit sends out a request, the REF 542plus transmits the stored events, marked by the absolute time (year-month-day-hour-second-millisecond). REF 542plus shows the number of stored events in a dedicated location, so the master unit can read the event table (by polling). [6]

RCE extended table:

Information	Direction	Register
Number of available events	r	0
Overflow indicator	r	1
Clear RCE	w	2
Event 1	r	3
		...
		D+2
Event 2	r	D+3
		...
		(D*2) + 2
...	...	...

Table 93: RCE extended table

Information	Direction	Register
Event MAX	r	(D*(MAX-1)) + 3
		...
		(D*MAX) + 2
Unused	error	(D*MAX) + 3
...	...	...
Unused	error	9999

Table 93: RCE extended table

With D = size of (Event) / 2 = 22 bytes / 2 = 11 word

MAX = 100

These Event handling parameters can be configured in the line folder of RTUtil500 separately for each datapoint.

Device Type: REF 542plus, Datapoint type: SPI, DPI

Parameter name	Default	Parameter location
Event handling enabled	Disabled	Line parameter
Enabled / Disabled This parameter enables / disables the mechanism of event handling for this IED.		
Channel number	0	Line parameter
Integer Range 0 ... 65 535 Number of the communication channel		
Event number state 'on'	0	Line parameter
Integer Range 0 ... 127 Number of the event		
Event number state 'off'	0	Line parameter
Integer Range 0 ... 127 Number of the event		

11.4 System events

The subdevice communication interface manages internal status messages for every device connected to this line. These status messages are created from the subdevice communication interface itself for every connected device.

Parameter name	Default	Parameter location
Fix SEV address schema	enabled	SDI - line
Value range: enabled/ disabled if enabled: a base address for the whole block of system events is defined at the SDI node if disabled: individual addresses per SEV can be defined In order to avoid collisions, the addresses of the system events may not be used for other process objects.		
In use	enabled	SDI - line
Value range: enabled/ disabled if disabled: no SEVs will be transmitted on this line		

The subdevice communication interface generates the following system events:

IED SEVs influ-enced by the SCI	Description of system event	Address offset
X	Device is active While initialization the value of SEV#024 is set to ON. On a running system this system event does not change anymore.	#024
	At least one DCE (data communication equipment) faulty	#044
	Device connected (controled by SSC#003)	#045
X	Device inoperable The SEV#048 is set in dependency of the state of the subordinated device.	#048
	Device out of service (controled by SSC#001)	#049
	Device reachable on redundant line 1 / 2	#180, #181
	Device reachable on redundant line 3 / 4	#182, #183
	Device active on redundant line 1 / 2	#184, #185
	Device active on redundant line 3 / 4	#186, #187
	Device preferred on redundant line 1 / 2	#188, #189
	Device preferred on redundant line 3 / 4	#190, #191
X[1]	Process command collision with host x, $1 \le x \le 16$	#242 ... #257
X[1]	Process command collision with Integrated HMI	#258
X[1]	Process command collision with webserver	#259
X[1]	Process command collision with PLC	#260

Table 94: Description of system events

1) The process command collision will be signalized as 1ms impulse in two following system events.

11.4.1 Status Change Device OFFLINE to Device ONLINE

If the state of a subordinated device or line changes from OFFLINE to ONLINE, a general interrogation command is send to the concerning device(s).

The system event "device inoperable" (SEV#048) with value 0 is sent as SPI to the internal communication for every device that changed its state to ONLINE.

11.4.2 Status Change Device ONLINE to Device OFFLINE

If the state of a subordinated device or line changes from ONLINE to OFFLINE all configured data points connected to these devices are sent to the internal communication with the actual state, marked as INVALID (IV) or NOT TOPICAL (NT) and with the timestamp of the own RTU. INVALID or NOT TOPICAL is set depending on the configuration parameter Information object qualifier.

Parameter name	Default	Parameter location
Information object qualifier (usage for discon-nected subordinated devices)	Mark as invalid (IV)	RTU - Parameter
Value range: Mark as invalid (IV) / Mark as not topical (NT)		

ADVICE
Also in not topical (NT) configuration are data points which have not been updated since RTU startup marked as invalid (IV).

The system event DEVICE_INOPERABLE (48) with value 1 is sent as SPI to the internal communication for every device that changed its state to OFFLINE.

11.5 System commands

The behavior of subordinated devices connected to a sub-device communication interface with protocol Modbus can be modified with system single commands (SSC).

If system commands are configured to a subordinated device not directly connected to the sub-device communication interface they are send as single command with the protocol address configured for this SSC in RTUtil500 to the next subordinated device. Devices directly connected to a sub-device communication interface are processed by the sub-device communication interface itself.

The following system single commands are supported:

SSC supported	Description of SSC	Address offset
	Set device out of service	#001
	Reset device process	#002
	Connect/disconnect device	#003
	Set redundant line 1 / 2 as preferred line	#004, #005
	Set redundant line 3 / 4 as preferred line	#006, #007
	Force global process image update, i.e. force process image update of all subdevices	#012
	Request redundancy change over for the active CMU x, 1 ≤ x ≤ 16	#016 … #031

Table 95: Description of system single commands (SSC)

11.5.1 Set redundant line as preferred line

To modify the preferred redundant line in case of configured redundant communication lines the system single command "Set redundant line x as preferred line" is used.

RTU internal value	Status
off	<ignored>
on	set redundant line as preferred line

Table 96: Conversion of values

12 Interoperability list

12.1 Supported and Selectable Parameters

In this document parameter settings and selections of the Modbus protocol that are supported by RTU500 series are marked by squares with a tick ☒.

Functions and parameters with filled (black) squares ■ are not supported by RTU500 series!

12.2 Network configuration

(network-specific parameter)

✓	Point-to-point	✓	Multipoint star

12.3 Physical Layer

12.3.1 Electrical Interface

☒ RS-232

☒ EIA RS-485

☒ Ethernet

Number of unit loads: max. 32 slave devices

ADVICE
EIA RS-485 standard defines unit loads so that 32 of them can be operated on one line. For detailed information, refer to clause 3 of EIA RS-485 standard.

12.3.2 Transmission speed

Transmission settings are defined according to the chosen framing type. (serial only)

✓	300 bit/s	✓	600 bit/s	✓	1 200 bit/s
✓	2 400 bit/s	✓	4 800 bit/s	✓	9 600 bit/s
✓	19 200 bit/s				

Transmission on Ethernet networks

✓ 10 MBit/s
✓ 100 MBit/s

12.3.3 Transmission settings (only serial)

✓ even parity, 1 stop bit
✓ odd parity, 1 stop bit
✓ none parity, 1 stop bit

✓ none parity, 2 stop bits (CP1 / CP2 only)

12.3.4 Link Layer

Framing types (only serial)

✓ ASCII framing (7 bit ASCII characters)
✓ RTU framing (8 bit characters)

Message length

≤ 255	Maximum length L (number of characters)

12.3.5 Application Layer

12.3.5.1 Function codes

✓	<01>	Read Coil Status	✓	<02>	Read Input Status
✓	<03>	Read Holding Registers	✓	<04>	Read Input Registers
✓	<05>	Force Single Coil	✓	<06>	Preset Single Register
■	<07>	Read Exception Status	■	<08>	Diagnostics
■	<09>	Program 484	■	<10>	Poll 484
■	<11>	Fetch Communication Event Counter	■	<12>	Fetch Communication Event Log
■	<13>	Program Controller	■	<14>	Poll Controller
✓	<15>	Force Multiple Coils	✓	<16>	Write Multiple Registers
■	<17>	Report Slave ID	■	<18>	Program 884/M84
■	<19>	Reset Communication Link	✓	<20>	Read General Reference
✓	<21>	Write General Reference	■	<22>	Mask Write 4X Register
■	<23>	Read/Write 4X Registers	■	<24>	Read FIFO Queue

12.3.5.2 Exception codes

✓	<01>	Illegal Function Code	✓	<02>	Illegal Data Address
✓	<03>	Illegal Data Value	✓	<04>	Slave Device Failure
■	<05>	Acknowledge	■	<06>	Server Busy
✓	<0A>	Gateway Problem	✓	<0B>	Gateway Problem

12.3.5.3 Basic application functions

Clock synchronization

✓ Clock synchronization

Command transmission

✓	Direct command transmission	
□	Select and execute command	(Note: Select is internally simulated by RTU500 series-SCI)
✓	Direct set point command transmission	
□	Select and execute set point command	(Note: Select is internally simulated by RTU500 series-SCI)

13 Glossary

AMI	Analog Measured value Input
ASO	Analog Setpoint command Output
BSI	Bit String Input
BSO	Bit String Output
CMU	Communication and Data Processing Unit
CRC	Cyclic Redundancy Check
CTS	Clear to Send
DCD	Data Carrier Detect
DCE	Data Communication Equipment
DCO	**D**ouble **C**ommand **O**utput
DMI	Digital Measured value Input (8, 16 bit)
DO	Digital Output
DPI	Double Point Input
DSO	Digital Setpoint command Output (8, 16 bit)
EPI	Event of Protection equipment Input (1 bit)
FC	Functional Constraint
FSO	Floating Setpoint Command Output
IED	Intelligent Electronic Device
ITI	Integrated Totals Input
MAX	Maximum
MFI	Analog Measured value Floating Input
Min	Minimum
MS	Microsoft
PDU	Protocol Data Unit
PLC	Programmable Logic Control
RCO	Regulation step Command Output
RTS	Request to Send
RTU	Remote Terminal Unit
SCI	Sub-Device Communication Interface
SCO	Single Command Output
SEV	System Event
SPI	Single Point Input or Single point information

SSC	System Single Command
STI	Step position Input
TCP/IP	Transmission Control Protocol / Internet Protocol
TDC	Transparent Data Communication
Tx	Transmit Direction
UART	Universal Asynchronous Receiver-transmitter

Note:

The specifications, data, design or other information contained in this document (the "Brochure") - together: the "Information" - shall only be for information purposes and shall in no respect be binding. The Brochure does not claim to be exhaustive. Technical data in the Information are only approximate figures. We reserve the right at any time to make technical changes or modify the contents of this document without prior notice. The user shall be solely responsible for the use of any application example or information described within this document. The described examples and solutions are examples only and do not represent any comprehensive or complete solution. The user shall determine at its sole discretion, or as the case may be, customize, program or add value to the ABB products including software by creating solutions for the end customer and to assess whether and to what extent the products are suitable and need to be adjusted or customized.

This product is designed to be connected to and to communicate information and data via a network interface. It is the users sole responsibility to provide and continuously ensure a secure connection between the product and users or end customers network or any other network (as the case may be). The user shall establish and maintain any appropriate measures (such as but not limited to the installation of firewalls, application of authentication measures, encryption of data, installation of anti-virus programs, etc) to protect the product, the network, its system and the interface against any kind of security breaches, unauthorized access, interference, intrusion, leakage and/or theft of data or information. ABB AG is not liable for any damages and/or losses related to such security breaches, any unauthorized access, interference, intrusion, leakage and/or theft of data or information.

ABB AG shall be under no warranty whatsoever whether express or implied and assumes no responsibility for the information contained in this document or for any errors that may appear in this document. ABB AG's liability under or in connection with this Brochure or the files included within the Brochure, irrespective of the legal ground towards any person or entity, to which the Brochure has been made available, in view of any damages including costs or losses shall be excluded. In particular ABB AG shall in no event be liable for any indirect, consequential or special damages, such as – but not limited to – loss of profit, loss of production, loss of revenue, loss of data, loss of use, loss of earnings, cost of capital or cost connected with an interruption of business or operation, third party claims. The exclusion of liability shall not apply in the case of intention or gross negligence. The present declaration shall be governed by and construed in accordance with the laws of Switzerland under exclusion of its conflict of laws rules and of the Vienna Convention on the International Sale of Goods (CISG).

Visit us

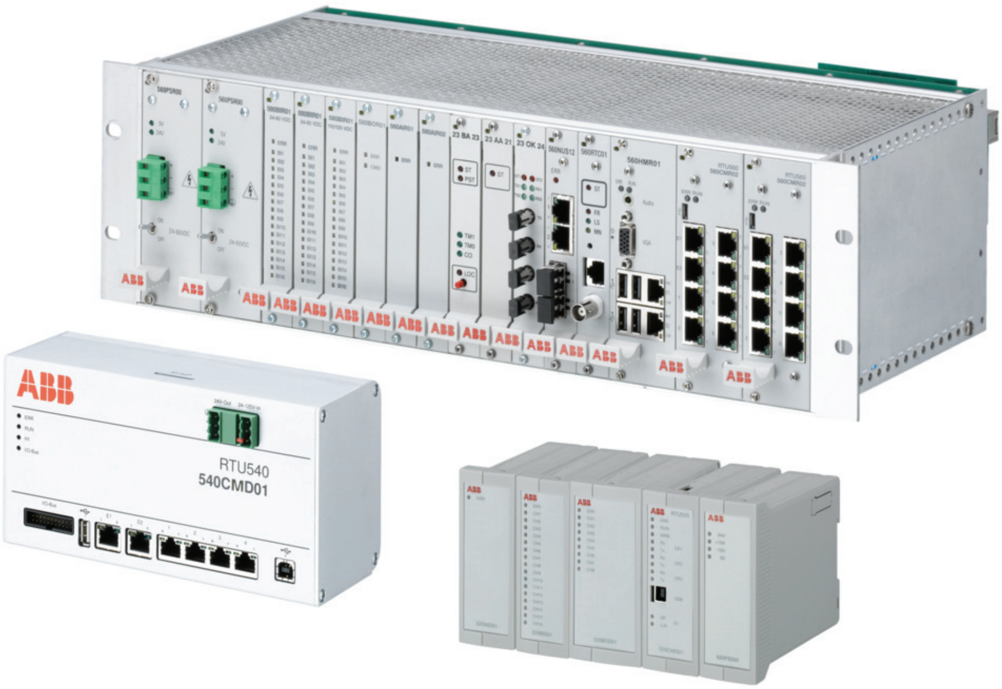
ABB AG
Power Grids
P.O. Box 10 03 51
68128 Mannheim, Germany

www.abb.com/remote-terminal-units

1KGT 150 486 V022 1

Power Grids

Remote Terminal Units
Host Communication Interface with DNP3
Protocol description



Revision

Document identity:		1KGT 150 489 V030 1
Revision:	**Date:**	**Changes:**
0	11/2001	Initial version
1	01/2002	
2	03/2002	Function ‘Read Date and Time’ added
3	06/2002	Additional information about ITI included
4	06/2003	Qualifier 27 supported for Object 12, Variation 1
5	10/2003	New System Events introduced Bit position of DPI corrected
6	06/2004	Dial-up function added
7	03/2005	New System Events Conversion of value for SCO changed Conversion of value for RCO changed Note: Conversion also changed in FW Release 6.3 Build 3
8	04/2005	New Return Codes for ‘COT’ Counter Change Events not supported New configuration parameter (see chapter 4) New parameter added for time accuracy (see chapter 10)
9	03/2006	New Qualifier Codes for Object 20 and 21
10	06/2006	New function: Collision Avoidance Subset Level 3 supported
11	01/2007	Interoperability List extended for Control Operations
12	01/2008	Device Profile: Send/Execute Control Operation corrected Actual List of communication units System Events updated
13	06/2008	Chapter ‘IP based communication’ expanded by slave parameter description Chapter 7.6 ITI – Integrated Totals Information expanded by data object 22. Table 4-1 SEV and data object 22 added Interoperability list expanded by data object 22
14	05/2009	File transfer description and data objects added
15	10/2009	Chapter 7.8.1 Analog Limit Excursion added Dial-up Parameters corrected System Events added
16	05/2011	DPI Object Type 3 and 4 added MFI and FSO objects added Interoperability List Updated

Document identity:		1KGT 150 489 V030 1
Revision:	**Date:**	**Changes:**
		Chapter 12 Line Redundancy added
17	05/2011	In SOE buffer buffered measurand were added in the reporting mode
18	04/2012	Chapter 2 and 4, New parameters (Offline time and Infinite Unsolicited Response retries) were added in Link and application layer
19	07/2012	New layout
20	09/2012	Added SSCs Explanation for FSO scaling added Explanation for MFI scaling added Interoperability list corrected – Direct Operate, no ACK marked as always
21	02/2013	Updated description for ITI points Restriction on length of file name added for file transfer
22	05/2013	Updated Direct Command without ACK for SCO, DCO, RCO and SSC New layout
23	02/2014	Explained event poll from redundant masters Added Object group 11, 13, 42, 43 and corresponding parameters Added details on separate buffers for analog and digital events Added details on not sending time tagged events until RTU is synchronized Corrected variations for MFI
24	06/2016	Updated chapter System events and System commands Type variation '0' removed from monitoring data points Updated maximum queue size of SOE Buffer to 20000 entries
		Updated chapter 'Application layer' (PR#27135, PR#28077)
		Updated chapter 'Application Layer' (PR#29036)
	07/2016	A misspelling has been fixed throughout the document (PR#30614)
	11/2016	Added missing variations 3 and 4 for data object group 30 (PR#21689)
		Updated the tables 'Data object in monotoring direction' and 'Date objects in control direction' (PR#31818)
	04/2017	Fixed the inconsistencies in table 'Conversion of quality descrip-tors' (PR#30636)
25	05/2017	Updated chapter 'IP based Communication' (PR#34594)
26	07/2017	Added chapter 'Line Redundancy' and removed 'Redundant lines - not supported' (PR#34888)
27	08/2017	New chapter: Secure Authentication (PR#3060)
28	11/2017	Updated data object library (PR#36146, #36149)
29	12/2017	Updated tables 'Requires Data Link Layer Confirmation' and 'Requires Application Layer Confirmation' of Interoperability list (PR#31856, #31857)

Document identity:		1KGT 150 489 V030 1
Revision:	**Date:**	**Changes:**
		Added information about SOE buffer alarm system event (PR#34639)
		Updated information about Request Link Status and Test Link data link frames (PR#34236)
	04/2018	New layout
30	06/2018	Removed obsolete file types from chapter 'File Transfer' (PR#38279)
	10/2018	Updated chapter 'Application Layer' (PR#39425)

Contents

1 Introduction........5
- 1.1 Preface........5
- 1.2 Conventions........5
- 1.3 References........5

2 Physical Layer........7
- 2.1 Serial line-based communication........7
- 2.2 Collision Avoidance........7
- 2.3 IP based Communication........8
  - 2.3.1 IP protocol TCP/IP........9
  - 2.3.2 IP protocol UDP/IP........9
- 2.4 Host interface........9

3 Link Layer........11
- 3.1 General........11
- 3.2 Transmission mode........11
- 3.3 Dial-up function........12
  - 3.3.1 12

4 Transport Layer........17

5 Application Layer........19
- 5.1 19

6 Addressing........25

7 Function Codes........27
- 7.1 Cold restart........27
  - 7.1.1 Supported data types........27
  - 7.1.2 Values........27
  - 7.1.3 Command Authority........27
  - 7.1.4 Additional Information........27
- 7.2 Warm restart........27
  - 7.2.1 Supported data types........27
  - 7.2.2 Values........27
  - 7.2.3 Command Authority........27
  - 7.2.4 Additional Information........28
- 7.3 Enable unsolicited messages........28
  - 7.3.1 Supported data types........28
  - 7.3.2 Values........28
  - 7.3.3 Command Authority........28
  - 7.3.4 Additional Information........28
- 7.4 Disable unsolicited messages........28
  - 7.4.1 Supported data types........28
  - 7.4.2 Values........28
  - 7.4.3 Command Authority........28

7.4.4 Additional Information........ 29
7.5 Assign class........ 29
7.5.1 Supported data types........ 29
7.5.2 Values........ 29
7.5.3 Command Authority........ 29
7.5.4 Additional Information........ 29

8 Data Types - Monitoring Direction........ 31
8.1 AMI – Analog Measured Information........ 31
8.1.1 Supported data types........ 31
8.1.2 Additional Information........ 31
8.1.3 AMI_Type variants........ 31
8.1.4 Conversion of values........ 31
8.1.5 Conversion of quality descriptors........ 32
8.1.6 Analog limit excursion........ 32
8.2 BSI – Bit String Information........ 32
8.2.1 Supported data types........ 33
8.2.2 Additional Information........ 33
8.2.3 Conversion of values........ 33
8.2.4 Conversion of quality descriptors........ 33
8.3 DMI – Digital Measured Information........ 34
8.3.1 Supported data types........ 34
8.3.2 Additional Information........ 34
8.3.3 Conversion of values........ 34
8.3.4 Conversion of quality descriptors........ 35
8.4 DPI – Double Point Information........ 35
8.4.1 Supported data types........ 35
8.4.2 Additional Information........ 35
8.4.3 Conversion of values........ 36
8.4.4 Conversion of quality descriptors........ 36
8.5 EPI – Protection Event Information........ 36
8.6 ITI – Integrated Totals Information........ 36
8.6.1 Supported data types........ 36
8.6.2 Additional information........ 37
8.6.3 Additional configuration parameters........ 37
8.6.4 Conversion of values........ 37
8.6.5 Conversion of quality descriptors........ 37
8.7 MFI – Measured Float Information........ 38
8.7.1 Supported data types........ 38
8.7.2 Additional configuration parameters........ 38
8.7.3 Conversion of values........ 39
8.7.4 Conversion of quality descriptors........ 39
8.8 SPI – Single Point Information........ 39
8.8.1 Supported data types........ 39
8.8.2 Conversion of Values........ 40
8.8.3 Additional Information........ 40
8.8.4 Conversion of quality descriptors........ 40

8.9 STI – Step Position Information ... 40
8.9.1 Supported data types ... 40
8.9.2 Additional Information ... 40
8.9.3 Conversion of Values ... 41
8.9.4 Conversion of quality descriptors ... 41

9 Data Types - Controlling Direction ... 43
9.1 ASO – Analog Setpoint Output ... 43
9.1.1 Supported data types ... 43
9.1.2 Command Authority ... 43
9.1.3 Additional information ... 43
9.1.4 Conversion of values ... 43
9.1.5 Conversion of quality descriptors ... 44
9.1.6 Conversion of causes of transmission ... 44
9.2 BSO – Bit String Output ... 45
9.2.1 Supported data types ... 45
9.2.2 Command Authority ... 45
9.2.3 Additional information ... 45
9.2.4 Conversion of values ... 45
9.2.5 Conversion of quality descriptors ... 46
9.2.6 Conversion of causes of transmission ... 46
9.3 DCO – Double Command Output ... 47
9.3.1 Supported data types ... 47
9.3.2 Command Authority ... 47
9.3.3 Additional information ... 47
9.3.4 Conversion of values ... 47
9.3.5 Conversion of quality descriptors ... 48
9.3.6 Conversion of causes of transmission ... 48
9.4 DSO – Digital Setpoint Output ... 48
9.4.1 Supported data types ... 49
9.4.2 Command Authority ... 49
9.4.3 Additional information ... 49
9.4.4 Conversion of values ... 49
9.4.5 Conversion of quality descriptors ... 50
9.4.6 Conversion of causes of transmission ... 50
9.5 FSO – Floating Point Setpoint Output ... 50
9.5.1 Supported data types ... 51
9.5.2 Command Authority ... 51
9.5.3 Additional information ... 51
9.5.4 Additional scaling parameters ... 51
9.5.5 Conversion of values ... 52
9.5.6 Conversion of quality descriptors ... 52
9.5.7 Conversion of causes of transmission ... 52
9.6 RCO – Regulation Command Output ... 53
9.6.1 Supported data types ... 53
9.6.2 Additional information ... 54
9.6.3 Conversion of values ... 54

9.6.4 Conversion of quality descriptors....54
9.6.5 Conversion of causes of transmission....54
9.7 SCO – Single Command Output....55
9.7.1 Supported data types....55
9.7.2 Additional information.... 55
9.7.3 Conversion of values....56
9.7.4 Conversion of quality descriptors....56
9.7.5 Conversion of causes of transmission....56

10 File Transfer.... 57
10.1 Supported variations....57
10.2 Command Authority....58
10.3 Conversion of causes of transmission....58
10.4 Download....58
10.5 Upload.... 58

11 Class data polling....59
11.1 Supported data types....59
11.2 Values....59
11.3 Command Authority....59
11.4 Additional Information....59

12 Line Redundancy....61
12.1 Configuration with RTUtil500....61

13 Internal Functions....63
13.1 Time synchronization.... 63
13.1.1 General.... 63
13.1.2 Maximum response time.... 63
13.1.3 Serial line-based communication.... 63
13.1.4 IP-based communication.... 64
13.2 System Events.... 64
13.2.1 SOE Buffer Filling Status System Events....66
13.3 System commands.... 66
13.3.1 Reset device process....67
13.3.2 Force process image update....67
13.3.3 Request redundancy change over.... 67

14 Secure Authentication.... 69
14.1 Introduction....69
14.2 Configure with RTUtil500.... 69
14.3 Critical Functions Codes.... 70
14.4 Secure statistics....70
14.5 Secure Authentication Errors....71

15 Interoperability list.... 73
15.1 Data object library.... 75

16 Glossary.... 83

1 Introduction

1.1 Preface

This document describes the functions of the host communication interface in RTU500 series according to DNP3.

1.2 Conventions

In this document function codes of data types according to DNP3 are marked with square brackets: <Function code>

Bold fonts with the table heading "Parameter name" are references to configuration parameters in RTUtil500. The parameter is followed by the parameter location where to find this parameter in RTUtil500. The first element of the parameter location defines the node in the hardware tree on the left side (e. g. RTU, CMU, line, IED) and the second element defines selected header control tab in the parameter window on the right side (e. g. general, interfaces, protocol).

Example:

Parameter name	Default	Parameter location
In use	Enabled	data point (e.g. SPI) - line T101/104
If enabled, the data point is transmitted to the host communication interface. This setting refers to data in monitoring and command direction.		

In this document references to elements of the standard and other references will be printed in brackets. Example: [2, 7.4]

The tables in the next chapters include lists of the functions, options and message types supported according to the protocol structure given in IEC 60870-5 (EPA three layer model) for

- the physical layer
- the link layer
- the application layer

This layered model is valid for the protocol DNP3.

1.3 References

[1] DNP V3.00
Transport Functions

Version 0.01, May 30, 1997

DNP Users Group

[2] DNP V3.00
Data Link Layer Protocol Description

Version 0.02,May 30, 1997

DNP Users Group

[3] DNP V3.00
Application Layer Protocol Description

Version 0.03, May 28, 1997

DNP Users Group

[4] DNP V3.00
Data Object Library

Version 0.02, July 8, 1997

DNP Users Group

[5] DNP V3.00
Intelligent Electronic Device (IED) Certification Procedure Subset Level 1

Version 1.01, December 15, 1999

DNP Users Group

[6] DNP V3.00
Intelligent Electronic Device (IED) Certification Procedure, Subset Level 2

Version 2.4, November 9, 2004

DNP Users Group

[7] DNP V3.00
Technical Bulletin 9804-007

Clarification of Collision Avoidance Procedures

April 22, 1998

DNP Users Group

[8] DNP V3.00
Distributed Network Protocol (DNP3)

June 8, 2012

IEEE Standard for Electric Power Systems Communications

2 Physical Layer

2.1 Serial line-based communication

The protocol DNP3 is running on the serial communication interfaces of the CMUs. For more details see RTU500 series Interfaces and Protocols Release 12 (1KGT 150 939).

Set the communication parameters according to the following table:

Parameter name	Default	Parameter location
Interface type	RS232C	CMU - serial interfaces
Type of physical interface. Select from list. Value range: RS232C, RS485 or fix if selection is not supported		
Baud rate	9600 bits/sec	CMU - serial interfaces
Value range: 50, 75, 100, 110, 150, 200, 300, 600, 1200, 1500, 2400, 4800, 9600, 19200, 38400 bits/sec; 50-600 bits/sec only on selected interfaces		
Modem control	Direct link (TxD/RxD only)	CMU - serial interfaces
Value range: • Direct link (TxD/RxD only) • WT link full duplex (no handshake) • WT link half duplex (RTS/CTS handshake) • WT link half duplex (RTS/DCD handshake) • Dial up (external modem DCD handshake) • Loop switch unit (DSTC 3002), RP570/71 Host interface only • Link with collision avoidance (DCD handshake), DNP 3 only Usage of the controls for this interface. Direct Link: No modem controls. Loop Switch Unit: RP570/71 Host Interface only. Collision Avoidance: DNP3.0 Host/Sub-Interface only		
Transmit delay time	disabled	CMU - serial interfaces
If 'Transmit Delay Time' is enabled: Delay time in Milliseconds. Value range: 1 to 10000 ms. Recommended value for WT modems in half-duplex mode: 30 ms		

ADVICE

The possibility to use different transmission speeds in control and in monitor direction is not supported by RTU500 series.

2.2 Collision Avoidance

If unsolicited messages are sent by several devices sharing a half-duplex, multi-drop link, using the DCD (Data Carrier Detect) signal [7], the serial line interface (in RS232C mode) with DNP3 protocol is able to avoid collisions between these unsolicited messages.

Parameter name	Default	Parameter location
Link with collision avoidance		RTU parameter – Line parameter

If the link is busy (DCD), the device waits a backoff_time, before it tries again indefinitely.

backoff_time = fixed delay + random (maximum of random delay)

Parameter name	Default	Parameter location
Fixed delay		RTU parameter – Line parameter
Maximum random delay		RTU parameter – Line parameter

2.3 IP based Communication

The protocol DNP3 is running on the Ethernet-Interfaces of the CMU. For more details see RTU500 series Interfaces and Protocols Release 12 (1KGT 150 939).

For each Ethernet interface following parameters can be configured:

Parameter name	Default	Parameter location
Interface mode	Auto-negotiation	CMU - Network Interfaces
Transmisssion rate and duplex modes. Possible values are: - 100BaseTx half duplex - 100BaseTx full duplex - 10BaseT half duplex - 10BaseT full duplex - Auto-negotiation Default value: Auto-negotiation		
Node name	none	CMU - Network Interfaces
Node name of RTU at this ethernet interface		
IP Address	0.0.0.0	CMU - Network Interfaces
IP Address of this RTU interface		
Subnet mask	0.0.0.0	CMU - Network Interfaces
Subnet mask of IP address		
Default gateway IP	0.0.0.0	CMU - Network Interfaces
IP address of default gateway		

Following Ethernet line parameters can be configured for the master:

Parameter name	Default	Parameter location
Master IP Address	0.0.0.0 (only one host, all master IP addresses accepted)	Line Tx - DNP3
IP address of host		
2nd Master IP Address	disabled	Line Tx - DNP3
IP address of the second host.		
Port number	20000	Line Tx - DNP3
TCP port number on which the RTU expects the connection requests of the 2 possible masters. For all masters the same. Value range: 1 to 65535		
IP protocol	TCP/ IP	Line Tx - DNP3
Type of Internet protocol Value range: TCP/IP or UDP/IP		

2.3.1 IP protocol TCP/IP

Using this mode the master should try to connect the RTU500 series using its IP address and the Port number configured. After start the RTU500 series will be prepared to accept a connection from a master with the IP address and Port number specified in the parameter of upper table. If a connection is established the connection will be maintained until an error occurs. If the RTU500 series recognizes an error it will close the active connection and wait for a new one.

2.3.2 IP protocol UDP/IP

Using this mode both parts send its DNP3 telegrams by using the UDP transport protocol of the network. Each part sends its telegrams to the IP address and the Port number of the opposite side without building a connection.

2.4 Host interface

All host interfaces will be configured according to the following table.

Parameter name	Default	Parameter location
Host number	1	CMU - all interfaces
Logical number of this host interface. Value range: 1 to 16. The Host Number has to be unique in a system, and will point to the data in the system event block		
Interlock with local control authority	disabled	CMU - all interfaces
If enabled: No commands are accepted from the host, as long as a user has successfully requested the 'Command Authority' in the 'Integrated HMI'		

3 Link Layer

3.1 General

A master/slave address model is used for all RTU500 series host interfaces. The basic procedures for data transfer, protection against loss and duplication and flow control are described in [2].

These master and slave address is configurable in the line folder of RTUtil500 separately for every line.

Parameter name	Default	Parameter location
Master station address	1	Line TDNP3
0 ... 65 519 (65 520 … 65 535 is normally reserved)		
Slave station address	1	Line TDNP3
0 ... 65 519 0xFFFF is used as broadcast address(0xFFFD and 0xFFFE are not supported)		

Communication primitives like framing of messages, parity checks or retransmissions are handled by the telecontrol protocol. These tasks are executed in the link layer that connects RTUs and control systems or other RTUs.

The RTU does not send Request Link Status data link layer frames. It may sends Test Link data link frames but only if Requires Data Link confirmation parameter is set to Always.

The selectable parameters have to be calculated regarding the real communication technology.

Parameter name	Default	Parameter location
Max. frame length	255	Line parameters
255net value exc. start characters and CRCs		
Communication retries	3	Line parameters
0 ... 15 times / 0 means no retry		
Requires Data Link confirmation	On large Application Layer segments	Line parameters
Never, always, on large Application Layer segments		
Confirmation timeout	2 s	Line parameters
1 … 65 535 s		
Cycle time test supervision	Enabled 120 s	Line parameters
Enabled / Disabled If enabled: 30 ... 65535 s		
Offline timeout	Enabled 120 s	Line parameters
Enabled / Disabled If enabled: 30 ... 65535 s		

3.2 Transmission mode

- Controlling station and controlled station (RTU) act simultaneously as primary and secondary stations.

- Both, controlling station and controlled station use SEND/CONFIRM services for message exchange, controlling station may also use the SEND/NO REPLY service.
- During link establishment both, controlling station and controlled station use the REQUEST/RESPOND service.
- Frame format is FT3. The Master station always sets the Direction Bit to 1, the Slave station sets the Direction Bit to 0.

3.3 Dial-up function

DNP3 is a calling protocol. Only the unsolicited mode enabled to transfer spontaneous message after a communication link is established. But not all control systems allow this mode. For dial-up this definition is very important!

3.3.1.1 Dial-up events

In the dial-up mode a communication link can be established via HAYES-compatible modems between a RTU500 series and a higher-level system. In this case the RTU500 series receives telephone calls and then switches over to the data mode.

When a telephone connection has been established, but communication according to the protocol does not take place the telephone connection will be terminated after elapse of the time defined with the interface parameter Maximum time period until connection is established.

Additionally, the RTU500 series may ring up the higher-level system on its own as soon as spontaneous changes of Prio1 data points (see parameter Address) or system events have occurred or cyclical calls from the RTU500 series have been configured. It is always the task of the control system to terminate the connection to the RTU500 series.

If there is no communication with the control system for a configurable time, the RTU500 series terminates the telephone connection by itself. (Parameter: Time period until hanging up because of inactivity).

When the attempt to establish the telephone connection has failed dialing will be repeated several times (interface parameter: Maximum number of dialing attempts). If the higher-level system supports a modem pool functionality and several telephone numbers have been configured the next telephone number will be called and establishing the telephone connection be attempted.

- Without unsolicited or class 1 data events

The host interface will never invoke the control system spontaneously. Data are only transferred after the host interface is called by the control system.

After restart the host interface calls the control system.

- With unsolicited or class 1 data events

After restart the host interface calls the control system.

Only unsolicited or class 1 data message are base for the host interface to call the control system spontaneously via deal up handler. After the telephone connection is established the host interface must be called by the control system. After the communication link is established the host interfaces send the unsolicited message spontaneously and the class1 data are inquired from the control system.

3.3.1.2 Dial-up configuration

In addition to the protocol-specific settings described in the chapters Physical Layer and Link Layer, some settings shall be made for the dial-up mode, too.

The dial-up mode is available only, if the parameter dial-up active on the serial communication interface (COM) of the CMU is enabled.

Parameter name	Default	Parameter location
Modem control:Dial up (external modem DCD handshake)		CMU - serial interfaces
Dial up enabled: enabled		CMU - serial interfaces
If enabled: This interface is using a dial-up connection to the sub devices or the host interfaces. Note: Not all protocols are supporting 'dial-up'. Available only, if 'Dial up' is selected		

All interface settings such as parity, baud rate, number of data bits, etc. depend on the protocol selected and are valid for both the configuration and the data mode.

The dial-up mode parameters are available in separate dialogue windows in the network and hardware Tree of the configuration tool RTUtil500.

3.3.1.3 Dial-up parameters at the the serial interfaces of the CMU

Parameter name	Default	Parameter location
Escape sequence preceding silent time	1 s	CMU - serial interfaces (dial up parameters)
Range: 1 … 255 s Minimal delay time between data mode and Hayes command mode		
Configuration string for modem	ATE0X3S0=1	CMU - serial interfaces (dial up parameters)
String Configuration string initializing the modem used. Note:The configuration string depends on the type of modem, the modem manufacturer and the modem function used.		
Dial string for modem	ATDT	CMU - serial interfaces (dial up parameters)
String Command Hayes to establish a modem connection		
Escape string for modem	+++	CMU - serial interfaces (dial up parameters)
String Command Hayes to switch from data mode to command mode		
Answer string for modem	Disable <no defaults>	CMU - serial interfaces (dial up parameters)
String Enable/Disable If enabled: An incoming call is answered with this string. Note: For standard HAYES modems the value S0=0 shall be set in the configuration string, if this feature is enabled (see modem description).		
Hang up string for modem	ATH	CMU - serial interfaces (dial up parameters)
String String requesting the modem to terminate the telephone connection.		
Connect string of modem	CONNECT	CMU - serial interfaces (dial up parameters)
String String sent by the modem if a telephone connection has been established.		

Parameter name	Default	Parameter location
OK string of modem	OK	CMU - serial interfaces (dial up parameters)
String		
String sent by the modem to acknowledge a command		
Disconnect string of modem	NO CARRIER	CMU - serial interfaces (dial up parameters)
String		
String sent by the modem if the connection is aborted		
Ring string of modem	RING	CMU - serial interfaces (dial up parameters)
String		
String sent by the modem signaling an incoming call.		
Busy string of modem	BUSY	CMU - serial interfaces (dial up parameters)
String		
With this string the modem signals that the remote terminal called is busy.		
PIN configuration string for GSM modem	Disable	CMU - serial interfaces (dial up parameters)
String		
Enable/Disable		
Service configuration string for GSM modem	Disable	CMU - serial interfaces (dial up parameters)
String		
Enable/Disable		

3.3.1.4 Dial-up parameters of the RTU

The configuration of the dial-up timeout parameters can be found only in the network tree at the RTU node (left window) and on the specific line (right window) at the tab dial up parameters.

Parameter name	Default	Parameter location
Maximum time till link is established	60 s	Network tree only: RTU - line
Value range: 1 ... 255 s		
Maximum time interval until the connection to a higher-level system must be established. When this time has elapsed the modem connection will be terminated.		
Maximum number of dial attempts	2	Network tree only: RTU - line
Value range: 1 ... 255 attempts		
Maximum number of times a telephone number is called. If the higher-level system supports a modem-pool function the next telephone number will then be called.		
Time between dial attempts	60 s	Network tree only: RTU - line
Value range: 1 ... 15 300 s		
When an attempt has failed the number will be called again after elapse of this time.		
Time between two series of dial attempts	7 800 s	Network tree only: RTU - line
Value range: 60 … 15 300 s		
Waiting time between dial series with different telephone numbers (modem pool)		
Inactivity hang up delay	disabled	Network tree only: RTU - line
Value range: disabled, 1 ... 15 300 s		
Inactivity hang up delay after commands	disabled	Network tree only: RTU - line
Value range: disabled, 1 ... 15 300 s		
Maximum period for one telephone connection	600 s	Network tree only: RTU - line
Value range: disabled, 10 ... 15 300 s		

Parameter name	**Default**	**Parameter location**
Cyclic calls of dial up slave	disabled	Network tree only: RTU - line
Value range: disabled / enabled		
If enabled: Start time of cyclic calls [hour, minutes]; Time interval between two calls [days, hours, minutes]		

3.3.1.5 Dial-up parameters of the control system

This window can be found only in the network tree at the connected control system.

Parameter name	**Default**	**Parameter location**
Telephone number 1	<no default>	Network tree only: Control system - Telephone numbers
Value range: string (length max. 27 characters)		
Telephone number under which a higher-level system can be called.		
Telephone number 2 ... 16	deactivated	Network tree only Control system - Telephone numbers
Value range: deactivated, string (length max. 27 characters)		
Additional telephone numbers under which a higher-level system can be called. If the higher-level system does not support the modem-pool function the telephone numbers need not to be configured.		

4 Transport Layer

The DNP3 Transport Layer is used to split Application Layer Fragments in segments which fit into a Data Link Layer frame. There are no parameters to set for the Transport Layer. For additional information see [1].

5 Application Layer

Several basic parameters need to be defined for a connection. All these parameters are also presented in the Device Profile at the end of this document, see Interoperability list (page "17-1").

Parameter name	Default	Parameter location
Requires Application Layer Confirmation from opposite station	Always	Line TDNP3 - DNP 3.0
Never, always, when reporting event data		
Application Layer response timeout	10 s	Line TDNP3 - DNP 3.0
0 ... 120 s		
Max length of a Application Layer fragment	4 096	Line TDNP3 - DNP 3.0
2048 ... 65 535, Size of Application Layer Fragments containing the response to a request		
Enable unsolicited responses class 1	Disabled	Line TDNP3 - DNP 3.0
Enable / Disable		
Enable unsolicited responses class 2	Disabled	Line TDNP3 - DNP 3.0
Enable / Disable		
Enable unsolicited responses class 3	Disabled	Line TDNP3 - DNP 3.0
Enable / Disable		
Send unsolicited response	Enabled	Line TDNP3 - DNP 3.0
Enable / Disable		
Unsolicited Responses Retries	5	Line TDNP3 - DNP 3.0
0 ... 65 535		
Unsolicited Responses Conf. Timeout	10 s	Line TDNP3 - DNP 3.0
0 ... 65 535 s		
Size of COS buffer	2 000	Line TDNP3 - DNP 3.0
100 … 8 000		
SOE buffer assignment	Same buffer for binary and analog events	Line TDNP3 - DNP 3.0
Same buffer for binary and analog events Independent buffers for binary and analog eventsIf the option Independent buffers for binary and analog events is selected, AMI and MFI events will be stored in analog events buffer and all other events will be stored in binary events buffer		
Size of SOE buffer	2 000	Line TDNP3 - DNP 3.0
100 … 20 000		
Size SOE buffer binary events	1 000	Line TDNP3 - DNP 3.0
100 … 20 000		
Size SOE buffer analog events	1 000	Line TDNP3 - DNP 3.0
100 … 20 000		
Queue filling alarm	Disabled	Line TDNP3 - DNP 3.0
If enabled: Percentage of SOE queue after which alarm event will be raised.		
Protocol profile	Default	Line TDNP3 - DNP 3.0
Default: no analog limit excursion configurable PEA: analog limit excursion configurable for virtual AMIs		
Double bit binary support	Disabled	Line TDNP3 - DNP 3.0
Enable / Disable		
Enable binary output event	Disabled	Line TDNP3 - DNP 3.0
Enable / Disable Enabling this parameter will generate binary output events in object group 11		

Parameter name	Default	Parameter location
Enable binary output command event	Disabled	Line TDNP3 - DNP 3.0
Enable / Disable Enabling this parameter will generate binary output command events in object group 13		
Enable analog output event	Disabled	Line TDNP3 - DNP 3.0
Enable / Disable Enabling this parameter will generate analog output events in object group 42		
Enable analog output command event	Disabled	Line TDNP3 - DNP 3.0
Enable / Disable Enabling this parameter will generate analog output command events in object group 43		
Handling of time tagged events until RTU time synchronized	Buffer events	Line TDNP3 - DNP 3.0
Buffer events No transmission of time tagged eventsIf the option “No transmission of time tagged events” is selected, RTU will inhibit sending the time tagged events until RTU is synchronized subject to a maximum time of “Maximum time until RTU time synchronized”		
Maximum time until RTU time synchronized	30 s	Line TDNP3 - DNP 3.0
1 … 87400 s		

Overview on functions for data elements of the application layer defined in [3].

The column RTU500 series type shows the type of data with must be configured in RTUtil500. Object Group/Variation combinations for DNP3 Subset Level 3 are implemented.

Here is the list of data types which are used in monitoring direction (which can be read):

ADVICE

If Infinite unsolicited response retries is enabled then Unsolicited response retries will be disabled in RTUtil500.If Infinite unsolicited response retries is disabled then Unsolicited response retries will be retried for the configured number of times and if still confirmation is not received RTU500 series will start Unsolicited response retries indefinitely.

	DNP3		RTU
Data object group	**Variation**	**Description**	**Data type**
1	1	Binary input	SPI, DPI, SEV
	2	Binary input with status	
2	1	Binary input change without time	SPI, DPI, SEV
	2	Binary input change with time	
	3	Binary input relative change with time	
3	1	Double bit binary input	DPI
	2	Double bit binary input with status	
4	1	Double bit binary input change without time	DPI
	2	Double bit binary input change with time	
	3	Double bit binary input relative change with time	
20	1	32-bit binary counter	ITI

Table 1: Data objects in monitoring direction

DNP3			RTU
Data object group	**Variation**	**Description**	**Data type**
	2	16-bit binary counter	
	3	32-bit delta counter	
	4	16-bit delta counter	
	5	32-bit binary counter without flag	
	6	16-bit binary counter without flag	
	7	32-bit delta counter without flag	
	8	16-bit delta counter without flag	
21	1	32-bit frozen counter	ITI
	2	16-bit frozen counter	
	9	32-bit frozen counter without flag	
	10	16-bit frozen counter without flag	
22	1	32-bit with flag	ITI
	2	16-bit with flag	
	5	32-bit with flag and time	
	6	16-bit with flag and time	
30	1	32-bit analog input with flag	STI, AMI, DMI, BSI, MFI
	2	16-bit analog input with flag	
	3	32-bit analog input without flag	
	4	16-bit analog input without flag	
	5	Analog Input - Single-prec flt-pt with flag	
31	1	32-bit Analog Change Event without time	STI, AMI, DMI, BSI, MFI
	2	16-bit Analog Change Event without time	
	3	32-bit Analog Change Event with time	
	4	16-bit Analog Change Event with time	
	5	Analog Input Event – Single-prec flt-pt without time	
	7	Analog Input Event – Single-prec flt-pt with time	
70	4	File command status	FDR, FTR
	5	File transport	
	6	File transport status	
	7	File descriptor	

Table 1: Data objects in monitoring direction

Here is the list of data types which are used in controlling direction (which can be read and controlled):

DNP3			RTU
Data object group	Variation	Description	Data type
10	1	Binary Output – Packed format	SCO, DCO, RCO, SSC
11	1	Binary Output Event – Status without time	SCO,DCO,RCO
	2	Binary Output Event – Status with time	
12	1	Control relay output block	SCO, DCO, RCO, SSC
	2	Pattern control block	
	3	Pattern mask	
13	1	Binary Output Command Event – Command status without time	SCO,DCO,RCO
	2	Binary Output Command Event – Command status with time	
40	1	32-bit analog output status	ASO, DSO, BSO, FSO
	2	16-bit analog output status	
	3	Analog Output Status – Single-prec flt-pt with flag	
41	1	32-bit analog output block[1]	ASO, DSO, BSO,FSO
	2	16-bit analog output block	
	3	Analog Output – Single-prec flt-pt	
42	1	Analog Output Event – 32-bit without time	ASO, DSO, BSO, FSO
	2	Analog Output Event – 16-bit without time	
	3	Analog Output Event – 32-bit with time	
	4	Analog Output Event – 16-bit with time	
43	1	Analog Output Command Event – 32-bit without time	ASO, DSO, BSO, FSO
	2	Analog Output Command Event – 16-bit without time	
	3	Analog Output Command Event – 32-bit with time	
	4	Analog Output Command Event – 16-bit with time	
70	3	File command	FDR, FTR
	4	File command status	
	5	File transport	
	6	File transport status	
	7	File descriptor	

Table 2: Data objects in control direction

1 The highest 16 bits are unused.

For every data point these parameters have to be defined:

Parameter name	Default	Parameter location
Class assignment for binary inputs, counters, analog inputs, binary output event, binary output command event, analog output event, analog output command event	See chapters Data types Monitoring direction (page 9-1) and Data types Controlling direction (page 10-1)	
0, 1, 2, 3		
Default object group/variation	See chapters Data types Monitoring direction (page 9-1) and Data types Controlling direction (page 10-1)	
See chapters Data types Monitoring direction (page 9-1) and Data types Controlling direction (page 10-1)		
Report with time of occurrence	No	
Yes/No		

Parameters for data points

For DNP3 analog input data point these parameters have to be defined:

Parameter name	Default	Parameter location
Event reporting	Actual	
Actual/first/buffered		

6 Addressing

The sizes of the addressing fields for the station address cannot be configured. The sizes of the master ID is always 16 bit. The size of the slave ID is also always 16 bit.

The length of the index address is variable and could change on every telegram. Valid sizes are 8, 16 or maximum 32 bit. The length of the index address is defined by three bits in the control field of each telegram.

Parameter name	Default	Parameter location
Index address length		
Max. 4 octets Not configurable Dynamically changed in dependency of the size of the index address		
Master ID length		
2 octets Not configurable		
Slave ID length		
2 octets Not configurable		

DNP3 supports separate address spaces for different data types. The following data types with their own address space are:

- binary inputs
- binary outputs
- counter
- analog inputs
- analog outputs

7 Function Codes

7.1 Cold restart

Process command to reset the whole RTU500 series.

7.1.1 Supported data types

Function code	Function code name	Description
<13>	COLD_RESTART	Forces the device to perform a complete restart.

Table 3: Supported data types

7.1.2 Values

None.

7.1.3 Command Authority

None

7.1.4 Additional Information

None

7.2 Warm restart

Process command to restart the DNP3 Host Interface.

7.2.1 Supported data types

Function code	Function code name	Description
<14>	WARM_RESTART	Forces the device to perform a partial reset.

Table 4: Supported data types

7.2.2 Values

None.

7.2.3 Command Authority

None

7.2.4 Additional Information

None

7.3 Enable unsolicited messages

Command to enable reporting of events by Unsolicited Response.

7.3.1 Supported data types

Function code	Function code name	Description
<20>	ENABLE_UNSOLICITED	Enables device to initiate unsolicited responses.

Table 5: Supported data types

7.3.2 Values

None.

7.3.3 Command Authority

None

7.3.4 Additional Information

None

7.4 Disable unsolicited messages

Command to disable reporting of events by Unsolicited Response.

7.4.1 Supported data types

Function code	Function code name	Description
<21>	DISABLE_UNSOLICITED	Prevents device to initiate unsolicited responses.

Table 6: Supported data types

7.4.2 Values

None.

7.4.3 Command Authority

None

7.4.4 Additional Information

None

7.5 Assign class

Command to assign data points to a specific class.

7.5.1 Supported data types

Function code	Function code name	Description
<22>	ASSIGN_CLASS	Device assigns events generated by data points to one of the classes.

Table 7: Supported data types

7.5.2 Values

None.

7.5.3 Command Authority

None

7.5.4 Additional Information

None

8 Data Types - Monitoring Direction

8.1 AMI – Analog Measured Information

Analog process information indicated by 16 bit used as a measured value from analog inputs in normalized or scaled format.

8.1.1 Supported data types

DNP3			RTU				
Group	**Variation**	**Default variation**	**Data type**	**Parameter name**	**Parameter location**	**Parameter range / Explanation**	**Default**
30	1, 2, 3, 4	2	AMI	Index address	AMI – Protocol address and parameters		
32	1, 2, 3, 4	2	AMI	Index address	AMI – Protocol address and parameters		

Table 8: AMI – Supported data types

8.1.2 Additional Information

None

8.1.3 AMI_Type variants

Only for virtual AMI:

Standard: PEA – Analog limit excursion, see chapter Analog limit excursion (page "9-11")

8.1.4 Conversion of values

Range	RTU internal value	DNP3 value
Range min.	-100 %	16-bit: -32 768 32-bit: -2 147 483 648
...	...	
Range max.	+100 %	16-bit: +32 768 32-bit: +2 147 483 648

Table 9: AMI – Conversion of values

8.1.5 Conversion of quality descriptors

RTU		DNP3
Internal communication (short)	**Internal communication (long)**	**Communication**
OV	Overflow	Flag octet: overrange
BL	Blocked	Flag octet: online=0
SB	Substituted	not used
NT	Not Topical	Flag octet: online=0
IV	Invalid	Flag octet: online=0

Table 10: AMI – Conversion of quality descriptors

8.1.6 Analog limit excursion

For virtual AMIs defined in a PLC task, a parameter Type variant is available which allows the configuration of an AMI limit excursion sequence.

The PLC includes the function to calculate analog sags and swells. With 4 AMI values with the same index address it is possible to send a packed set of measured values. These values are sent to the host as four consecutive 16-bit analog input change events with time.

The first value indicates a start value and time of an analog excursion.

The second value indicates the maximum or minimum of the analog excursion with time.

The third value indicates the average value and time of the analog excursion.

The fourth value indicates the analog value and time at the end of the excursion.

All four points are reported by exception within the same DNP3 message. To differentiate these points from other possible 16-bit analog points with time, the reserved bit (i.e., the most significant bit, bit 7) in the analog point status flag, as part of the message, is set to one.

Messages with static data will always report the actual value, not the whole sequence. This value is indicated by the reserved bit set to zero.

8.2 BSI – Bit String Information

Binary process information is indicated by 8, 16 or 32 bit.

8.2.1 Supported data types

DNP3			RTU				
Group	Variation	Default variation	Data type	Parameter name	Parameter location	Parameter range / Explanation	Default
30	1, 2, 3, 4	2	BSI	Index address	BSI – Protocol address and parameters		
32	1, 2, 3, 4	4	BSI	Index address	BSI – Protocol address and parameters		

Table 11: BSI – Supported data types

8.2.2 Additional Information

None

8.2.3 Conversion of values

Range	RTU internal value	DNP3
Range min.	0	0
...	...	
Range max.	BSI8: Bit mask of 8 bit; range ... 255	255
	BSI16: Bit mask of 16 bit; range ... 65 535	65 535
	BSI32: Bit mask of 32 bit; range ... 4 294 967 295	4 294 967 295

Table 12: BSI - Conversion of values

8.2.4 Conversion of quality descriptors

RTU		DNP3
Internal communication (short)	Internal communication (long)	Communication
OV	Overflow	Flag octet: overrange
BL	Blocked	Flag octet: online=0
SB	Substituted	not used
NT	Not Topical	Flag octet: online=0

Table 13: BSI – Conversion of quality descriptors

RTU		DNP3
Internal communication (short)	Internal communication (long)	Communication
IV	Invalid	Flag octet: online=0

Table 13: BSI – Conversion of quality descriptors

8.3 DMI – Digital Measured Information

Binary process information indicated by 8 or 16 bit is used as a measured value from digital inputs in normalized format.

8.3.1 Supported data types

DNP3			RTU				
Group	Variation	Default variation	Data type	Parameter name	Parameter location	Parameter range / Explanation	Default
30	1, 2, 3, 4	2	DMI	Index address	DMI – Protocol address and parameters		
32	1, 2, 3, 4	2	DMI	Index address	DMI – Protocol address and parameters		

Table 14: DMI – Supported data types

8.3.2 Additional Information

None

8.3.3 Conversion of values

Range	RTU internal value	DNP3 value
Range min.	-100 %	16-bit: -32 768 32-bit: -2 147 483 648
...	...	
Range max.	+100 %	16-bit: +32 767 32-bit: +2 147 483 648

Table 15: DMI – Conversion of values

8.3.4 Conversion of quality descriptors

RTU		DNP3
Internal communication (short)	Internal communication (long)	Communication
OV	Overflow	Flag octet: overrange
BL	Blocked	Flag octet: online=0
SB	Substituted	not used
NT	Not Topical	Flag octet: online=0
IV	Invalid	Flag octet: online=0

Table 16: DMI – Conversion of quality descriptors

8.4 DPI – Double Point Information

Binary process information is indicated by two bits.

8.4.1 Supported data types

DNP3			RTU				
Group	Variation	Default variation	Data type	Parameter name	Parameter location	Parameter range / Explanation	Default
1	1, 2	1	DPI	Index address	DPI – Protocol address and parameters		
2	1, 2, 3	2	DPI	Index address	DPI – Protocol address and parameters		
3	1, 2	1	DPI	Index address	DPI – Protocol address and parameters		
4	1, 2, 3	2	DPI	Index address	DPI – Protocol address and parameters		

Table 17: DPI – Supported data types

8.4.2 Additional Information

None

8.4.3 Conversion of values

RTU internal value	DNP3
intermediate	00
off	10
on	01
indeterminate	11

Table 18: DPI – Conversion of values

8.4.4 Conversion of quality descriptors

RTU		DNP3
Internal communication (short)	Internal communication (long)	Communication
BL	Blocked	Flag octet: online=0
SB	Substituted	not used
NT	Not Topical	Flag octet: online=0
IV	Invalid	Flag octet: online=0

Table 19: DPI – Conversion of quality descriptors

8.5 EPI – Protection Event Information

Binary process information is indicated by two bits and relative timetag (used by protection relays).

8.6 ITI – Integrated Totals Information

Binary process information is indicated by 31 bit as a counter value.

8.6.1 Supported data types

DNP3			RTU				
Group	Variation	Default variation	Data type	Parameter name	Parameter location	Parameter range / Explanation	Default
20	1, 2, 3, 4, 5, 6, 7, 8	1	ITI	Index address	ITI – Protocol address and parameters		
21	1, 2, 9, 10	1	ITI	Index address	ITI – Protocol address and parameters		
22	1, 2, 5, 6	5	ITI	Index address	ITI – Protocol address and parameters		

Table 20: ITI – Supported data types

8.6.2 Additional information

Commands Freeze and Clear from other Host Interfaces will interfere with the DNP3 counter.

If Freeze (and Clear) is used for Counter Interrogation, counters have to be configured as End of period wrap around counter and must belong to a Counter Interrogation Group not equal to zero (PDP parameter).

If Counter Read Requests (Function code=1) are used, counters have to be configured with EPR/IR cycle, and they have to belong to a Data point class (Host parameter).

Commands Freeze to counter, connected to a subordinate device with DNP3 protocol, are not supported.

ADVICE
Due to internal sequences, it is necessary to perform a Counter Freeze in order to get the actual counter value.

8.6.3 Additional configuration parameters

Parameter name	Default	Parameter location
Reporting of data after request	Only non-frozen values	ITI – Protocol address and parameters
Only non-frozen values: Only non-frozen values are reported in a class poll response Frozen and non-frozen values: Both frozen and non-frozen values are reported in a class poll response Only frozen values: Only frozen values are reported in a class poll response		

ITI – Additional configuration parameters

8.6.4 Conversion of values

Range	RTU internal value	DNP3
Range min.	0	0
...	...	...
Range max.	65 535	65 535

Table 21: ITI - Conversion of values

8.6.5 Conversion of quality descriptors

RTU		DNP3
Internal communication (short)	**Internal communication (long)**	**Communication**
SEQ	Sequence number	not used
CY	Carry	not used
CA	Adjusted	not used
IV	Invalid	Flag octet: online=0
-	-	Flag octet: rollover

Table 22: ITI – Conversion of quality descriptors

RTU		DNP3
Internal communication (short)	**Internal communication (long)**	**Communication**
		is set for each a counter reset to zero

Table 22: ITI – Conversion of quality descriptors

8.7 MFI – Measured Float Information

32 bit analog process information is used as a measured value in float format.

8.7.1 Supported data types

DNP3			RTU				
Group	**Variation**	**Default variation**	**Data type**	**Parameter name**	**Parameter location**	**Parameter range / Explanation**	**Default**
30	1, 2, 3, 4, 5	1	MFI	Index address	MFI – Protocol address and parameters		
32	1, 2, 3, 4, 5, 7	1	MFI	Index address	MFI – Protocol address and parameters		

Table 23: MFI – Supported data types

8.7.2 Additional configuration parameters

Parameter name	**Default**	**Parameter location**
Min. float value	0	MFI – Protocol address and parameters
When the MFI value is transmitted in 16-bit or 32-bit variations, the parameter Min. float value specifies the float value corresponding to the minimum transmitted value. When the MFI value is transmitted in a single precision float format, this parameter is ignored. 16-bit: -32 768 corresponds to the float value specified in the parameter Min. float value 32-bit: -2 147 483 648 corresponds to the float value specified in the parameter Min. float value		
Max. float value	65 535	MFI – Protocol address and parameters
When the MFI value is transmitted in 16-bit or 32-bit variations, the parameter Min. float value specifies the float value corresponding to the minimum transmitted value. When the MFI value is transmitted in a single precision float format, this parameter is ignored. 16-bit: +32 767 corresponds to the float value specified in the parameter Max. float value 32-bit: +2 147 483 647 corresponds to the float value specified in the parameter Max. float value		

MFI – Additional configuration parameters

8.7.3 Conversion of values

Range	RTU internal value	DNP3 value
Range min.	Min. float value	16-bit: -32 768
	Min. float value	32-bit: -2 147 483 648
	-3.4 x 10e38	Single precision floating point: -3.4 x 10e38
...	...	
Range max.	Max. float value	16-bit: +32 767
	Max. float value	32-bit: +2 147 483 647
	+3.4 x 10e38	Single precision floating point: +3.4 x 10e38

Table 24: MFI – Conversion of values

8.7.4 Conversion of quality descriptors

RTU		DNP3
Internal communication (short)	Internal communication (long)	Communication
OV	Overflow	Flag over-range
BL	Blocked	Flag octet: online=0
SB	Substituted	not used
NT	Not Topical	Flag octet: online=0
IV	Invalid	Status/Flag on-line

Table 25: MFI – Conversion of quality descriptors

8.8 SPI – Single Point Information

Binary process information is indicated by one bit.

8.8.1 Supported data types

DNP3			RTU				
Group	Variation	Default variation	Data type	Parameter name	Parameter location	Parameter range / Explanation	Default
1	1, 2	1	SPI	Index address	SPI – Protocol address and parameters		
2	1, 2, 3	2	SPI	Index address	SPI – Protocol address and parameters		

Table 26: SPI – Supported data types

8.8.2 Conversion of Values

RTU internal value	DNP3
off	0
on	1

Table 27: SPI - Conversion of values

8.8.3 Additional Information

None

8.8.4 Conversion of quality descriptors

RTU		DNP3
Internal communication (short)	Internal communication (long)	Communication
BL	Blocked	Flag octet: online=0
SB	Substituted	not used
NT	Not Topical	Flag octet: online=0
IV	Invalid	Flag octet: online=0

Table 28: SPI – Conversion of quality descriptors

8.9 STI – Step Position Information

Binary process information is indicated by 8 bits.

8.9.1 Supported data types

DNP3			RTU				
Group	Variation	Default variation	Data type	Parameter name	Parameter location	Parameter range / Explanation	Default
30	1, 2, 3, 4	2	STI	Index address	STI – Protocol address and parameters		
32	1, 2, 3, 4	4	STI	Index address	STI – Protocol address and parameters		

Table 29: STI – Supported data types

8.9.2 Additional Information

None

8.9.3 Conversion of Values

Range	RTU internal value	DNP3
Range min.	-63	-63
...	...	
Range max.	+63	+63

Table 30: STI - Conversion of values

8.9.4 Conversion of quality descriptors

RTU		DNP3
Internal communication (short)	**Internal communication (long)**	**Communication**
OV	Overflow	Flag octet: overrange
BL	Blocked	Flag octet: online=0
SB	Substituted	not used
NT	Not Topical	Flag octet: online=0
IV	Invalid	Flag octet: online=0
T	Transient Bit	not used

Table 31: STI – Conversion of quality descriptors

9 Data Types - Controlling Direction

9.1 ASO – Analog Setpoint Output

Analog process command (16 bit signed number).

9.1.1 Supported data types

DNP3			RTU				
Group	Variation	Default variation	Data type	Parameter name	Parameter location	Parameter range / Explanation	Default
41	1, 2	2	ASO	Index address	ASO – Protocol address and parameters		
42	1,2,3,4	4	ASO	Index address	ASO – Protocol address and parameters		
43	1,2,3,4	4	ASO	Index address	ASO – Protocol address and parameters		

Table 32: ASO – Supported data types

9.1.2 Command Authority

None

9.1.3 Additional information

Command Select is ignored.

Analog set-point output is a persistent output.

9.1.4 Conversion of values

Range	RTU internal value	DNP3 value
Range min.	-100 %	16-bit: -32 768 32-bit: -2 147 483 648
...	...	
Range max.	+100 %	16-bit: +32 768

Table 33: ASO – Conversion of values

Range	RTU internal value	DNP3 value
		32-bit: +2 147 483 648

Table 33: ASO – Conversion of values

9.1.5 Conversion of quality descriptors

RTU		DNP3
Internal communication (short)	**Internal communication (long)**	**Communication**
SE	Select	Select
	Execute	Execute / Direct operate

Table 34: ASO – Conversion of quality descriptors

9.1.6 Conversion of causes of transmission

RTU		DNP3
Internal communication (short)	**Internal communication (long)**	**Communication**
T	Test	not used
Cause	Activation	not used in command direction
	Positive activation confirmation	0 – OK
	Negative activation confirmation	1 – Select timer timed out 2 – Execute without previous select 3 – Command format incorrect 4 – Control operation not supported 5 – Controlled object already in use 6 – Hardware problems 8 – Max. number of controllable objects 9 – Insufficient authorization
	Deactivation	not supported
	Deactivation Confirmation	not supported
	Activation Termination	not supported

Table 35: ASO – Conversion of causes of transmission

ADVICE

Only 16-bit signed numbers are supported by i/o interfaces. Some Subdevice Communication Interfaces support 32-bit signed numbers.

9.2 BSO – Bit String Output

Binary process command (1, 2, 8, 16, 32 bit unsigned number).

9.2.1 Supported data types

DNP3			RTU				
Group	Variation	Default variation	Data type	Parameter name	Parameter location	Parameter range / Explanation	Default
41	1, 2	2	BSO	Index address	BSO – Protocol address and parameters		
42	1,2,3,4	4	BSO	Index address	BSO – Protocol address and parameters		
43	1,2,3,4	4	BSO	Index address	BSO – Protocol address and parameters		

Table 36: BSO – Supported data types

9.2.2 Command Authority

None

9.2.3 Additional information

Command Select is ignored.

Always persistent output; instead of command deactivation a new command with the data value 0 has to be generated.

Only the two most significant octets of a 32-bit value are supported for local output.

9.2.4 Conversion of values

Range	RTU internal value	DNP3 value
Range min.	0	0
...	...	
Range max.	BSO01: Bit mask of 1 bit range ... 1	1
	BSO02:	3

Table 37: BSO – Conversion of values

Range	RTU internal value	DNP3 value
	Bit mask of 2 bit range ... 3	
	BSO08: Bit mask of 8 bit range ... 255	255
	BSO16: Bit mask of 16 bit range ... 65 535	65 535

Table 37: BSO – Conversion of values

9.2.5 Conversion of quality descriptors

RTU		DNP3
Internal communication (short)	**Internal communication (long)**	**Communication**
SE	Select Execute	Select Execute / Direct operate

Table 38: BSO – Conversion of quality descriptors

9.2.6 Conversion of causes of transmission

RTU		DNP3
Internal communication (short)	**Internal communication (long)**	**Communication**
T	Test	not used
Cause	Activation	not used in command direction
	Positive activation confirmation	0 – OK
	Negative activation confirmation	3 – Command format incorrect 4 – Control operation not supported 5 – Controlled object already in use 6 – Hardware problems 8 – Max. number of controllable objects 9 – Insufficient authorization
	Deactivation	not supported
	Deactivation Confirmation	not supported
	Activation Termination	not supported

Table 39: BSO – Conversion of causes of transmission

9.3 DCO – Double Command Output

Binary process command (two bits).

9.3.1 Supported data types

DNP3			RTU				
Group	**Variation**	**Default variation**	**Data type**	**Parameter name**	**Parameter location**	**Parameter range / Explanation**	**Default**
10	1	1	DCO	Index address	DCO – Protocol address and parameters		
12	1, 2, 3	1	DCO	Index address	DCO – Protocol address and parameters		
11	1,2	2	DCO	Index address	DCO – Protocol address and parameters		
13	1,2	2	DCO	Index address	DCO – Protocol address and parameters		

Table 40: DCO – Supported data types

9.3.2 Command Authority

None

9.3.3 Additional information

DNP3 parameters Count, On time and Off time are not supported.

Only one command can be selected concurrently.

9.3.4 Conversion of values

RTU internal value	DNP3 value
off (01)	0 x 81 (off)
on (10)	0 x 41 (on)

Table 41: DCO – Conversion of values

9.3.5 Conversion of quality descriptors

RTU		DNP3
Internal communication (short)	**Internal communication (long)**	**Communication**
SE	Select	Select
	Execute	Execute / Direct operate

Table 42: DCO – Conversion of quality descriptors

9.3.6 Conversion of causes of transmission

RTU		DNP3
Internal communication (short)	**Internal communication (long)**	**Communication**
T	Test	not used
Cause	Activation	not used in command direction
	Positive activation confirmation	0 – OK
	Negative activation confirmation	1 – Select timer timed out 2 – Execute without previous select 3 – Command format incorrect 4 – Control operation not supported 5 – Controlled object already in use 6 – Hardware problems 7 – Local/Remote in local position 8 – Max. number of controllable objects 9 – Insufficient authorization
	Deactivation	not supported
	Deactivation Confirmation	not supported
	Activation Termination	not supported

Table 43: DCO – Conversion of causes of transmission

9.4 DSO – Digital Setpoint Output

Binary process command (8 or 16 bit signed number).

9.4.1 Supported data types

DNP3			RTU				
Group	Variation	Default variation	Data type	Parameter name	Parameter location	Parameter range / Explanation	Default
41	1, 2	2	DSO	Index address	DSO – Protocol address and parameters		
42	1,2,3,4	4	DSO	Index address	DSO – Protocol address and parameters		
43	1,2,3,4	4	DSO	Index address	DSO – Protocol address and parameters		

Table 44: DSO – Supported data types

9.4.2 Command Authority

None

9.4.3 Additional information

Command Select is ignored.

Digital set-point output is a persistent output.

9.4.4 Conversion of values

Range	RTU internal value	DNP3 value
Range min.	-100 %	16-bit: -32 768 32-bit: -2 147 483 648
...	...	
Range max.	+100 %	16-bit: +32 768 32-bit: +2 147 483 648

Table 45: DSO – Conversion of values

9.4.5 Conversion of quality descriptors

RTU		DNP3
Internal communication (short)	**Internal communication (long)**	**Communication**
SE	Select	Select
	Execute	Execute / Direct operate

Table 46: DSO – Conversion of quality descriptors

9.4.6 Conversion of causes of transmission

RTU		DNP3
Internal communication (short)	**Internal communication (long)**	**Communication**
T	Test	not used
Cause	Activation	not used in command direction
	Positive activation confirmation	0 – OK
	Negative activation confirmation	1 – Select timer timed out 2 – Execute without previous select 3 – Command format incorrect 4 – Control operation not supported 5 – Controlled object already in use 6 – Hardware problems 8 – Max. number of controllable objects 9 – Insufficient authorization
	Deactivation	not supported
	Deactivation Confirmation	not supported
	Activation Termination	not supported

Table 47: DSO – Conversion of causes of transmission

ADVICE

Only 16-bit signed numbers are supported by i/o interfaces.Some Subdevice Communication Interfaces support 32-bit signed numbers.

9.5 FSO – Floating Point Setpoint Output

Floating point process command (32 bit short floating point number)

9.5.1 Supported data types

DNP3			RTU				
Group	**Variation**	**Default variation**	**Data type**	**Parameter name**	**Parameter location**	**Parameter range / Explanation**	**Default**
40	1, 2, 3	1	FSO	Index address	FSO – Protocol address and parameters		
41	1, 2, 3	1	FSO	Index address	FSO – Protocol address and parameters		
42	1,2,3,4,5,7	4	FSO	Index address	FSO – Protocol address and parameters		
43	1,2,3,4,5,7	4	FSO	Index address	FSO – Protocol address and parameters		

Table 48: FSO – Supported data types

9.5.2 Command Authority

None

9.5.3 Additional information

Command Select is ignored.

Floating set-point output is a persistent output.

9.5.4 Additional scaling parameters

	Parameter name	**Default**	**Parameter location**
Min. float value		0	Protocol address and parameters

Range: -3.4 x 10e38 to +3.4 x 10e38

When the command is received in 16-bit or 32-bit variations, the parameter Min. float value specifies the float value corresponding to the minimum received value.

When the command is received in a single precision float format, this parameter is ignored.

16-bit: -32 768 corresponds to the float value specified in the parameter Min. float value

32-bit: -2 147 483 648 corresponds to the float value specified in the parameter Min. float value

Parameter name	Default	Parameter location
Max. float value	65 535	Protocol address and parameters

Range: -3.4 x 10e38 to +3.4 x 10e38

When the command is received in 16-bit or 32-bit variations, the parameter Max. float value specifies the float value corresponding to the maximum received value.

When the command is received in a single precision float format, this parameter is ignored.

16-bit: +32 767 corresponds to the float value specified in the parameter Max. float value

32-bit: +2 147 483 647 corresponds to the float value specified in the parameter Max. float value

FSO – Additional scaling parameters

9.5.5 Conversion of values

Range	RTU internal value	DNP3 value
Range min.	Min. float value	16-bit: -32 768
	Min. float value	32-bit: -2 147 483 648
	-3.4 x 10e38	Single precision floating point: -3.4 x 10e38
...	...	
Range max.	Max. float value	16-bit: +32 767
	Max. float value	32-bit: +2 147 483 647
	+3.4 x 10e38	Single precision floating point: +3.4 x 10e38

Table 49: FSO – Conversion of values

9.5.6 Conversion of quality descriptors

RTU		DNP3
Internal communication (short)	**Internal communication (long)**	**Communication**
SE	Select	Select
	Execute	Execute / Direct operate

Table 50: FSO – Conversion of quality descriptors

9.5.7 Conversion of causes of transmission

RTU		DNP3
Internal communication (short)	**Internal communication (long)**	**Communication**
T	Test	not used
Cause	Activation	not used in command direction
	Positive activation confirmation	0 – OK
	Negative activation confirmation	1 – Select timer timed out 2 – Execute without previous select

Table 51: FSO – Conversion of causes of transmission

RTU		DNP3
Internal communication (short)	Internal communication (long)	Communication
		3 – Command format incorrect 4 – Control operation not supported 5 – Controlled object already in use 6 – Hardware problems 8 – Max. number of controllable objects 9 – Insufficient authorization
	Deactivation	not supported
	Deactivation Confirmation	not supported
	Activation Termination	not supported

Table 51: FSO – Conversion of causes of transmission

9.6 RCO – Regulation Command Output

Regulation step command (two bits).

9.6.1 Supported data types

DNP3			RTU				
Group	Variation	Default variation	Data type	Parameter name	Parameter location	Parameter range / Explanation	Default
10	1	1	RCO	Index address	RCO – Protocol address and parameters		
12	1, 2, 3	1	RCO	Index address	RCO – Protocol address and parameters		
11	1,2	2	RCO	Index address	RCO – Protocol address and parameters		
13	1,2	2	RCO	Index address	RCO – Protocol address and parameters		

Table 52: RCO – Supported data types

9.6.2 Additional information

DNP3 parameters Count, On time and Off time are not supported.

Only one command can be selected concurrently.

Regulating step commands are in principle retriggerable commands.

9.6.3 Conversion of values

RTU internal value	DNP3 value
Lower (01)	0 x 81 (off)
Higher (10)	0 x 41 (on)

Table 53: RCO – Conversion of values

9.6.4 Conversion of quality descriptors

RTU		DNP3
Internal communication (short)	Internal communication (long)	Communication
SE	Select	Select
	Execute	Execute / Direct operate

Table 54: RCO – Conversion of quality descriptors

9.6.5 Conversion of causes of transmission

RTU		DNP3
Internal communication (short)	Internal communication (long)	Communication
T	Test	not used
Cause	Activation	not used in command direction
	Positive activation confirmation	0 – OK
	Negative activation confirmation	1 – Select timer timed out 2 – Execute without previous select 3 – Command format incorrect 4 – Control operation not supported 5 – Controlled object already in use 6 – Hardware problems 8 – Max. number of controllable objects

Table 55: RCO – Conversion of causes of transmission

RTU		DNP3
Internal communication (short)	**Internal communication (long)**	**Communication**
		9 – Insufficient authorization
	Deactivation	not supported
	Deactivation Confirmation	not supported
	Activation Termination	not supported

Table 55: RCO – Conversion of causes of transmission

9.7 SCO – Single Command Output

Binary process command (one bit).

9.7.1 Supported data types

DNP3			RTU				
Group	**Variation**	**Default variation**	**Data type**	**Parameter name**	**Parameter location**	**Parameter range / Explanation**	**Default**
10	1	1	SCO	Index address	SCO – Protocol address and parameters		
12	1, 2, 3	1	SCO	Index address	SCO – Protocol address and parameters		
11	1,2	2	SCO	Index address	SCO – Protocol address and parameters		
13	1,2	2	SCO		SCO – Protocol address and parameters		

Table 56: SCO – Supported data types

9.7.2 Additional information

DNP3 parameters Count, On time and Off time are not supported.

Only one command can be selected concurrently.

9.7.3 Conversion of values

RTU internal value	DNP3 value
off (0)	0 x 81 (off)
on (1)	0 x 41 (on)

Table 57: SCO – Conversion of values

9.7.4 Conversion of quality descriptors

RTU		DNP3
Internal communication (short)	Internal communication (long)	Communication
SE	Select	Select
	Execute	Execute / Direct operate

Table 58: SCO – Conversion of quality descriptors

9.7.5 Conversion of causes of transmission

RTU		DNP3
Internal communication (short)	Internal communication (long)	Communication
T	Test	not used
Cause	Activation	not used in command direction
	Positive activation confirmation	0 – OK
	Negative activation confirmation	1 – Select timer timed out 2 – Execute without previous select 3 – Command format incorrect 4 – Control operation not supported 5 – Controlled object already in use 6 – Hardware problems 7 – Local/Remote in local position 8 – Max. number of controllable objects 9 – Insufficient authorization
	Deactivation	not supported
	Deactivation Confirmation	not supported
	Activation Termination	not supported

Table 59: SCO – Conversion of causes of transmission

10 File Transfer

The file transfer is used for exchanging files between a control center and a RTU500 series or a subordinate device.

The following file types can be transferred via the DNP3 protocol and can be configured by RTUtil500.

Supported file type	Explanation
RCD configuration file	RTU configuration file generated by RTUtil500
PRO configuration file	PLC file generated by MULTIPROG wt 2 or MULTIPROG 5
Disturbance recorder	Disturbance recorder file of various devices, see SCI description
UNDEF file	Not specified in greater detail

Table 60: Supported file types

Files which belong to a subordinate device are routed through the RTU500 series.

The DNP3 protocol identifies its files only via a file name assignable by RTUtil500. This can be any user defined ASCII string. The file name string is limited to 200 characters.

The file name is the full path name and should correspond to the file name received from the master.

Supported function code	Function code	Description
FC_readfnc_file	<1>	Read
FC_writefnc_file	<2>	Write
FC_open_file	<25>	File open
FC_close_file	<26>	File close
FC_get_file_info	<28>	Get file info
FC_file_abort	<30>	Abort file transaction
FC_response_file	<129>	Response to request

Table 61: Supported function codes

Not supported function code	Function code	Description
FC_delete_file	<27>	File delete
FC_file_authenticate	<29>	File authentication

Table 62: Not supported function codes

10.1 Supported variations

File control objects	Variation
VAR_FILE_COMMAND	3
VAR_FILE_COMMAND_STATUS	4
VAR_FILE_TRANSPORT	5
VAR_FILE_TRANSPORT_STATUS	6
VAR_FILE_DESCRIPTOR	7

Table 63: Supported variations

10.2 Command Authority

None

10.3 Conversion of causes of transmission

RTU		DNP3
Internal communication (short)	**Internal communication (long)**	**Communication**
T	Test	Ignored
P/N	Positive/negative confirmation	negative confirmation converted to abort file transaction
Cause	Spontaneous	Ignored
	Requested	Ignored
	File transfer	Ignored

Table 64: File transfer – Conversion of causes of transmission

10.4 Download

The download of configuration files does not trigger any restarting mechanism in the RTU500 series. For activating the new configuration file, the control center has to issue a cold restart command (FC_COLD_RESTART, function code 13) after writing the files to the RTU500 series.

The IOD and GCD configuration files are distributed to every CMU board in the system concerned after download is completed. Configuration file distribution will only be done, if the file belongs to the RTU500 series itself. Otherwise the file transfer will only be routed to the subordinate device it belongs to. In this case the file transfer handling is done by the subordinate device (e.g. a RTU of the RTU500 series).

PTX and PRO configuration files are only stored local when the download is completed. This means, that archive or PLC functions using this configuration files have to be located on the same CMU-board where the host communication interface handling the file transfer is located.

The distribution is completed if the close command (FC_close_file, function code 26) is confirmed on application layer level.

The close command is only confirmed positively when file transfer and file distribution were successful. If a file transfer to a RTU500 series is confirmed negatively, the downloaded file was not stored and the previous file is not deleted or overwritten.

10.5 Upload

All supported file types can also be uploaded from a RTU500 series or subordinate devices.

11 Class data polling

The class data polling includes single point information (with RTU500 series System Events), step positions, measured values, bit strings and integrated totals.

The assignment of a data point to a class is configurable in the RTUtil500 (Default object variation).

If class data polling is performed, the data types are sent with their default variation when the master does not specify a variation in its request.

Remember that before you do a static data poll (Class 0) you should do an event data poll (Class 1, 2 or 3). The event data is stored in the COS or SOE buffer. These buffers are cleared by polling for event data. If you poll for static data, you will get the current value. If you poll for event data, then you get the events stored in the buffers. If the events are older, then the event poll may return an older value as the static poll.

11.1 Supported data types

Data object	Variation
60	1, 2, 3, 4

Table 65: Class data polling – Supported data types

11.2 Values

0

11.3 Command Authority

None

11.4 Additional Information

None

12 Line Redundancy

RTU500 series supports redundant lines for the DNP3 host communication interface. It is possible to have the following number and combination of lines:

- Up to 4 redundant serial lines per DNP3 HCI.
- Up to 2 redundant Ethernet lines per DNP3 HCI.
- A combination of redundant serial lines and redundant Ethernet lines per DNP3 HCI: Up to 4 redundant serial lines and up to 2 redundant Ethernet lines.

General functions:

- All redundant lines of a DNP3 HCI have the same addressing for data points and commands and the same master/slave addresses.
- Serial lines can be configured with different connection speeds.
- There is no preferred line. All hosts can connect via the lines to the RTU at the same time.
- Unsolicited responses are sent through one of the connected lines.

The configuration of redundant lines is part of the RTU500 series configuration tool RTUtil500. The redundant lines of a DNP3 HCI have to be connected to the same CMU board.

When concurrent read requests for event data is received from two different redundant masters, the event data will be reported to the master from where the request is received first. The second master will be responded with a NULL response. This is applicable for class 1,2,3 poll.

12.1 Configuration with RTUtil500

- For redundant serial lines link the line up to 4 serial ports of the same CMU board.
- For redundant Ethernet lines link the line to one Ethernet interface and enter two IP addresses.
- For a combination of redundant serial lines and redundant Ethernet lines link the line up to 4 serial ports and one Ethernet interface and enter up to 2 IP addresses.

13 Internal Functions

13.1 Time synchronization

13.1.1 General

The RTU500 series supports different methods of time synchronization.

The time synchronization can be done via the following methods of synchronization:

- Radio Clock, sntp
- Clock synchronization command from a control system
- Clock synchronization command from a control system combined with an external minute pulse
- A combination of up to eight of these time sources

	Parameter name	Default	Parameter location
Time administration			RTU parameter
External minute pulse			RTU parameter

The DNP3 IIN Time request from Master value is set at start up of the RTU500 series and as soon as 90 % of the Time synchronization lost timeout value (RTU parameter) is reached.

The following effects have to be considered:

- Time base drift over a 10-minute interval: < 1 ms (2 to 3 hours after first time synchronization)
- Maximum internal time reference error when set from the protocol: 5 ms

13.1.2 Maximum response time

The maximum response time depends on the telegram, but will not exceed 100 ms.

13.1.3 Serial line-based communication

The DNP3 function Delay Measurement (function code 23) is supported and returns the time period the Delay Measurement function takes to be parsed and executed in the RTU500 series.

Maximum delay measurement error: 10 ms

13.1.3.1 Supported data types

Data object	Variation
50	1

Table 66: Time synchronization – Supported data types

13.1.3.2 Values

Complete time and date information in CP56Time2a format.

13.1.3.3 Command Authority

None

13.1.3.4 Additional Information

None

13.1.4 IP-based communication

The DNP3 function Record Current Time (function code 24) is supported [Transporting DNP V3.00 over Local and Wide Area Networks, DNP Users Group, Chap. 6]. The time of reception of the last octet of the Record Current Time request is recorded and is used to set the clock accordingly to the Write request with a Time And Date at Last Recorded Time object (object 50, variation 3).

13.1.4.1 Supported data types

Data object	Variation
50	3

Table 67: IP-based communication – Supported data types

13.1.4.2 Values

Complete time and date information in CP56Time2a format.

13.1.4.3 Command Authority

None

13.1.4.4 Additional Information

None

13.2 System Events

The host interface manages internal status messages of the RTU500 series. These status messages can be created from the host itself or other activities of the RTU500 series. The system events of other activities are sent via internal communication and are processed by the HCI.

Parameter name	Default	Parameter location
Fix SEV address schema	enabled	SDI - line
Value range: enabled/ disabled if enabled: a base address for the whole block of system events is defined at the SDI node if disabled: individual addresses per SEV can be defined In order to avoid collisions, the addresses of the system events may not be used for other process objects.		
In use	enabled	SDI - line
Value range: enabled/ disabled if disabled: no SEVs will be transmitted on this line		

The following table shows the system events available for the host interface. System events send spontaneous as SPI with or without timestamp and contained in a general interrogation (without timestamp):

Description of system event	Address offset
At least one indication faulty	SEV#016
At least one analog value faulty	SEV#017
At least one digital value faulty	SEV#018
At least one integrated total faulty	SEV#019
At least one object or regulation command faulty	SEV#020
At least one analog output faulty	SEV#021
At least one digital output faulty	SEV#022
RTU is faulty	SEV#023
Device/ RTU active	SEV#024
RTU synchronized	SEV#025
External clock inoperable	SEV#026
Local printer offline	SEV#027
At least one indication oscillating	SEV#028
Battery voltage low (RTU560E only)	SEV#029
AC power supply failure (RTU560E only)	SEV#030
Test mode active	SEV#042
At least one data object simulated	SEV#043
At least one data communication equipment (DCE) faulty	SEV#044
Device connected	SEV#045
At least one PLC function not running	SEV#046
At least one PLC function cycle time exceeded	SEV#047
Device/ RTU inoperable	SEV#048
Device/ RTU is out of service	SEV#049
Power supply failure in RTU central sub-rack	SEV#059
Command supervision circuit x disconnected or faulty, 1 ≤ x ≤ 32	SEV#064 ... #095
SNTP client 1 is synchronized	SEV#096
SNTP client 2 is synchronized	SEV#097
Local control authority active	SEV#100
Host x Online, 1 ≤ x ≤ 16	SEV#101 ... #116
Host interface x: At least one change of information lost, 1 ≤ x ≤ 16	SEV#117 ... #132

Table 68: Description of system events

Description of system event	Address offset
Host interface x: At least one pulse counter lost, 1 ≤ x ≤ 16	SEV#133 ... #148
CMU x is inoperable, 1 ≤ x ≤ 16	SEV#149 … #164
Database identity tag	SEV#174
Device reachable on redundant line x, 1 ≤ x ≤ 4	SEV#180 … #183
Device active on redundant line x, 1 ≤ x ≤ 4	SEV#184 … #187
Device preferred on redundant line x, 1 ≤ x ≤ 4	#SEV188 … #191
Network element x is operable, 1 ≤ x ≤ 32	SEV#192 … #223
CMU x is active, 1 ≤ x ≤ 16	SEV#224 … #239
Process command collision with host x, 1 ≤ x ≤ 16	SEV#242 ... #257
Command collision with Integrated HMI	SEV#258
Command collision with web server	SEV#259
Command collision with PLC	SEV#260
HMI Client x online,1 ≤ x ≤ 16	SEV#261 ... #276
PRP interface x: Network interface E1 link on, 1 ≤ x ≤ 8	SEV#277 ... #284
PRP interface x: Network interface E2 link on, 1 ≤ x ≤ 8	SEV#285 ... #292
Host interface x: SOE buffer filling status is not reached, 1 ≤ x ≤ 16	SEV#293 ... #308
CAM Client x online, 1 ≤ x ≤ 4	SEV#309 ... #312
RTC battery voltage low[1]	SEV#313

Table 68: Description of system events

1 540CID01, 540CMD01 and 560CMR01/02

13.2.1 SOE Buffer Filling Status System Events

SOE buffer filling status system events is strictly related with DNP3 host interface. It is possible to configure RTU to generate it when filling of SOE buffer for DNP3 host interface will overflowed configured threshold. Option can be set in DNP3 configuration and is named 'Queue filling alarm'.

13.3 System commands

System Single Commands (SSC) are accepted by the host communication interface with protocol DNP3. If the command is addressed to the RTU itself, the RTU performs the command. If the command is addressed to the connected subdevice, the SSC command is sent to the corresponding subinterface.

SSC supported	Description of SSC	Address offset
X	Set device out of service	#001
X	Reset device process	#002
X	Connect/disconnect device	#003
	Set redundant line 1 / 2 as preferred line	#004, #005
	Set redundant line 3 / 4 as preferred line	#006, #007
X	Force global process image update, i.e. force process image update of all subdevices	#012

Table 69: Description of system single commands (SSC)

SSC supported	Description of SSC	Address offset
X	Request redundancy change over for the active CMU x, 1 ≤ x ≤ 16	#016 … #031

Table 69: Description of system single commands (SSC)

13.3.1 Reset device process

The SSC command performs a reset for the addressed device. If the command is addressed to the RTU itself, the RTU performs a restart. If the command is addressed to the connected subdevice, the SSC command is sent to the corresponding sub-device interface.

RTU internal value	Status
off	<Ignored>
on	reset device process

Table 70: Conversion of values SSC#002

13.3.2 Force process image update

If the SSC command is addressed to the RTU itself, SSC commands "force process image update" are delegated to all sub-device interfaces. If the SSC command is addressed to the connected sub-device, the command is routed to the corresponding sub-device interface.

RTU internal value	Status
off	<Ignored>
on	Force process image update

Table 71: Conversion of values SSC#012

13.3.3 Request redundancy change over

The SSC command performs a switchover to the CMU specified by the command. If the command is addressed to the RTU itself, the RTU forces a CMU reset when the CMU is active and the standby partner is ok. If the command is addressed to the connected subdevice, the SSC command is sent to the corresponding subinterface.

RTU internal value	Status
off	<Ignored>
on	Request redundancy change over

Table 72: Conversion of values SSC#016 … #031

14 Secure Authentication

14.1 Introduction

Secure Authentication is a DNP3 protocol extension based on IEC 62351-5. It aims to address threats like frame spoofing, frame modification and replay attacks. It is meant to be a simple mechanism of challenges and replies. In case when master station attempts to perform action that needs to be authenticated outstation responds with Authentication Challenge. Before action will be executed it needs to be confirmed by master with use of agreed keys and cryptographic algorithms.

It is Application Layer extension only. That makes it possible to use it on both serial and Ethernet connections. It is done by adding new object group and several object variations that are used to manage authentication mechanisms.

DNP3 Secure Authentication does not provide complete encryption of transported data. Traffic is still vulnerable for sniffing.

Process makes use of two main elements which are Update Key and pair of Session Keys. Update Key is predefined in RTU configuration. It is used to encrypt a set of Session Keys that are exchanged in predefined interval. Master responsibility is to generate and provide RTU with random set. Session Keys are used to digitally sign critical messages.

14.2 Configure with RTUtil500

Feature can be configured in both serial and LAN/WAN DNP3 line configurator windows. There are several options that can be tuned:

Parameter name	Default	Parameter location
Enable Secure Authentication	Authentication disabled	Line DNP3
Enables and disables Secure Authentication for DNP3 line.		
Update Key		Line DNP3
Key that will be used by master for exchange of Session Keys. Need to be the same as configured on master side. Accepted in hexadecimal format. Length depends on Key Wrap Algorithm.		
Respond with Authentication Error Messages	Enabled	Line DNP3
Enables and disables Secure Authentication Errors.		
Max. Authentication Error Messages	2	Line DNP3
Maximal number of error frames that are possible to be send by RTU.		
Authentication Challenge Timeout	2	Line DNP3
Time in seconds within Authentication Replies for Authentication Challenges will be accepted.		
Session Key Count	1000	Line DNP3
Number of authenticated messages after which Session Keys set will be considered as invalid and need to be reloaded by master.		
Session Key Interval	900	Line DNP3
Time in seconds during which Session Keys set is considered valid. After this time master station need to reload those keys.		
HMAC Algorithm	1–SHA-1 / 3–SHA-256	Line DNP3
Algorithm used to calculate Message Authentication Codes. SHA1 and SHA256 algorithms are available.		
Key Wrap Algorithm	AES-128	Line DNP3
Algorithm used to encrypt Session Keys between master and RTU.		

Parameter name	Default	Parameter location
Enable Aggressive Mode	Disabled	Line DNP3
Enables and disables if RTU accepts Aggressive Mode requests. Aggressive Mode shortens authentication procedure as master sends request already authenticated – there will be no additional Challenge and Reply messages exchange.		

RTU supports one default user with ID 1 and additional 10 users with ID of master's choice. All users need to share same Update Key. However each user needs to have different Session Keys set.

14.3 Critical Functions Codes

RTU500 supports predefined list of a critical function codes. DNP3 standard [8] specifies a list of function codes that need to be considered as critical. Each request using this function codes will result with Authentication Challenge from RTU side unless it is send from Master in Aggressive Mode already authenticated.

Function code	Description
2	Write
3	Select
4	Operate
5	Direct Operate
6	Direct Operate – No Acknowledgment
13	Cold Restart
14	Warm Restart
20	Enable Unsolicited Responses
21	Disable Unsolicited Responses
24	Record Current Time
25	Open File
26	Close File
28	Get File Information
30	Abort File

Table 73: Critical Request function codes

14.4 Secure statistics

With Secure Authentication enabled RTU keeps track of events like unsuccessful Session Keys exchange. Increased number of these events may indicate that RTU is misconfigured and master with different Update Key is trying to connect or that outstation may be under attack. All events are available under group 120. They are also returned in Class 0 request if Secure Authentication is enabled. Several of different events may be logged.

Object Index Offset	Description
1	Authorization Failures
2	Authentication Failures
3	Reply Timeouts
4	Rekeys due to Authentication Failure

Table 74: Index of security statistics objects

Object Index Offset	Description
5	Total Messages Sent (not used)
6	Total Messages Received (not used)
7	Critical Messages Sent (not used)
8	Discarded Messages
9	Error Messages Sent
10	Error Messages Received
11	Successful Authentications
12	Session Keys Changes
13	Failed Session Keys Changes
14	Failed Session Keys Changes
15	Update Keys Changes
16	Failed Update Keys Changes
17	Rekeys due to Restart

Table 74: Index of security statistics objects

Index of object is calculated by Host Interface Number multiplied by 100 and move by Object Index Offset from Table. Those statistics are persisted between reboots.

For more information about specific event refer to DNP3 Specification [8].

14.5 Secure Authentication Errors

If Authentication Errors is enabled then in case of authentication operation failure proper message is sent in response. Each Error message contains error code and ASCII encoded human readable information what was the problem. An example of such error message may be a response to Aggressive Mode request when it is disabled in RTU configuration.

Error ID	Description
1	Authentication Failed
2 (deprecated)	Unexpected Response
3 (deprecated)	No response For Challenge Received
4	Aggressive Mode Not Supported
5	HMAC Not Supported
6	Wrap Algorithm Not Supported
7	Authorization Failed
8	Update Method Not Permitted
9	Invalid Signature
10	Invalid Certificate Data
11	Unknown User
12	Max Session Key Status Requests
128 (custom for RTU)	Too Many Users
129 (custom for RTU)	Frame Format Incorrect

Table 75: Error messages

15 Interoperability list

The following interoperability definitions are copied from DNP3 Subset Definitions, the original numbering and layout is maintained.

DNP V3.00

DEVICE PROFILE DOCUMENT

Vendor Name:	ABB AG Power Technologies Division Power Technology Systems
Device Name:	RTU500 series

Highest DNP Level Supported:		**Device Function:**	
For Requests (No Counter Events)	Level 3	Master	X Slave
For Responses (No Counter Events)	Level 3		

Notable objects, functions, and/or qualifiers supported in addition to the Highest DNP Levels Supported (the complete list is described in the attached table):

See attached table in chapter Data object library (page "17-3").

Maximum Data Link Frame Size (octets):		**Maximum Application Fragment Size (octets):**	
Transmitted	292	Transmitted (if >2048, must be configurable)	4096
Received	(must be 292)	Received	2048 (must be >= 249)

	Maximum Data Link Re-tries:		**Maximum Application Layer Re-tries:**
	None		None
	Fixed at ______________________		Configurable, range 0 to 255
X	Configurable, range __0_ to _15____	X	(Fixed is not permitted)

	Requires Data Link Layer Confirmation:		
	Never		
	Always		
	Sometimes	If 'Sometimes', when?	________________________________
X	Configurable	If 'Configurable', how?	Never, always, on large AL segments

	Requires Application Layer Confirmation:
	Never

Requires Application Layer Confirmation:			
	Always (not recommended)		
	When reporting Event Data (Slave devices only)		
	When sending multi-fragment responses (Slave devices only)		
	Sometimes	If 'Sometimes', when?	______________________________
X	Configurable	If 'Configurable', how?	Never, Always, When reporting event data

Timeouts while waiting for:							
Data Link Confirm		None	Fixed at ____	X	Variable		Configurable
Complete Appl. Fragment		None	Fixed at ____		Variable	X	Configurable
Application Confirm		None	Fixed at ____		Variable	X	Configurable
Complete Appl. Response		None	Fixed at ____		Variable	X	Configurable
Others	______________________________						

Sends / Execute Control Operations								
WRITE Binary Outputs		Never	X	Always		Sometimes		Configurable
Select / Operate		Never	X	Always		Sometimes		Configurable
Direct Operate		Never		Always		Sometimes	X	Configurable
Direct Operate, no ACK		Never	X	Always		Sometimes		Configurable
Count > 1	X	Never		Always		Sometimes		Configurable
Pulse ON		Never	X	Always		Sometimes		Configurable
Pulse OFF		Never	X	Always		Sometimes		Configurable
Latch ON1		Never		Always	X	Sometimes		Configurable
Latch OFF1		Never		Always	X	Sometimes		Configurable
Queue	X	Never		Always		Sometimes		Configurable
Clear Queue	X	Never		Always		Sometimes		Configurable

1Note:

Latch ON/OFF for Single Command Output (SCO) only.

	Reports Binary Input Change Events when no specific variation requested:		**Reports time-tagged Binary Input Change Events when no specific variation requested:**
	Never		Never
	Only time-tagged	X	Binary Input Change With Time
	Only non-time-tagged		Binary Input Change With Relative Time
X	Configurable to send both, one or the other		Configurable

	Sends Unsolicited Responses:		**Sends Static Data in Unsolicited Responses:**
	Never	X	Never
X	Configurable		When Device Restarts
	Only certain objects		When Status Flags Change

	Sends Unsolicited Responses:		Sends Static Data in Unsolicited Responses:
	Sometimes		No other options are permitted.
X	ENABLE/DISABLE UNSOLICITED Function codes supported		

	Default Counter Object/Variation:		Counters Roll Over at:
	No Counters Reported		No Counters Reported
	Configurable		Configurable
X	Default Object: 20 Default Variation: 1		16 bits
	Point-by-point list attached	X	32 bits
			Other value
			Point-by-point list attached

Sends Multi-Fragment Responses:	X	Yes	No

15.1 Data object library

The following implementation table includes all object variations, function codes and qualifiers which must be supported for DNP3-L3.

Object			REQUEST (slave must parse)		RESPONSE (master must parse)	
Obj.	**Var.**	**Description**	**Func. codes (dec)**	**Qual. codes (hex)**	**Func. codes**	**Qual. codes (hex)**
1	0	Binary Input – All Variations	1 , 22	00, 01, 06		
	1	Binary Input	1	00, 01, 06	129, 130	00, 01
	2	Binary Input with Status	1	00, 01, 06	129, 130	00, 01
2	0	Binary Input Change – All Variations	1	06, 07, 08		
	1	Binary Input Change without Time	1	06, 07, 08	129, 130	17, 28
	2	Binary Input Change with Time	1	06, 07, 08	129, 130	17, 28
	3	Binary Input Change with Relative Time	1	06, 07, 08	129, 130	17, 28
3	0	Double-bit Binary Input – All Variations	1, 22	06, 07, 08	129, 130	17, 28
	1	Double-bit Binary Input – Packed format	1	06, 07, 08	129, 130	17, 28
	2	Double-bit Binary Input – With flags	1	06, 07, 08	129, 130	17, 28

Object			REQUEST		RESPONSE	
			(slave must parse)		(master must parse)	
Obj.	**Var.**	**Description**	**Func. codes (dec)**	**Qual. codes (hex)**	**Func. codes**	**Qual. codes (hex)**
4	0	Double-bit Binary Input Event – All Variations	1	06, 07, 08	129, 130	17, 28
	1	Double-bit Binary Input Event – Without time	1	06, 07, 08	129, 130	17, 28
	2	Double-bit Binary Input Event – With absolute time	1	06, 07, 08	129, 130	17, 28
	3	Double-bit Binary Input Event – With relative time	1	06, 07, 08	129, 130	17, 28
10	0	Binary Output – All Variations	1	00, 01,06		
	1	Binary Output	2	17, 27, 28		
	2	Binary Output Status	1	00, 01, 06	129, 130	00, 01
11	0	Binary Output Event – All variations	1, 22	06, 07, 08	129, 130	17, 28
	1	Binary Output Event – Status without time	1	06, 07, 08	129, 130	17, 28
	2	Binary Output Event – Status with time	1	06, 07, 08	129, 130	17, 28
12	0	Control Block – All Variations				
	1	Control Relay Output Block	3, 4, 5, 6	17,27, 28	129	echo of request
	2	Pattern Control Block	5, 6	17, 28	129	echo of request
	3	Pattern Mask	5, 6	00, 01	130	echo of request
13	0	Binary Output Command Event – All variations	1, 22	06, 07, 08	129, 130	17, 28
	1	Binary Output Command Event – Command status without time	1	06, 07, 08	129, 130	17, 28
	2	Binary Output Command Event – Command status with time	1	06, 07, 08	129, 130	17, 28
20	0	Binary Counter – All Variations	1, 7, 8, 9, 10, 22	00, 01, 06		
	1	32-bit Binary Counter	1	00, 01, 06	129, 130	00, 01
	2	16-bit Binary Counter	1	00, 01, 06	129, 130	00, 01
	3	32-bit Delta Counter	1	00, 01, 06	129, 130	00, 01
	4	16-bit Delta Counter	1	00, 01, 06	129, 130	00, 01

Object			REQUEST (slave must parse)		RESPONSE (master must parse)	
Obj.	**Var.**	**Description**	**Func. codes (dec)**	**Qual. codes (hex)**	**Func. codes**	**Qual. codes (hex)**
	5	32-bit Binary Counter without Flag	1	00, 01, 06	129, 130	00, 01
	6	16-bit Binary Counter without Flag	1	00, 01, 06	129, 130	00, 01
	7	32-bit Delta Counter without Flag	1	00, 01, 06	129, 130	00, 01
	8	16-bit Delta Counter without Flag	1	00, 01, 06	129, 130	00, 01
21	0	Frozen Counter – All Variations	1,22	00, 01, 06		
	1	32-bit Frozen Counter	1	00, 01, 06	129, 130	00, 01
	2	16-bit Frozen Counter	1	00, 01, 06	129, 130	00, 01
	3	32-bit Frozen Delta Counter				
	4	16-bit Frozen Delta Counter				
	5	32-bit Frozen Counter with Time of Freeze				
	6	16-bit Frozen Counter with Time of Freeze				
	7	32-bit Frozen Delta Counter with Time of Freeze				
	8	16-bit Frozen Delta Counter with Time of Freeze				
	9	32-bit Frozen Counter without Flag	1	00, 01, 06	129, 130	00, 01
	10	16-bit Frozen Counter without Flag	1	00, 01, 06	129, 130	00, 01
	11	32-bit Frozen Delta Counter without Flag				
	12	16-bit Frozen Delta Counter without Flag				
22	0	Counter Change Event – All Variations	1	06, 07, 08		
	1	32-bit Counter Change Event without Time	1	06, 07, 08	129, 130	17, 28
	2	16-bit Counter Change Event without Time	1	06, 07, 08	129, 130	17, 28
	3	32-bit Delta Counter Change Event without Time				
	4	16-bit Delta Counter Change Event without Time				

Object			REQUEST		RESPONSE	
			(slave must parse)		(master must parse)	
Obj.	**Var.**	**Description**	**Func. codes (dec)**	**Qual. codes (hex)**	**Func. codes**	**Qual. codes (hex)**
	5	32-bit Counter Change Event with Time	1	06, 07, 08	129, 130	17, 28
	6	16-bit Counter Change Event with Time	1	06, 07, 08	129, 130	17, 28
	7	32-bit Delta Counter Change Event with Time				
	8	16-bit Delta Counter Change Event with Time				
23	0	Frozen Counter Event – All Variations				
	1	32-bit Frozen Counter Event without Time				
	2	16-bit Frozen Counter Event without Time				
	3	32-bit Frozen Delta Counter Event without Time				
	4	16-bit Frozen Delta Counter Event without Time				
	5	32-bit Frozen Counter Event with Time				
	6	16-bit Frozen Counter Event with Time				
	7	32-bit Frozen Delta Counter Event with Time				
	8	16-bit Frozen Delta Counter Event with Time				
30	0	Analog Input – All Variations	1, 22	00, 01, 06	129, 130	00, 01
	1	32-bit Analog Input	1	00, 01, 06	129, 130	00, 01
	2	16-bit Analog Input	1	00, 01, 06	129, 130	00, 01
	3	32-bit Analog Input without Flag	1	00, 01, 06	129, 130	00, 01
	4	16-bit Analog Input without Flag	1	00, 01, 06	129, 130	00, 01
	5	Analog Input – Single-prec flt-pt with flag	1	00, 01, 06	129, 130	00, 01
31	0	Frozen Analog Input – All Variations				
	1	32-bit Frozen Analog Input				

Object			REQUEST (slave must parse)		RESPONSE (master must parse)	
Obj.	**Var.**	**Description**	**Func. codes (dec)**	**Qual. codes (hex)**	**Func. codes**	**Qual. codes (hex)**
	2	16-bit Frozen Analog Input				
	3	32-bit Frozen Analog Input with Time of Freeze				
	4	16-bit Frozen Analog Input with Time of Freeze				
	5	32-bit Frozen Analog Input without Flag				
	6	16-bit Frozen Analog Input without Flag				
32	0	Analog Change Event – All Variations	1, 22	06, 07, 08	129, 130	
	1	32-bit Analog Change Event without Time	1	06, 07, 08	129, 130	17, 28
	2	16-bit Analog Change Event without Time	1	06, 07, 08	129, 130	17, 28
	3	32-bit Analog Change Event with Time	1	06, 07, 08	129, 130	17, 28
	4	16-bit Analog Change Event with Time	1	06, 07, 08	129, 130	17, 28
	5	Analog Input Event – Single-prec flt-pt without time	1	06, 07, 08	129, 130	17, 28
	7	Analog Input Event – Single-prec flt-pt with time	1	06, 07, 08	129, 130	17, 28
33	0	Frozen Analog Event – All Variations				
	1	32-bit Frozen Analog Event without Time				
	2	16-bit Frozen Analog Event without Time				
	3	32-bit Frozen Analog Event with Time				
	4	16-bit Frozen Analog Event with Time				
40	0	Analog Output Status – All Variations	1	00, 01, 06		
	1	32-bit Analog Output Status	1	00, 01, 06	129, 130	00, 01
	2	16-bit Analog Output Status	1	00, 01, 06	129, 130	00, 01
	3	Analog Output Status – Single-prec flt-pt with flag	1	00, 01, 06	129, 130	00, 01

Object			REQUEST		RESPONSE	
			(slave must parse)		(master must parse)	
Obj.	**Var.**	**Description**	**Func. codes (dec)**	**Qual. codes (hex)**	**Func. codes**	**Qual. codes (hex)**
41	0	Analog Output Block – All Variations				
	1	32-Bit Analog Output Block	3, 4, 5, 6	17, 28	129	echo of request
	2	16-Bit Analog Output Block	3, 4, 5, 6	17, 28	129	echo of request
	3	Analog Output – Single-prec flt-pt	3, 4, 5, 6	17, 28	129	echo of request
42	0	Analog Output Event – All variations	1, 22	06, 07, 08	129, 130	17, 28
	1	Analog Output Event – 32-bit without time	1	06, 07, 08	129, 130	17, 28
	2	Analog Output Event – 16-bit without time	1	06, 07, 08	129, 130	17, 28
	3	Analog Output Event – 32-bit with time	1	06, 07, 08	129, 130	17, 28
	4	Analog Output Event – 16-bit with time	1	06, 07, 08	129, 130	17, 28
	5	Analog Output Event – Single-prec flt-pt without time	1	06, 07, 08	129, 130	17, 28
	7	Analog Output Event – All variations	1	06, 07, 08	129, 130	17, 28
43	0	Analog Output Command Event – 32-bit without time	1, 22	06, 07, 08	129, 130	17, 28
	1	Analog Output Command Event – 32-bit without time	1	06, 07, 08	129, 130	17, 28
	2	Analog Output Command Event – 16-bit without time	1	06, 07, 08	129, 130	17, 28
	3	Analog Output Command Event – 32-bit with time	1	06, 07, 08	129, 130	17, 28
	4	Analog Output Command Event – 16-bit with time	1	06, 07, 08	129, 130	17, 28
	5	Analog Output Command Event – Single-prec flt-pt without time	1	06, 07, 08	129, 130	17, 28
	7	Analog Output Command Event – Single-prec flt-pt with time	1	06, 07, 08	129, 130	17, 28

Object			REQUEST (slave must parse)		RESPONSE (master must parse)	
Obj.	**Var.**	**Description**	**Func. codes (dec)**	**Qual. codes (hex)**	**Func. codes**	**Qual. codes (hex)**
50	0	Time and Date – All Variations				
	1	Time and Date	1, 2	07 where quantity = 1		
	2	Time and Date with Interval				
	3	Time and Date at last recorded time	2	07 where quantity = 1		
51	0	Time and Date CTO – All Variations				
	1	Time and Date CTO		129, 130	07, quan-tity=1	
	2	Unsynchronized Time and Date CTO		129, 130	07, quan-tity=1	
52	0					
	1	Time Delay Coarse		129	07, quan-tity=1	
	2	Time Delay Fine		129	07, quan-tity=1	
60	0					
	1	Class 0 Data	1	06		
	2	Class 1 Data	1	06, 07, 08		
			20, 21, 22	06		
	3	Class 2 Data	1	06, 07, 08		
			20, 21, 22	06		
	4	Class 3 Data	1	06, 07, 08		
			20, 21, 22	06		
70	3	File Command	25	11		
	4	File Command Status	26, 30, 1	11	129	11
	5	File Transport	1, 2	11	129	
	6	File Transport Status			129	11
	7	File Descriptor	28	11	129	11
80	1	Internal Indications	2	00 index=7		
81	1	Storage Object				
82	1	Device Profile				
83	1	Private Registration Object				
	2	Private Registration Object Descriptor				
90	1	Application Identifier				
100	1	Short Floating Point				
	2	Long Floating Point				

Object			REQUEST (slave must parse)		RESPONSE (master must parse)	
Obj.	**Var.**	**Description**	**Func. codes (dec)**	**Qual. codes (hex)**	**Func. codes**	**Qual. codes (hex)**
	3	Extended Floating Point				
101	1	Small Packed Binary-Coded Decimal				
	2	Medium Packed Binary-Coded Decimal				
	3	Large Packed Binary-Coded Decimal				
112	1 - 255	Virtual Terminal Output Block				
113	1 - 255	Virtual Terminal Event Data				
120	1	Authentication Challenge	32	91	131	91
	2	Authentication Reply	32	91	131	91
	3	Aggressive Mode Request	Main request code	07	131	07
	4	Session Key Status Request	32	07		
	5	Session Key Status			131	91
	6	Session Key Change	32	91		
	7	Authentication Error	33	91	131	91
	9	Message Authentication Code	32	91	131	91
121	1	Security Statistics 32 bit with flag	1	06	131	01, 02
		No Object	13			
		No Object	23			

16 Glossary

AC	Alternating Current
AES	Advanced Encryption Standard
AMI	Analog Measured value Input
ASO	Analog Setpoint command Output
BSI	Bit String Input
BSO	Bit String Output
CAM	Central User Account Management
CHAP	Challenge Handshake Authentication Protocol
CMU	Communication and Data Processing Unit
CTO	Common Time Object
CTS	Clear to Send
DCD	Data Carrier Detect
DCE	Data Communication Equipment
DCO	**D**ouble **C**ommand **O**utput
DMI	Digital Measured value Input (8, 16 bit)
DO	Digital Output
DPI	Double Point Input
DSO	Digital Setpoint command Output (8, 16 bit)
EPI	Event of Protection equipment Input (1 bit)
FDR	File transfer directory
FSO	Floating Setpoint Command Output
FTR	File transfer file
GCD	General Configuration Data
GSM	Global Standard for Mobile Communications
HCI	Human Maschine Interface (here Integrated HMI function of the RTU500 series)
IED	Intelligent Electronic Device
IIN	Internal Indication
IOD	Input Output Data
ITI	Integrated Totals Input
MAX	Maximum
MFI	Analog Measured value Floating Input

Min	Minimum
MS	Microsoft
PDP	Process Data Processing
PIN	Personal Identity Number
PLC	Programmable Logic Control
PRP	Parallel Redundancy Protocol
RCD	RTU Configuration Data
RCO	Regulation step Command Output
RTC	Real Time Clock
RTS	Request to Send
RTU	Remote Terminal Unit
SCI	Sub-Device Communication Interface
SCO	Single Command Output
SEV	System Event
SHA	Secure Hash Algorithms
SNTP	Simple Network Time Protocol (according to RFC 4330)
SOE	Sequence-of-Event Queue
SPI	Single Point Input or Single point information
SSC	System Single Command
STI	Step position Input
TCP/IP	Transmission Control Protocol / Internet Protocol
Tx	Transmit Direction
UDP	User Datagram Protocol

Note:

The specifications, data, design or other information contained in this document (the “Brochure”) - together: the “Information” - shall only be for information purposes and shall in no respect be binding. The Brochure does not claim to be exhaustive. Technical data in the Information are only approximate figures. We reserve the right at any time to make technical changes or modify the contents of this document without prior notice. The user shall be solely responsible for the use of any application example or information described within this document. The described examples and solutions are examples only and do not represent any comprehensive or complete solution. The user shall determine at its sole discretion, or as the case may be, customize, program or add value to the ABB products including software by creating solutions for the end customer and to assess whether and to what extent the products are suitable and need to be adjusted or customized.

This product is designed to be connected to and to communicate information and data via a network interface. It is the users sole responsibility to provide and continuously ensure a secure connection between the product and users or end customers network or any other network (as the case may be). The user shall establish and maintain any appropriate measures (such as but not limited to the installation of firewalls, application of authentication measures, encryption of data, installation of anti-virus programs, etc) to protect the product, the network, its system and the interface against any kind of security breaches, unauthorized access, interference, intrusion, leakage and/or theft of data or information. ABB AG is not liable for any damages and/or losses related to such security breaches, any unauthorized access, interference, intrusion, leakage and/or theft of data or information.

ABB AG shall be under no warranty whatsoever whether express or implied and assumes no responsibility for the information contained in this document or for any errors that may appear in this document. ABB AG's liability under or in connection with this Brochure or the files included within the Brochure, irrespective of the legal ground towards any person or entity, to which the Brochure has been made available, in view of any damages including costs or losses shall be excluded. In particular ABB AG shall in no event be liable for any indirect, consequential or special damages, such as – but not limited to – loss of profit, loss of production, loss of revenue, loss of data, loss of use, loss of earnings, cost of capital or cost connected with an interruption of business or operation, third party claims. The exclusion of liability shall not apply in the case of intention or gross negligence. The present declaration shall be governed by and construed in accordance with the laws of Switzerland under exclusion of its conflict of laws rules and of the Vienna Convention on the International Sale of Goods (CISG).

Visit us

ABB AG
Power Grids
P.O. Box 10 03 51
68128 Mannheim, Germany

www.abb.com/remote-terminal-units

1KGT 150 489 V030 1

RTU500 series

RTU500 series Remote Terminal Unit
Protocol description
Host Communication Interface with SNMP

Power and productivity
for a better world™

Revision

Document identity:		1KGT 150 963 V000 1
Revision:	Date:	Changes:
0	03/2017	New document

Contents

1 Introduction 1-1
1.1 Preface 1-1
1.2 References 1-1
1.3 Conventions 1-1

2 Physical Layer 2-1
2.1 IP based Communication 2-1
2.2 Host interface 2-1

3 Application Layer 3-1
3.1 General 3-1
3.2 SNMP Interface 3-2
3.3 Object Identifiers (OIDs) 3-3
3.4 OID Data Types 3-3
3.5 SNMP Messages 3-4

4 Parameters and addressing 4-1
4.1 General data point parameters 4-1
4.2 Address elements 4-1

5 Data Types - Monitoring Direction 5-1
5.1 SPI – Single Point Information 5-1
5.1.1 Supported Data Types 5-1
5.1.2 Additional Information 5-1
5.1.3 Conversion of Values 5-1
5.1.4 Conversion of Quality Descriptors 5-1
5.1.5 Conversion of Cause of Transmission 5-2

6 Internal Functions 6-1
6.1 System events 6-1

7 Interoperability List 7-1
7.1 MIB System Group 7-1
7.2 MIB Enterprise RTU500 7-1
7.2.1 MIB Configuration Versions 7-2
7.2.2 MIB Table of IEDs/ SubRTUs 7-2
7.2.3 MIB Table of CMUs 7-2
7.2.4 MIB System Events of the RTU 7-3
7.2.5 MIB Table of System Events of IEDs/ SubRTUs 7-6
7.2.6 MIB Configured SPIs 7-7

8 Glossary 8-1

1 Introduction

1.1 Preface

This document describes the functions of the host communication interface in RTU500 series according to SNMP.

1.2 References

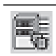
[1] RFC 1441 - Transmission protocols Introduction to version 2 of the Internet-standard Network Management Framework
[2] RFC 3411 –An Architecture for Describing Simple Network Management Protocol (SNMP) Management Frameworks
[3] RFC 3412 - Message Processing and Dispatching for the Simple Network Management Protocol (SNMP)
[4] RTU500 series Interfaces and Protocols Release 12 (1KGT 150 939)
[5] User Manual RTUtil500 Release 12 (1KGT 150 950)

1.3 Conventions

In this document function codes of data types according to SNMP are marked with brackets: <Function code>

Bold fonts with the table heading "Parameter name" are references to configuration parameters in RTUtil500. The parameter is followed by the parameter location where to find this parameter in RTUtil500. The first element of the parameter location defines the node in the hardware tree on the left side (e. g. RTU, CMU, line, IED) and the second element defines selected header control tab in the parameter window on the right side (e. g. general, interfaces, protocol).

Example:

	**Parameter name**	**Default**	**Parameter location**
In use		enabled	data point (e.g. SPI) - line GP SNMP
If enabled, the data point is transmitted to the host communication interface. This setting refers to data in monitoring and command direction.			

2 Physical Layer

2.1 IP based Communication

The protocol SNMP is running on the Ethernet-Interfaces of the CMU. For more details see RTU500 series Interfaces and Protocols Release 12 (1KGT 150 939).

For each Ethernet interface following parameters can be configured:

Parameter name	Default	Parameter location
Interface mode	Auto-negotiation	CMU - Network Interfaces
Transmisssion rate and duplex modes. Possible values are: - 100BaseTx half duplex - 100BaseTx full duplex - 10BaseT half duplex - 10BaseT full duplex - Auto-negotiation Default value: Auto-negotiation		
Node name	none	CMU - Network Interfaces
Node name of RTU at this ethernet interface		
IP Address	0.0.0.0	CMU - Network Interfaces
IP Address of this RTU interface		
Subnet mask	0.0.0.0	CMU - Network Interfaces
Subnet mask of IP address		
Default gateway IP	0.0.0.0	CMU - Network Interfaces
IP address of default gateway		

Following Ethernet line parameters can be configured for the master:

Parameter name	Default	Parameter location
Trap destination IP address	disabled	Line GP SNMP - General Parameter
IP address of the SNMP manager where traps will be sent. Value Range: disabled or valid IP address		
Trap destination port number	162	Line GP SNMP - General Parameter
IP port of the SNMP manager where traps will be sent. Value range: 1 ... 65535		

2.2 Host interface

All host interfaces will be configured according to the following table.

Parameter name	Default	Parameter location
Host number	1	CMU - all interfaces
Logical number of this host interface. Value range: 1 to 16. The Host Number has to be unique in a system, and will point to the data in the system event block		

Parameter name	Default	Parameter location
Host offline timeout	600 sec	Line GP SNMP - General Parameter
Supervision timeout for the system event "host online".		

3 Application Layer

3.1 General

SNMP is an Application Layer Protocol that uses UDP as a Transport Protocol. RTU500 series fulfills the requirements of SNMP version 2 and version 3.

The following parameters must be configured:

Parameter name	Default	Parameter location
Enable SNMPv2	enabled	Line GP SNMP - General Parameter
if enabled: SNMP V2 and SNMP V3 is supported. if disabled: only SNMP V3 is supported.		
Community string (SNMPv2)	public	Line GP SNMP - General Parameter
The “SNMP Community string” is like a user id or password that allows access to the SNMP data of the RTU.		

Table 1: SNMP V2 compatibility parameters

Parameter name	Default	Parameter location
User name		Line GP SNMP - General Parameter
User name for authentification		
Security level	noAuthNoPriv	Line GP SNMP - General Parameter
Security level of SNMPv3. Value range: - noAuthNoPriv: no authentication and no privacy - AuthNoPriv: authentication, but no privacy - AuthPriv: authentication and privacy (encryption)		
Authentication protocol	SHA1	Line GP SNMP - General Parameter
Authentication protocol of SNMPv3 Value range: – None – SHA1 – MD5		
Authentication protocol password		Line GP SNMP - General Parameter
Password for the authentication protocol. (minimum 8 characters)		
Privacy protocol	None	Line GP SNMP - General Parameter
Privacy protocol of SNMPv3 Value range: – None – AES128 – DES		
Privacy protocol password		Line GP SNMP - General Parameter
Password for the privacy protocol. (minimum 8 characters)		

Table 2: SNMP V3 security parameters

Parameter name	Default	Parameter location
System description		Line GP SNMP - General Parameter
System description used for MIB Tree "sysDescr"OID: 1.3.6.1.2.1.1.1		
System location		Line GP SNMP - General Parameter
System location used for MIB Tree "sysLocation"OID: 1.3.6.1.2.1.1.6		
System contact		Line GP SNMP - General Parameter
System contact used for MIB Tree "sysContact"OID: 1.3.6.1.2.1.1.5		

Table 3: SNMP system group configuration

3.2 SNMP Interface

The SNMP HCI interface runs an SNMP agent which answers requests from the network. The agent provides a number of Object Identifiers (OIDs). An OID can be thought as the “name of a variable". The agent populates the values of the variables and makes them available. An SNMP manager (client) can then query the agents OIDs for specific information. The collection of all the objects of an SNMP agent makes up the MIB (Management Information Base), which can be described in a text document according to the standard.

SNMP is based on several other standards including the Abstract Syntax Notation 1 Basic Encoding Rules (ASN.1 BER) which defines the SNMP used data types and the Structure of Management Information (SMI) which details the grammar used by SNMP MIBs.

3.3 Object Identifiers (OIDs)

OIDs, or Object Identifiers, uniquely identify key values offered by an SNMP Agent. SNMP OIDs are laid out in a hierarchy forming unique addresses into a tree. Like many other forms of addressing, OIDs can be used in 2 forms: fully qualified and relative (sometimes called ”relevant”).

The fully qualified form starts from the root and moves outward to the individual value on a device. An example of a fully qualified address is:
– .1.3.6.1.4.1.789.1.6.4.8.0

This OID could be written in human readable form as:
– .iso.org.dod.internet.private.enterprises.netapp.netapp1.raid.diskSummary.diskSpareCount.0

All fully qualified OIDs will begin with .iso.org.dod.internet.private represented numerically as .1.3.6.1.4. Almost all OIDs will then be followed by enterprises (.1) and a unique number for the vendor as assigned by the Internet Assigned Numbers Authority (IANA). Everything beyond the vendor ID is based on the vendors implementation and may vary between implementations.

The complete list of enterprise assignments can be found at the IANA website:
– http://www.iana.org/assignments/enterprise-numbers

The relative form of an OID, on the other hand, begins from the enterprises value and leaves all the implied addressing off.

The OID for the RTU500 upto the enterprise ID is (refered as *):
– 1.3.6.1.4.1.27527.10
– iso.org.dod.internet.private.enterprises.abb.rtu500

3.4 OID Data Types

SMI defines a fixed number of datatypes which are returned by OIDs. These datatypes include:
– Integer Signed:
  32bit Integer (values between -2147483648 and 2147483647)
– Integer32:
  Same as Integer Signed
– UInteger32:
  Unsigned 32bit Integer (values between 0 and 4294967295)
– Octet String:
  Arbitrary binary or textual data, typically limited to 255 characters in length
– Object Identifier:
  An OID
– Bit String:
  Represents an enumeration of named bits. This is an unsigned datatype
– IpAddress:
  An IP address

- Counter32:
  Represents a non-negative integer which monotonically increases until it reaches a maximum value of 32bits-1 (4294967295 dec), when it wraps around and starts increasing again from zero
- Counter64:
  Same as Counter32 but has a maximum value of 64bits-1
- TimeTicks:
  Represents an unsigned integer which represents the time, modulo 2ˆ32 (4294967296 dec), in hundredths of a second between two epochs
- NsapAddress:
  Represents an OSI address as a variable-length OCTET STRING

3.5 SNMP Messages

SNMP foresees the following types of messages. Every message defines its own PDU (Protocol Data Unit):

- GetRequest:
  The basic SNMP request message. Sent by a management system, it requests information about a single MIB entry on an agent — for example, the amount of free drive space.
- GetNextRequest:
  An extended type of request message that can be used to browse the entire hierarchy of management objects. When it processes a GET-NEXT request for a particular object, the agent returns the identity and value of the object that logically follows the previous information that was sent. The GET-NEXT request is useful mostly for dynamic tables, such as an internal IP route table.
- GetBulk:
  A request that the data transferred by the agent be as large as possible within the given restraints of message size. This minimizes the number of protocol exchanges required to retrieve a large amount of management information.
- SetRequest:
  A message that can be used to send and assign an updated MIB value to the agent when write access is permitted.
- Notify:
  Also called a trap message, NOTIFY is an unsolicited message that is sent by an agent to a management system when the agent detects a certain type of event. For example, a trap message might be sent when a system restart occurs. The management system that receives the trap message is referred to as the trap destination.

UDP port 161 is used to listen for SNMP messages and port 162 (unless configured otherwise) is used to listen for SNMP traps.

4 Parameters and addressing

4.1 General data point parameters

	Parameter name	Default	Parameter location
In use		enabled	data point (e.g. SPI) - line GP SNMP
If enabled, the data point is transmitted to the host communication interface. This setting refers to data in monitoring and command direction.			

	Parameter name	Default	Parameter location
Notification enabled		disabled	SPI - line GP SNMP
If enabled: Notification will be active for this data point			
Notification hysteresis time		0	SPI - line GP SNMP
Hysteresis time between notifications for this data point. Value range: 10 ... 600 sec			

Table 4: General data point parameters

4.2 Address elements

Selection according to [1].

	Parameter name	Default	Parameter location
SPI ID		1	SPI - line GP SNMP
ID of SPI mapped to project specific MIB with OID 1.3.6.1.4.1.27527.10.7.SPI_ID.x With: Name (x=1), state (x=2) Value range: 1…100			

5 Data Types - Monitoring Direction

5.1 SPI – Single Point Information

Binary process information is indicated by one bit.

5.1.1 Supported Data Types

SNMP	RTU		
OID	Data type	Parameter name	Parameter location
SPI Name: 1.3.6.1.4.1.27527.10.7.{SPI ID}.1	SPI		
SPI State: 1.3.6.1.4.1.27527.10.7.{SPI ID}.2 0: ON; 1: OFF; 2: not configured 3: invalid	SPI		

Table 5: SPI - Supported data types

5.1.2 Additional Information

None

5.1.3 Conversion of Values

RTU internal value	SNMP state (X= .2)
off	0 - false
on	1 - true
	2 - not configured
	3 - invalid

Table 6: SPI - Conversion of values

5.1.4 Conversion of Quality Descriptors

RTU		SNMP
Internal communication (short)	Internal communication (long)	Communication state (x= .2)
BL	Blocked	N/A
SB	Substituted	N/A
NT	Not Topical	N/A
IV	Invalid	3 - invalid

Table 7: SPI - Conversion of quality descriptors

5.1.5 Conversion of Cause of Transmission

RTU		SNMP
Internal communication (short)	**Internal communication (long)**	**Communication**
T	Test	N/A
P/N	Positive/negative confirmation	- Irrelevant -
Cause	Spontaneous	N/A
	Requested	N/A
	Interrogated	N/A

Table 8: SPI - Conversion of causes of transmission

6 Internal Functions

6.1 System events

The host interface manages internal status messages of the RTU500 series. These status messages can be created from the host itself or other activities of the RTU500 series. The system events of other activities are sent via internal communication and are processed by the HCI.

Parameter name	Default	Parameter location
Fix SEV address schema	enabled	SDI - line
Value range: enabled/ disabled if enabled: a base address for the whole block of system events is defined at the SDI node if disabled: individual addresses per SEV can be defined In order to avoid collisions, the addresses of the system events may not be used for other process objects.		
In use	enabled	SDI - line
Value range: enabled/ disabled if disabled: no SEVs will be transmitted on this line		

The following table shows the system events available for the host interface:

Description of system event	Address offset
At least one indication faulty	SEV#016
At least one analog value faulty	SEV#017
At least one digital value faulty	SEV#018
At least one integrated total faulty	SEV#019
At least one object or regulation command faulty	SEV#020
At least one analog output faulty	SEV#021
At least one digital output faulty	SEV#022
RTU is faulty	SEV#023
Device/ RTU active	SEV#024
RTU synchronized	SEV#025
External clock inoperable	SEV#026
Local printer offline	SEV#027
At least one indication oscillating	SEV#028
Battery voltage low (RTU560E only)	SEV#029
AC power supply failure (RTU560E only)	SEV#030
Test mode active	SEV#042
At least one data object simulated	SEV#043
At least one data communication equipment (DCE) faulty	SEV#044

Table 9: Description of system events

Description of system event	Address offset
Device connected	SEV#045
At least one PLC function not running	SEV#046
At least one PLC function cycle time exceeded	SEV#047
Device/ RTU inoperable	SEV#048
Device/ RTU is out of service	SEV#049
Power supply failure in RTU central sub-rack	SEV#059
Command supervision circuit x disconnected or faulty, 1 ≤ x ≤ 32	SEV#064 ... #095
SNTP client 1 is synchronized	SEV#096
SNTP client 2 is synchronized	SEV#097
Local control authority active	SEV#100
Host x Online, 1 ≤ x ≤ 16	SEV#101 ... #116
Host interface x: At least one change of information lost, 1 ≤ x ≤ 16	SEV#117 ... #132
Host interface x: At least one pulse counter lost, 1 ≤ x ≤ 16	SEV#133 ... #148
CMU x is inoperable, 1 ≤ x ≤ 16	SEV#149 … #164
Database identity tag	SEV#174
Device reachable on redundant line x, 1 ≤ x ≤ 4	SEV#180 … #183
Device active on redundant line x, 1 ≤ x ≤ 4	SEV#184 … #187
Device preferred on redundant line x, 1 ≤ x ≤ 4	#SEV188 … #191
Network element x is operable, 1 ≤ x ≤ 32	SEV#192 … #223
CMU x is active, 1 ≤ x ≤ 16	SEV#224 … #239
Process command collision with host x, 1 ≤ x ≤ 16	SEV#242 ... #257
Command collision with Integrated HMI	SEV#258
Command collision with web server	SEV#259
Command collision with PLC	SEV#260
HMI Client x online,1 ≤ x ≤ 8	SEV#261 ... #268
PRP interface x: Network interface E1 link on, 1 ≤ x ≤ 8	SEV#277 ... #284
PRP interface x: Network interface E2 link on, 1 ≤ x ≤ 8	SEV#285 ... #292

Table 9: Description of system events

7 Interoperability List

7.1 MIB System Group

OID	MIB Tree	Format	Value
1.3.6.1.2.1.1.1	sysDescr	String	As configured
1.3.6.1.2.1.1.2	sysObjectID	String	enterprises.8072.3.2.255
1.3.6.1.2.1.1.3	sysUptime	TimeTicks	The time (in hundredth of a second) since the network management portion of the system (the SNMP agent) was last re-initialized.
1.3.6.1.2.1.1.4	sysContact	String	As configured
1.3.6.1.2.1.1.5	sysName	String	RTU500
1.3.6.1.2.1.1.6	sysLocation	String	As configured

Table 10: SNMP System Group

7.2 MIB Enterprise RTU500

OID[1)]	MIB Tree[2)]	Format	Description
*.2.1.x	*.config.configVersion.x		Configuration versions "Tab. 12: ABB-RTU500-MIB Configuration Versions"
*.2.2	*.config.ioDeviceNumber	Integer	Number of IEDs/SubRTUs
*.2.3.x	*.config.ioDeviceCfgTable.x	Table	Table of IEDs/SubRTUs "Tab. 13: ABB-RTU500-MIB OIDs of Table of IED/SubRTUs"
*.3.1	*.diagnostics.cmuNumber	Integer	Number of CMUs in RTU500
*.3.2.x	*.diagnostics.cmuTable.x	Table	Table of CMUs in RTU500 "Tab. 14: ABB-RTU500-MIB OIDS of Table of CMUs"
*.4.1	*.notifications.rtuSevStateNotification	OID	OID. of the trap sent on RTU System Events
*.4.2	*.notifications.ioDeviceSevStateNotification	OID.	OID. of the trap sent on IO Devices System Events
*.4.3	*.notifications.spiStateNotification	OID.	OID. of the trap sent on SPI Status Changes
*.5.1.x	*.systemEvent.rtuSev.rtuSevState.x		System events of the RTU "Tab. 15: ABB-RTU500 MIB System Events of the RTU"
*.5.2.x	*.systemEvent.ioDeviceServ.ioDeviceSevStateTable.x	Table	Table of system events of the IEDs/subRTUs "Tab. 16: ABB-RTU500-MIB Table of System Events of IEDs/ SubRTUs"

Table 11: ABB RTU500 MIB

OID[1)]	MIB Tree[2)]	Format	Description
*.7.{SPI ID}.x	*.processData.spi{SPI ID}.x		Configured SPIs "Tab. 17: ABB-RTU500-MIB Configured SPIs"

Table 11: ABB RTU500 MIB

1) *= .1.3.6.1.4.1.27527.10
2) *= .iso.org.dod.internet.private.enterprises.abb.rtu500

7.2.1 MIB Configuration Versions

OID[1)]	MIB Tree[2)]	Format	Description
*.2.1.1	*.config.configVersion.rcdActiveConfigVersion	String	Version number/Revision number of active RCD configuration file
*.2.1.2	*.config.configVersion.rcdActiveConfigCreationTime	String	Creation time active RCD configuration file
*.2.1.3	*.config.configVersion.rcdActiveConfigLastMaintainer	String	Name of last maintainer of RCD configuration file

Table 12: ABB-RTU500-MIB Configuration Versions

1) *= .1.3.6.1.4.1.27527.10
2) *= .iso.org.dod.internet.private.enterprises.abb.rtu500

7.2.2 MIB Table of IEDs/ SubRTUs

OID[1)]	MIB Tree[2)]	Format	Description
*.2.2	*.config.ioDeviceNumber	Integer	Number of IEDs/SubRTUs
*.2.3.1.1.x	*.config.ioDeviceCfgTable.ioDeviceCfgTableEntry. ioDeviceType	String	IED/subRTU type (e.g. IED, RTU520, RTU560) x= 1… ioDeviceNumber
*.2.3.1.2.x	*.config.ioDeviceCfgTable.ioDeviceCfgTableEntry. ioDeviceName	String	IED/subRTU name according to RTUtil configuration x= 1… ioDeviceNumber
*.2.3.1.3.x	*.config.ioDeviceCfgTable.ioDeviceCfgTableEntry. ioDeviceIndex	Integer	MIB table index x= 1… ioDeviceNumber

Table 13: ABB-RTU500-MIB OIDs of Table of IED/SubRTUs

1) *= .1.3.6.1.4.1.27527.10
2) *= .iso.org.dod.internet.private.enterprises.abb.rtu500

7.2.3 MIB Table of CMUs

OID[1)]	MIB Tree	Format	Description
*.3.1	*.diagnostics.cmuNumber	Integer	

Table 14: ABB-RTU500-MIB OIDS of Table of CMUs

OID[1]	MIB Tree	Format	Description
*.3.2.1.1.x	*.diagnostics.cmuTable.cmuTableEntry.c-muNo	Integer	CMU number according to RTUtil config-uration x= 1... cmuNumber
*.3.2.1.2.x	*.diagnostics.cmuTable.cmuTableEntry.c-muFwVersion	String	CMU firmware version (e.g. "12.2.1.0") x = 1… cmuNumber
*.3.2.1.3.x	*.diagnostics.cmuTable.cmuTableEntry.c-muCpuUsage	Integer (0... 100)	CPU usage in % x = 1… cmuNumber
*.3.2.1.4.x	*.diagnostics.cmuTable.cmuTableEn-try.freeMemory	Integer	Free memory in KB x = 1… cmuNumber
*.3.2.1.5.x	*.diagnostics.cmuTable.cmuTableEntry.c-muIndex	Integer	MIB table index x= 1... cmuNumber

Table 14: ABB-RTU500-MIB OIDS of Table of CMUs

1) ***= .1.3.6.1.4.1.27527.10**
2) ***= .iso.org.dod.internet.private.enterprises.abb.rtu500**

7.2.4 MIB System Events of the RTU

OID[1]	MIB Tree[2]	Format	Description
*.5.1.1.1	*.systemEvent.rtuSev.rtuSevState .rtuSevAtLeastOneIndicationFaultyState	Integer (0, 1, 2, 3)	SEV#016: At least one indication faulty
*.5.1.1.2	*.systemEvent.rtuSev.rtuSevState .rtuSevAtLeastOneAnalogValueFaultyState	Integer (0, 1, 2, 3)	SEV#017: At least one analog value faulty
*.5.1.1.3	*.systemEvent.rtuSev.rtuSevState .rtuSevAtLeastOneDigitalValueFaultyState	Integer (0, 1, 2, 3)	SEV#018: At least one digital value faulty
*.5.1.1.4	*.systemEvent.rtuSev.rtuSevState .rtuSevAtLeastOnePulseCounterValueFaultyState	Integer (0, 1, 2, 3)	SEV#019: At least one integrated total faulty
*.5.1.1.5	*.systemEvent.rtuSev.rtuSevState .rtuSevAtLeastOneObjectCommandFaultyState	Integer (0, 1, 2, 3)	SEV#020: At least one object or regulation command faulty
*.5.1.1.6	*.systemEvent.rtuSev.rtuSevState .rtuSevAtLeastOneAnalogOutputFaultyState	Integer (0, 1, 2, 3)	SEV#021: At least one analog out-put faulty
*.5.1.1.7	*.systemEvent.rtuSev.rtuSevState .rtuSevAtLeastOneDigitalOutputFaultyState	Integer (0, 1, 2, 3)	SEV#022: At least one digital out-put faulty
*.5.1.1.8	*.systemEvent.rtuSev.rtuSevState .rtuSevRtuFaultyState	Integer (0, 1, 2, 3)	SEV#023: RTU is faulty
*.5.1.1.9	*.systemEvent.rtuSev.rtuSevState .rtuSevRtuActiveState	Integer (0, 1, 2, 3)	SEV#024: RTU active
*.5.1.1.10	*.systemEvent.rtuSev.rtuSevState .rtuSevSynchronizedState	Integer (0, 1, 2, 3)	SEV#025: RTU synchronized
*.5.1.1.11	*.systemEvent.rtuSev.rtuSevState .rtuSevClockInoperableState	Integer (0, 1, 2, 3)	SEV#026: External clock inoperable
*.5.1.1.12	*.systemEvent.rtuSev.rtuSevState .rtuSevPrinterOfflineState	Integer (0, 1, 2, 3)	SEV#027: Local printer offline

Table 15: ABB-RTU500 MIB System Events of the RTU

OID[1)]	MIB Tree[2)]	Format	Description
*.5.1.1.13	*.systemEvent.rtuSev.rtuSevState .rtuSevAtLeastOneIndicationOscillatingState	Integer (0, 1, 2, 3)	SEV#028: At least one indication oscillating
*.5.1.1.14	*.systemEvent.rtuSev.rtuSevState .rtuSevBatteryLowState	Integer (0, 1, 2, 3)	SEV#029: Battery voltage low
*.5.1.1.15	*.systemEvent.rtuSev.rtuSevState .rtuSevACFailureState	Integer (0, 1, 2, 3)	SEV#030: AC power supply failure
*.5.1.1.16	*.systemEvent.rtuSev.rtuSevState .rtuSevTestModeActiveState	Integer (0, 1, 2, 3)	SEV#042: Signal test mode active
*.5.1.1.17	*.systemEvent.rtuSev.rtuSevState .rtuSevAtLeastOneObjectSimulatedState	Integer (0, 1, 2, 3)	SEV#043: At least one process object or system object simulated
*.5.1.1.18	*.systemEvent.rtuSev.rtuSevState .rtuSevAtLeastOneDCEFaultyState	Integer (0, 1, 2, 3)	SEV#044: At least one DCE (data com-munication equipment) is faulty
*.5.1.1.19	*.systemEvent.rtuSev.rtuSevState .rtuSevDeviceConnectedState	Integer (0, 1, 2, 3)	SEV#045: Device is connected (in case of dial-up)
*.5.1.1.20	*.systemEvent.rtuSev.rtuSevState .rtuSevAtLeastOnePLCInactiveState	Integer (0, 1, 2, 3)	SEV#046: At least one PLC-function is not active
*.5.1.1.21	*.systemEvent.rtuSev.rtuSevState .rtuSevAtLeastOnePLCCycleTimeExceededState	Integer (0, 1, 2, 3)	SEV#047: At least one PLC-function exceeded cycletime by watchdog or system-overload
*.5.1.1.22	*.systemEvent.rtuSev .rtuSevState.rtuSevRtuInoperableState	Integer (0, 1, 2, 3)	SEV#048: RTU inoperable
*.5.1.1.23	*.systemEvent.rtuSev.rtuSevState .rtuSevRtuOutOfServiceState	Integer (0, 1, 2, 3)	SEV#049: RTU out of service
*.5.1.1.24	*.systemEvent.rtuSev.rtuSevState .rtuSevPowerSupplyFailureState	Integer (0, 1, 2, 3)	SEV#059: Power supplyFailure in RTU central subrack
*.5.1.1.25	*.systemEvent.rtuSev.rtuSevState .rtuCmdSupervisionCircuit1Faulty	Integer (0, 1, 2, 3)	SEV#064: 1.Cmd. supervision circuit is Faulty
*.5.1.1.26	*.systemEvent.rtuSev.rtuSevState .rtuCmdSupervisionCircuit2Faulty	Integer (0, 1, 2, 3)	SEV#065: 2.Cmd. supervision circuit is Faulty
...	...	...	...
*.5.1.1.57	*.systemEvent.rtuSev.rtuSevState .rtuSevSNTPClient1SynchronizedState	Integer (0, 1, 2, 3)	SEV#096: SNTP Client 1 synchronized
*.5.1.1.58	*.systemEvent.rtuSev.rtuSevState .rtuSevSNTPClient2SynchronizedState	Integer (0, 1, 2, 3)	SEV#097: SNTP Client 2 synchronized
*.5.1.1.59	*.systemEvent.rtuSev.rtuSevState .rtuSevLocalControlAuthActive	Integer (0, 1, 2, 3)	SEV#100: Local control authority available
*.5.1.1.60	*.systemEvent.rtuSev.rtuSevState .rtuSevHost1OnlineState	Integer (0, 1, 2, 3)	SEV#101: Host 1 online
*.5.1.1.61	*.systemEvent.rtuSev.rtuSevState .rtuSevHost2OnlineState	Integer (0, 1, 2, 3)	SEV#102: Host 2 online
...	...	...	...

Table 15: ABB-RTU500 MIB System Events of the RTU

OID[1)]	MIB Tree[2)]	Format	Description
*.5.1.1.75	*.systemEvent.rtuSev.rtuSevState .rtuSevHost16OnlineState	Integer (0, 1, 2, 3)	SEV#116: Host 16 online
*.5.1.1.76	*.systemEvent.rtuSev.rtuSevState .rtuSevInfoChangeInHost1Lost	Integer (0, 1, 2, 3)	SEV#117: Hostinterface 1: At least one change of information lost
*.5.1.1.77	*.systemEvent.rtuSev.rtuSevState .rtuSevInfoChangeInHost2Lost	Integer (0, 1, 2, 3)	SEV#118: Hostinterface 2: At least one change of information lost
...	...	...	...
*.5.1.1.91	*.systemEvent.rtuSev.rtuSevState .rtuSevInfoChangeInHost16Lost	Integer (0, 1, 2, 3)	SEV#132: Hostinterface 16: At least one change of information lost
*.5.1.1.92	*.systemEvent.rtuSev.rtuSevState .rtuSevPulseCounterInHost1Lost	Integer (0, 1, 2, 3)	SEV#133: Hostinterface 1: At least one pulse counter lost
*.5.1.1.93	*.systemEvent.rtuSev.rtuSevState .rtuSevPulseCounterInHost2Lost	Integer (0, 1, 2, 3)	SEV#134: Hostinterface 2: At least one pulse counter lost
...	...	...	...
*.5.1.1.107	*.systemEvent.rtuSev.rtuSevState .rtuSevPulseCounterInHost16Lost	Integer (0, 1, 2, 3)	SEV#148: Hostinterface 16: At least one pulse counter lost
*.5.1.1.108	*.systemEvent.rtuSev.rtuSevState .rtuSevCmu1Inoperable	Integer (0, 1, 2, 3)	SEV#149: CMU 1 Inoperable
*.5.1.1.109	*.systemEvent.rtuSev.rtuSevState .rtuSevCmu2Inoperable	Integer (0, 1, 2, 3)	SEV#150: CMU 2 inoperable
...	...	...	...
*.5.1.1.123	*.systemEvent.rtuSev.rtuSevState .rtuSevCmu16Inoperable	Integer (0, 1, 2, 3)	SEV#164: CMU 16 inoperable
*.5.1.1.124	*.systemEvent.rtuSev.rtuSevState .rtuSevNetWElement1Operable	Integer (0, 1, 2, 3)	SEV#192: Network element no. 1 operable
*.5.1.1.125	*.systemEvent.rtuSev.rtuSevState .rtuSevNetWElement2Operable	Integer (0, 1, 2, 3)	SEV#193: Network element no. 2 opera-ble
...	...	...	...
*.5.1.1.155	*.systemEvent.rtuSev.rtuSevState .rtuSevNetWElement32Operable	Integer (0, 1, 2, 3)	SEV#223: Network element no. 32 operable
*.5.1.1.156	*.systemEvent.rtuSev.rtuSevState .rtuSevCmu1Active	Integer (0, 1, 2, 3)	SEV#224: CMU 1 active
*.5.1.1.157	*.systemEvent.rtuSev.rtuSevState .rtuSevCmu2Active	Integer (0, 1, 2, 3)	SEV#225: CMU 2 active
...	...	...	...
*.5.1.1.171	*.systemEvent.rtuSev.rtuSevState .rtuSevCmu16Active	Integer (0, 1, 2, 3)	SEV#239: CMU 16 active
*.5.1.1.172	*.systemEvent.rtuSev.rtuSevState .rtuSevCmdCollisionHost1	Integer (0, 1, 2, 3)	SEV#242: Command collision for Host no. 1
*.5.1.1.173	*.systemEvent.rtuSev.rtuSevState .rtuSevCmdCollisionHost2	Integer (0, 1, 2, 3)	SEV#243: Command collision for Host no. 2
...	...	...	...

Table 15: ABB-RTU500 MIB System Events of the RTU

OID[1)]	MIB Tree[2)]	Format	Description
*.5.1.1.187	*.systemEvent.rtuSev.rtuSevState .rtuSevCmdCollisionHost16	Integer (0, 1, 2, 3)	SEV#257: Command collision for Host no. 16
*.5.1.1.188	*.systemEvent.rtuSev.rtuSevState .rtuSevCmdCollisionHMI	Integer (0, 1, 2, 3)	SEV#258: Command collision for HMI
*.5.1.1.189	*.systemEvent.rtuSev.rtuSevState .rtuSevCmdCollisionWEB	Integer (0, 1, 2, 3)	SEV#259: Command collision for Web Server
*.5.1.1.190	*.systemEvent.rtuSev.rtuSevState .rtuSevCmdCollisionPLC	Integer (0, 1, 2, 3)	SEV#260: Command collision for PLC
*.5.1.1.191	*.systemEvent.rtuSev.rtuSevState .rtuSevHMI1ClientOnline	Integer (0, 1, 2, 3)	SEV#261: HMI Client 1 online
*.5.1.1.192	*.systemEvent.rtuSev.rtuSevState .rtuSevHMI2ClientOnline	Integer (0, 1, 2, 3)	SEV#262: HMI Client 2 online
...	...	...	...
*.5.1.1.198	*.systemEvent.rtuSev.rtuSevState .rtuSevHMI8ClientOnline	Integer (0, 1, 2, 3)	SEV#268: HMI Client 8 online
*.5.1.1.199	*.systemEvent.rtuSev.rtuSevState .rtuSevPrpNo1If1LinkUpState	Integer (0, 1, 2, 3)	SEV#277: PRP interface 1: Network interface E1 link down
*.5.1.1.200	*.systemEvent.rtuSev.rtuSevState .rtuSevPrpNo2If1LinkUpState	Integer (0, 1, 2, 3)	SEV#278: PRP interface 2: Network interface E1 link down
...	...	...	...
*.5.1.1.206	*.systemEvent.rtuSev.rtuSevState .rtuSevPrpNo8If1LinkUpState	Integer (0, 1, 2, 3)	SEV#284: PRP interface 8: Network interface E1 link down
*.5.1.1.207	*.systemEvent.rtuSev.rtuSevState .rtuSevPrpNo1If2LinkUpState	Integer (0, 1, 2, 3)	SEV#285: PRP interface 1: Network interface E2 link down
*.5.1.1.208	*.systemEvent.rtuSev.rtuSevState .rtuSevPrpNo2If2LinkUpState	Integer (0, 1, 2, 3)	SEV#286: PRP interface 2: Network interface E2 link down
...	...	...	...
*.5.1.1.214	*.systemEvent.rtuSev.rtuSevState .rtuSevPrpNo8If2LinkUpState	Integer (0, 1, 2, 3)	SEV#292: PRP interface 8: Network interface E2 link down

Table 15: ABB-RTU500 MIB System Events of the RTU

1) ***= .1.3.6.1.4.1.27527.10**
2) ***= .iso.org.dod.internet.private.enterprises.abb.rtu500**

7.2.5 MIB Table of System Events of IEDs/ SubRTUs

OID[1)]	MIB Tree[2)]	Format	Description
*.2.2	*.config.ioDeviceNumber	Integer	
*.5.2.1.1.1.x	*.ioDeviceSevStateTable.Entry.ioDeviceSevDeviceActiveState	Integer	SEV#024: Device/ RTU active x= 1... ioDeviceNumber
*.5.2.1.1.2.x	*.ioDeviceSevStateTable.Entry.ioDeviceSevDeviceInoperableState	Integer	SEV#045: Device connected (in case of dial-up) x= 1... ioDeviceNumber

Table 16: ABB-RTU500-MIB Table of System Events of IEDs/ SubRTUs

OID[1]	MIB Tree[2]	Format	Description
*.5.2.1.1.3.x	*.ioDeviceSevStateTable.Entry.ioDeviceSevDeviceConnectedState	Integer	SEV#048: Device/ RTU inoperable x= 1... ioDeviceNumber
*.5.2.1.1.4.x	*.ioDeviceSevStateTable.Entry.ioDeviceSevDeviceReachableOnRedLine1State	Integer	SEV#049: Device/ RTU is out of service x= 1... ioDeviceNumber
*.5.2.1.1.5.x	*.ioDeviceSevStateTable.Entry.ioDeviceSevDeviceReachableOnRedLine1State	Integer	SEV#180: Device reachable on redundant line no. 1 x= 1... ioDeviceNumber
*.5.2.1.1.6.x	.ioDeviceSevStateTable.Entry.ioDeviceSevDeviceReachableOnRedLine2State	Integer	SEV#181: Device reachable on redundant line no. 2 x= 1... ioDeviceNumber
...	...	...	...
*.5.2.1.1.8.x	*.ioDeviceSevStateTable.Entry.ioDeviceSevDeviceReachableOnRedLine4State	Integer	SEV#183: Device reachable on redundant line no. 4 x= 1... ioDeviceNumber
*.5.2.1.1.9.x	*.ioDeviceSevStateTable.Entry.ioDeviceSevDeviceActiveOnRedLine1State	Integer	SEV#184: Device active on redundant line no. 1 x= 1... ioDeviceNumber
*.5.2.1.1.10.x	*.ioDeviceSevStateTable.Entry.ioDeviceSevDeviceActiveOnRedLine2State	Integer	SEV#185: Device active on redundant line no. 2 x= 1... ioDeviceNumber
...	...	...	...
*.5.2.1.1.12.x	*.ioDeviceSevStateTable.Entry.ioDeviceSevDeviceActiveOnRedLine4State	Integer	SEV#187: Device active on redundant line no. 4 x= 1... ioDeviceNumber
*.5.2.1.1.13.x	*.ioDeviceSevStateTable.Entry.ioDeviceSevStateIndex	Integer	MIB table index x= 1... ioDeviceNumber

Table 16: ABB-RTU500-MIB Table of System Events of IEDs/ SubRTUs

1) *= .1.3.6.1.4.1.27527.10
2) *= .iso.org.dod.internet.private.enterprises.abb.rtu500

7.2.6 MIB Configured SPIs

OID[1]	MIB Tree[2]	Format	Description
*.7.{SPI ID}.1	*.processData.spi{SPI ID}.Name	String	SPI name as configured in RTUtil {SPI ID} as configured in RTUtil
*.7.{SPI ID}.2	*.processData.spi{SPI ID}.State	Integer (0, 1, 2, 3)	0: ON; 1: OFF; 2: not configured 3: invalid

Table 17: ABB-RTU500-MIB Configured SPIs

1) *= .1.3.6.1.4.1.27527.10
2) *= .iso.org.dod.internet.private.enterprises.abb.rtu500

8 Glossary

CMU	Communication and Data Processing Unit
DCE	Data Communication Equipment
HCI	Human Maschine Interface (here Integrated HMI function of the RTU500 series)
IED	Intelligent Electronic Device
MIB	Management Information Base
OID	Object Identifier (SNMP)
OSI	Open Systems Interconnection Model
PDU	Protocol Data Unit
PLC	Programmable Logic Control
PRP	Parallel Redundancy Protocol
RCD	RTU Configuration Data
RTU	Remote Terminal Unit
SEV	System Event
SNMP	Simple Network Management Protocol
SPI	Single Point Input or Single point information
UDP	User Datagram Protocol

Note:

The specifications, data, design or other information contained in this document (the “Brochure”) - together: the “Information” - shall only be for information purposes and shall in no respect be binding. The Brochure does not claim to be exhaustive. Technical data in the Information are only approximate figures. We reserve the right at any time to make technical changes or modify the contents of this document without prior notice. The user shall be solely responsible for the use of any application example or information described within this document. The described examples and solutions are examples only and do not represent any comprehensive or complete solution. The user shall determine at its sole discretion, or as the case may be, customize, program or add value to the ABB products including software by creating solutions for the end customer and to assess whether and to what extent the products are suitable and need to be adjusted or customized.

This product is designed to be connected to and to communicate information and data via a network interface. It is the users sole responsibility to provide and continuously ensure a secure connection between the product and users or end customers network or any other network (as the case may be). The user shall establish and maintain any appropriate measures (such as but not limited to the installation of firewalls, application of authentication measures, encryption of data, installation of anti-virus programs, etc) to protect the product, the network, its system and the interface against any kind of security breaches, unauthorized access, interference, intrusion, leakage and/or theft of data or information. ABB AG is not liable for any damages and/or losses related to such security breaches, any unauthorized access, interference, intrusion, leakage and/or theft of data or information.

ABB AG shall be under no warranty whatsoever whether express or implied and assumes no responsibility for the information contained in this document or for any errors that may appear in this document. ABB AG's liability under or in connection with this Brochure or the files included within the Brochure, irrespective of the legal ground towards any person or entity, to which the Brochure has been made available, in view of any damages including costs or losses shall be excluded. In particular ABB AG shall in no event be liable for any indirect, consequential or special damages, such as – but not limited to – loss of profit, loss of production, loss of revenue, loss of data, loss of use, loss of earnings, cost of capital or cost connected with an interruption of business or operation, third party claims. The exclusion of liability shall not apply in the case of intention or gross negligence. The present declaration shall be governed by and construed in accordance with the laws of Switzerland under exclusion of its conflict of laws rules and of the Vienna Convention on the International Sale of Goods (CISG).

11 Conformance Statements

11.1 Abstract Communication Service Interface (ACSI)

The following ACSI conformance statements are used to provide an overview and details about RTU500 series IEC 61850 client, version 12.4 :

- ASCI basic conformance statement,
- ACSI models conformance statement,
- ACSI service conformance statement

The statements specify the communication features mapped to IEC 61850-8-1 Edition 1 and Edition 2. The following tables contain a column for the RTU500 series IEC 61850 client (named “RTU500 series client”).

11.1.1 ACSI Basic Conformance Statement

The ACSI basic conformance statement for RTU500 series IEC 61850 client is defined in following table.

		Client/ subscriber	Server/ publisher	RTU500 series client
Client-server roles				
B11	Server side (of TWO-PARTYAPPLICATION-ASSOCIATION)	-	c1	-
B12	Client side (of TWO-PARTYAPPLICATION-ASSOCIATION)	c1	-	YES
SCSMs supported				
B21	SCSM: IEC 61850-8-1 used			YES
B22	SCSM: IEC 61850-9-1 used			-
B23	SCSM: IEC 61850-9-2 used			-
B24	SCSM: other			-
Generic substation event model (GSE)				
B31	Publisher side	-	O	-
B32	Subscriber side	O	-	-
Transmission of sampled value model (SVC)				
B41	Publisher side	-	O	-
B42	Subscriber side	O	-	-

c1 – shall be ‘M’ if support for LOGICAL-DEVICE model has been declared.

O – Optional

M – Mandatory

Table 22: ACSI basic conformance statement

11.1.2 ACSI Models Conformance Statement

The ACSI models conformance statement for RTU500 series IEC 61850 client is defined in following table.

		Client/ subscriber	Server/ publisher	RTU500 series client
If Server or Client side (B11/B12) supported				
M1	Logical device	c2	c2	YES
M2	Logical node	c3	c3	YES
M3	Data	c4	c4	YES
M4	Data set	c5	c5	YES
M5	Substitution	O	O	-
M6	Setting group control	O	O	-
	Reporting			
M7	Buffered report control	O	O	YES
M7-1	sequence-number			YES
M7-2	report-time-stamp			YES
M7-3	reason-for-inclusion			YES
M7-4	data-set-name			YES
M7-5	data-reference			YES
M7-6	buffer-overflow			YES
M7-7	entryID			YES
M7-8	BufTm			YES
M7-9	IntgPd			YES
M7-10	GI			YES
M7-11	conf-revision			YES
M8	Unbuffered report control	O	O	YES
M8-1	sequence-number			YES
M8-2	report-time-stamp			YES
M8-3	reason-for-inclusion			YES
M8-4	data-set-name			YES
M8-5	data-reference			YES
M8-6	BufTm			YES
M8-7	IntgPd			YES
M8-8	GI			YES
M8-9	conf-revision			YES
	Logging			
M9	Log control	O	O	-
M9-1	IntgPd			-
M10	Log	O	O	-
M11	Control	M	M	YES
If GSE (B31/B32) is supported				
M12	GOOSE	O	O	-
M13	GSSE	O	O	-
If SVC (B41/B42) is supported				
M14	Multicast SVC	O	O	-
M15	Unicast SVC	O	O	-
For all IEDs				

Table 23: ACSI model conformance statement

		Client/ subscriber	Server/ publisher	RTU500 series client
M16	Time	M	M	YES
M17	File Transfer	O	O	YES

c2 – shall be ‘M’ if support for LOGICAL-NODE model has been declared.

c3 – shall be ‘M’ if support for DATA model has been declared.

c4 – shall be ‘M’ if support for DATA-SET, Substitution, Report, Log Control, or Time model has been declared.

c5 – shall be ‘M’ if support for Report, GSE, or SV models has been declared.

O – Optional

M – Mandatory

Table 23: ACSI model conformance statement

11.1.3 ACSI Service Conformance Statement

The ACSI service conformance statement for RTU500 series IEC 61850 client is defined in following table (depending on the statements of table "Tab. 23: ACSI model conformance statement").

Services		AA: TP/MC	Client/ subscriber	Server/ publisher	RTU500 series client
Server (Clause 7)					
S1	GetServerDirectory	TP		M	-
Application association (Clause 8)					
S2	Associate		M	M	YES
S3	Abort		M	M	YES
S4	Release		M	M	YES
Logical device (Clause 9)					
S5	GetLogicalDeviceDirectory	TP	M	M	-
Logical node (Clause 10)					
S6	GetLogicalNodeDirectory	TP	M	M	-
S7	GetAllDataValues	TP	O	M	-
Data (Clause 11)					
S8	GetDataValues	TP	M	M	YES
S9	SetDataValues	TP	O	O	YES
S10	GetDataDirectory	TP	O	M	YES
S11	GetDataDefinition	TP	O	M	YES
Data set (Clause 12)					
S12	GetDataSetValues	TP	O	M	-
S13	SetDataSetValues	TP	O	O	-
S14	CreateDataSet	TP	O	O	-
S15	DeleteDataSet	TP	O	O	-
S16	GetDataSetDirectory	TP	O	O	YES

Table 24: ACSI service conformance statement

	Services	AA: TP/MC	Client/ subscriber	Server/ publisher	RTU500 series client
Setting group control (Clause 16)					
S18	SelectActiveSG	TP	O	O	-
S19	SelectEditSG	TP	O	O	-
S20	SetEditSGValues	TP	O	O	-
S21	ConfirmEditSGValues	TP	O	O	-
S22	GetEditSGValues	TP	O	O	-
S23	GetSGCBValues	TP	O	O	-
Reporting (Clause 17)					
Buffered report control block (BRCB)					
S24	Report	TP	c6	c6	YES
S24-1	data-change (dchg)				YES
S24-2	qchg-change (qchg)				YES
S24-3	data-update (dupd)				YES
S25	GetBRCBValues	TP	c6	c6	YES
S26	SetBRCBValues	TP	c6	c6	YES
Unbuffered report control block (URCB)					
S27	Report	TP	c6	c6	YES
S27-1	data-change (dchg)				YES
S27-2	qchg-change (qchg)				YES
S27-3	data-update (dupd)				YES
S28	GetURCBValues	TP	c6	c6	YES
S29	SetURCBValues	TP	c6	c6	YES
Logging (Clause 17)					
Log control block					
S30	GetLCBValues	TP	M	M	-
S31	SetLCBValues	TP	O	M	-
Log					
S32	QueryLogByTime	TP	c7	M	-
S33	QueryLogAfter	TP	c7	M	-
S34	GetLogStatusValues	TP	M	M	-
Generic substation event model (GSE)					
GOOSE (Clause 18)					
S35	SendGOOSEMessage	MC	c8	c8	-
S36	GetGoReference	TP	O	c9	-
S37	GetGOOSEElementNumber	TP	O	c9	-
S38	GetGoCBValues	TP	O	O	-
S39	SetGoCBValues	TP	O	O	-
GSSE (Annex C)					
S40	SendGSSEMessage	MC	c8	c8	-
S41	GetGsReference	TP	O	c9	-
S42	GetGSSEDataOffset	TP	O	c9	-
S43	GetGsCBValues	TP	O	O	-

Table 24: ACSI service conformance statement

	Services	AA: TP/MC	Client/ subscriber	Server/ publisher	RTU500 series client
S44	SetGsCBValues	TP	O	O	-
Transmission of sampled value model (SVC) (Clause 19)					
Multicast SVC					
S45	SendMSVMessage	MC	c10	c10	-
S46	GetMSVCBValues	TP	O	O	-
S47	SetMSVCBValues	TP	O	O	-
Unicast SVC					
S48	SendUSVMessage	TP	c10	c10	-
S49	GetUSVCBValues	TP	O	O	-
S50	SetUSVCBValues	TP	O	O	-
Control (Clause 20)					
S51	Select	TP	M	O	YES
S52	SelectWithValue	TP	M	O	YES
S53	Cancel	TP	O	O	YES
S54	Operate	TP	M	M	YES
S55	Command-Termination	TP	M	O	YES
S56	TimeActivated-Operate	TP	O	O	-
File transfer (Clause 23)					
S57	GetFile	TP	O	M	YES
S58	SetFile	TP	O	O	-
S59	DeleteFile	TP	O	O	-
S60	GetFileAttributeValues	TP	O	M	YES
Time (5.5)					
T1	Time resolution of internal clock				10 (1 msec)
T2	Time accuracy of internal clock				T1
T3	Supported TimeStamp resolution				10 (1 msec)

c6 – shall declare support for at least one (BRCB or URCB)

c7 – shall declare support for at least one (QueryLogByTime or QueryLogAfter)

c8 – shall declare support for at least one (SendGOOSEMessage or SendGSSEMessage)

c9 – shall declare support if TP association is available

c10 – shall declare support for at least one (SendMSVMessage or SendUSVMessage)

O – Optional

Table 24: ACSI service conformance statement

11.1.4 Specific Communication Service Mapping (SCSM)

See B21 table "Tab. 22: ACSI basic conformance statement" and [IEC 61850-7-2].

11.2 Protocol Implementation Conformance Statement (PICS)

This protocol implementation conformance statement is applicable for RTU500 series IEC 61850 client, version 12.4.

11.2.1 Basic Profile Conformance

11.2.1.1 PICS for A-Profile support

The PICS for A-Profile support for RTU500 series IEC 61850 client are defined in following table.

A-Profile shortcut	Profile Description	Client	Server	RTU500 series client
A1	Client/server A-Profile	c1	c1	YES
A2	GOOSE/GSE management A-Profile	c2	c2	-
A3	GSSE A-Profile	c3	c3	-
A4	TimeSync A-Profile	c4	c4	YES
A5	Security for client/server A-Profile	o	o	-
A6	Security for GOOSE/GSE management A-Profile	o	o	-

c1 Shall be ‘m’ if support for any service specified in [IEC 61850-8-1] Table 2 are declared within the ACSI basic conformance statement (see Table 5).

c2 Shall be ‘m’ if support for any service specified in [IEC 61850-8-1] Table 6 are declared within the ACSI basic conformance statement (see Table 5).

c3 Shall be ‘m’ if support for any service specified in [IEC 61850-8-1] Table 9 are declared within the ACSI basic conformance statement (see Table 5).

c4 Support for at least one other A-Profile shall be declared (e.g. in A1-A3) in order to claim conformance to [IEC 61850-8-1].[IEC 61850-8-1].

Table 25: PICS for A-Profile support

11.2.1.2 PICS for T-Profile support

The PICS for T-Profile support for RTU500 series IEC 61850 client are defined in following table.

T-Profile shortcut	Profile Description	Client	Server	RTU500 series client
T1	TCP/IP T-Profile	c1	c1	YES
T2	OSI T-Profile	c2	c2	-
T3	GOOSE/GSE T-Profile	c3	c3	-
T4	GSSE T-Profile	c4	c4	-
T5	TimeSync T-Profile	O	O	YES

Table 26: PICS for T-Profile support

T-Profile short-cut	Profile Description	Client	Server	RTU500 series client
c1 Shall be ‘m’ if support for table 9-4 A1 is declared. Otherwise, shall be 'i'.				
c2 Shall be ‘o’ if support for table 9-4 A1 is declared. Otherwise, shall be 'i'.				
c3 Shall be ‘m’ if support for table 9-4 A2 is declared. Otherwise, shall be 'i'.				
c4 Shall be ‘m’ if support for table 9-4 A3 is declared. Otherwise, shall be 'i'.				
i – out-of-scope: The implementation of the item is not within the scope of this standard				
O – Optional				

Table 26: PICS for T-Profile support

11.2.2 MMS Conformance

All needed services supporting the ACSI services stated to be supported in chapter ’9.1.3 "ACSI Service Conformance Statement" ’ are supported by the MMS stack used.

11.3 Model Implementation Conformance Statement (MICS)

This model implementation conformance statement is applicable for RTU500 series IEC 61850 client, version 12.4.

This MICS document specifies the modelling implementations and extensions compared to IEC 61850 Edition 1 and Edition 2. For the exact details on the standardized model please compare the ICD substation configuration files generated by RTUtil500.

- Chapter 11.3.1 describes the common data class extensions
- Chapter 11.3.2 contains the list of implemented logical nodes.
- Chapters 11.3.3 to 11.3.4 describe the implemented logical nodes.

11.3.1 Common Data Class Extensions

11.3.1.1 Supported common data classes

Following table defines the list of common data classes supported by RTU500 series IEC 61850 client.

Common data class specifications for status information	
SPS	Single point status
DPS	Double point status
INS	Integer status
ENS[1]	Enumerated status
ACT	Protection activation information
ACD	Directional protection activation information
BCR	Binary counter reading

Table 27: Common data classes supported by the RTU500 series IEC 61850 client

Common data class specifications for measurand information	
MV	Measured value
CMV	Complex measured value
WYE	Phase to ground related measured values of a three phase system
DEL	Phase to phase related measured values of a three phase system
SEQ	Sequence
Common data class specifications for controlls	
SPC	Controllable single point
DPC	Controllable double point
INC	Controllable integer status
ENC[1]	Controllable enumerated status
BSC	Binary controlled step position information
ISC	Integer controlled step position information
Common data class specifications for status settings	
SPG	Single point setting
ING	Integer status setting
ENG[1]	Enumerated status setting
Common data class specifications for analogue settings	
ASG	Analogue setting

Table 27: Common data classes supported by the RTU500 series IEC 61850 client

1 Support by IEC 61850 Edition 2 client only

11.3.1.2 Unsupported common data classes

Following table defines the list of common data classes not supported by RTU500 series IEC 61850 client.

Common data class specifications for status information	
SEC	Security violation counting
HST	Histogram
VSS	Visible string status
Common data class specifications for measurand information	
SAV	Sampled value
HMV	Harmonic Value
HYE	Harmonic value for WYE
HDEL	Harmonic value for DEL
Common data class specifications for controlls	
APC	Controllable analogue set point information
BAC	Binary controlled analog process value
Common data class specifications for status settings	
ORG	Object reference setting
TSG	Time setting group
CUG	Currency setting group
VSG	Visible string setting

Table 28: Common data classes unsupported by the RTU500 series IEC 61850 client

Common data class specifications for analogue settings	
CURVE	Setting curve
CSG	Curve shape setting
Common data class specifications for description information	
DPL	Device name plate
LPL	Logical node name plate
CSD	Curve shape description

Table 28: Common data classes unsupported by the RTU500 series IEC 61850 client

11.3.2 Logical Node List

Following table defines the list of logical nodes supported by RTU500 series IEC 61850 client.

LN Group L: System logical nodes	
LPHD	Physical device information
LLN0	Logical node zero
LCCH[1]	Physical communication channel supervision
LTMS[1]	Time master supervision
LN Group I: Logical nodes for interfacing and archiving	
ITCI	Telecontrol interface

Table 29: Logical nodes supported by the RTU500 series IEC 61850 client

1 Supported for IEC 61850 Edition 2 client/server only

11.3.3 LN Group L: System logical nodes

11.3.3.1 LN type: LPHD

LPHD		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
PhyNam	DPL	Physical device name plate
PhyHealth	INS	Physical device health
Proxy	SPS	Indicates if this LN is a proxy

Table 30: Logical node type LPHD

LPHD		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
PhyNam	DPL	Physical device name plate
PhyHealth	ENS	Physical device health
Proxy	SPS	Indicates if this LN is a proxy

Table 31: Logical node type LPHD (Edition 2)

11.3.3.2 LN type: LLN0

LLN0		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
	Common logical node information	
Mod	INC	Mode
Beh	INS	Behaviour
Health	INS	Health
NamPlt	LPL	Name plate
Loc	SPS	Local operation for complete logical device
RemCtlBlk	SPC	Authority control for the whole substation (see chapter 8.7)

Table 32: Logical node type LLN0 (Edition 1)

LLN0		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
	Common logical node information	
Mod	ENC	Mode
Beh	ENS	Behaviour
Health	ENS	Health
NamPlt	LPL	Name plate
Loc	SPS	Local operation for complete logical device
LocSta	SPC	Authority control for the whole substation (see chapter 8.7)

Table 33: Logical node type LLN0 (Edition 2)

11.3.3.3 LN Type LCCH

LCCH		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
	Common logical node information	
Beh	ENS	Behaviour
ChLiv	SPS	Physical channel status; true, if channel receives telegrams within a specified time interval.
RedChLiv	SPS	Physical channel status of redundant channel

Table 34: Logical node type LCCH (Edition 2)

LCCH		
FerCh	INS	Frame error rate on this channel; count of erroneous (or missed, in case of redundancy) messages for each 1 000 messages forwarded to the application.
RedFerCh	INS	Frame error rate on redundant channel; count of missed messages on this channel for each 1 000 messages forwarded to the application.

Table 34: Logical node type LCCH (Edition 2)

11.3.3.4 LN type LTMS

LTMS		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
	Common logical node information	
Beh	ENS	Behaviour
TmSrc	VSS	Current time source
TmSyn	ENS	Time synchronized according to IEC 61850-9-2
TmChSt1	SPS	Time channel status (up/down)

Table 35: Logical node type LTMS (Edition 2)

11.3.4 LN Group L: Logical nodes for interfacing and archiving

11.3.4.1 LN type: ITCI

ITCI		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
	Common logical node information	
Mod	INC	Mode
Beh	INS	Behaviour
Health	INS	Health
NamPlt	LPL	Name plate

Table 36: Logical node type ITCI (Edition 1)

ITCI		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
	Common logical node information	
Beh	INS	Behaviour

Table 37: Logical node type ITCI (Edition 2)

11.4 Tissues Conformance Statement (TICS)

This chapter contains the technical issues (tissues) conformance statement. According to the UCA IUG QAP the tissue conformance statement is required to perform a conformance test and is referenced on the certificate.

The tissues are grouped in mandatory interoperability tissues (IntOp tissues), optional interoperability tissues and other tissues. The following tables are structured in the columns:

Part: Section of the IEC 61850 standard the tissue belongs to

Tissue Nr: Number of the tissue according to the database provided under http://www.tissues.iec61850.com

Description: Short description of the tissue

Implemented: Indicates whether the tissue is implemented in the device. The meaning of the abbreviations are
Y = Yes the tissue is implemented in the device
N = No the tissue is not implemented in the device
na = Not applicable, the tissue is not applicable for the device

The following chapters are applicable for RTU500 series IEC 61850 Edition 1 and Edition 2 client, version 12.4.

11.4.1 Mandatory Edition 1 IntOp Tissues

During the October 2006 meeting IEC TC57 working group 10 decided that:

- green Tissues with the category “IntOp¨ are mandatory for IEC 61850 edition 1
- Tissues with the category “Ed.2¨ Tissues should not be implemented.

Below table gives an overview of the implemented Edition 1 IntOp Tissues.

Part	Tissue Nr	Description	Implemented Y/na
8-1	116	GetNameList with empty response?	Y
	165	Improper Error Response for GetDataSetValues	Y
	183	GetNameList error handling	Y
7-4	252	PTTR.AlmThm	na
7-3	28	Definition of APC	na
	54	Point def xVal, not cVal	na
	55	Ineut = Ires ?	na
	63	mag in CDC CMV	na
	219	operTm in ACT	na
	270	WYE and DEL rms values	na
	1199	Allow INT32 for CDC BCR	Y
7-2	30	control parameter T	Y

Table 38: Mandatory Edition 1 IntOp Tissues

Part	Tissue Nr	Description	Implemented Y/na
	31	Typo	na
	32	Typo in syntax	na
	35	Typo Syntax Control time	na
	36	Syntax parameter DSet-Ref missing	na
	37	Syntax GOOSE "T" type	Y
	39	Add DstAddr to GoCB	Y
	40	GOOSE Message “AppID” to “GoID”	Y
	41	GsCB “AppID” to “GsID”	na
	42	SV timestamp: “EntryTime” to “TimeStamp"	na
	43	Control "T" semantic	Y
	44	AddCause - Object not sel	Y
	45	Missing AddCauses (neg range)	na
	46	Synchro check cancel	Y
	47	"." in LD Name?	na
	49	BRCB TimeOfEntry (part of #453)	Y
	50	LNName start with number?	na
	51	ARRAY [0..num] missing	na
	52	Ambiguity GOOSE SqNum	Y
	53	Add DstAddr to GsCB, SV	na
	151	Name constraint for control blocks etc.	na
	166	DataRef attribute in Log	na
	185	Logging - Integrity periode	na
	189	SV Format	na
	190	BRCB: EntryId and TimeOfEntry (part of #453)	Y
	191	BRCB: Integrity and buffering reports (part of #453)	Y
	234	New type CtxInt (Enums are mapped to 8 bit integer)	na
	275	Confusing statement on GI usage (part of #453)	Y
	278	EntryId not valid for a server (part of #453)	Y
	297	Sequence number (part of #453)	Y
	298	Type of SqNum (part of #453)	Y
	305	Reporting with BufTm=0 (part of #453)	Y

Table 38: Mandatory Edition 1 IntOp Tissues

Part	Tissue Nr	Description	Implemented Y/na
	322	Write Configuration attribute of BRCBs (part of #453)	Y
	329	Reporting and BufOvl (part of #453)	Y
	333	Enabling of an incomplete GoCB	na
	335	Clearing of Bufovfl (part of #453)	Y
	348	URCB class and report (part of #453)	Y
	349	BRCB TimeOfEntry has two definitions (part of #453)	Y
	1281	Default for TrgOps.GI is TRUE	Y
6	1	Syntax	na
	5	tExtensionAttributeNameEnum is restricted	na
	8	SIUnit enumeration for W	Y
	10	Base type for bitstring usage	Y
	17	DAI/SDI elements syntax	na
	169	Ordering of enum differs from 7-3	na
NOTE: Tissue 49, 190, 191, 275 and 278 are part of the optional tissue #453, all other technical tissues in the table are mandatory if applicable.			
NOTE: Editorial tissues are marked as “na”.			
NOTE: Final proposal on tissue 45 is not defined yet			

Table 38: Mandatory Edition 1 IntOp Tissues

11.4.2 Optional Edition 1 IntOp Tissues

After the approval of the server conformance test procedures version 2.2 the following IntOp tissues were added or changed. It is optional to implement these tissues.

Part	Tissue Nr	Description	Implemented Y/N/na
8-1	246	Control negative response (SBOns) with LastApplError	N
	545	Skip file directories with no files	na
7-2	333	Enabling of an incomplete GoCB	na
	453	Combination of all reporting and logging tissues	Y
6	245	Attribute RptId in SCL is optional	na
	526	Replace sev - Unknown by unknown	na

Table 39: Optional Edition 1 IntOp Tissues

11.4.3 Mandatory Edition 2 Tissues

Below table gives an overview of the implemented Edition 2 Tissues.

Part	Tissue Nr	Description	Implemented Y/na
8-1	753	Whether "GoID" and "DatSet" in GoCB are writable?	na
	770	GoID type mitmatch 18.1.1 and 18.1.2.5.2	na
	777	AddCause values	na
	784	Tracking of control (CTS)	na
	817	Fixed-length GOOSE float encoding	na
	821	AlternateAccess in GetAllDataValues	na
	827	Mandatory ACSI services	na
	834	File dir name length 64	na
	851	bType wrong for "check" in sample SCL file	na
	854	GetDataValues - single or multiple objects	Y
	935	Typing error in table 101	na
	942	Wrong description of S bit in reserved word	na
	951	Encoding of Owner attribute	na
	1036	FileDirectory response	na
	1037	GetDataSetValues SpecWithResult	Y
	1040	More associate error codes	Y
	1041	LTS and OTS mapping	na
	1042	SGCB definition includes information that is not mapping specific	na
	1043		na
	1047	SetEditSGValues should not detail nothing about non-volatile storage	na
	1058	"Currency" basictype is not mapped	Y
	1066	OSI-AP-Title value	na
	1155	UtcTime wrong referecne	Y
	1164	ResvTms definition should be integer in the BRCB structure	na
	1178		Y
	1181	DeleteDataSet response- refers to wrong clause	na
	1192	Select Response+ is non-null value	na
	1274	Conformance requirement for InformationReport Ambiguous	na
	1285	GoCB MinTime/MaxTime size	Y
	1287	GetServerDirectory(FILE) typo	na
	1289		na

Table 40: Mandatory Edition 2 Tissues

Part	Tissue Nr	Description	Implemented Y/na
	1299	ICD file must have a communication section for 8-1 implementation	na
	1300	COMTRADE zip file contents	na
	1309	typo: LLNO -> LLN0	na
	1324	Missing semantics for localDetailCalling	na
	1336	Behavior for a ContimueAfter where the File no longer exists	na
	1361	Extraneous normative reference:10608-1 and -2	Y
	1441	The response- for DeleteNamedVariableList is not defined	Y
	1442	enhanced the mapping text for the setValues.	Y
	1443	Variable length Quality encoding	na
	1453	Optonal fields in buffered reports	Y
	1454	Journal variableTag for ReasonCode	Y
	1462	Reading SE when EditSG=0	na
	1495	Purge buffer on write to BRCB	na
		Reports can be generated before write(RptEna=true) is confirmed	
		SNTP references to RFCs are different	
		GetVariableAccessAttributes error code	
7-4	671	Mistake in definition of Mod & Beh	Y
	674	CDC of ZRRC.LocSta is wrong	na
	675	SIML LN	Y
	676	Same data object name used with different CDC	na
	677	MotStr is used with different CDC in PMMS and SOPM LN classes	na
	679	Remove CycTrMod Enum	na
	680	SI unit for MHYD.Cndct	na
	681	Enum PIDAlg	na
	682	ANCR.ParColMod	na
	683	Enum QVVR.IntrDetMth	na
	685	Enum ParTraMod	na
	686	New annex H - enums types in XML	Y
	689		na

Table 40: Mandatory Edition 2 Tissues

Part	Tissue Nr	Description	Implemented Y/na
	693	RREC - diagram	Y
	694	Description of LTMS.TmChSt1	na
	695	Data object CmdBlk	na
	696	ARIS.Auto	na
	712	LSVS.St (Status of subscription)	na
	713	Interpretation of quality operatorBlocked	na
	714	DO Naming of time constants in FFIL	N
	715	Enums for ShOpCap and SwOpCap	na
	716	RBDR.ChNum1	na
	724	TAXD text for condition	na
	725	ANCR.Auto	na
	727	Loc in LN A-group	na
	734	RREC - diagram	na
	735	LLN0.OpTmh vs. LPHD.OpTmh	na
	736	ISAF.Alm and ISAF.AlmReset	na
	742	PFSign	Y
	743	GAPC.Str, GAPC.Op and GAPC.StrVal	na
	744	CCGR.PmpCtl and CCGR.FanCtl	na
	748	LN STMP, EEHealth and EEName	na
	749	CBOpCap	na
	772	Description BndCtrChg	na
	773	LPHD.PwrUp/PwrDn shall be transient	N
	774	Loc, LocKey and LocSta YPSH and YLTC	na
	775	ITCI.LocKey	na
	776	KVLV.ClsLim and OpnLim	na
	790	LPHD.OutOv/InOv and LCCH.OutOv/InOv	na
	800	TVTR.VolSv not in table 10	na
	802	Misspelling in CSYN	na
	808	CCGR and Harmonized control authority	na
	830	Presence condition of ZMOT.DExt and new DOs	na
		Mode/Behaviour & Quality	

Table 40: Mandatory Edition 2 Tissues

Part	Tissue Nr	Description	Implemented Y/na
	831	Setting of ConfRevNum in LGOS	na
	838	Testing in Beh=Blocked	na
	842	GAPC.Auto change type to SPS	na
	843	GGIO.AnOut1 move to Controls	na
	844	MFLK.PhPiMax, MFLK.PhPiLoFil, MFLK.PhPiRoot DEL->WYE	na
	849	Presence conditions re-assessing in case of derived statistical calculation	na
7-4	877	QVUB -settings should be optional	na
	879	Duplicate definition of HzChr	na
	902	Control Blocks in CommonLN	na
	908	ARIS.StrSeq - transient	na
	909	Remove ANCR.ColOpR and ColOpL	na
	912	Clarification of PwrRtg/VARtg	na
	920	Resetable Counter is NOT resetable	na
	932	Rename AVCO.SptVol to AVCO.VolSpt	na
	933	Presence of LCCH.RedFerCh and RedRxCnt	Y
	939	Change CDC for ANCR.FixCol	na
	940	Clarification of feedback MX for DO with CDC APC	na
	967	Statistical calculation and "M" attributes	na
	991	LGOS: GoCBRef (as well as LSVS.SvCBRef) should be mandatory	na
	1007	PTRC as fault indicator - Update of description required	na
	1044	TapChg in AVCO	na
	1077	Rename DOnames within LTIM	na
	1177	Winding ratio for TCTR and TVTR	na
	1273	Behavior of DOI "Beh" due internal condition	na
	1294	Description of SIML.GasInsAlm reg. Buchholz	Y
	1330	proposal in tissue 830 seems not consistent with 7-3 Ed2	na
	1331	Mod, Beh and Health with q=TEST, client can't receive their states	na
	1333		na
	1456		na
	1568	SPS datapoint for Select is not present in LN ATCC for process bus	na

Table 40: Mandatory Edition 2 Tissues

Part	Tissue Nr	Description	Implemented Y/na
		Annex A and Mod/Beh/Health ISAF.AlmReset ->transient	
7-3	697	persistent command / PulseConfig	na
	698	Wrong case is BAC.dB attribute	na
	709	Semantic of tstEna	na
	722	Units for 'h' and 'min' not in UnitKind enumeration.	Y
	814	subQ bit used	na
	819	APC and ASG	na
	832	Data attribute semantic of minVal & maxVal	na
	839	Use of opRcvd also in Blocked	na
	887	Data semantics for q and t	na
	919	Presence Condition for sVC	na
	924	Missing curve characteristics	na
	925	Presence of i or f attribute - Problem with writing	na
	926	Presence Conditions within RangeConfig	na
	929	condition AC_SCAV unclear	na
	953	missing trigger option forCSG units	na
	954	Data attributes with FC=CF should have trgOp=dchg	na
	962	instMag optional?	na
	968	BCR value range	N
	1078	CMV.t update if rangeAng changed	na
	1079	q and t semantic syntax errors	na
	1187	ldNs example value shal be 2007A	na
	1253	Can CDC ACT be used for 3-phase indication?	Y
	1387	Default value of SboClasses	na
	1430	opRcvd for controllable object	na
	1481	configRev presence condition	Y
7-2	728	BRCB: could PurgeBuf be set when RptEna=TRUE?	Y
	778	AddCause values	Y
	780	What are unsupported trigger option at a control block?	Y
	783	TimOper Resp- ; add Authorization check	na

Table 40: Mandatory Edition 2 Tissues

Part	Tissue Nr	Description	Implemented Y/na
	786	AddCause values 26 and 27 are switched	Y
	813	TimeAccuracy choices	na
	820	Mandatory ACSI services (use for PICS template)	Y
	850	Report Value needs a corresponding index when data-FALSE	Y
	852	Check condition type - parameter type wrong	na
	858	Typo in enumeration ServiceType	Y
	861	dchg of ConfRev attribute	na
	869	Grammer/spelling error	na
	875	GenLogiclNodeClass and compatible LN Classes	na
	876	GenLogiclNodeClass and SGCB, GoCB, MsvCB, UsvCB	na
	943	control model change to "local" when TimeActivated-Operate	na
	970		na
	1038	Wrong reference to GSSE	na
	1050	Loss of Info Detection After Resynch	na
	1061	GTS Phycomaddr definition in SCL	na
	1062	EntryTime wrongly appllied	na
	1071	Entrytime not used in CDC	Y
	1091	Length of DO name	na
	1092	The sentence "The initial value of EditSG shall be 0" in 7.2	na
	1116		na
	1127	NewEntrTm and OldEntrTm Type in LOG Class	na
	1145	CONTROL service(s) parameter 'orgin' misspelled	na
	1154	Missing owner attribute in BTS and UTS	na
	1202	T – control time-stamp	Y
	1232	Inconistent Definition for Response Parameter	Y
	1242	GI not optional	na
	1252	EntryID needs clarification	na
	1283	NTS definiton	na
	1307	Data-Instance-ID: is 01 allowed?	Y
	1341	pleonasm "qchg-change" (for Ed.2)	Y
	1428	Segemented report with Buffer overflow	na

Table 40: Mandatory Edition 2 Tissues

Part	Tissue Nr	Description	Implemented Y/na
	1569	Attribute Owner is missing in GetBRCBValues services	na
		MTS and NTS should use svOptFlds	
		How to track Select service in service tracking?	
7-1	828	Data model namespace revision IEC 61850-7-4:2007[A]	Y
	874	Logical Node Class needs to be updated	na
	948	Enumeration (string) values format	na
	1060	Error in encoding in Figure F.9	na
	1072	Statistical Data and Reporting	na
	1129	Rules for extending nameplate information	na
	1151	Simulated GOOSE disappears after 1st appearance	na
	1251	All "L" logical nodes shall be in the same LD - except for gateways	Y
	1268	Assigment of single CDC to DOclass	na
	1312	Presence condition of lnNs and dataNs	Y
	1396	The use and configuration flow of LGOS and LSVS is Unclear	na
	1491	CmdBlk blocks itself?	na
6	658	Tracking related features	na
	660	XML encoding header repeat	na
	663	FCDA element cannot "functionally constrained logical node"	Y
	668	Autotransformer modeling	na
	687	SGCB ResvTms	na
	699	DO type description table	na
	719	ConfDataSet - maxAttributes definition is confusing	Y
	721	Log element name	na
	731	quoted SCL inconsistant with annex.	na
	752	Input Section/ Inputs Section	na
	768	bType VisString65 is missing	na
	779	Object references	Y
	787	SICS I45 inconsistency	Y
	788	SICS S56 from optional to mandatory	na
	789		Y

Table 40: Mandatory Edition 2 Tissues

Part	Tissue Nr	Description	Implemented Y/na
	804	ConfLdName as services applies to both server and client	na
	806	valKind and IED versus System configuration	na
	807	Max length of log name inconsistent between -6 and -7-2	Y
	823		Y
	824	Need a way to indicate if "Owner" present in RCB	na
	825	ValKind for structured data attributes	na
	845	Short addresses on structured data attributes	na
	853	Floating point value	na
	855	SGCB ResvTms	N
	856	SBO and ProtNs	na
	857	Recursive SubFunction	Y
	873	VoltageLevel frequency and phases	na
	886	Function/SubFunction for ConductingEquipment	na
	901	Examples for "curvPts"	na
	936	Missing 8-1 P-types	na
	949	tServices as AP or as IED element	na
	1118	SupSubscription parameter usage is difficult	na
	1147	type of LN inst is ambiguous	na
	1175	Clarification of how tClientLN is used to enable Report Control Blocks	na
	1185		na
	1195	tServices - FileHandling not consistent with -7-2	na
	1208	IPv6 address lowercase only na	na
	1284	Valkind value Conf for EX FC data	Y
	1298	Typographical Error	na
	1304	IPv6 Address format	na
	1318	SCSM mapping may require a communication section in an ICD file	na
	1328	How to differentiate preconfigured Report Datasets and generated ones	Y
	1354		Y
	1365	Error in the SCL object model	N
	1397	SSD will not validate against XSD	na

Table 40: Mandatory Edition 2 Tissues

Part	Tissue Nr	Description	Implemented Y/na
	1398	Limitation on the size of data type templates identifiers	N
	1415	Changes to SICS Template	na
	1444	Need to tighten up the XSD in regards to IEDName usage	Y
	1445	Subscription limitation visible in IxD file	Y
		originalSclVersion management in SCT	
		SICS-S110 IID import mandatory for Edition2	
		Need to support fixed and SCT controlled Datasets	
		ConfReportControl and a fixed ReportSettings	
6	1447	Restriction on ENUMtypes in SCL	Y
	1450	originalSclXxx computation rules	N
	1451	Services section-"client" is confusing	na
	1457	Multiple DOI nodes with the same name.	Y
NOTE: Editorial tissues are marked as “na”.			

Table 40: Mandatory Edition 2 Tissues

11.5 Protocol Implementation extra Information for Testing (PIXIT)

This document specifies the protocol implementation extra information for testing (PIXIT) of the IEC 61850 interface in the client system: RTU500 series IEC 61850 client, version 12.4 (further referred to as "client").

Together with the PICS and the MICS the PIXIT forms the basis for a conformance test according to IEC 61850-10.

Each chapter specifies the PIXIT for each applicable ACSI service model as structured in IEC 61850-10and the "Conformance Test Procedures for Client System with IEC 61850-8-1 interface".

11.5.1 PIXIT for Configuration

Description	Value / Clarification
Describe how the client handles nameplate configuration revision mismatches	The actual server name plate configuration revision is read from the server during the connection establishment. The configuration revision from the SCD file is not part of specific client configuration file. Therefore a mismatch between the SCD file and the actual server name plate configuration revision is not checked by the client.

Table 41: PIXIT for configuration

Description	Value / Clarification
Describe how the client handles report control block configuration revision mismatches	The report control block configuration revision is written from SCD file to the specific client configuration file. During connection establishment the client reads the report control block configuration revision from the data model of the server and compares the value with the revision from the SCD file. In case of a mismatch an internal minor error is generated that can be seen with a device specific log tool. The internal minor error has no influence on the processing of the report control block. The configuration revision send by the server in an actual report is not checked by the client.

Table 41: PIXIT for configuration

11.5.2 PIXIT for Association model

Description	Value / Clarification
Guaranteed number of servers that can set-up an association simultaneously (one association per server)	32
Lost connection detection time range (default range of TCP_KEEPALIVE is 1 - 20 seconds)	5 seconds
Lost (abort) connection retry time	TCP_KEEPIDLE = 10 s TCP_KEEPCNT = 3 TCP_KEEPINIT = 10 s TCP_KEEPINTVL = 5s 10s after association start to begin sending keep-alive and 15s (3 * 5s) to detect lost connection.
Is authentication supported?	N
What is the maximum and minimum MMS PDU size	Max MMS PDU size 32000 bytes Min MMS PDU size 1024 bytes
What is the typical start-up time after a power supply interrupt	Depending on the size of the configuration a typical start-up time is 5 minutes (including association to all configured servers)
How does the client behave in case of a lost connection with (one of) the associated servers?	The server is marked as offline. After a timeout of 15 seconds the client tries to reconnect the server. The reconnect timeout is increased to 60 seconds after 3 failed connection requests. The client never stops the reconnect retries. Note: In case the connection to several

Table 42: PIXIT for Association model

Description	Value / Clarification
	servers are lost at the same time the actual reconnect timeouts can be longer.
How does the client behave when a server denies an Association request by the client?	The server is marked as offline. After a time-out of 15 seconds the client tries to connect the server again. The connect timeout is increased to 60 seconds after 3 failed connection requests. The client never stops the connect retries. Note: In case the connection to several servers are lost at the same time the actual reconnect timeouts can be longer.
Does the client automatically reconnect to the configured servers after start-up (Automatic start-up)?	Y

Table 42: PIXIT for Association model

11.5.3 PIXIT for Server model

Description	Value / Clarification
Maximum object identification length	129 octets: <64>/<64>
Does the client support auto-description?	The client support auto-description in the means of adaptation to minor configuration mismatches between the SCD configuration and the actual server data model. But the client needs a complete SCD configuration with all servers and there data models included as starting point. During the first connection establishment the client reads parts of the actual data model of a server and modifies (when possible) the model from the SCD configuration according the actual read data. The processing is then done on the corrected data model. At any further connection requests to a server (during the runtime of the client) the data model is not read again. Instead the client uses the data model read during the first connection establishment.
Describe how to view/display data values	The IEC 61850 data values are mapped to IEC 870-5-101 data values that can be viewed in the web server provided by the device.
What analogue value (MX) quality bits are used in the client	Y Good, Y Invalid, N Reserved, N Questionable Y Overflow Y OutofRange Y BadReference

Table 43: PIXIT for Server model

Description	Value / Clarification
	Y Oscillatory Y Failure Y OldData Y Inconsistent Y Inaccurate Y Process Y Substituted Y Test Y OperatorBlocked
Which status value (ST) quality bits are used in the client	Y Good, Y Invalid, N Reserved, N Questionable N BadReference N Oscillatory N Failure Y OldData N Inconsistent N Inaccurate Y Process Y Substituted Y Test Y OperatorBlocked
Describe how to view/display quality values	The IEC 61850 quality bits are mapped to IEC 870-5-101 like quality attributes that can be viewed in the web server provided by the device.
Which time quality bits are used in the client	N LeapSecondsKnown Y ClockFailure Y ClockNotSynchronized
Describe how to view/display time quality bits	The IEC 61850 time quality bit ClockNotSynchronized is mapped to a time invalid attribute that can be viewed in the web server provided by the device.

Table 43: PIXIT for Server model

Description	Value / Clarification
Describe how to force a SetDataValues request	Control an analogue or digital set-point that is mapped to an IEC 61850 data object with functional constraint SP.
Describe how to force GetDataValues request	Control a data object with control model 'sbo-with-normal-security'. The service 'Select' is defined as reading of the SBO data attribute with the ACSI GetDataValues service.
Describe how to force a GetAllDataValues request	The ACSI service GetAllDataValues is not supported by the client.
Does the Client support writing blkEna values?	N
Describe how the client behaves in case of: - GetServerDirectory response-	The ACSI service GetServerDirectory is not used by the client. The client gets the logical devices of a server from the configured SCD data model of that server. Differences between the configured and the actual data model of a server are not considered.
Describe how the client behaves in case of: - GetLogicalDeviceDirectory response-	The ACSI service GetLogicalDeviceDirectory is not used by the client. The client gets the logical node and data set information from the configured SCD data model of a server. Differences between the configured and the actual data model of a server are not considered.
Describe how the client behaves in case of: - GetLogicalNodeDirectory response-	The ACSI service GetLogicalNodeDirectory is not used by the client. The client gets the data set information from the configured SCD data model of a server. Differences between the configured and the actual data model of a server are not considered.
Describe how the client behaves in case of: - GetDataDirectory response- - GetDataDefinition response-	The ACSI services GetDataDirectory / GetDataDefinition are used by the client to read data model information of logical nodes during connection establishment. In case of a negative service response the association to the server is concluded. Afterwards The client tries to reconnect the server according the rules described in "PIXIT for Association model".
Describe how the client behaves in case of: - GetAllDataValues response-	The ACSI service GetAllDataValues is not supported by the client.
Describe how the client behaves in case of: - GetDataValues response-	The ACSI service GetDataValues is used by the client to read the actual server name plate configuration revision during connection establishment. In case of a negative service response an internal minor error is generated that can be seen with a device specific log tool. The internal minor error has no influence on the further connection establishment.
Describe how the client behaves in case of: - SetDataValues response-	The ACSI service SetDataValues is used by the client to write a data element with functional constraint SP (Set Point). The origin of this write request is a set point command from a

Table 43: PIXIT for Server model

Description	Value / Clarification
	host functionality within the client (e.g. IEC 870-5-104 connection to a network control center). In case of a negative service response from the server the set point command is confirmed negative.

Table 43: PIXIT for Server model

11.5.4 PIXIT for Dataset model

Description	Value / Clarification
Describe how to force a GetDataSetValues request	The ACSI service GetDataSetValues is not supported by the client.
Describe how to force a SetDataSetValues request	The ACSI service SetDataSetValues is not supported by the client.
Describe how to force a DeleteDataSet request	The ACSI service DeleteDataSet is not supported by the client.
Describe how the client handles following dataset mismatches between the SCL and the data sets exposed via MMS: (1) New dataset element (2) Missing dataset element (3) Dataset elements with different data type (4) Reordered dataset members in a dataset of a different data type (5) Reordered dataset members in a dataset of the same data type	With the first connection establishment the client reads the actual configuration of a dataset. This information is stored and used for the decoding of reports containing this dataset. The datasets read by the client are selected from the SCD configuration of the client. Afterwards the client reads for all known dataset elements the data structure and type. Known dataset elements are elements configured in the SCD (of the client) and mapped to an internal data objects. Dataset elements that are not mapped to an internal data object are not read from the server. The read data structure and type are used to map received dataset elements to internal data objects. (1) If a server dataset contains additional (new) elements, the elements are ignored by the client (internally trashed). All other known elements are processed as normal in this case. (2) If elements are missing in a server dataset, the internal data objects mapped to the missing dataset elements remain invalid. All other known elements are processed as normal in this case. If elements are missing that are not mapped to an internal data object nothing happens. (3) If server dataset elements have different data types than in the client configuration, the client tries to map the actual data type to the internal data object. That means the client decodes the received dataset elements according to the data types read from the

Table 44: PIXIT for Dataset model

Description	Value / Clarification
	actual server configuration and tries to map the information to the internal data objects. Whether the mapping is successful depends on the mismatch. For example a Boolean data type can be mapped to an integer type but the other way round information is lost. (4) If dataset elements are reordered in a server dataset all known elements are processed as normal. Unknown reordered dataset elements are ignored. Different data types are handled as described in (3). (5) If dataset elements are reordered in a server dataset all known elements are processed as normal. Unknown reordered dataset elements are ignored. CAUTION: The above describe configuration adjustments are done at the first connection establishment only. If a server disconnects and re-connects later the configuration of the server is not read again. In this case the client uses the read configuration from the first connection establishment. If the server communication part (e.g. datasets) is re-configured between two connection establishments the behavior of the client is undefined. After a server re-configuration (communication part) the client must be re-started in any case (see “PIXIT for Server model”).
Describe how the client behaves in case of: - GetLogicalNodeDirectory(DATA-SET) response-	The ACSI service GetLogicalNodeDirectory(DATA-SET) is not used by the client. The client gets the data sets of a logical node from the configured SCD data model of a server. Differences between the configured data sets and the actual data model of a server are not considered.
Describe how the client behaves in case of: - GetDataSetDirectory response-	The ACSI service GetDataSetDirectory is used by the client to read the FCDs of a data set during connection establishment. In case of a negative service response the association to the server is concluded. Afterwards The client tries to reconnect the server according the rules described in "PIXIT for Association model".
Maximum name length for dataset Maximum name length for dataset member including LD and FC	Dataset name: 32 characters (name only) Dataset member: 129 characters (whole object reference)
Does the client support the creation of: - persistent datasets - non-persistent datasets	N N

Table 44: PIXIT for Dataset model

Description	Value / Clarification
Describe how the client behaves in case of: - CreateDataSet response- - DeleteDataSet response-	The ACSI services CreateDataSet and DeleteDataSet are not supported by the client.
Describe how the client behaves when it receives a SetDataSetValues.Response-	The ACSI service SetDataSetValues is not supported by the client.
What is the maximum number of data elements in one server data set the client can process?	300

Table 44: PIXIT for Dataset model

11.5.5 PIXIT for Substitution model

Substitution is not supported by the client.

11.5.6 PIXIT for Setting group control model

Setting group control is not supported by the client.

11.5.7 PIXIT for Reporting model

Description	Value / Clarification
Does the client search for RCB in all logical nodes? When not specify the logical nodes	In the configuration process the tool searches in all logical nodes of a server for RCBs. If the RCB is assigned to the client and at least one dataset member is mapped to an internal data object, the RCB is configured and enabled independent from the logical node.
Which dynamic RCB attributes are/can be configured by the client	RptID Y DataSet N Optional fields Y Trigger conditions Y Buffer time Y Integrity period Y
Does the client supports IEDs with indexed and non-indexed report control blocks (RCB)	Buffered RCB indexed Y Buffered RCB not indexed Y Unbuffered RCB indexed Y Unbuffered RCB not indexed Y
The supported trigger conditions are	Integrity Y data change Y quality change Y

Table 45: PIXIT for Reporting model

Description	Value / Clarification
	data update Y general interrogation Y
The supported optional fields are	sequence-number Y report-time-stamp Y reason-for-inclusion Y data-set-name Y data-reference Y buffer-overflow Y entryID Y conf-rev Y
The minimum required optional fields are	sequence-number N report-time-stamp N reason-for-inclusion Y data-set-name N data-reference N buffer-overflow N entryID N conf-rev N
Does the client support segmented reports	Y
Does the client support pre-assigned RCB	Y (Pre-assigning is required for the client)
Does the client support indexed RCBs	Y
Does the client support reported data set containing structured data objects or data attributes?	reporting of data objects Y reporting of data attributes N (Note: Unstructured data attributes are processed by the client, but the other parts in the device doesn't support them. Therefore the usage of data attributes are permitted.)
Describe how the client does respond when an URCB is already reserved by another client for: • Indexed URCB with max>1 configured in SCL (static reporting) • Indexed URCD with max=1 configured in SCL (static reporting) • URCB not configured in SCL (dynamic reporting)	The client checks for each URCB whether this is already enabled (ACSI service GetURCB-Values). If the URCB is already enabled the client tries to disable the URCB by writing the flag “RptEna” with false. If this is success-ful the client continues with the URCB setup (reading and writing the URCB attributes) and enables the URCB at the end. If disabling of the URCB fails the client concludes the con-nection to the server and re-starts the con-nection according to the association model.

Table 45: PIXIT for Reporting model

Description	Value / Clarification
	For enabling the client tries to access the specific URCB instance according to the configuration in the SCD file. The URCB instance number is derived from the position of the client within the list of the “RptEnabled” tag. For example, if the client is configured at the second position of the list the URCB instance number 2 is used when accessing and enabling the URCB. That means: If the “max” attribute within the “RptEnabled” tag is greater 1 (max>1) the accessed instance number is determined from the client position in the list. If the “max” attribute within the “RptEnabled” tag is 1 (max=1) the client access the instance number 1 because the client position in the list is 1 also. In both cases, if the access with the determined instance number fails, the client tries to access the URCB without instance number. Dynamic reporting is not supported by the client. So, URCBs that are not configured in SCL are not accessed or enabled.
Describe how the client does respond when a BRCB is already reserved by another client for: • Indexed BRCB with max>1 configured in SCL (static reporting) • Indexed BRCD with max=1 configured in SCL (static reporting) • BRCB not configured in SCL (dynamic reporting)	The client checks for each BRCB whether this is already enabled (ACSI service GetURCB-Values). If the BRCB is already enabled the client tries to disable the BRCB by writing the flag “RptEna” with false. If this is successful the client continues with the BRCB setup (reading and writing the BRCB attributes) and enables the BRCB at the end. If disabling of the BRCB fails the client concludes the connection to the server and re-starts the connection according to the association model. For enabling the client tries to access the specific BRCB instance according to the configuration in the SCD file. The BRCB instance number is derived from the position of the client within the list of the “RptEnabled” tag. For example, if the client is configured at the second position of the list the BRCB instance number 2 is used when accessing and enabling the BRCB. That means: If the “max” attribute within the “RptEnabled” tag is greater 1 (max>1) the accessed instance number is determined from the client position in the list. If the “max” attribute within the “RptEnabled” tag is 1 (max=1) the client access the instance

Table 45: PIXIT for Reporting model

Description	Value / Clarification
	number 1 because the client position in the list is 1 also. In both cases, if the access with the determined instance number fails, the client tries to access the BRCB without instance number. Dynamic reporting is not supported by the client. So, BRCBs that are not configured in SCL are not accessed or enabled.
Describe how the client does respond on a SetBRCBValues(EntryID) respond-	If the service to write the EntryID fails an internal minor error is generated that can be seen with a device specific log tool. The internal minor error has no influence on the processing of the report control block.
Describe how the client does respond when a report has an unknown: dataset, RptID, unexpected number of dataset entries, and/or unexpected data type format entries	With the first connection establishment the client reads the actual configuration of a dataset. This information is stored and used for the decoding of reports containing this dataset. The datasets read by the client are selected from the SCD configuration of the client. That means: • Additional datasets configured in the server but not in the client are ignored. • Datasets missing in the server don’t lead to an error and the processing continues with the next dataset. • Different named datasets are not detected and handled as missing datasets (continue with next dataset). For accessing and enabling of reports the clients uses the RptID from the SCD configuration. That means: • Additional reports configured in the server but not in the client are ignored. • Reports missing in the server lead to a conclusion of the connection. • Different named reports are not detected and handled as missing reports (connection conclude). For the handling of dataset configuration mismatches see “PIXIT for Dataset model”.
Describe how the client detects reporting configuration changes (mismatches). Does it check the "configuration revision" attributes and/or does it check the dataset members? Is the dataset update done online or offline?	Report configuration mismatches are not detected by the client (see description above). During first connection establishment the actual dataset configuration is read. This allows adaptation to dataset configuration changes (for detailed information see “PIXIT for Dataset model”). The adaptation to dataset changes are done online but at the first connection establishment only.

Table 45: PIXIT for Reporting model

Description	Value / Clarification
	The "configuration revision" attribute is ignored.
Describe how to force the client to change the RCB BufTm	The buffer time is set to the value configured in the SCD file. By revising the SCD file and reconfiguring the client the buffer time can be changed.
Does the client set server trigger option GI prior to first issuance of GI command?	N
Describe how to force the client to send the GI request	During each connection establishment all correct configured RCBs are enabled by the client. If enabling is successful GI requests are send for the RCBs.
Describe how to force the client to enable a RCB	During each connection establishment all correct configured RCBs are enabled by the client.
Describe how the client does respond when a report control block is renamed or deleted: • Does it prevent reading the deleted RCB? • If is reads the missing RCB, how does it handle the GetXRCBValues response-?	For accessing and enabling of reports the clients uses the RptID from the SCD configuration always. The client doesn't detect when an RCB is renamed or deleted on the server. The client tries to access the RCB and concludes the connection as result of a negative response. Afterwards the connection is restarted according to the association model.
Describe how the client behaves when it receives a report that has the buffer overflow flag set?	The buffer overflow flag is ignored by the client.
Describe how to force the client to write a (valid) EntryID value.	Connect a server and send some reports to client with included EntryID. Then disconnect the server. With the following reconnect the client sets the last received EntryID before enabling the report.
Describe how to force the client to purge the report buffer.	The client purges the report buffer of a server during the first connection establishment after start-up only. At any further connection establishments during the runtime of the server the report buffer is not purged. To force the client to purge the report buffer of a server, reset the client and wait for the first connection establishment to the server.
Describe how the client responds when it receives a GetXRCBValues.response-	The ACSI services GetXRCBValues are used by the client to read the attributes of report control blocks. If reading of specific attributes fails with a negative response an internal minor error is generated that can be seen with a device specific log tool. The internal minor error has no influence on the processing of the report control block.
Describe how the client responds when it receives a SetXRCBValues.response-	The ACSI services SetXRCBValues are used by the client to write the attributes of report control blocks. If writing of specific attributes fails with a negative resposne (e.g. BufTm) an internal minor error is generated that can be

Table 45: PIXIT for Reporting model

Description	Value / Clarification
	seen with a device specific log tool. In most of the cases the internal minor error has no influence on the processing (enabling) of the report control block. But if the RptID cannot be written the actual RptId from the server is taken for enabling the report. And if the trigger options cannot be written at all (read back trigger options are 0) the connection is concluded.
Describe how the client responds when it tries to use a RCB that is reserved by another client	The client checks for each RCB whether this is already enabled by another client. If the RCB is already enabled the client tries to disable the RCB by writing the flag “RptEna” with false. If this is successful the client continues with the RCB setup (reading and writing the RCB attributes) and enables the RCB at the end. If disabling of the RCB fails the client concludes the connection to the server and re-starts the connection according to the association model.
Describe how the client behaves when it receives a report that contains optional fields that are not supported by the client	The client supports all optional fields (see above) but if reason-for-inclusion is missing in the report, not changed data elements (e.g. integrity report) are not processed.
Describe how the client behaves when it receives a report that was caused by one or more trigger conditions that are not supported by the client	All trigger options are supported by the client.
Describe how the client behaves when it encounters an RCB with a different confRev value than expected	During the connection establishment the client reads the report control block configuration revision from the data model of the server and compares the value with the revision from the SCD file. In case of a mismatch an internal minor error is generated that can be seen with a device specific log tool. The internal minor error has no influence on the processing of the report control block. The confRev value send in the actual report is ignored and the report is processed according the read data model information.
Describe how the client responds when it sets an EntryID value that is not recognized by the server.	The EntryID send by the server in an actual report is not checked by the client against the last set EntryID.
Are there a maximum number of report control blocks that the client can enable?	The maximum number of report control blocks per server are: - 1000 buffered reports - 1000 unbuffered reports (Practically the limitation is the number of data objects that can be handled by the client)

Table 45: PIXIT for Reporting model

Description	Value / Clarification
Does the client support writing resvTms?	N
Does the client support writing owner?	N

Table 45: PIXIT for Reporting model

11.5.8 PIXIT for Logging model

Logging is not supported by the client.

11.5.9 PIXIT for Generic substation events model

GOOSE communication is not supported by the client.

11.5.10 PIXIT for Control model

Description	Value / Clarification
What control modes are supported	Y status-only Y direct-with-normal-security Y sbo-with-normal-security Y direct-with-enhanced-security Y sbo-with-enhanced-security
Is Time activated operate (operTm) supported	N
Is “operate-many” supported	N
Can the client set the test flag?	Y
What check conditions can be set	Y synchrocheck Y interlock-check
Which originator categories are supported and what is the originator identification?	The supported originator categories are station-control and remote-control. The originator identification is an internal decimal number representing the functionality that is the origin of the command.
Describe if and how the client sets/increments the ctlNum	The control sequence number is set to 0 always.
What does the client do when it receives a LastApplicationError and describes how to view the additional cause?	The AddCause from the LastApplicationError is added to the negative command response and send to the originator. The AddCause can be accessed / processed in a user application program (PLC) only.
What does the client do when it receives a Select, SelectWithValue or Operate respond negative?	The negative command response is send to the originator. The further processing depends on the originator (e.g. host communication protocol or web server). In case the originator is the web server an error message is shown.

Table 46: PIXIT for Control model

Description	Value / Clarification
Can the client change the control model via online services?	N
What does the client do when the ctlModel is not initialized in the SCL?	It is not possible to configure the client when the control model (ctlModel) is not initialized.
What does the client when the ctlModel in the SCD and in the server is different?	The client uses the ctlModel configured in the SCD always. If the server with a different ctlModel responds negative to a control request the command originator (e.g. host communication protocol or web server) gets a negative command response. If the server with a different ctlModel responds positive to a control request the command is processed as normal.
Describe how the client responds when it receives a positive Command Termination	The positive command response is send to the originator. The further processing depends on the originator (e.g. host communication protocol or web server). In case the originator is the web server a success message is shown.
Describe how the client responds when it receives a negative Command Termination	The negative command response is send to the originator. The further processing depends on the originator (e.g. host communication protocol or web server). In case the originator is the web server an error message is shown.
Describe how the client responds when it receives a negative Operate response	The negative command response is send to the originator. The further processing depends on the originator (e.g. host communication protocol or web server). In case the originator is the web server an error message is shown.
Describe how the client responds when it receives a positive Cancel response	The positive command response is send to the originator. The further processing depends on the originator (e.g. host communication protocol).
Describe how the client responds when it receives a negative Command Termination	The negative command response is send to the originator. The further processing depends on the originator (e.g. host communication protocol).

Table 46: PIXIT for Control model

11.5.11 PIXIT for Time and time synchronization model

Description	Value / Clarification
Described how to view the internal time & quality or how to expose the timestamp and timestamp quality via the IEC 61850 interface	View: The internal time and quality (synchronized or not synchronized) can be Viewed in the web server provided by the Client.

Table 47: PIXIT for Time and time synchronization model

	Expose: The internal time is added to the Operate Request and can be exposed there.
What time quality bits are supported	Y LeapSecondsKnown Y ClockFailure Y ClockNotSynchronized
What is the behaviour when the time synchronization signal/messages are lost	Depending on the kind of time synchronization (e.g. internal real time clock, SNTP, host communication protocol) the internal time quality is set to not synchronized: • when the real time clock indicates a not reliable time • or after a configurable time (SNTP, host communication protocol.
When is the quality bit "ClockFailure" set?	The time quality bit "ClockFailure” is set: - At start-up before synchronization - When after synchronization for a configurable time (typical 10 minutes) no new synchronization is received.
When is the quality bit "ClockNotSynchronized” set?	The time quality bit "ClockNotSynchronized” is set: - At start-up before synchronization - When after synchronization for a configurable time (typical 10 minutes) no new synchronization is received.
When is the quality bit "LeapSecondsKnown" set?	The quality bit "LeapSecondsKnown" is set, when the internal time gets synchronized.

Table 47: PIXIT for Time and time synchronization model

11.5.12 PIXIT for File transfer model

Description	Value / Clarification
Describe when or how to force the client to request GetServerDirectory(FILE) and what it does with the responded filenames	After start-up and connection establishment the directories of all for file transfer configured servers are read. Afterwards the directories are requested in a time interval of 30 seconds. The responded filenames are used to extract a unique file number to determine whether the file was already transferred to the client. In case no file number is provided new files are identified by name, size and time of last modification. New detected files are then requested by the client.

Table 48: PIXIT for File transfer model

Description	Value / Clarification
Does the client uses a wildcard in the GetServerDirectory(FILE) request	The used wildcard depends on the configured server type. The client supports no wildcard, wildcard = “*” and wildcard = “*.*”.
Does the client support IEDs that include the path in the file name in the GetServerDirectory(FILE) respond?	Y* path included Y* path not included * the actual type must be configured
Does the client support IEDs that use the file separator	Y* “/” Y* “\” * the actual separator must be configured (defined by IED type)
What is the maximum file name size including path	255 characters
Can the client read a file with size 0	Y
Are directory/file name case sensitive	The directory/file name is used as it is received from the server. The extraction of the file number from the file name (server dependent) is case sensitive.
Maximum file size	512 Kbytes In case the files are zipped by the client during reading from server (server dependent) the maximum file size applies to the resulting ZIP file on the client. Note: If a file on the server exceeds the maximum size the client will not request any further files from the server till the file is removed.
Describe how the client behaves in case of: - GetFileAttributes response-	The request is discarded and the processing continues as normal. The affected server is requested again after the defined polling interval. Note: If a file on the server can not be accessed the client will not request any further files from the server till the access is possible again.

Table 48: PIXIT for File transfer model

11.5.13 PIXIT for Service Tracking model

Service tracking is not supported by the client.

11.6 SCL Implementation Conformance Statement (SICS)

This SICS is applicable for:

- Tool name: RTUtil500
- Main role: ICT
- Version: 12.4

The following tables contain mandatory and optional features of System Configuration tools and IED configuration tools. It is up to the tool manufacturer to decide to which extent his tool fulfills one or both roles. At least for one main role all mandatory features shall be supported.

The IED configurator features can also partly be implemented within the IED itself, if it can be configured by an SCD or CID file. In this case the conformance statement refers to the combination of IED and IED configurator tool. If an IED tool supports several IED types with different engineering capabilities, then for each combination of tool and IED type a separate IED configurator conformance statement should be given.

The features are grouped. If a group is mandatory, then at least all mandatory features of this group shall be implemented. If a group is optional, then either all features of this group shall be missing, or at least all mandatory ones shall be implemented.

The result of an export function can be checked in the generated SCL file. The result of an import can be checked by tool behaviour, and at the final configured IED, by browsing through it or by its communication behaviour.

		Mandatory/ optional	Value/ comments
ICD export		**M**	
I11	Fix ICD file (no adaptable export needed)	GC_1 (1)	NO
I12	Export of ICD file or IID file according to IED pre-configuration performed by tool	GC_1 (1)	YES
I13	State the data model name space (61850-7-3 subclause 7.2) within ICD file (LLN0.NamPlt.ldNs value)	M	YES
I14	State the data model version (61850-7-3 sub-clause 7.8.3) and any predefined / fixed configura-tion values within ICD file ([10] 9.5.4.4)	M	YES
I15	Version 2003 export	GC_1 (2)	YES
I16	Version 2007A export	GC_1 (2)	YES
I17	Predefined data sets	O	YES
I18	Predefined control blocks	O	YES
I19	Substation bay template with IED part	O	NO
I110	Communication section with default address	O	YES
I111	Export correct valKind value ([10] Table 46)	O	YES (RO)
I112	Exports internal addresses as InRef or Input sec-tion (subclause 285H 9.3.13)	O	NO
I113	Exports internal addresses in Input section with expected serviceType (subclause [10] 9.3.13)	O	NO
I114	Exports in UTF-8 coding	M	YES
SCD import		**M**	
I21	Identify IED to be configured in SCD file by IED name	M	YES

Table 49: IED configurator conformance statement

		Mandatory/ optional	Value/ comments
I22	Configure LD name (at least via ldInst, dependent on the IED capabilities) and IED addresses from SCD	M	YES
I23	Determine communication side addresses of IED inputs from SCD	C1	YES
I24	Determine and use clock communication addresses from SCD	C1	NO
I25	Configure values of (existing) control block from SCD([10] 9.3)	C3	NO
I26	Prepare (new) control block instances according to SCD file	C3	NO
I27	Prepare / configure data sets according to SCD file	C3	NO
I28	Modify predefined data sets according to SCD	C3	NO
I29	Interpret client references in the control blocks of other IEDs to find the control block instances allocated to this IED, and data sent to this IED.	C1	YES
I210	Set IED configuration values and parameter values as defined in SCD file	O	NO
I211	Support changed (reduced capability) valKind (e.g. from Set to RO or to Conf) ([10] Table 46)	O	NO
I212	Support ldName on other IEDs ([10] 9.3.4)	C3	NO
I213	Interpret input signal references to source control blocks (290H 9.3.13)	O	YES
I214	Imports UTF-8 coding of XML	M	YES
IID export after IED engineering			
I31	IED version and instance information: LPHD.PhyNam: hwRev, swRev, serNum, LLN0.NamPlt.configRev	O	NO
I32	Configuration values (fc=CF)	O	NO
I33	Setting Parameter values (fc=SP, SG)	O	NO
I34	SCL Header management ([10] 9.1)	C3	NO
I35	Modify IED data model (add LN/Data object/LD, or remove unused LD/LN/Data object)	O	NO
Tool functionality			
I41	Support MustUnderstand concept ([10] 8.2)	M	YES
I42	Bind incoming 61850 signals to IED internal (input) signals	C1	YES
I43	Use or create IED Input section for binding incoming (external) signals to internal signals, to document this binding	O	YES
I44	Create CID file for IED	O	NO
I45	Support ldName for LD name specification	C3	YES
I46	Modify LN prefixes or lnInst	O	YES (Both can be set as wanted)

Table 49: IED configurator conformance statement

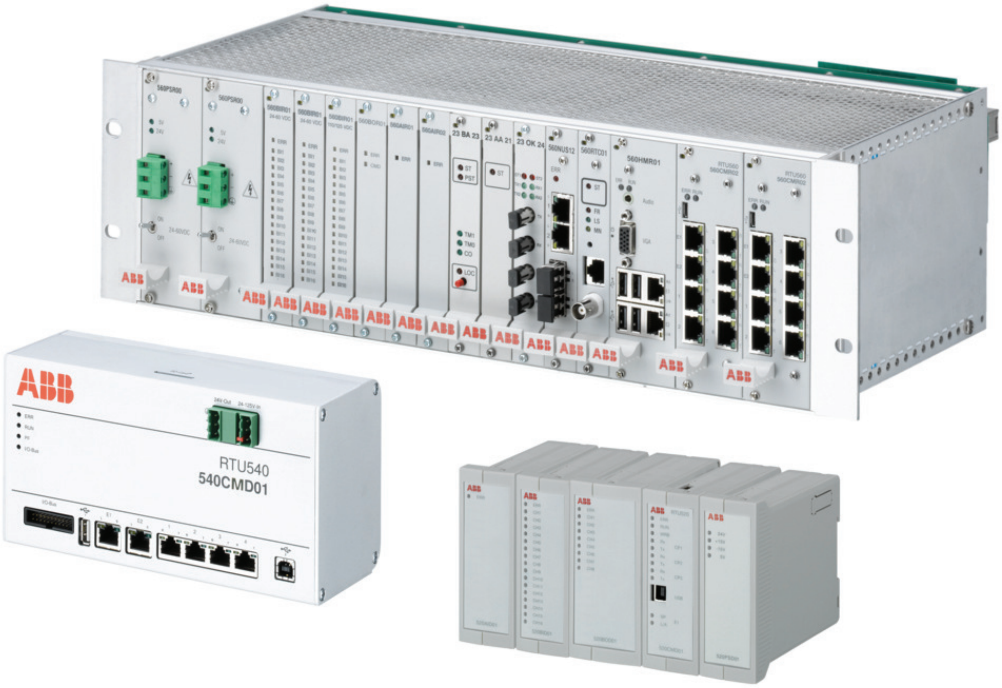
	Mandatory/ optional	Value/ comments
C1 - Mandatory, if the IED can receive data from other IEDs, i.e. be either client or subscriber C2 - Mandatory, if any of the other features in this table section is supported. C3 - Mandatory, if the appropriate IED capability is claimed in PIXIT or IED capability section. GC_1 (n) - At least one of the elements of group n shall be available. O - Optional; should match the IED capabilities; i.e. if an IED claims that RCBs can be configured by SCL, then the IED tool shall support it. M - Mandatory		

Table 49: IED configurator conformance statement

Power Grids

Remote Terminal Units IEC 61850 Client

Protocol description



Revision

Document identity:		1KGT 150 590 V009 1
Revision:	**Date:**	**Changes:**
0	05/2007	Base version
1	12/2009	Add description of file transfer functionality Add description IEC 61850 server functionality
2	03/2011	Add description of functional constraint “SP” Add information about IEC 61850 edition 2 Add description for message filtering Add information about startup log file
3	11/2012	Update for Release 10.6 Revise document for KEMA Conformance test Add chapter ‘Conformance Statement’ Add description for command handling Add description for system commands Update file transfer description
4	08/2014	Add support of functional constraint SP Add support of transient attribute ValWTr.transInd Revise conversion of quality descriptors Revise file transfer description for generic IEDs Add information about NOT TOPICAL inoperable indication New layout
5	12/2014	Describe file directory path parameter for generic IEDs Include note about SCL2003 restriction Add description of high communication load diagnosis message
6	06/2016	Add description of parameter "File search pattern" (PR#22596)
	03/2017	Model implementation conformance statement refered to out-dated ICD substation configuration file (PR#26101)
7	08/2017	Include descriptions and conformance statements for IEC 61850 Edition 2 client
8	03/2018	Chapter System limits updated (PR#22818, #36769)
		Disturbance file upload triggered by SPI (PR#33023)
		New layout
9	09/2018	Updated chapter ACSI, MICS, PICS, TICS, PIXIT and SICS for IEC 61850 Edition 2 TÜV conformance test (PR#32989) Corrected table reference in chapter 'Transfer of Disturbance Data Files' (PR#39445)

Contents

1 Introduction.....5
- 1.1 Preface..... 5
- 1.2 References.....5
- 1.3 Conventions..... 6

2 Physical Layer.....7

3 Link Layer..... 9
- 3.1 General.....9
- 3.2 Client/server services..... 9

4 Application Layer..... 11
- 4.1 Selection of protocol edition..... 11
- 4.2 Logical nodes.....11

5 Addressing..... 13
- 5.1 IEC 61850 Object References.....13

6 Monitoring Direction.....15
- 6.1 General..... 15
- 6.2 SPI – Single Point Information.....15
- 6.3 DPI – Double Point Information.....16
- 6.4 STI – Step Position Information..... 17
- 6.5 BSI – Bit String Information.....18
- 6.6 ITI – Integrated Totals Information.....20
- 6.7 DMI – Digital Measured Information..... 21
- 6.8 AMI – Analog Measured Information..... 21
- 6.9 MFI – Measured Float Information..... 23

7 Controlling Direction.....27
- 7.1 SCO – Single Command Output.....27
- 7.2 DCO – Double Command Output..... 28
- 7.3 RCO – Regulation Command Output..... 29
- 7.4 ASO – Analog Setpoint Output.....31
- 7.5 DSO – Digital Setpoint Output.....33
- 7.6 FSO – Floating Point Setpoint Output..... 35
- 7.7 BSO – Bit String Output..... 36

8 File transfer.....39
- 8.1 Transfer of Disturbance Data Files..... 39
- 8.2 File Transfer Configuration..... 40
- 8.3 Generic IED Type..... 41

9 Internal Functions..... 45
- 9.1 Startup log..... 45
- 9.2 Time Synchronization.....45
- 9.3 General Interrogation.....45

9.4 System Events....45
9.5 System commands....47
9.5.1 Set device out of service.... 47
9.6 Message Filtering....47
9.7 Command Handling....48
9.7.1 IEC 61850 Control Models.... 48
9.7.2 Qualifier of Command....50
9.8 IEC 61850 server functionality....50
9.8.1 Logical node physical health identification.... 50
9.8.2 Time master supervision....51
9.8.3 Redundant physical communication channel supervision....51
9.8.4 Authority control for the whole substation.... 52
9.9 High Communication Load.... 53

10 Limits and Recommendations....55
10.1 System Limits.... 55
10.2 Mixed systems.... 55

11 Conformance Statements.... 57
11.1 Abstract Communication Service Interface (ACSI).... 57
11.1.1 ACSI Basic Conformance Statement....57
11.1.2 ACSI Models Conformance Statement.... 57
11.1.3 ACSI Service Conformance Statement....59
11.1.4 Specific Communication Service Mapping (SCSM)....61
11.2 Protocol Implementation Conformance Statement (PICS).... 62
11.2.1 Basic Profile Conformance....62
11.2.2 MMS Conformance.... 63
11.3 Model Implementation Conformance Statement (MICS).... 63
11.3.1 Common Data Class Extensions.... 63
11.3.2 Logical Node List....65
11.3.3 LN Group L: System logical nodes....65
11.3.4 LN Group L: Logical nodes for interfacing and archiving.... 67
11.4 Tissues Conformance Statement (TICS)....68
11.4.1 Mandatory Edition 1 IntOp Tissues....68
11.4.2 Optional Edition 1 IntOp Tissues.... 70
11.4.3 Mandatory Edition 2 Tissues....70
11.5 Protocol Implementation extra Information for Testing (PIXIT).... 79
11.5.1 PIXIT for Configuration....79
11.5.2 PIXIT for Association model....80
11.5.3 PIXIT for Server model.... 81
11.5.4 PIXIT for Dataset model....84
11.5.5 PIXIT for Substitution model.... 86
11.5.6 PIXIT for Setting group control model....86
11.5.7 PIXIT for Reporting model....86
11.5.8 PIXIT for Logging model.... 92
11.5.9 PIXIT for Generic substation events model....92
11.5.10 PIXIT for Control model....92

11.5.11 PIXIT for Time and time synchronization model.. 93
11.5.12 PIXIT for File transfer model.. 94
11.5.13 PIXIT for Service Tracking model... 95
11.6 SCL Implementation Conformance Statement (SICS).. 95

12 Glossary.. 99

1 Introduction

1.1 Preface

This document describes the functions of the subdevice communication interface in RTU500 series according to IEC 61850.

1.2 References

1 IEC 61850-6:2004(E)
Communication networks and systems in substations
Part 6: Configuration description language for communication in electrical substation related to IEDs
First edition 2004-03
2 IEC 61850-7-1:2003(E)
Communication networks and systems in substations
Part 7-1: Basic communication structure for substation and feeder equipment – Principles and models
First edition 2003-07
3 IEC 61850-7-2:2003(E)
Communication networks and systems in substations
Part 7-2: Basic communication structure for substation and feeder equipment – Abstract communication service interface (ACSI)
First edition 2003-05
4 IEC 61850-7-4:2003(E)
Communication networks and systems in substations
Part 7-4: Basic communication structure for substation and feeder equipment – Compatible logical node classes and data classes
First edition 2003-05
5 IEC 61850-8-1:2004(E)
Communication networks and systems in substations
Part 8-1: Specific communication service mapping (SCSM) – Mappings to MMS (ISO9506-1 and ISO9506-2) and to ISO/IEC 8802-3
First edition 2004-05
6 User Manual RTUtil500 Release 12 (1KGT 150 950)
7 RTU500 series Interfaces and Protocols Release 12 (1KGT 150 939)
8 RTU500 series function description - part 6: RTU500 functions (1KGT 150 945)
9 RTU500 series function description - part 7: archive functions (1KGT 150 946)
10 IEC 61850-6:2009(E)
Communication networks and systems for power utility automation
Part 6: Configuration description language for communication in electrical substations related to IEDs
Edition 2.0 2009-12
11 IEC 61850-7-1:2011(E)
Communication networks and systems for power utility automation
Part 7-1: Basic communication structure – Principles and models
Edition 2.0 2011-07
12 IEC 61850-7-2:2010(E)
Communication networks and systems for power utility automation
Part 7-2: Basic information and communication structure – Abstract communication service interface (ACSI)
Edition 2.0 2010-08

13 IEC 61850-7-4:2010(E)
Communication networks and systems for power utility automation
Part 7-4: Basic communication structure – Compatible logical node classes and data object classes
Edition 2.0 2010-03

14 IEC 61850-8-1:2011(E)
Communication networks and systems for power utility automation
Part 8-1: Specific communication service mapping (SCSM) – Mappings to MMS (ISO 9506-1 and ISO 9506-2) and to ISO/IEC 8802-3
Edition 2.0 2011-06

1.3 Conventions

In this document function codes of data types according to IEC 61850 are marked with brackets: <Function code>

Bold fonts with the table heading "Parameter name" are references to configuration parameters in RTUtil500. The parameter is followed by the parameter location where to find this parameter in RTUtil500. The first element of the parameter location defines the node in the hardware tree on the left side (e. g. RTU, CMU, line, IED) and the second element defines selected header control tab in the parameter window on the right side (e. g. general, interfaces, protocol).

Example:

	**Parameter name**	**Default**	**Parameter location**

The tables in the next chapters include lists of the functions, options and message types supported according to the protocol structure given in IEC 60870-5 (EPA three layer model) for

The tables in the next chapters include lists of the functions, options and message types supported according to the protocol structure given in IEC 60870-5 (EPA three layer model) for

- the physical layer
- the link layer
- the application layer

This layered model is valid for the protocol IEC 61850.

2 Physical Layer

The transmission speed in control and in monitor direction is 10 or 100 Mbit/sec.

For details see RTU500 series Interfaces and Protocols Release 12 (1KGT 150 939).

3 Link Layer

3.1 General

The IEC 61850 Client provides support for Edition 1 and Edition 2 Client/Server services as described in [5] respectively [14]. GSE management and GOOSE services are available for the Server only. GSSE Services are not implemented.

Services like ‘Sampled Values’ described in IEC 61850-9 are not supported.

3.2 Client/server services

The IEC 61850 Client acts in IEC 61850 station bus as Edition 1 or Edition 2 client .

Following services as described in [3] respectively [12] are supported:

IEC 61850-7-2 model	IEC 61850-7-2 service	SCI support
Server	GetServerDirectory	
Association	Associate	X
	Abort	X
	Release	X
Logical Device	GetLogicalDeviceDirectory	
Logical Node	GetLogicalNodeDirectory	
	GetAllDataValues	
Data	GetDataValues	X
	SetDataValues	X
	GetDataDirectory	X
	GetDataDefinition	X
Data Set	GetDataSetValues	
	SetDataSetValues	
	CreateDataSet	
	DeleteDataSet	
	GetDataSetDirectory	X
Substitution	GetDataValues	
	SetDataValues	
Setting Group Control Block	SelectActiveSG	
	SelectEditSG	
	SetSGValues	
	ConfirmEditSGValues	
	GetSGValues	
	GetSGCBValues	
Report Control Block	Report	X
	GetBRCBValues	X
	SetBRCBValues	X
	GetURCBValues	X
	SetURCBValues	X

Table 1: Supported IEC 61850-7-2 services

IEC 61850-7-2 model	IEC 61850-7-2 service	SCI support
LOG Control Block	GetLCBValues	
	SetLCBValues	
	GetLogStatusValues	
	QueryLogByTime	
	QueryLogAfter	
GOOSE	SendGOOSEMessage	
	GetGoReference	
	GetGOOSEElementNumber	
	GetGoCBValues	
	SetGoCBValues	
GSSE	SendGSSEMessage	
	GetGsReference	
	GetGSSEElementNumber	
	GetGsCBValues	
	SetGsCBValues	
Control	Select	X
	SelectWithValue	X
	Cancel	X
	Operate	X
	CommandTermination	X
	TimeActivatedOperate	
FILE transfer	GetFile	X
	SetFile	
	DeleteFile	
	GetFileAttributeValues	X

Table 1: Supported IEC 61850-7-2 services

4 Application Layer

4.1 Selection of protocol edition

The RTU500 series IEC 61850 client and server supports Edition 1 and Edition 2 of the standard. For each RTU500 series client and server in a configuration the used protocol edition must be defined. Due to the differences in the data model between Edition 1 and Edition 2 the selected protocol edition cannot be changed anymore after an SCD import was done or after any data points are configured for the client or server. So be sure to select the protocol edition first when starting a configuration.

For details how to select the protocol edition in RTUtil500 see [6].

4.2 Logical nodes

In IEC 61850 information are grouped according to the process needs in logical nodes. Logical nodes consist of attributes of common data classes. Conversion of information is done on common data class basis. This gives the possibility to support also logical nodes probably defined in the future or for special process purposes.

Compatible logical nodes and data classes can be found in [4] respectively [13].

5 Addressing

5.1 IEC 61850 Object References

For addressing of IEC 61850 object references are used. These references are a concatenation of the following names (see [2] respectively [11]):

LDName/LNName.DataName.DataAttribute[&FC]

Abbreviation	Name	Description
LDName	Logical device instance name	Unique name of a logical device
LNName	Logical node instance name	Concatenation of • LN Prefix • LN name • LN Instance number
DataName	Name of common data class in logical node	
DataAttribute	Attribute name in common data class	
FC	Functional Constraint	

References can not be modified with RTUtil500. They are always synchronized from a SCD file to the Excel Import file of RTUtil500 without modifications. The server data points with IEC 61850 objects are defined in the Excel import file only.

The complete engineering process in RTUtil500 is described in [6].

6 Monitoring Direction

6.1 General

In monitoring direction the SCI IEC 61850 supports data transfer by data sets only. That means all process information to receive must be part of data sets. This particularly applies to the functional constraint SP (Set Point) that can be used in data sets only. There is no polling functionality provided to receive set point values in monitoring direction.

The common data classes and data attributes listed in the following chapters are restricted to none array attribute types only. The SCI IEC 61850 doesn’t support collections of values combined in an array.

6.2 SPI – Single Point Information

Binary process information indicated by one bit.

Supported Data Types	**Common Data Class**	**Attribute Name**	**Functional Constraint**	**Conversion of Value Type**
	ACD	general	ST	A
	ACD	neut	ST	A
	ACD	phsA	ST	A
	ACD	phsB	ST	A
	ACD	phsC	ST	A
	ACT	general	ST	A
	ACT	neut	ST	A
	ACT	phsA	ST	A
	ACT	phsB	ST	A
	ACT	phsC	ST	A
	BSC	stSeld	ST	A
	DPC	stSeld	ST	A
	ENC[1]	stSeld	ST	A
	INC	stSeld	ST	A
	ISC	stSeld	ST	A
	SPC	stSeld	ST	A
	SPC	stVal	ST	A
	SPG	setVal	SP	A
	SPS	stVal	ST	A
Additional	**None**			

1 Available for IEC 61850 Edition 2 client only

Conversion of value (Type A)

RTU500 series internal communication	**Protocol specific (Attribute value)**
Off	FALSE
On	TRUE

Conversion of quality descriptors

RTU500 series internal communication		Protocol specific
BL	Blocked	q.operatorBlocked == TRUE
SB	Substituted	q.source == substituted
NT	Not Topical	q.detailQual.oldData == TRUE
IV	Invalid	q.validity == invalid or q.validity == questionable

Conversion of cause of transmission

RTU500 series internal communication		Protocol specific
T	Test	q.test == TRUE
P/N	Positive/negative confirmation	- Irrelevant -
Cause	Spontaneous	-
	Requested	-
	Interrogated	-

6.3 DPI – Double Point Information

Binary process information indicated by two bits.

Supported Data Types	Common Data Class	Attribute Name	Functional Constraint	Conversion of Value Type
	ACD	dirGeneral	ST	A
	ACD	dirNeut	ST	B
	ACD	dirPhsA	ST	B
	ACD	dirPhsB	ST	B
	ACD	dirPhsC	ST	B
	DPC	stVal	ST	C
	DPS	stVal	ST	C
	ENC[1]	stVal	ST	D
	ENG[1 2]	setVal	SP	D
	ENS[1]	stVal	ST	D
Additional	**None**			

1 Available for IEC 61850 Edition 2 client only
2 Only as part of a receiving data set

Conversion of value (Type A)

RTU500 series internal communication	Protocol specific (Attribute value)
Intermediate	Unknown
Off	Forward
On	Backward
Indeterminate	Both

Conversion of value (Type B)

RTU500 series internal communication	Protocol specific (Attribute value)
Intermediate	Unknown
Off	Forward
On	Backward
Indeterminate	-

Conversion of value (Type C)

RTU500 series internal communication	Protocol specific (Attribute value)
Intermediate	intermediate-state
Off	Off
On	On
Indeterminate	bad-state

Conversion of value (Type D)

RTU500 series internal communication	Protocol specific (Attribute value)[1]
Intermediate	Enumeration value 0
Off	Enumeration value 1
On	Enumeration value 2
Indeterminate	Enumeration value 3

1 Shall be used only for enumerations with up to 4 values.

Conversion of quality descriptors

RTU500 series internal communication		Protocol specific
BL	Blocked	q.operatorBlocked == TRUE
SB	Substituted	q.source == substituted
NT	Not Topical	q.detailQual.oldData == TRUE
IV	Invalid	q.validity == invalid or q.validity == questionable

Conversion of cause of transmission

RTU500 series internal communication		Protocol specific
T	Test	q.test == TRUE
P/N	Positive/negative confirmation	- Irrelevant -
Cause	Spontaneous	-
	Requested	-
	Interrogated	-

6.4 STI – Step Position Information

Binary process information indicated by 8 bit.

Supported Data Types	Common Data Class	Attribute Name	Functional Constraint	Conversion of Value Type

	BSC	valWTr.posVal	ST	A
	ISC	valWTr.posVal	ST	A
Additional	**None**			

Conversion of value (Type A)

RTU500 series internal communication		Protocol specific (Attribute value)
Range min.	-63	-63
...	...	
Range max.	+63	+63

Conversion of quality descriptors

RTU500 series internal communication		Protocol specific
OV	Overflow	q.detailQual.overflow == TRUE or q.detailQual.outOfRange == TRUE or q.detailQual.badReference == TRUE or q.detailQual.oscillatory == TRUE or q.detailQual.failure == TRUE or q.detailQual.inconsistent == TRUE or q.detailQual.inaccurate == TRUE
BL	Blocked	q.operatorBlocked == TRUE
SB	Substituted	q.source == substituted
NT	Not Topical	q.detailQual.oldData == TRUE
IV	Invalid	q.validity == invalid or q.validity == questionable
T	Transient Bit	valWTr.transInd

Conversion of cause of transmission

RTU500 series internal communication		Protocol specific
T	Test	q.test == TRUE
P/N	Positive/negative confirmation	- Irrelevant -
Cause	Spontaneous	-
	Requested	-
	Interrogated	-

6.5 BSI – Bit String Information

Binary process information indicated by 8, 16 or 32 bit.

Supported Data Types	Common Data Class	Attribute Name	Functional Constraint	Conversion of Value Type
	ENC[1]	stVal	ST	A
	ENG[1 2]	setVal	SP	A

	ENS[1]	stVal	ST	A
	INC	stVal	ST	B
	ING[2]	setVal	SP	B
	INS	stVal	ST	B
Additional	**None**			

1 Available for IEC 61850 Edition 2 client only
2 Only as part of a receiving data set

Conversion of value (Type A)

RTU500 series internal communication		Protocol specific (Attribute value)
Range min.	0	Enumeration value 0
...	...	
Range max.	BSI8: Bit mask of 8 bit; range ... 255	Enumeration value 255
	BSI16: Bit mask of 16 bit; range ... 65 535	Enumeration value 65 535
	BSI32: Bit mask of 32 bit; range ... 4 294 967 295	Enumeration value 4 294 967 295

Conversion of value (Type B)

RTU500 series internal communication		Protocol specific (Attribute value)
Range min.	0	0
...	...	
Range max.	BSI8: Bit mask of 8 bit; range ... 255	255
	BSI16: Bit mask of 16 bit; range ... 65 535	65 535
	BSI32: Bit mask of 32 bit; range ... 4 294 967 295	4 294 967 295

Conversion of quality descriptors

RTU500 series internal communication		Protocol specific
OV	Overflow	q.validity == invalid q.detailQual.overflow == TRUE q.detailQual.outOfRange == TRUE
BL	Blocked	q.validity == questionable q.operatorBlocked == TRUE q.detailQual.oldData == TRUE (only if not invalid IV is set)
SB	Substituted	q.source == substituted
NT	Not Topical	q.validity == questionable q.detailQual.oldData == TRUE (only if not invalid IV is set)

RTU500 series internal communication		Protocol specific
IV	Invalid	q.validity == invalid

Conversion of cause of transmission

RTU500 series internal communication		Protocol specific
T	Test	q.test == TRUE
P/N	Positive/negative confirmation	- Irrelevant -
Cause	Spontaneous	-
	Requested	-
	Interrogated	-

6.6 ITI – Integrated Totals Information

Binary process information indicated by 32 bit as a countered value.

Supported Data Types	Common Data Class	Attribute Name	Functional Constraint	Conversion of Value Type
	BCR	actVal	ST	A
	BCR	frVal	ST	A
Additional	**None**			

Conversion of value (Type A)

RTU500 series internal communication		Protocol specific (Attribute value)
Range min.	-2147483648	-2147483648
...	...	...
Range max.	+2147483647	+2147483647

Conversion of quality descriptors

RTU500 series internal communication		Protocol specific
SEQ	Sequence number	-
CY	Carry	q.detailQual.overflow == TRUE or q.detailQual.outOfRange == TRUE or q.detailQual.badReference == TRUE or q.detailQual.oscillatory == TRUE or q.detailQual.failure == TRUE or q.detailQual.inconsistent == TRUE or q.detailQual.inaccurate == TRUE
CA	Adjusted	-
IV	Invalid	q.validity == invalid or q.validity == questionable

Conversion of cause of transmission

RTU500 series internal communication		Protocol specific
T	Test	q.test == TRUE
P/N	Positive/negative confirmation	- Irrelevant -
Cause	Spontaneous	-
	Requested	-
	Interrogated	-

6.7 DMI – Digital Measured Information

Binary process information indicated by 8 or 16 bit used as a measured value from digital inputs in normalized format.

Mapping of IEC 61850 information to DMIs is by default not enabled in RTUtil500, but supported by subdevice communication interface IEC 61850. If mapping of DMIs is required please contact ABB for more detailed information.

6.8 AMI – Analog Measured Information

Analog process information indicated by integer or floating point values, used as a measured value from analog inputs.

Supported Data Types	**Common Data Class**	**Attribute Name**	**Functional Constraint**	**Conversion of Value Type**
	INC	stVal	ST	A
	ING[1]	setVal	SP	A
	INS	stVal	ST	A
	MV	mag.f	MX	A
	SAV	instMag.f	MX	A
	SAV	instMag.i	MX	A
	SEQ	c1.cVal.mag.f	MX	A
	SEQ	c2.cVal.mag.f	MX	A
	SEQ	c3.cVal.mag.f	MX	A
	SEQ	cVal.mag.f	MX	A
Additional	**Maximum Value** **Maximum Value in the external protocol to be converted to +100 % on RTU500 series internal communication** Parameter: Maximum Value (AMI – Protocol Sub Parameter) [Range: - 2147483648 .. 2147483647] **Minimum Value** **Minimum Value in the external protocol to be converted to -100 % on RTU500 series internal communication.** Parameter: Minimum Value (AMI- Protocol Sub Parameter) [Range: -2147483648 .. 2147483647]			

Threshold Supervision
Enables the threshold supervision for measured values received from the external protocol and send on the RTU500 series internal communication.
Parameter:
Threshold Supervision (AMI – Protocol Sub Parameter)

Threshold Supervision Type
Defines the algorithm used for the threshold supervision of measured values received from the external protocol.
Parameter:
Threshold Supervision Type (AMI – Protocol Sub Parameter)
[Selection: "Integrated Threshold Supervision" or
"Absolute Threshold Supervision"]

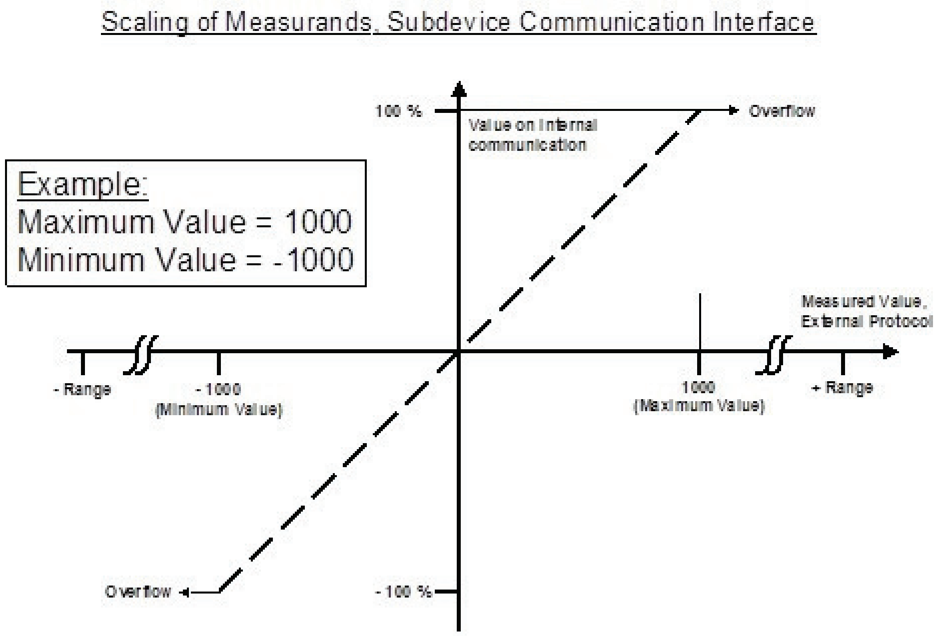
Threshold
Defines the threshold value used for the threshold supervision algorithm.
Parameter:
Minimum Value (AMI- Protocol Sub Parameter)
[Range: 0 .. 100%]

---

1 Only as part of a receiving data set

Conversion of value (Type A)

RTU500 series internal communication		Protocol specific (Attribute value)
Range min.	-100%	Parameter: Minimum Value
...	...	
Range max.	+100%	Parameter: Maximum Value



Conversion of quality descriptors

RTU500 series internal communication		Protocol specific
OV	Overflow	q.detailQual.overflow == TRUE or q.detailQual.outOfRange == TRUE or

RTU500 series internal communication		Protocol specific
		q.detailQual.badReference == TRUE or q.detailQual.oscillatory == TRUE or q.detailQual.failure == TRUE or q.detailQual.inconsistent == TRUE or q.detailQual.inaccurate == TRUE
BL	Blocked	q.operatorBlocked == TRUE
SB	Substituted	q.source == substituted
NT	Not Topical	q.detailQual.oldData == TRUE
IV	Invalid	q.validity == invalid or q.validity == questionable

Conversion of cause of transmission

RTU500 series internal communication		Protocol specific
T	Test	q.test == TRUE
P/N	Positive/negative confirmation	- Irrelevant -
Cause	Spontaneous	-
	Requested	-
	Interrogated	-

6.9 MFI – Measured Float Information

Analog process information indicated by 32 bit used as measured value from analog inputs in float format.

Supported Data Types	Common Data Class	Attribute Name	Functional Constraint	Conversion of Value Type
	ASG	setMag.f	SP	A
	CMV	cVal.mag.f	MX	A
	CMV	cVal.ang.f	MX	A
	DEL	cVal.mag.f	MX	A
	DEL	phsAB.cVal.mag.f	MX	A
	DEL	phsBC.cVal.mag.f	MX	A
	DEL	phsCA.cVal.mag.f	MX	A
	MV	mag.f	MX	A
	SAV	instMag.f	MX	A
	SEQ	c1.cVal.mag.f	MX	A
	SEQ	c2.cVal.mag.f	MX	A
	SEQ	c3.cVal.mag.f	MX	A
	WYE	cVal.mag.f	MX	A
	WYE	phsA.cVal.mag.f	MX	A
	WYE	phsB.cVal.mag.f	MX	A
	WYE	phsC.cVal.mag.f	MX	A

	WYE	neut.cVal.mag.f	MX	A
Additional	**Threshold Supervision** **Enables the threshold supervision for measured values received from the external protocol and send on the RTU500 series internal communication.** Parameter: Threshold Supervision (MFI – Protocol Sub Parameter) **Threshold Supervision Type** **Defines the algorithm used for the threshold supervision of measured values received from the external protocol.** Parameter: Threshold Supervision Type (MFI – Protocol Sub Parameter) [Selection: “Integrated Threshold Supervision” or “Absolute Threshold Supervision”] **Threshold** **Defines the threshold value used for the threshold supervision algorithm.** Parameter: Minimum Value (MFI- Protocol Sub Parameter) [Range: 0.0 .. 3.4028 * 10^{38}]			

Conversion of value (Type A)

RTU500 series internal communication		Protocol specific (Attribute value)
Range min.	-3.410^{38}	-3.410^{38}
...		
Range max.	$+ 3.410^{38}$	$+ 3.410^{38}$

Conversion of quality descriptors

RTU500 series internal communication		Protocol specific
OV	Overflow	q.detailQual.overflow == TRUE or q.detailQual.outOfRange == TRUE or q.detailQual.badReference == TRUE or q.detailQual.oscillatory == TRUE or q.detailQual.failure == TRUE or q.detailQual.inconsistent == TRUE or q.detailQual.inaccurate == TRUE
BL	Blocked	q.operatorBlocked == TRUE
SB	Substituted	q.source == substituted
NT	Not Topical	q.detailQual.oldData == TRUE
IV	Invalid	q.validity == invalid or q.validity == questionable

Conversion of cause of transmission

RTU500 series internal communication		Protocol specific
T	Test	q.test == TRUE

RTU500 series internal communication		Protocol specific
P/N	Positive/negative confirmation	- Irrelevant -
Cause	Spontaneous	-
	Requested	-
	Interrogated	-

7 Controlling Direction

7.1 SCO – Single Command Output

Binary process command (one bit)

Supported Data Types	Common Data Class	Attribute Name	Functional Constraint	Conversion of Value Type
	SPC	ctVal	CO	A
	SPG	stVal	SP	B
Command Authority	**None**			
Additional	**Signal Support Select Before Operate** **Defined by control model of external protocol. Not available for functional constraint SP.** Parameter: Supports Select Before Operate (SCO – Protocol Address) **Signal Support Enhanced Security** **Defined by control model of external protocol. Not available for functional constraint SP.** Parameter: Supports Enhanced Security (SCO – Protocol Address) **Default Command Qualifier** **Defines the value of the IEC 61850 'check' data attribute in case the qualifier of command is not set to a predefined value.** Parameter: Default Command Qualifier (SCO – Protocol Sub Parameter) [Selection: “run interlocking, run synchrocheck” or “run synchrocheck” or “run interlocking” or “no command check”] **Select Before Operate Only** **If set to YES select before operate (SBO) commands are allowed for this output only.** Parameter: Select Before Operate Only (SCO – Protocol Sub Parameter)			

Conversion of value (Type A and Type B)

RTU500 series internal communication	Protocol specific (Attribute value)
Off	FALSE
On	TRUE

Conversion of quality descriptors (Type A)

RTU500 series internal communication		Protocol specific
SE	Select / Execute	ACSI control service: SBO/SBOw request / ACSI control service: Operate request

Conversion of quality descriptors (Type B)

RTU500 internal communication		Protocol specific
SE	Select / Execute	Not supported by protocol. Handled in SCI IEC 61850.

Conversion of cause of transmission (Type A)

RTU500 series internal communication		Protocol specific
T	Test	ACSI control service: Test parameter
P/N	Positive/negative confirmation	ACSI control service: response +/-
Cause	Activation	ACSI control service: Select/Operate request
	Activation Confirmation	ACSI control service: Select/Operate response
	Deactivation	ACSI control service: Cancel request
	Deactivation Confirmation	ACSI control service: Cancel response
	Activation Termination	Reception of controlled attribute value

Conversion of cause of transmission (Type B)

RTU500 series internal communication		Protocol specific
T	Test	Not supported by protocol.
P/N	Positive/negative confirmation	ACSI control service: response +/-
Cause	All values	Not supported by protocol. Handled in SCI IEC 61850.

7.2 DCO – Double Command Output

Binary process command (two bits)

Supported Data Types	**Common Data Class**	**Attribute Name**	**Functional Constraint**	**Conversion of Value Type**
	DPC	ctVal	CO	A
Command Authority	**None**			
Additional	**Signal Support Select Before Operate** **Defined by control model of external protocol. Not available for functional constraint SP.** Parameter: Supports Select Before Operate (DCO – Protocol Address) **Signal Support Enhanced Security** **Defined by control model of external protocol. Not available for functional constraint SP.** Parameter:			

Supports Enhanced Security (DCO – Protocol Address)

Default Command Qualifier
Defines the value of the IEC 61850 'check' data attribute in case the qualifier of command is not set to a predefined value.
Parameter:
Default Command Qualifier (DCO – Protocol Sub Parameter)
[Selection: “run interlocking, run synchrocheck” or
“run synchrocheck” or
“run interlocking” or
“no command check”]

Select Before Operate Only
If set to YES select before operate (SBO) commands are allowed for this output only.
Parameter:
Select Before Operate Only (DCO – Protocol Sub Parameter)

Conversion of value (Type A)

RTU500 series internal communication	Protocol specific (Attribute value)
off	FALSE
on	TRUE

Conversion of quality descriptors

RTU500 series internal communication		Protocol specific
SE	Select / Execute	ACSI control service: SBO/SBOw request / ACSI control service: Operate request

Conversion of cause of transmission

RTU500 series internal communication		Protocol specific
T	Test	ACSI control service: Test parameter
P/N	Positive/negative confirmation	ACSI control service: response +/-
Cause	Activation	ACSI control service: Select/Operate request
	Activation Confirmation	ACSI control service: Select/Operate response
	Deactivation	ACSI control service: Cancel request
	Deactivation Confirmation	ACSI control service: Cancel response
	Activation Termination	Reception of controlled attribute value

7.3 RCO – Regulation Command Output

Regulation process command (two bits)

Supported Data Types	Common Data Class	Attribute Name	Functional Constraint	Conversion of Value Type
	BSC	ctVal	CO	A
Command Authority	**None**			
Additional	**Signal Support Select Before Operate** **Defined by control model of external protocol. Not available for functional constraint SP.** Parameter: Supports Select Before Operate (RCO – Protocol Address) **Signal Support Enhanced Security** **Defined by control model of external protocol. Not available for functional constraint SP.** Parameter: Supports Enhanced Security (RCO – Protocol Address) **Default Command Qualifier** **Defines the value of the IEC 61850 'check' data attribute in case the qualifier of command is not set to a predefined value.** Parameter: Default Command Qualifier (RCO – Protocol Sub Parameter) [Selection: “run interlocking, run synchrocheck” or “run synchrocheck” or “run interlocking” or “no command check”] **Select Before Operate Only** **If set to YES select before operate (SBO) commands are allowed for this output only.** Parameter: Select Before Operate Only (RCO – Protocol Sub Parameter)			

Conversion of value (Type A)

RTU500 series internal communication	Protocol specific (Attribute value)
Lower	lower
Higher	higher

Conversion of quality descriptors

RTU500 series internal communication		Protocol specific
SE	Select / Execute	ACSI control service: SBO/SBOw request / ACSI control service: Operate request

Conversion of cause of transmission

RTU500 series internal communication		Protocol specific
T	Test	ACSI control service: Test parameter
P/N	Positive/negative confirmation	ACSI control service: response +/-

RTU500 series internal communication		Protocol specific
Cause	Activation	ACSI control service: Select/Operate request
	Activation Confirmation	ACSI control service: Select/Operate response
	Deactivation	ACSI control service: Cancel request
	Deactivation Confirmation	ACSI control service: Cancel response
	Activation Termination	Reception of controlled attribute value

7.4 ASO – Analog Setpoint Output

Analog process command (16 bit signed number)

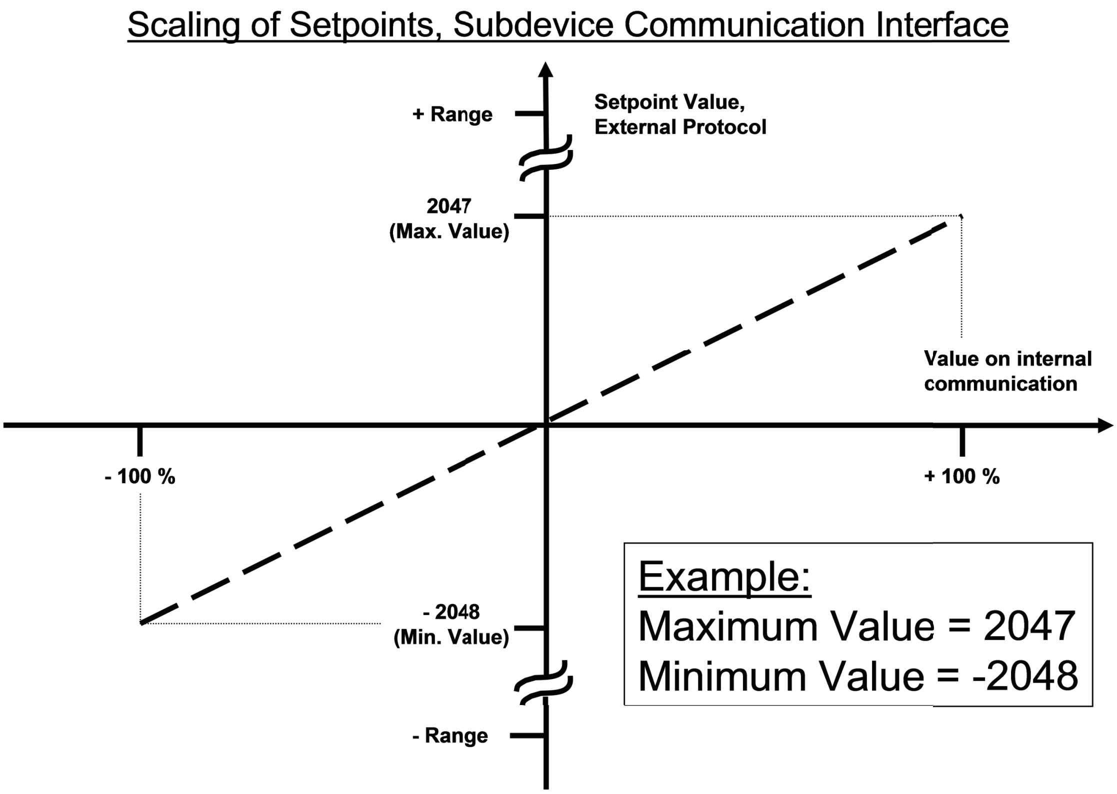
Supported Data Types	Common Data Class	Attribute Name	Functional Constraint	Conversion of Value Type
	INC	ctlVal	CO	A
	ING	stVal	SP	B
	ASG	setMag.f	SP	C
Command Authority	**None**			
Additional	**Signal Support Select Before Operate** **Defined by control model of external protocol. Not available for functional constraint SP.** Parameter: Supports Select Before Operate (ASO – Protocol Address) **Signal Support Enhanced Security** **Defined by control model of external protocol. Not available for functional constraint SP.** Parameter: Supports Enhanced Security (ASO – Protocol Address) **Maximum Value** **Maximum Value in the external protocol to be converted to +100 % on RTU500 series internal communication** Parameter: Maximum Value (ASO – Protocol Sub Parameter) [Range: - 2147483648 .. 2147483647] **Minimum Value** **Minimum Value in the external protocol to be converted to -100 % on RTU500 series internal communication.** Parameter: Minimum Value (ASO- Protocol Sub Parameter) [Range: - 2147483648 .. 2147483647] **Select Before Operate Only** **If set to YES select before operate (SBO) commands are allowed for this output only.**			

	Parameter: Select Before Operate Only (ASO – Protocol Sub Parameter)

Conversion of value (Type A, Type B and Type C)

RTU500 series internal communication		Protocol specific (Attribute value)
Range min.	-100%	Parameter: Minimum Value
...	...	
Range max.	+100%	Parameter: Maximum Value

For the value types A and B the protocol specific value range is -32768 .. +32767 (16 Bit). That means for value type A and B the scaling parameters must be limited to -32768 .. +32767 (16 Bit) as well. Higher scaling parameters results in wrong protocol attribute values.



Conversion of quality descriptors (Type A)

RTU500 series internal communication		Protocol specific
SE	Select / Execute	ACSI control service: SBO/SBOw request / ACSI control service: Operate request

Conversion of quality descriptors (Type B and Type C)

RTU500 series internal communication		Protocol specific
SE	Select / Execute	Not supported by protocol. Handled in SCI IEC 61850.

Conversion of cause of transmission (Type A)

RTU500 series internal communication		Protocol specific
T	Test	ACSI control service: Test parameter
P/N	Positive/negative confirmation	ACSI control service: response +/-
Cause	Activation	ACSI control service: Select/Operate request
	Activation Confirmation	ACSI control service: Operate response
	Deactivation	-
	Deactivation Confirmation	-
	Activation Termination	-

Conversion of cause of transmission (Type B and Type C)

RTU500 series internal communication		Protocol specific
T	Test	Not supported by protocol.
P/N	Positive/negative confirmation	ACSI control service: response +/-
Cause	All values	Not supported by protocol. Handled in SCI IEC 61850.

7.5 DSO – Digital Setpoint Output

Binary process command (8 or 16 bit signed number)

Supported Data Types	Common Data Class	Attribute Name	Functional Constraint	Conversion of Value Type
	INC	ctlVal	CO	A
	ING	stVal	SP	B
	ASG	setMag.f	SP	C
Command Authority	**None**			
Additional	**Signal Support Select Before Operate** **Defined by control model of external protocol. Not available for functional constraint SP.** Parameter: Supports Select Before Operate (DSO – Protocol Address) **Signal Support Enhanced Security** **Defined by control model of external protocol. Not available for functional constraint SP.** Parameter: Supports Enhanced Security (DSO – Protocol Address) **Maximum Value** **Maximum Value in the external protocol to be converted to +100 % on RTU500 series internal communication** Parameter: Maximum Value (DSO – Protocol Sub Parameter)			

[Range: - 2147483648 .. 2147483647]

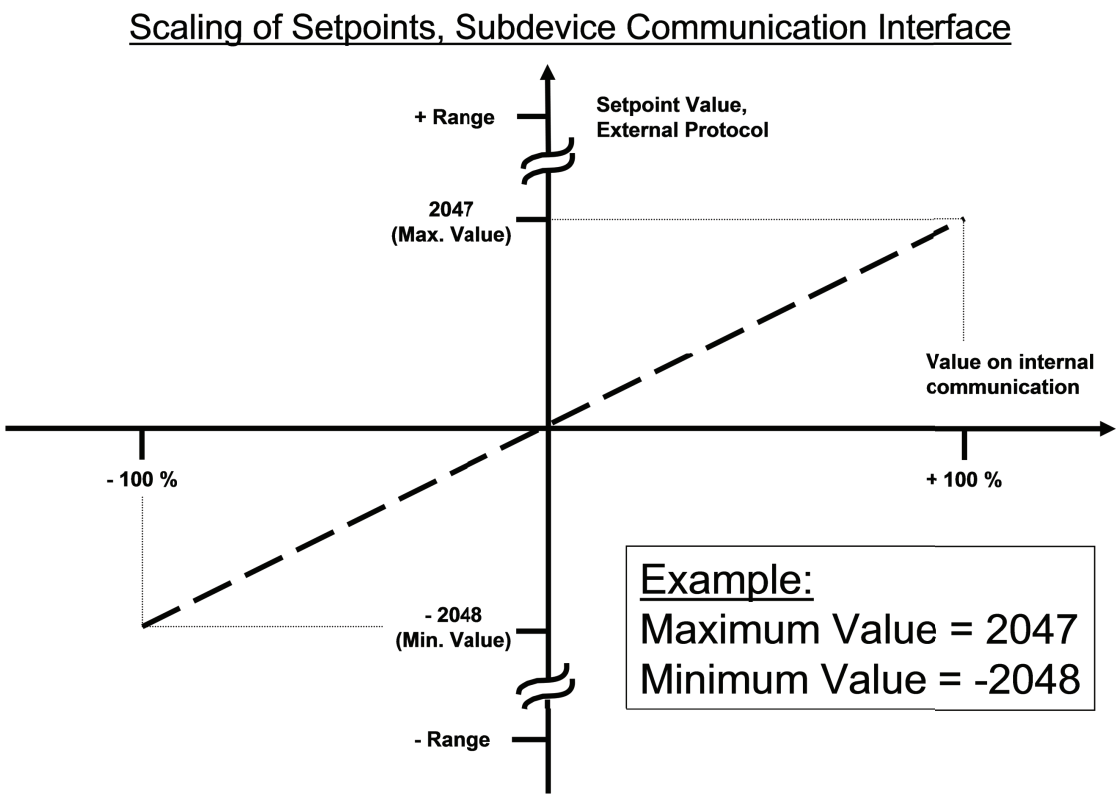
Minimum Value
Minimum Value in the external protocol to be converted to -100 % on RTU500 series internal communication.
Parameter:
Minimum Value (DSO- Protocol Sub Parameter)
[Range: - 2147483648 .. 2147483647]

Select Before Operate Only
If set to YES select before operate (SBO) commands are allowed for this output only.
Parameter:
Select Before Operate Only (DSO – Protocol Sub Parameter)

Conversion of value (Type A, Type B and Type C)

RTU500 series internal communication		Protocol specific (Attribute value)
Range min.	-100%	Parameter: Minimum Value
...	...	
Range max.	+100%	Parameter: Maximum Value

For the value types A and B the protocol specific value range is -32768 .. +32767 (16 Bit). That means for value type A and B the scaling parameters must be limited to -32768 .. +32767 (16 Bit) as well. Higher scaling parameters results in wrong protocol attribute values.



Conversion of quality descriptors (Type A)

RTU500 series internal communication		Protocol specific
SE	Select / Execute	ACSI control service: SBO/SBOw request / ACSI control service: Operate request

Conversion of quality descriptors (Type B and Type C)

RTU500 series internal communication		Protocol specific
SE	Select / Execute	Not supported by protocol. Handled in SCI IEC 61850.

Conversion of cause of transmission (Type A)

RTU500 series internal communication		Protocol specific
T	Test	ACSI control service: Test parameter
P/N	Positive/negative confirmation	ACSI control service: response +/-
Cause	Activation	ACSI control service: Select/Operate request
	Activation Confirmation	ACSI control service: Operate response
	Deactivation	-
	Deactivation Confirmation	-
	Activation Termination	-

Conversion of cause of transmission (Type B and Type C)

RTU500 series internal communication		Protocol specific
T	Test	Not supported by protocol.
P/N	Positive/negative confirmation	ACSI control service: response +/-
Cause	All values	Not supported by protocol. Handled in SCI IEC 61850.

7.6 FSO – Floating Point Setpoint Output

Floating point process command (32 bit short floating point number)

Supported Data Types	**Common Data Class**	**Attribute Name**	**Functional Constraint**	**Conversion of Value Type**
	ASG	setMag.f	SP	A
Command Authority	**None**			
Additional	**Select Before Operate Only** **If set to YES select before operate (SBO) commands are allowed for this output only.** Parameter: Select Before Operate Only (FSO – Protocol Sub Parameter)			

Conversion of value (Type A)

RTU500 series internal communication		Protocol specific (Attribute value)
Range min.	-3.410^{38}	-3.410^{38}
...		
Range max.	$+ 3.410^{38}$	$+ 3.410^{38}$

Conversion of quality descriptors (Type A)

RTU500 series internal communication		Protocol specific
SE	Select / Execute	Not supported by protocol. Handled in SCI IEC 61850.

Conversion of cause of transmission (Type B and Type C)

RTU500 series internal communication		Protocol specific
T	Test	Not supported by protocol.
P/N	Positive/negative confirmation	ACSI control service: response +/-
Cause	All values	Not supported by protocol. Handled in SCI IEC 61850.

7.7 BSO – Bit String Output

Binary process command (1, 2, 8, 16 bit unsigned number)

Supported Data Types	Common Data Class	Attribute Name	Functional Constraint	Conversion of Value Type
	ISC	ctlVal	CO	A
	ING	setVal	SP	B
	ASG	setMag.f	SP	C
	ENC[1]	ctlVal	CO	D
	ENG[1]	setVal	SP	E
Command Authority	**None**			
Additional	**Signal Support Select Before Operate** **Defined by control model of external protocol. Not available for functional constraint SP.** Parameter: Supports Select Before Operate (BSO – Protocol Address) **Signal Support Enhanced Security** **Defined by control model of external protocol. Not available for functional constraint SP.** Parameter: Supports Enhanced Security (BSO – Protocol Address) **Select Before Operate Only** **If set to YES select before operate (SBO) commands are allowed for this output only.**			

	Parameter: Select Before Operate Only (BSO – Protocol Sub Parameter)

1 Available for IEC 61850 Edition 2 client only

Conversion of value (Type A)

RTU500 series internal communication		Protocol specific (Attribute value)
Range min.	0	0
...	...	…
	63	63
…	…	
	65471	-64
…	…	…
Range max.	65535	-1

Protocol specific value range is mapped to BSO8 and BSO16 in 2´s complement format.

Conversion of value (Type B)

RTU500 series internal communication		Protocol specific (Attribute value)
Range min.	0	0
...	...	…
	32767	32767
	32768	-32768
…	…	…
Range max.	65535	-1

Protocol specific value range is mapped to BSO16 in 2´s complement format.

Conversion of value (Type C)

RTU500 series internal communication		Protocol specific (Attribute value)
Range min.	0	0.0
...	...	
Range max.	65535	65535.0

Conversion of value (Type D)

RTU500 series internal communication		Protocol specific (Attribute value)
Range min.	0	Enumeration value 0
...	...	
Range max.	65535	Enumeration value 65535

Conversion of value (Type E)

RTU500 series internal communication		Protocol specific (Attribute value)
Range min.	0	Enumeration value 0
...	...	
Range max.	65535	Enumeration value 65535

Conversion of quality descriptors (Type A and Type D)

RTU500 series internal communication		Protocol specific
SE	Select / Execute	ACSI control service: SBO/SBOw request / ACSI control service: Operate request

Conversion of quality descriptors (Type B, Type C and Type E)

RTU500 series internal communication		Protocol specific
SE	Select / Execute	Not supported by protocol. Handled in SCI IEC 61850.

Conversion of cause of transmission (Type A and Type D)

RTU500 series internal communication		Protocol specific
T	Test	ACSI control service: Test parameter
P/N	Positive/negative confirmation	ACSI control service: response +/-
Cause	Activation	ACSI control service: Select/Operate request
	Activation Confirmation	ACSI control service: Operate response
	Deactivation	-
	Deactivation Confirmation	-
	Activation Termination	-

Conversion of cause of transmission (Type B, Type C and Type E)

RTU500 series internal communication		Protocol specific
T	Test	Not supported by protocol.
P/N	Positive/negative confirmation	ACSI control service: response +/-
Cause	All values	Not supported by protocol. Handled in SCI IEC 61850.

8 File transfer

8.1 Transfer of Disturbance Data Files

The IEC 61850 Client is capable to read disturbance data files from an IEC 61850 IED (IEC 61850 server) and to store them on the Compact Flash memory file system of the RTU500 series. The user is able to access them via the internal web server. The web server is also used to transfer these files to a workspace PC. The transmission of disturbance data files is according to **[2]**, **[3]** and **[5]**.

The supported IEC 61850 file transfer services are:

IEC 61850-7-2 service	Meaning
GetFileAttributeValues	Used by a client to obtain the name and attributes of a specific file in the server's file store.
GetFile	Used by a client to transfer the contents of a file from the server to the client.

Table 2: Supported IEC 61850-7-2 file transfer services

The IEC 61850 service attributes are mapped to the RTU500 series file attributes according following table:

IEC 61850 attributes	Meaning	RTU500 series file attributes
FileName	Name of the file	The disturbance record number is extracted from the file name if possible (see below for more information)
FileSize [0..n]	Size of the file	Size
LastModified	Time of last modification	Last Modified

Table 3: Mapping of IEC 61850 file transfer attributes

The IEC 61850 Client supports file transfer with the following specific IEC 61850 IEDs:

- ABB Control and Protection devices REx615, REx630, REx650 and REx670
- ABB Busbar Protection REB500
- ABB IEC 61850 adapter SPA-ZC 400 for REJ/REU 52x, REF/REM/REU 610, REF/REMRET 541/3/5
- Disturbance recorder BEN6000
- Control and Protection devices SIEMENS Siprotec
- Control and Protection device AREVA P436

Additional to the specific IEDs the IEC 61850 Client supports a generic type with configurable parameters. This generic type can be used for not supported IEDs. The chapter "Generic IED Type" contains detailed information how to use the generic type.

The IEC 61850 file name is for each of the supported IEC 61850 IED different. The conversion to the RTU500 series file name is summarized in following table.

IEC 61850 IED	Meaning
ABB REx630, REx650 and REx670	The disturbance record number is extracted from IEC 61850 file name. The resulting RTU500 series file name is “Fault xx” with xx representing the disturbance record number.

Table 4: Conversion IEC 61850 file name to RTU500 series file name

IEC 61850 IED	Meaning
ABB REx615	The disturbance record number is extracted from IEC 61850 file name. The filename contains a 4 character serial number that is used as disturbance record number. The resulting RTU500 series file name is “Fault xxxx”.
ABB REB500	IEC 61850 file name doesn’t include a disturbance record number. So, a hash value (CRC16) is calculated from the file name to get a unique number. This ensures that together with the file date, the file number clearly identifies a record. The resulting RTU500 series file name is “Fault xxxxx”.
ABB SPA-ZC 400	The disturbance record is number is built from IEC 61850 file name. The record number consists of month (first 4 Bits), day (next 5 Bits), serial number of records at the same day (last 7 Bits). The resulting RTU500 series file name is “Fault xx” with xx representing the disturbance record number.
BEN6000	The disturbance record number is extracted from IEC 61850 file name. The resulting RTU500 series file name is “Fault xx” with xx representing the disturbance record number.
SIEMENS Siprotec	The disturbance record number is extracted from IEC 61850 file name. The filename contains a 4 character serial number that is used as disturbance record number. The resulting RTU500 series file name is “Fault xxxx”.
AREVA P436	The disturbance record number is extracted from IEC 61850 file name. The filename contains a 3 character file number that is used as disturbance record number. The resulting RTU500 series file name is “Fault xxxx”.

Table 4: Conversion IEC 61850 file name to RTU500 series file name

8.2 File Transfer Configuration

The general configuration of a disturbance record file archive in the RTU500 series is described in **[7]** in chapter “Disturbance Data File Archive”. To use the file transfer of an IEC 61850 IED a file directory (FDR) with at least one file (FTR) must be configured. The IEC 61850 file transfer is different for each supported IED. Therefore the type of IED must be set for the files and directories in RTUtil500. As described above supported are several ABB and non ABB IEDs.

The number of directories per IEC 61850 IED depends on the IED type. The following table shows the configuration details for the different IED types.

IEC 61850 IED	Max no. of directories	Name of directory
ABB REx630, REx650 and REx670	1	Not relevant
ABB REx615	1	Not relevant
ABB REB500	60 (one per bay unit)	Name must be the logical device name of the bay unit
ABB SPA-ZC 400	1	Not relevant
BEN6000	1	Name must be the logical device name that contains disturbance files
SIEMENS Siprotec	1	Not relevant
AREVA P436	1	Not relevant

Table 5: File directory configuration for IEC 61850 IEDs

The number of files in a directory depends on the capabilities of the IEC 61850 IED. Please see the specific IED documentation for more information. In the RTU500 series the number of files in a directory is restricted to 15. The name of the files is created according the rules in the chapter above.

The subdevice interface loads the newest disturbance records only. That means if one FTR is configured the newest record is loaded, if two FTRs are configured the two newest records are loaded and so on.

The disturbance record files in IEC 61850 are in COMTRADE format. The number of files per disturbance record depends on the IED type (see table below).

IEC 61850 IED	Meaning
ABB REx630, REx650 and REx670	The disturbance record files are placed as ZIP archive on the IED. Each ZIP archive representing a disturbance record consists of a .DAT (data), .CFG (configuration) and .HDR (header) file.
ABB REx615	The disturbance record files are placed as separate files on the IED. The RTU500 series loads per disturbance record the .DAT (data) and the .CFG (configuration) file. The files are zipped together and stored in the RTU500 series file archive.
ABB REB500	The disturbance record files are placed as ZIP archive on the IED. Each ZIP archive representing a disturbance record consists of a .DAT (data), .CFG (configuration) and .HDR (header) file.
ABB SPA-ZC 400	The disturbance record files are placed as separate files on the IED. The RTU500 series loads per disturbance record the .DAT (data), .CFG (configuration) and .INF (information) file. The files are zipped together and stored in the RTU500 series file archive.
BEN6000	The disturbance record files are placed as separate files on the IED. The RTU500 series loads per disturbance record the .DAT (data) and the .CFG (configuration) file. The files are zipped together and stored in the RTU500 series file archive.
SIEMENS Siprotec	The disturbance record files are placed as separate files on the IED. The RTU500 series loads per disturbance record the .DAT (data), .CFG (configuration) and .TXT (text) file. The files are zipped together and stored in the RTU500 series file archive.
AREVA P436	The disturbance record files are placed as separate files on the IED. The RTU500 series loads per disturbance record the .DAT (data) and the .CFG (configuration) file. The files are zipped together and stored in the RTU500 series file archive.

Table 6: Files per disturbance record.

For each FDR a data point of type SPI can be configured to trigger disturbance recorder directory update.

Parameter name	Default	Parameter location
Disturbance recorder trigger update	Disabled	FDR - line T61850
If enabled, a SPI can be linked to trigger disturbance recorder directory update.		

8.3 Generic IED Type

The subdevice interface supports beside the several pre-defined IEC 61850 IED types a generic type that can be used for the disturbance file transfer of any IED. The following sections describe the configuration and restrictions of the generic type.

To use the file transfer for the generic IED a file directory (FDR) with at least one file (FTR) must be configured. At the file directory the IED type "Disturbance recorder - IEC61850 - Generic IED" must be selected. With selecting the type the additional configuration parameters “File directory search pattern”, “File directory path” and "File search pattern" became accessible at the file directory. The first two parameters control the directory access and the third parameter controls the file selection. The meaning of the parameters is as follows:

- File directory search pattern
  This string parameter must be set to the search pattern that returns in a get directory request the content of the disturbance record file directory.
- File directory path
  This string parameter contains the file directory path information in case the generic IED doesn’t provide the complete file name and path. Please see the specific IED documentation (PIXIT) for more information about the search pattern and the directory path required by the IED.
- File search pattern
  If this string parameter is set, the RTU500 checks whether the file name contains the defined pattern string (case insensitive). And only files that contain the pattern string are handled as disturbance record files. The pattern sting is a plain ASCII string that doesn't support any wild card characters.

Depending on the reply of the IED on a get directory request the files are loaded according the descriptions in the following table. Be sure to consider the meaning of the file directory (FDR) name set in the RTUtil500 configuration for the file transfer.

Functionality	Behavior for generic IED type
Get directory	For the get directory request the configured search pattern is used. The filenames returned by the request are checked for their extension. In case the IED provides zipped COMTRADE files (extension .ZIP), the files are loaded individual as they are. In case the IED provides single COMTRADE files, the files of one disturbance record are zipped together. The files of one disturbance record are identified by the same file name with different extensions. For a generic IED the COMTRADE files with the extension .DAT (data), .CFG (configuration) and .HDR (header) are zipped together. All other file extensions are ignored.
Directory name	The configured file directory path (see above) is used to complete the file path together with the file name provided by the IED. Be sure to set the directory path if a generic IED doesn't provide the complete file name. The directory path must be configured including the required separator characters “/” or “\”. If the generic IED provides the complete file name leave the file directory path configuration parameter empty. In this case the file name is used as it is to access the file.
Numbers of files	As for the standard IEDs each disturbance record provided by the generic IEDs is loaded. In case a disturbance record consists of more than one file the files are zipped together. So the number of configured FTRs shall be set to the actual number of disturbance records to load.
Get file	For generic IEDs the RTU500 tries to determine what files provided by the IED are disturbance record files. This is done by the file ending, that must be a COMTRADE ending (like *.dat) or a ZIP ending (*.zip). In case the IED provides files with these endings

Table 7: File transfer generic IED type

Functionality	Behavior for generic IED type
	that are no disturbance record files the parameter "File search pattern" can be used to restrict the selected files (see description above). According to the number FTRs configured the newest disturbance records are loaded only. That means if one FTR is configured the newest disturbance record is loaded, if two FTRs are configured the two newest disturbance records are loaded and so on.
RTU560 file name	It is not known whether the IED file name includes a disturbance record number. So, a hash value (CRC16) is calculated from the file name to get a unique number. This ensures that together with the file date, the file number clearly identifies a disturbance record. The resulting RTU500 series file name is “Fault xxxxx”.

Table 7: File transfer generic IED type

9 Internal Functions

9.1 Startup log

During startup of the SCI IEC 61850 detailed information about the configuration and initialization can be written to a startup log file. This file is placed on the compact flash card of a CMU and can be downloaded via the web server. The file is written after a CMU re-start when the startup log was enabled before in the web server. Enabling the startup log and downloading the resulting file are found in the web server under 'Test & Simulation -> Logging and debugging'.

9.2 Time Synchronization

Time synchronization of subordinated devices is done using SNTP time synchronization protocol. SNTP time synchronization protocol is a general function of RTU500 series and must be configured with RTUtil500. The configuration of SNTP is described in [8].

9.3 General Interrogation

The general interrogation to subordinated devices is part of the report control block handling defined in IEC 61850. There is no specific general interrogation command existing.

9.4 System Events

The subdevice communication interface manages internal status messages for every device connected to this line. These status messages are created from the subdevice communication interface itself for every connected device.

The subdevice communication interface supports the system events summarized in the following table:

Description of system event	Shortcut
Device active	#024
Device inoperable	#048
Device out-of-service	#049

Table 8: Supported system events

The protocol specific status information are converted to the internal system event representation according to the table below:

Description	RTU500 series internal	Protocol specific
Device active	Off	Device not active
	On	Device active
Device inoperable	Off	Device connected and PhyHealth stVal == Ok (1) and PhyHealth q.validity == good

Table 9: System event conversion

Description	RTU500 series internal	Protocol specific
	On	Device disconnected or PhyHealth stVal != Ok (1) or PhyHealth q.validity != good
Device out-of-service	Off	Device in-service
	On	Device out-of-service

Table 9: System event conversion

While initialization the value of system event ‘Device is active’ (#024) is set to ON. On a running system this system event doesn’t change anymore.

The system event ‘Device inoperable’ (#048) is set in dependency of the state of the subordinated device. For a correct signalization attribute ‘PhyHealth’ of logical node LD0 must be mapped to a DPI data point and have to be imported in RTUtil500. If no LD0 is available in synchronized SCD file, the first found attribute ‘PhyHealth’ will be used for mapping of signalization. To ensure a correct signalization in this case only one attribute ‘PhyHealth’ must be imported.

A subordinated device is operable if the device is connected and attribute ‘PhyHealth.stVal’ is ‘Ok’ and attribute ‘PhyHealth.q.validity’ is ‘good’. When operable the device system event ‘Device inoperable’ (#048) is send with value Off (0) to the internal communication. If the state of a subordinated device changes from inoperable to operable, all configured data points of the device are requested and sent to the internal communication.

A subordinated device is inoperable if the device is not connected or attribute ‘PhyHealth.stVal’ is not ‘Ok’ or attribute ‘PhyHealth.q.validity’ is not ‘good’. When inoperable the device system event ‘Device inoperable’ (#048) is send with value On (1) to the internal communication. If the state of a subordinated device changes from operable to inoperable all configured data points connected to this device are sent to the internal communication with the actual state, marked as **INVALID** or **NOT TOPICAL** and with the timestamp of the own RTU. **INVALID** or **NOT TOPICAL** is set depending on the configuration parameter Information object qualifier (see table below).

Parameter name	Parameter location	Parameter range / Explanation	Default
Information object qualifier (usage for disconnected subor-dinated devices)	RTU Parameter	- Mark as invalid (IV) - Mark as not topical (NT)	Mark as invalid (IV)
Note: Also in not topical configuration are data points which have not been updated since RTU startup marked as invalid (IV)			

Table 10: Information object qualifier parameter

The system event ‘Device out-of-service’ (#049) is set to OFF during initialization. That means the device is in-service and the SCI IEC 61850 tries to connect the device. The device can be set out-of-service with a system command (see next chapter). In the state out-of-service an actual connection to a device is concluded and no new connection is initiated as long as the state remains. The device can be set back in-service with the same system command.

9.5 System commands

The behavior of subordinated devices connected to a sub-device communication interface with protocol IEC 61850 can be modified with system single commands (SSC).

The following system single commands are supported:

SSC supported	Description of SSC	Address offset
X	Set device out of service	#001
	Reset device process	#002
	Connect/disconnect device	#003
	Set redundant line 1 / 2 as preferred line	#004, #005
	Set redundant line 3 / 4 as preferred line	#006, #007
	Force global process image update, i.e. force process image update of all subdevices	#012
	Request redundancy change over for the active CMU x, $1 \le x \le 16$	#016 ... #031

Table 11: Description of system single commands (SSC)

9.5.1 Set device out of service

The devices connected to the subdevice interface are set to in-service during initialization. During runtime the device can be set out-of-service by operating the system single command 'Set device out-of-service' with state ON. In the state out-of-service an actual connection to a device is concluded and no new connection is initiated as long as the state remains. The device can be set back in-service by operating the system single command with state OFF. When the device is already in the desired state the command is confirmed negative.

Description	RTU500 series internal	Protocol specific
Set device out-of-service	Off	Set device in-service
	On	Set device out-of-service

Table 12: System command conversion

9.6 Message Filtering

The RTU500 series IEC 61850 communication engineering (data sets) is based on data object level. That means for common data classes that include a selected (stSeld) data attribute (e.g. DPC data class) that with each change of the stSeld attribute the value indication (e.g. stVal) is send as well. This value indication is an unintended, spontaneous message that contains the current status of the indication. To filter this unintended messages the following algorithm is used in the SCI IEC 61850:

Value indications in controllable common data class that contains a selected data attribute (stSeld) are identified in the configuration. For this kind of indications a received message is checked for value and qualifier changes. If value or qualifier is changed the message is transmitted. If value or qualifier is not changed the message is ignored.

This is valid for all supported controllable common data classes that contains a selected (stSeld) data attribute (see chapter 5.1 SPI- Single Point Information).

9.7 Command Handling

9.7.1 IEC 61850 Control Models

The RTU500 series IEC 61850 client supports all control models defined in standard. The mapping functionality of the IEC 61850 control models to the commands of the RTU500 series internal communication is shown in the table below.

RTU500 internal command	IEC 61850 control model	Protocol specific mapping functionality
Direct command	direct-with-normal-security	• The received Execute command is transmitted to the device and answered by the device. • According to the command type a termination is created by the subdevice interface.
SBO command	direct-with-normal-security	• The received Select command is answered by the subdevice interface depending on operable state of the device. • The received Execute command is transmitted to the device and answered by the device. • According to the command type a termination is created by the subdevice interface.
Direct command	sbo-with-normal-security	• The received Execute command is transmitted to the device as Select command. In case of a positive answer the Execute command is transmitted to the device and answered by the device. In case of a negative answer the received Execute command is answered negative. • According to the command type a termination is created by the subdevice interface.
SBO command	sbo-with-normal-security	• The received Select command is transmitted to the device and answered by the device. • The received Execute command is transmitted to the device and answered by the device. • According to the command type a termination is created by the subdevice interface.
Direct command	direct-with-enhanced-security	• The received Execute command is transmitted to the device and answered by the device. • The command termination send by the device is transferred to the internal communication. In case the command type requires no termination the termination is ignored.

Table 13: Mapping functionality of IEC 61850 control models

RTU500 internal command	IEC 61850 control model	Protocol specific mapping functionality
SBO command	direct-with-enhanced-security	• The received Select command is answered by the subdevice interface depending on operable state of the device. • The received Execute command is transmitted to the device and answered by the device. • The command termination send by the device is transferred to the internal communication. In case the command type requires no termination the termination is ignored.
Direct command	sbo-with-enhanced-security	• The received Execute command is transmitted to the device as Select command. In case of a positive answer the Execute command is transmitted to the device and answered by the device. In case of a negative answer the received Execute command is answered negative. • The command termination send by the device is transferred to the internal communication. In case the command type requires no termination the termination is ignored.
SBO command	sbo-with-enhanced-security	• The received Select command is transmitted to the device and answered by the device. • The received Execute command is transmitted to the device and answered by the device. • The command termination send by the device is transferred to the internal communication. In case the command type requires no termination the termination is ignored.

Table 13: Mapping functionality of IEC 61850 control models

The following remarks have to be considered for the mapping functionality above:

- In case the command in the device doesn't support select-before-operate a Select command send by the internal communication is answered by the subdevice interface. The Select command is answered positive if the device is operable according to the system event 'Device inoperable' (#048). If the device is inoperable the Select command is answered negative. See chapter "System Events" for detailed information about the operable/inoperable indication.
- The IEC 61850 subdevice interface provides for each command type the parameter "Select Before Operate Only". If this parameter is set to YES, only select-before-operate commands are allowed for the specific command object. In this case direct commands are confirmed negative. The default value for this parameter is NO.

9.7.2 Qualifier of Command

The RTU500 series command types SCO, DCO and RCO support a mapping of the command attribute ‘Qualifier of command’ (QU) to the IEC 61850 command data attribute ‘check’. The attribute ‘check’ allows setting of additional command information like ‘run with interlocking’ or ‘run with synchrocheck’.

The command parameter ‘Default command qualifier’ defines the value of the IEC 61850 'check' data attribute in case the qualifier of command is not set to predefined value. The following values are possible for the ‘Default command qualifier’:

- "run interlocking, run synchrocheck" or
  "no interlocking, run synchrocheck" or
  "run interlocking, no synchrocheck" or
  "no command check"

The mapping of the ‘Qualifier of command’ to the IEC 61850 command check attribute is shown in the table below.

Qualifier of command (QU)	Command check attribute on IEC 61850 set to
0 .. 8	value of ‘Default command qualifier’
9	no interlocking, run synchrocheck
10	run interlocking, no synchrocheck
11	no interlocking, no synchrocheck
12	run interlocking, run synchrocheck
13 .. 31	value of ‘Default command qualifier’

Table 14: Mapping of IEC 61850 check attribute

9.8 IEC 61850 server functionality

The RTU500 series IEC 61850 client provides internal functionality of the RTU500 serie interfaced as IEC 61850 server. The internal functions of the IEC 61850 subdevicecommunication interface of the RTU500 series are:

- Logical node physical health identification
- Time master supervision
- Redundant physical communication channel supervision
- Authority control for the whole substation

The next chapters describe the provided internal RTU500 series functions in detail. For information about the configuration aspects of the IEC 61850 server functionality see [6].

9.8.1 Logical node physical health identification

The physical health identification of the RTU500 series is provided in a standard data object of the logical node LPHD. The table below shows the relation between the data object and the RTU500 series functionality.

Logical Node	Data Object	RTU500 series functionality
LPHD	PhyHealth	Operable state of the RTU500 series. Derived from the system event “CMU operable/inoperable”. If operable

Table 15: Relation between Logical Node and RTU500 series functionality.

Logical Node	Data Object	RTU500 series functionality
		PhyHealth is set to Ok (value 1) otherwise set to Alarm (value 3).

Table 15: Relation between Logical Node and RTU500 series functionality.

To send the information about the physical health identification to clients on the station level the RTU500 series IEC 61850 server provides the predefined data set "StatNrmlA" with the data object "PhyHealth".

9.8.2 Time master supervision

The time master supervision of the RTU500 series is provided in standard data objects of the logical node LTMS. This logical node is available for Edition 2 client or server only. The table below shows the relation between the data objects and the RTU500 series functionality.

Logical Node	Data Object	RTU500 series functionality
LTMS	TmSyn	Status of the time synchronization in the RTU500 series. See table below for possible state values.
LTMS	TmChSt1	Shows as boolean value (up/down) the status of the SNTP time synchronization. If set ot true at least one SNTP client in the RTU500 series is synchronized.

Table 16: Relation between Logical Node and RTU500 series functionality.

The data objects "TmSyn" represents the actual time synchronization status in the following way:

TmSyn	Time synchronization status in RTU500 series
ExternalArea-Clock (Value 0)	The RTU500 series is not synchronized.
LocalAreaClock (Value 1)	The RTU500 series is synchronized by a local time source. Depending on the configuration this can be a local real time clock or a host communication interface.
GlobalAreaClock (Value 2)	The RTU500 series is synchronized by an SNTP server.

Table 17: Indication of time synchronization status

To send the information about time master supervision to clients on the station level the RTU500 series IEC 61850 server provides the predefined data set "StatNrmlA" with the data object "TmSyn".

The data object for the status of the SNTP time synchronization "TmChSt1" is not part of the data set per default. If required the data object can be added to a data set in the system configuration outside of RTUtil500.

9.8.3 Redundant physical communication channel supervision

The redundant physical communication channel supervision of the RTU500 series is provided in standard data objects of the logical node LCCH. This logical node is available for Edition 2 client or server only and if PRP is configured for the Ethernet interfaces. The table below shows the relation between the data objects and the RTU500 series functionality.

Logical Node	Data Object	RTU500 series functionality
LCCH	ChLiv	Physical channel status of redundant Ethernet interface 1. Derived from the system event “PRP interface no. X: network interface 1 link up”.
LCCH	RedChLiv	Physical channel status of redundant Ethernet interface 2. Derived from the system event “PRP interface no. X: network interface 2 link up”.
LCCH	FerCh	PRP frame error rate of redundant Ethernet interface 1.
LCCH	RedFerCh	PRP frame error rate of redundant Ethernet interface 2.

Table 18: Relation between Logical Node and RTU500 series functionality.

To send the information about the redundant physical communication channel supervision to clients on the station level the RTU500 series IEC 61850 server provides the predefined data set "StatNrmlA" with the data objects "ChLiv" and "RedChLiv".

The data objects for the PRP frame error rate "FerCh" and "RedFerCh" are not part of the data set per default. If required the data objects can be added to a data set in the system configuration outside of RTUtil500.

9.8.4 Authority control for the whole substation

The authority control of the RTU500 series is provided in standard data objects of the logical node LLN0. The table below shows the relation between the data objects and the RTU500 series functionality. The data object for requesting the local control authority is different for Edition 1 and Edition 2 clients.

Logical Node	Data Object	RTU500 series functionality
LLN0	Loc	Local control authority active. Derived from the system event “Local control authority active/inactive”.
LLN0	RemCtlBlk (Edition 1 only)	Request of local control authority by client on station level and indication whether authority is actual granted.
LLN0	LocSta (Edition 2 only)	Request of local control authority by client on station level and indication whether authority is actual granted.

Table 19: Relation between Logical Node and RTU500 series functionality.

The data objects "Loc" and "RemCtlBlk" respectively "LocSta" represents the actual control authority in the following way:

Loc	RemCtlBlk	Control authority state in RTU500 series
FALSE	FALSE	NCC’s on remote level have authority control. Another IEC 61850 client on station level is **not** allowed to control.
TRUE	FALSE	Authority control on station level granted to another instance (e.g. to the HMI). Another IEC 61850 client on station level is **not** allowed to control.
FALSE	TRUE	Not possible error state. Another IEC 61850 client on station level is **not** allowed to control.
TRUE	TRUE	Authority control on station level granted to another IEC 61850 client. Another IEC 61850 client on station level is allowed to control.

Table 20: Indication of control authority state

To send the information about authority control to clients on the station level the RTU500 series IEC 61850 server provides the predefined data set "StatNrmlA" with the data objects "Loc" and "RemCtlBlk" respectively "LocSta".

9.9 High Communication Load

The SCI IEC 61850 protocol implementation contains a functionality that supervises the communication load. This functionality is driven by the incoming IEC 61850 telegrams and triggers when many telegrams arrive in short period of time. As result the diagnosis messages “High Communication Load” is reported and the processing in the SCI IEC 61850 is slowed down temporarily. The processing slowdown is done to avoid blocking of other activities in the RTU560, e.g. the PLC. The slowdown is reset if the amount of receiving telegrams goes back to normal, resulting in the diagnosis message “Normal Communication Load”.

Triggering this functionality doesn’t mean that the SCI IEC 61850 communication is overloaded per se. The diagnosis message is a note for the user to review the system setup. If the message occurs very often and/or other functionalities in the RTU560 are blocked the amount of incoming telegrams shall be reduced. This can be done for example by filtering measurement changes at the source IEDs or by reducing the number of connected IEDs (Segmentation of IEDs on different SCI lines).

If a system works fine without any constraints the diagnosis message can be handled as informational.

10 Limits and Recommendations

10.1 System Limits

The following table specifies the system limits of IEC 61850 Client in RTU500 series:

Description	Limit
Maximum number of subdevice communication interfaces IEC 61850 per RTU	3
Maximum number of subdevice communication interfaces IEC 61850 per CMU	1
Maximum number of IEDs per RTU	120
Maximum number of IEDs per subdevice communication interface IEC 61850	30
Maximum number of process data points supported per RTU500 series	5000[1]
Maximum number of data set entries a subdevice communication interface IEC 61850 supports as client (regardless of communication type, sum across all data sets received)	7000
Maximum number of report control blocks (RCBs) respectively data sets per server connected to a subdevice communication interface IEC 61850	1000 buffered reports[2] 1000 unbuffered reports[2]
Maximum number of entries per data set	300
Maximum number of data attribute instances (DAIs) per subdevice communication interface IEC 61850	21000[3]

Table 21: System limits

1 Depending on the used license.
2 Practically the limitation is the overall number of data set entries that can be handled by the subdevice communication interface IEC 61850 (see above).
3 For a rough calculation based on the number of RTU500 data points, count 3 DAIs per monitoring data point and 20 DAIs per command data point.

For detailed limits on the IEC 61850 protocol implementation see chapter "Protocol Implementation extra Information for Testing (PIXIT)".

10.2 Mixed systems

The RTU500 series can work as IEC 61850 Edition 1 or Edition 2 client or server. The used protocol edition is defined for client and server in the configuration. In system with IEDs of one Edition only, no restrictions apply for the RTU500 series. But in mixed systems were IEDs of Edition 1 and Edition 2 are used together the following restrictions apply:

- For extensions of existing Edition 1 systems the RTU500 series must be configured as Edition 1 IED. The extension of Edition 1 system with Edition 2 devices is not supported.
- Mixed systems are supported for client/server communication. In mixed system the SCD file is Edition 2 including Edition 1 data models. There is one SCD file only for mixed systems.
- The RTU500 series doesn’t support GOOSE communication between editions. That means the GOOSE communication with the RTU500 series is restricted to IEDs of the same edition. The configuration tool RTUtil500 checks this restriction and GOOSE data points from IEDs with the wrong edition are ignored (Presenting a warning message for the user).

11 Conformance Statements

11.1 Abstract Communication Service Interface (ACSI)

The following ACSI conformance statements are used to provide an overview and details about RTU500 series IEC 61850 client, version 12.4 :

- ASCI basic conformance statement,
- ACSI models conformance statement,
- ACSI service conformance statement

The statements specify the communication features mapped to IEC 61850-8-1 Edition 1 and Edition 2. The following tables contain a column for the RTU500 series IEC 61850 client (named “RTU500 series client”).

11.1.1 ACSI Basic Conformance Statement

The ACSI basic conformance statement for RTU500 series IEC 61850 client is defined in following table.

		Client/ subscriber	Server/ publisher	RTU500 series client
Client-server roles				
B11	Server side (of TWO-PARTYAPPLICATION-ASSOCIATION)	-	c1	-
B12	Client side (of TWO-PARTYAPPLICATION-ASSOCIATION)	c1	-	YES
SCSMs supported				
B21	SCSM: IEC 61850-8-1 used			YES
B22	SCSM: IEC 61850-9-1 used			-
B23	SCSM: IEC 61850-9-2 used			-
B24	SCSM: other			-
Generic substation event model (GSE)				
B31	Publisher side	-	O	-
B32	Subscriber side	O	-	-
Transmission of sampled value model (SVC)				
B41	Publisher side	-	O	-
B42	Subscriber side	O	-	-

c1 – shall be ‘M’ if support for LOGICAL-DEVICE model has been declared.

O – Optional

M – Mandatory

Table 22: ACSI basic conformance statement

11.1.2 ACSI Models Conformance Statement

The ACSI models conformance statement for RTU500 series IEC 61850 client is defined in following table.

		Client/ subscriber	Server/ publisher	RTU500 series client
If Server or Client side (B11/B12) supported				
M1	Logical device	c2	c2	YES
M2	Logical node	c3	c3	YES
M3	Data	c4	c4	YES
M4	Data set	c5	c5	YES
M5	Substitution	O	O	-
M6	Setting group control	O	O	-
	Reporting			
M7	Buffered report control	O	O	YES
M7-1	sequence-number			YES
M7-2	report-time-stamp			YES
M7-3	reason-for-inclusion			YES
M7-4	data-set-name			YES
M7-5	data-reference			YES
M7-6	buffer-overflow			YES
M7-7	entryID			YES
M7-8	BufTm			YES
M7-9	IntgPd			YES
M7-10	GI			YES
M7-11	conf-revision			YES
M8	Unbuffered report control	O	O	YES
M8-1	sequence-number			YES
M8-2	report-time-stamp			YES
M8-3	reason-for-inclusion			YES
M8-4	data-set-name			YES
M8-5	data-reference			YES
M8-6	BufTm			YES
M8-7	IntgPd			YES
M8-8	GI			YES
M8-9	conf-revision			YES
	Logging			
M9	Log control	O	O	-
M9-1	IntgPd			-
M10	Log	O	O	-
M11	Control	M	M	YES
If GSE (B31/B32) is supported				
M12	GOOSE	O	O	-
M13	GSSE	O	O	-
If SVC (B41/B42) is supported				
M14	Multicast SVC	O	O	-
M15	Unicast SVC	O	O	-
For all IEDs				

Table 23: ACSI model conformance statement

		Client/ subscriber	Server/ publisher	RTU500 series client
M16	Time	M	M	YES
M17	File Transfer	O	O	YES

c2 – shall be 'M' if support for LOGICAL-NODE model has been declared.

c3 – shall be 'M' if support for DATA model has been declared.

c4 – shall be 'M' if support for DATA-SET, Substitution, Report, Log Control, or Time model has been declared.

c5 – shall be 'M' if support for Report, GSE, or SV models has been declared.

O – Optional

M – Mandatory

Table 23: ACSI model conformance statement

11.1.3 ACSI Service Conformance Statement

The ACSI service conformance statement for RTU500 series IEC 61850 client is defined in following table (depending on the statements of table "Tab. 23: ACSI model conformance statement").

Services		AA: TP/MC	Client/ subscriber	Server/ publisher	RTU500 series client
Server (Clause 7)					
S1	GetServerDirectory	TP		M	-
Application association (Clause 8)					
S2	Associate		M	M	YES
S3	Abort		M	M	YES
S4	Release		M	M	YES
Logical device (Clause 9)					
S5	GetLogicalDeviceDirectory	TP	M	M	-
Logical node (Clause 10)					
S6	GetLogicalNodeDirectory	TP	M	M	-
S7	GetAllDataValues	TP	O	M	-
Data (Clause 11)					
S8	GetDataValues	TP	M	M	YES
S9	SetDataValues	TP	O	O	YES
S10	GetDataDirectory	TP	O	M	YES
S11	GetDataDefinition	TP	O	M	YES
Data set (Clause 12)					
S12	GetDataSetValues	TP	O	M	-
S13	SetDataSetValues	TP	O	O	-
S14	CreateDataSet	TP	O	O	-
S15	DeleteDataSet	TP	O	O	-
S16	GetDataSetDirectory	TP	O	O	YES

Table 24: ACSI service conformance statement

Services		AA: TP/MC	Client/ subscriber	Server/ publisher	RTU500 series client
Setting group control (Clause 16)					
S18	SelectActiveSG	TP	O	O	-
S19	SelectEditSG	TP	O	O	-
S20	SetEditSGValues	TP	O	O	-
S21	ConfirmEditSGValues	TP	O	O	-
S22	GetEditSGValues	TP	O	O	-
S23	GetSGCBValues	TP	O	O	-
Reporting (Clause 17)					
Buffered report control block (BRCB)					
S24	Report	TP	c6	c6	YES
S24-1	data-change (dchg)				YES
S24-2	qchg-change (qchg)				YES
S24-3	data-update (dupd)				YES
S25	GetBRCBValues	TP	c6	c6	YES
S26	SetBRCBValues	TP	c6	c6	YES
Unbuffered report control block (URCB)					
S27	Report	TP	c6	c6	YES
S27-1	data-change (dchg)				YES
S27-2	qchg-change (qchg)				YES
S27-3	data-update (dupd)				YES
S28	GetURCBValues	TP	c6	c6	YES
S29	SetURCBValues	TP	c6	c6	YES
Logging (Clause 17)					
Log control block					
S30	GetLCBValues	TP	M	M	-
S31	SetLCBValues	TP	O	M	-
Log					
S32	QueryLogByTime	TP	c7	M	-
S33	QueryLogAfter	TP	c7	M	-
S34	GetLogStatusValues	TP	M	M	-
Generic substation event model (GSE)					
GOOSE (Clause 18)					
S35	SendGOOSEMessage	MC	c8	c8	-
S36	GetGoReference	TP	O	c9	-
S37	GetGOOSEElementNumber	TP	O	c9	-
S38	GetGoCBValues	TP	O	O	-
S39	SetGoCBValues	TP	O	O	-
GSSE (Annex C)					
S40	SendGSSEMessage	MC	c8	c8	-
S41	GetGsReference	TP	O	c9	-
S42	GetGSSEDataOffset	TP	O	c9	-
S43	GetGsCBValues	TP	O	O	-

Table 24: ACSI service conformance statement

Services		AA: TP/MC	Client/ subscriber	Server/ publisher	RTU500 series client
S44	SetGsCBValues	TP	O	O	-
Transmission of sampled value model (SVC) (Clause 19)					
Multicast SVC					
S45	SendMSVMessage	MC	c10	c10	-
S46	GetMSVCBValues	TP	O	O	-
S47	SetMSVCBValues	TP	O	O	-
Unicast SVC					
S48	SendUSVMessage	TP	c10	c10	-
S49	GetUSVCBValues	TP	O	O	-
S50	SetUSVCBValues	TP	O	O	-
Control (Clause 20)					
S51	Select	TP	M	O	YES
S52	SelectWithValue	TP	M	O	YES
S53	Cancel	TP	O	O	YES
S54	Operate	TP	M	M	YES
S55	Command-Termination	TP	M	O	YES
S56	TimeActivated-Operate	TP	O	O	-
File transfer (Clause 23)					
S57	GetFile	TP	O	M	YES
S58	SetFile	TP	O	O	-
S59	DeleteFile	TP	O	O	-
S60	GetFileAttributeValues	TP	O	M	YES
Time (5.5)					
T1	Time resolution of internal clock				10 (1 msec)
T2	Time accuracy of internal clock				T1
T3	Supported TimeStamp resolution				10 (1 msec)

c6 – shall declare support for at least one (BRCB or URCB)

c7 – shall declare support for at least one (QueryLogByTime or QueryLogAfter)

c8 – shall declare support for at least one (SendGOOSEMessage or SendGSSEMessage)

c9 – shall declare support if TP association is available

c10 – shall declare support for at least one (SendMSVMessage or SendUSVMessage)

O – Optional

Table 24: ACSI service conformance statement

11.1.4 Specific Communication Service Mapping (SCSM)

See B21 table "Tab. 22: ACSI basic conformance statement" and [IEC 61850-7-2].

11.2 Protocol Implementation Conformance Statement (PICS)

This protocol implementation conformance statement is applicable for RTU500 series IEC 61850 client, version 12.4.

11.2.1 Basic Profile Conformance

11.2.1.1 PICS for A-Profile support

The PICS for A-Profile support for RTU500 series IEC 61850 client are defined in following table.

A-Profile shortcut	Profile Description	Client	Server	RTU500 series client
A1	Client/server A-Profile	c1	c1	YES
A2	GOOSE/GSE management A-Profile	c2	c2	-
A3	GSSE A-Profile	c3	c3	-
A4	TimeSync A-Profile	c4	c4	YES
A5	Security for client/server A-Profile	o	o	-
A6	Security for GOOSE/GSE management A-Profile	o	o	-

c1 Shall be 'm' if support for any service specified in [IEC 61850-8-1] Table 2 are declared within the ACSI basic conformance statement (see Table 5).

c2 Shall be 'm' if support for any service specified in [IEC 61850-8-1] Table 6 are declared within the ACSI basic conformance statement (see Table 5).

c3 Shall be 'm' if support for any service specified in [IEC 61850-8-1] Table 9 are declared within the ACSI basic conformance statement (see Table 5).

c4 Support for at least one other A-Profile shall be declared (e.g. in A1-A3) in order to claim conformance to [IEC 61850-8-1].[IEC 61850-8-1].

Table 25: PICS for A-Profile support

11.2.1.2 PICS for T-Profile support

The PICS for T-Profile support for RTU500 series IEC 61850 client are defined in following table.

T-Profile shortcut	Profile Description	Client	Server	RTU500 series client
T1	TCP/IP T-Profile	c1	c1	YES
T2	OSI T-Profile	c2	c2	-
T3	GOOSE/GSE T-Profile	c3	c3	-
T4	GSSE T-Profile	c4	c4	-
T5	TimeSync T-Profile	O	O	YES

Table 26: PICS for T-Profile support

T-Profile short-cut	Profile Description	Client	Server	RTU500 series client
c1 Shall be ‘m’ if support for table 9-4 A1 is declared. Otherwise, shall be 'i'.				
c2 Shall be ‘o’ if support for table 9-4 A1 is declared. Otherwise, shall be 'i'.				
c3 Shall be ‘m’ if support for table 9-4 A2 is declared. Otherwise, shall be 'i'.				
c4 Shall be ‘m’ if support for table 9-4 A3 is declared. Otherwise, shall be 'i'.				
i – out-of-scope: The implementation of the item is not within the scope of this standard				
O – Optional				

Table 26: PICS for T-Profile support

11.2.2 MMS Conformance

All needed services supporting the ACSI services stated to be supported in chapter ’9.1.3 "ACSI Service Conformance Statement" ’ are supported by the MMS stack used.

11.3 Model Implementation Conformance Statement (MICS)

This model implementation conformance statement is applicable for RTU500 series IEC 61850 client, version 12.4.

This MICS document specifies the modelling implementations and extensions compared to IEC 61850 Edition 1 and Edition 2. For the exact details on the standardized model please compare the ICD substation configuration files generated by RTUtil500.

- Chapter 11.3.1 describes the common data class extensions
- Chapter 11.3.2 contains the list of implemented logical nodes.
- Chapters 11.3.3 to 11.3.4 describe the implemented logical nodes.

11.3.1 Common Data Class Extensions

11.3.1.1 Supported common data classes

Following table defines the list of common data classes supported by RTU500 series IEC 61850 client.

Common data class specifications for status information	
SPS	Single point status
DPS	Double point status
INS	Integer status
ENS[1]	Enumerated status
ACT	Protection activation information
ACD	Directional protection activation information
BCR	Binary counter reading

Table 27: Common data classes supported by the RTU500 series IEC 61850 client

Common data class specifications for measurand information	
MV	Measured value
CMV	Complex measured value
WYE	Phase to ground related measured values of a three phase system
DEL	Phase to phase related measured values of a three phase system
SEQ	Sequence
Common data class specifications for controlls	
SPC	Controllable single point
DPC	Controllable double point
INC	Controllable integer status
ENC[1]	Controllable enumerated status
BSC	Binary controlled step position information
ISC	Integer controlled step position information
Common data class specifications for status settings	
SPG	Single point setting
ING	Integer status setting
ENG[1]	Enumerated status setting
Common data class specifications for analogue settings	
ASG	Analogue setting

Table 27: Common data classes supported by the RTU500 series IEC 61850 client

1 Support by IEC 61850 Edition 2 client only

11.3.1.2 Unsupported common data classes

Following table defines the list of common data classes not supported by RTU500 series IEC 61850 client.

Common data class specifications for status information	
SEC	Security violation counting
HST	Histogram
VSS	Visible string status
Common data class specifications for measurand information	
SAV	Sampled value
HMV	Harmonic Value
HYE	Harmonic value for WYE
HDEL	Harmonic value for DEL
Common data class specifications for controlls	
APC	Controllable analogue set point information
BAC	Binary controlled analog process value
Common data class specifications for status settings	
ORG	Object reference setting
TSG	Time setting group
CUG	Currency setting group
VSG	Visible string setting

Table 28: Common data classes unsupported by the RTU500 series IEC 61850 client

Common data class specifications for analogue settings	
CURVE	Setting curve
CSG	Curve shape setting
Common data class specifications for description information	
DPL	Device name plate
LPL	Logical node name plate
CSD	Curve shape description

Table 28: Common data classes unsupported by the RTU500 series IEC 61850 client

11.3.2 Logical Node List

Following table defines the list of logical nodes supported by RTU500 series IEC 61850 client.

LN Group L: System logical nodes	
LPHD	Physical device information
LLN0	Logical node zero
LCCH[1]	Physical communication channel supervision
LTMS[1]	Time master supervision
LN Group I: Logical nodes for interfacing and archiving	
ITCI	Telecontrol interface

Table 29: Logical nodes supported by the RTU500 series IEC 61850 client

1 Supported for IEC 61850 Edition 2 client/server only

11.3.3 LN Group L: System logical nodes

11.3.3.1 LN type: LPHD

LPHD		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
PhyNam	DPL	Physical device name plate
PhyHealth	INS	Physical device health
Proxy	SPS	Indicates if this LN is a proxy

Table 30: Logical node type LPHD

LPHD		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
PhyNam	DPL	Physical device name plate
PhyHealth	ENS	Physical device health
Proxy	SPS	Indicates if this LN is a proxy

Table 31: Logical node type LPHD (Edition 2)

11.3.3.2 LN type: LLN0

LLN0		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
	Common logical node information	
Mod	INC	Mode
Beh	INS	Behaviour
Health	INS	Health
NamPlt	LPL	Name plate
Loc	SPS	Local operation for complete logical device
RemCtlBlk	SPC	Authority control for the whole substation (see chapter 8.7)

Table 32: Logical node type LLN0 (Edition 1)

LLN0		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
	Common logical node information	
Mod	ENC	Mode
Beh	ENS	Behaviour
Health	ENS	Health
NamPlt	LPL	Name plate
Loc	SPS	Local operation for complete logical device
LocSta	SPC	Authority control for the whole substation (see chapter 8.7)

Table 33: Logical node type LLN0 (Edition 2)

11.3.3.3 LN Type LCCH

LCCH		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
	Common logical node information	
Beh	ENS	Behaviour
ChLiv	SPS	Physical channel status; true, if channel receives telegrams within a specified time interval.
RedChLiv	SPS	Physical channel status of redundant channel

Table 34: Logical node type LCCH (Edition 2)

LCCH		
FerCh	INS	Frame error rate on this channel; count of erroneous (or missed, in case of redundancy) messages for each 1 000 messages forwarded to the application.
RedFerCh	INS	Frame error rate on redundant channel; count of missed messages on this channel for each 1 000 messages forwarded to the application.

Table 34: Logical node type LCCH (Edition 2)

11.3.3.4 LN type LTMS

LTMS		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
	Common logical node information	
Beh	ENS	Behaviour
TmSrc	VSS	Current time source
TmSyn	ENS	Time synchronized according to IEC 61850-9-2
TmChSt1	SPS	Time channel status (up/down)

Table 35: Logical node type LTMS (Edition 2)

11.3.4 LN Group L: Logical nodes for interfacing and archiving

11.3.4.1 LN type: ITCI

ITCI		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
	Common logical node information	
Mod	INC	Mode
Beh	INS	Behaviour
Health	INS	Health
NamPlt	LPL	Name plate

Table 36: Logical node type ITCI (Edition 1)

ITCI		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
	Common logical node information	
Beh	INS	Behaviour

Table 37: Logical node type ITCI (Edition 2)

11.4 Tissues Conformance Statement (TICS)

This chapter contains the technical issues (tissues) conformance statement. According to the UCA IUG QAP the tissue conformance statement is required to perform a conformance test and is referenced on the certificate.

The tissues are grouped in mandatory interoperability tissues (IntOp tissues), optional interoperability tissues and other tissues. The following tables are structured in the columns:

Part: Section of the IEC 61850 standard the tissue belongs to

Tissue Nr: Number of the tissue according to the database provided under http://www.tissues.iec61850.com

Description: Short description of the tissue

Implemented: Indicates whether the tissue is implemented in the device. The meaning of the abbreviations are
Y = Yes the tissue is implemented in the device
N = No the tissue is not implemented in the device
na = Not applicable, the tissue is not applicable for the device

The following chapters are applicable for RTU500 series IEC 61850 Edition 1 and Edition 2 client, version 12.4.

11.4.1 Mandatory Edition 1 IntOp Tissues

During the October 2006 meeting IEC TC57 working group 10 decided that:

- green Tissues with the category “IntOp¨ are mandatory for IEC 61850 edition 1
- Tissues with the category “Ed.2¨ Tissues should not be implemented.

Below table gives an overview of the implemented Edition 1 IntOp Tissues.

Part	Tissue Nr	Description	Implemented Y/na
8-1	116	GetNameList with empty response?	Y
	165	Improper Error Response for GetDataSetValues	Y
	183	GetNameList error handling	Y
7-4	252	PTTR.AlmThm	na
7-3	28	Definition of APC	na
	54	Point def xVal, not cVal	na
	55	Ineut = Ires ?	na
	63	mag in CDC CMV	na
	219	operTm in ACT	na
	270	WYE and DEL rms values	na
	1199	Allow INT32 for CDC BCR	Y
7-2	30	control parameter T	Y

Table 38: Mandatory Edition 1 IntOp Tissues

Part	Tissue Nr	Description	Implemented Y/na
	31	Typo	na
	32	Typo in syntax	na
	35	Typo Syntax Control time	na
	36	Syntax parameter DSet-Ref missing	na
	37	Syntax GOOSE "T" type	Y
	39	Add DstAddr to GoCB	Y
	40	GOOSE Message “AppID” to “GoID”	Y
	41	GsCB “AppID” to “GsID”	na
	42	SV timestamp: “EntryTime” to “TimeStamp"	na
	43	Control "T" semantic	Y
	44	AddCause - Object not sel	Y
	45	Missing AddCauses (neg range)	na
	46	Synchro check cancel	Y
	47	"." in LD Name?	na
	49	BRCB TimeOfEntry (part of #453)	Y
	50	LNName start with number?	na
	51	ARRAY [0..num] missing	na
	52	Ambiguity GOOSE SqNum	Y
	53	Add DstAddr to GsCB, SV	na
	151	Name constraint for control blocks etc.	na
	166	DataRef attribute in Log	na
	185	Logging - Integrity periode	na
	189	SV Format	na
	190	BRCB: EntryId and TimeOfEntry (part of #453)	Y
	191	BRCB: Integrity and buffering reports (part of #453)	Y
	234	New type CtxInt (Enums are mapped to 8 bit integer)	na
	275	Confusing statement on GI usage (part of #453)	Y
	278	EntryId not valid for a server (part of #453)	Y
	297	Sequence number (part of #453)	Y
	298	Type of SqNum (part of #453)	Y
	305	Reporting with BufTm=0 (part of #453)	Y

Table 38: Mandatory Edition 1 IntOp Tissues

Part	Tissue Nr	Description	Implemented Y/na
	322	Write Configuration attribute of BRCBs (part of #453)	Y
	329	Reporting and BufOvl (part of #453)	Y
	333	Enabling of an incomplete GoCB	na
	335	Clearing of Bufovfl (part of #453)	Y
	348	URCB class and report (part of #453)	Y
	349	BRCB TimeOfEntry has two definitions (part of #453)	Y
	1281	Default for TrgOps.GI is TRUE	Y
6	1	Syntax	na
	5	tExtensionAttributeNameEnum is restricted	na
	8	SIUnit enumeration for W	Y
	10	Base type for bitstring usage	Y
	17	DAI/SDI elements syntax	na
	169	Ordering of enum differs from 7-3	na
NOTE: Tissue 49, 190, 191, 275 and 278 are part of the optional tissue #453, all other technical tissues in the table are mandatory if applicable.			
NOTE: Editorial tissues are marked as “na”.			
NOTE: Final proposal on tissue 45 is not defined yet			

Table 38: Mandatory Edition 1 IntOp Tissues

11.4.2 Optional Edition 1 IntOp Tissues

After the approval of the server conformance test procedures version 2.2 the following IntOp tissues were added or changed. It is optional to implement these tissues.

Part	Tissue Nr	Description	Implemented Y/N/na
8-1	246	Control negative response (SBOns) with LastApplError	N
	545	Skip file directories with no files	na
7-2	333	Enabling of an incomplete GoCB	na
	453	Combination of all reporting and logging tissues	Y
6	245	Attribute RptId in SCL is optional	na
	526	Replace sev - Unknown by unknown	na

Table 39: Optional Edition 1 IntOp Tissues

11.4.3 Mandatory Edition 2 Tissues

Below table gives an overview of the implemented Edition 2 Tissues.

Part	Tissue Nr	Description	Implemented Y/na
8-1	753	Whether "GoID" and "DatSet" in GoCB are writable?	na
	770	GoID type mitmatch 18.1.1 and 18.1.2.5.2	na
	777	AddCause values	na
	784	Tracking of control (CTS)	na
	817	Fixed-length GOOSE float encoding	na
	821	AlternateAccess in GetAllDataValues	na
	827	Mandatory ACSI services	na
	834	File dir name length 64	na
	851	bType wrong for "check" in sample SCL file	na
	854	GetDataValues - single or multiple objects	Y
	935	Typing error in table 101	na
	942	Wrong description of S bit in reserved word	na
	951	Encoding of Owner attribute	na
	1036	FileDirectory response	na
	1037	GetDataSetValues SpecWithResult	Y
	1040	More associate error codes	Y
	1041	LTS and OTS mapping	na
	1042	SGCB definition includes information that is not mapping specific	na
	1043		na
	1047	SetEditSGValues should not detail nothing about non-volatile storage	na
	1058	"Currency" basictype is not mapped	Y
	1066	OSI-AP-Title value	na
	1155	UtcTime wrong referecne	Y
	1164	ResvTms definition should be integer in the BRCB structure	na
	1178		Y
	1181	DeleteDataSet response- refers to wrong clause	na
	1192	Select Response+ is non-null value	na
	1274	Conformance requirement for InformationReport Ambiguous	na
	1285	GoCB MinTime/MaxTime size	Y
	1287	GetServerDirectory(FILE) typo	na
	1289		na

Table 40: Mandatory Edition 2 Tissues

Part	Tissue Nr	Description	Implemented Y/na
	1299	ICD file must have a communication section for 8-1 implementation	na
	1300	COMTRADE zip file contents	na
	1309	typo: LLNO -> LLN0	na
	1324	Missing semantics for localDetailCalling	na
	1336	Behavior for a ContimueAfter where the File no longer exists	na
	1361	Extraneous normative reference:10608-1 and -2	Y
	1441	The response- for DeleteNamedVariableList is not defined	Y
	1442	enhanced the mapping text for the setValues.	Y
	1443	Variable length Quality encoding	na
	1453	Optonal fields in buffered reports	Y
	1454	Journal variableTag for ReasonCode	Y
	1462	Reading SE when EditSG=0	na
	1495	Purge buffer on write to BRCB	na
		Reports can be generated before write(RptEna=true) is confirmed	
		SNTP references to RFCs are different	
		GetVariableAccessAttributes error code	
7-4	671	Mistake in definition of Mod & Beh	Y
	674	CDC of ZRRC.LocSta is wrong	na
	675	SIML LN	Y
	676	Same data object name used with different CDC	na
	677	MotStr is used with different CDC in PMMS and SOPM LN classes	na
	679	Remove CycTrMod Enum	na
	680	SI unit for MHYD.Cndct	na
	681	Enum PIDAlg	na
	682	ANCR.ParColMod	na
	683	Enum QVVR.IntrDetMth	na
	685	Enum ParTraMod	na
	686	New annex H - enums types in XML	Y
	689		na

Table 40: Mandatory Edition 2 Tissues

Part	Tissue Nr	Description	Implemented Y/na
	693	RREC - diagram	Y
	694	Description of LTMS.TmChSt1	na
	695	Data object CmdBlk	na
	696	ARIS.Auto	na
	712	LSVS.St (Status of subscription)	na
	713	Interpretation of quality operatorBlocked	na
	714	DO Naming of time constants in FFIL	N
	715	Enums for ShOpCap and SwOpCap	na
	716	RBDR.ChNum1	na
	724	TAXD text for condition	na
	725	ANCR.Auto	na
	727	Loc in LN A-group	na
	734	RREC - diagram	na
	735	LLN0.OpTmh vs. LPHD.OpTmh	na
	736	ISAF.Alm and ISAF.AlmReset	na
	742	PFSign	Y
	743	GAPC.Str, GAPC.Op and GAPC.StrVal	na
	744	CCGR.PmpCtl and CCGR.FanCtl	na
	748	LN STMP, EEHealth and EEName	na
	749	CBOpCap	na
	772	Description BndCtrChg	na
	773	LPHD.PwrUp/PwrDn shall be transient	N
	774	Loc, LocKey and LocSta YPSH and YLTC	na
	775	ITCI.LocKey	na
	776	KVLV.ClsLim and OpnLim	na
	790	LPHD.OutOv/InOv and LCCH.OutOv/InOv	na
	800	TVTR.VolSv not in table 10	na
	802	Misspelling in CSYN	na
	808	CCGR and Harmonized control authority	na
	830	Presence condition of ZMOT.DExt and new DOs Mode/Behaviour & Quality	na

Table 40: Mandatory Edition 2 Tissues

Part	Tissue Nr	Description	Implemented Y/na
	831	Setting of ConfRevNum in LGOS	na
	838	Testing in Beh=Blocked	na
	842	GAPC.Auto change type to SPS	na
	843	GGIO.AnOut1 move to Controls	na
	844	MFLK.PhPiMax, MFLK.PhPiLoFil, MFLK.PhPiRoot DEL->WYE	na
	849	Presence conditions re-assessing in case of derived statistical calculation	na
7-4	877	QVUB -settings should be optional	na
	879	Duplicate definition of HzChr	na
	902	Control Blocks in CommonLN	na
	908	ARIS.StrSeq - transient	na
	909	Remove ANCR.ColOpR and ColOpL	na
	912	Clarification of PwrRtg/VARtg	na
	920	Resetable Counter is NOT resetable	na
	932	Rename AVCO.SptVol to AVCO.VolSpt	na
	933	Presence of LCCH.RedFerCh and RedRxCnt	Y
	939	Change CDC for ANCR.FixCol	na
	940	Clarification of feedback MX for DO with CDC APC	na
	967	Statistical calculation and "M" attributes	na
	991	LGOS: GoCBRef (as well as LSVS.SvCBRef) should be mandatory	na
	1007	PTRC as fault indicator - Update of description required	na
	1044	TapChg in AVCO	na
	1077	Rename DOnames within LTIM	na
	1177	Winding ratio for TCTR and TVTR	na
	1273	Behavior of DOI "Beh" due internal condition	na
	1294	Description of SIML.GasInsAlm reg. Buchholz	Y
	1330	proposal in tissue 830 seems not consistent with 7-3 Ed2	na
	1331		na
	1333	Mod, Beh and Health with q=TEST, client can't receive their states	na
	1456		na
	1568	SPS datapoint for Select is not present in LN ATCC for process bus	na

Table 40: Mandatory Edition 2 Tissues

Part	Tissue Nr	Description	Implemented Y/na
		Annex A and Mod/Beh/Health	
		ISAF.AlmReset ->transient	
7-3	697	persistent command / PulseConfig	na
	698	Wrong case is BAC.dB attribute	na
	709	Semantic of tstEna	na
	722	Units for 'h' and 'min' not in UnitKind enumeration.	Y
	814	subQ bit used	na
	819	APC and ASG	na
	832	Data attribute semantic of minVal & maxVal	na
	839	Use of opRcvd also in Blocked	na
	887	Data semantics for q and t	na
	919	Presence Condition for sVC	na
	924	Missing curve characteristics	na
	925	Presence of i or f attribute - Problem with writing	na
	926	Presence Conditions within RangeConfig	na
	929	condition AC_SCAV unclear	na
	953	missing trigger option forCSG units	na
	954	Data attributes with FC=CF should have trgOp=dchg	na
	962	instMag optional?	na
	968	BCR value range	N
	1078	CMV.t update if rangeAng changed	na
	1079	q and t semantic syntax errors	na
	1187	ldNs example value shal be 2007A	na
	1253	Can CDC ACT be used for 3-phase indication?	Y
	1387	Default value of SboClasses	na
	1430	opRcvd for controllable object	na
	1481	configRev presence condition	Y
7-2	728	BRCB: could PurgeBuf be set when RptEna=TRUE?	Y
	778	AddCause values	Y
	780	What are unsupported trigger option at a control block?	Y
	783	TimOper Resp- ; add Authorization check	na

Table 40: Mandatory Edition 2 Tissues

Part	Tissue Nr	Description	Implemented Y/na
	786	AddCause values 26 and 27 are switched	Y
	813	TimeAccuracy choices	na
	820	Mandatory ACSI services (use for PICS template)	Y
	850	Report Value needs a corresponding index when data-FALSE	Y
	852		na
	858	Check condition type - parameter type wrong	Y
	861	Typo in enumeration ServiceType	na
	869	dchg of ConfRev attribute	na
	875	Grammer/spelling error	na
	876	GenLogiclNodeClass and compatible LN Classes	na
	943	GenLogiclNodeClass and SGCB, GoCB, MsvCB, UsvCB	na
	970	control model change to "local" when TimeActivated-Operate	na
	1038	Wrong reference to GSSE	na
	1050	Loss of Info Detection After Resynch	na
	1061	GTS Phycomaddr definition in SCL	na
	1062	EntryTime wrongly appllied	na
	1071	Entrytime not used in CDC	Y
	1091	Length of DO name	na
	1092	The sentence "The initial value of EditSG shall be 0" in 7.2	na
	1116		na
	1127	NewEntrTm and OldEntrTm Type in LOG Class	na
	1145	CONTROL service(s) parameter 'orgin' misspelled	na
	1154	Missing owner attribute in BTS and UTS	na
	1202	T – control time-stamp	Y
	1232	Inconistent Definition for Response Parameter	Y
	1242	GI not optional	na
	1252	EntryID needs clarification	na
	1283	NTS definiton	na
	1307	Data-Instance-ID: is 01 allowed?	Y
	1341	pleonasm "qchg-change" (for Ed.2)	Y
	1428	Segemented report with Buffer overflow	na

Table 40: Mandatory Edition 2 Tissues

Part	Tissue Nr	Description	Implemented Y/na
	1569	Attribute Owner is missing in GetBRCBValues services	na
		MTS and NTS should use svOptFlds	
		How to track Select service in service tracking?	
7-1	828	Data model namespace revision IEC 61850-7-4:2007[A]	Y
	874	Logical Node Class needs to be updated	na
	948	Enumeration (string) values format	na
	1060	Error in encoding in Figure F.9	na
	1072	Statistical Data and Reporting	na
	1129	Rules for extending nameplate information	na
	1151	Simulated GOOSE disappears after 1st appearance	na
	1251	All "L" logical nodes shall be in the same LD - except for gateways	Y
	1268	Assigment of single CDC to DOclass	na
	1312	Presence condition of lnNs and dataNs	Y
	1396	The use and configuration flow of LGOS and LSVS is Unclear	na
	1491	CmdBlk blocks itself?	na
6	658	Tracking related features	na
	660	XML encoding header repeat	na
	663	FCDA element cannot "functionally constrained logical node"	Y
	668	Autotransformer modeling	na
	687	SGCB ResvTms	na
	699	DO type description table	na
	719	ConfDataSet - maxAttributes definition is confusing	Y
	721	Log element name	na
	731	quoted SCL inconsistant with annex.	na
	752	Input Section/ Inputs Section	na
	768	bType VisString65 is missing	na
	779	Object references	Y
	787	SICS I45 inconsistency	Y
	788	SICS S56 from optional to mandatory	na
	789		Y

Table 40: Mandatory Edition 2 Tissues

Part	Tissue Nr	Description	Implemented Y/na
	804	ConfLdName as services applies to both server and client	na
	806	valKind and IED versus System configuration	na
	807	Max length of log name inconsistent between -6 and -7-2	Y
	823		Y
	824	Need a way to indicate if "Owner" present in RCB	na
	825	ValKind for structured data attributes	na
	845	Short addresses on structured data attributes	na
	853	Floating point value	na
	855	SGCB ResvTms	N
	856	SBO and ProtNs	na
	857	Recursive SubFunction	Y
	873	VoltageLevel frequency and phases	na
	886	Function/SubFunction for ConductingEquipment	na
	901	Examples for "curvPts"	na
	936	Missing 8-1 P-types	na
	949	tServices as AP or as IED element	na
	1118	SupSubscription parameter usage is difficult	na
	1147	type of LN inst is ambiguous	na
	1175	Clarification of how tClientLN is used to enable Report Control Blocks	na
	1185	tServices - FileHandling not consistent with -7-2	na
	1195	IPv6 address lowercase only na	na
	1208	Valkind value Conf for EX FC data	na
	1284	Typographical Error	Y
	1298	IPv6 Address format	na
	1304	SCSM mapping may require a communication section in an ICD file	na
	1318		na
	1328	How to differentiate preconfigured Report Datasets and generated ones	Y
	1354	Error in the SCL object model	Y
	1365	SSD will not validate against XSD	N
	1397		na

Table 40: Mandatory Edition 2 Tissues

Part	Tissue Nr	Description	Implemented Y/na
	1398 1415 1444 1445	Limitation on the size of data type templates identifiers Changes to SICS Template Need to tighten up the XSD in regards to IEDName usage Subscription limitation visible in IxD file originalSclVersion management in SCT SICS-S110 IID import mandatory for Edition2 Need to support fixed and SCT controlled Datasets ConfReportControl and a fixed ReportSettings	N na Y Y
6	1447	Restriction on ENUMtypes in SCL	Y
	1450	originalSclXxx computation rules	N
	1451	Services section-"client" is confusing	na
	1457	Multiple DOI nodes with the same name.	Y
NOTE: Editorial tissues are marked as “na”.			

Table 40: Mandatory Edition 2 Tissues

11.5 Protocol Implementation extra Information for Testing (PIXIT)

This document specifies the protocol implementation extra information for testing (PIXIT) of the IEC 61850 interface in the client system: RTU500 series IEC 61850 client, version 12.4 (further referred to as "client").

Together with the PICS and the MICS the PIXIT forms the basis for a conformance test according to IEC 61850-10.

Each chapter specifies the PIXIT for each applicable ACSI service model as structured in IEC 61850-10and the "Conformance Test Procedures for Client System with IEC 61850-8-1 interface".

11.5.1 PIXIT for Configuration

Description	Value / Clarification
Describe how the client handles nameplate configuration revision mismatches	The actual server name plate configuration revision is read from the server during the connection establishment. The configuration revision from the SCD file is not part of specific client configuration file. Therefore a mismatch between the SCD file and the actual server name plate configuration revision is not checked by the client.

Table 41: PIXIT for configuration

Description	Value / Clarification
Describe how the client handles report control block configuration revision mismatches	The report control block configuration revision is written from SCD file to the specific client configuration file. During connection establishment the client reads the report control block configuration revision from the data model of the server and compares the value with the revision from the SCD file. In case of a mismatch an internal minor error is generated that can be seen with a device specific log tool. The internal minor error has no influence on the processing of the report control block. The configuration revision send by the server in an actual report is not checked by the client.

Table 41: PIXIT for configuration

11.5.2 PIXIT for Association model

Description	Value / Clarification
Guaranteed number of servers that can set-up an association simultaneously (one association per server)	32
Lost connection detection time range (default range of TCP_KEEPALIVE is 1 - 20 seconds)	5 seconds
Lost (abort) connection retry time	TCP_KEEPIDLE = 10 s TCP_KEEPCNT = 3 TCP_KEEPINIT = 10 s TCP_KEEPINTVL = 5s 10s after association start to begin sending keep-alive and 15s (3 * 5s) to detect lost connection.
Is authentication supported?	N
What is the maximum and minimum MMS PDU size	Max MMS PDU size 32000 bytes Min MMS PDU size 1024 bytes
What is the typical start-up time after a power supply interrupt	Depending on the size of the configuration a typical start-up time is 5 minutes (including association to all configured servers)
How does the client behave in case of a lost connection with (one of) the associated servers?	The server is marked as offline. After a timeout of 15 seconds the client tries to reconnect the server. The reconnect timeout is increased to 60 seconds after 3 failed connection requests. The client never stops the reconnect retries. Note: In case the connection to several

Table 42: PIXIT for Association model

Description	Value / Clarification
	servers are lost at the same time the actual reconnect timeouts can be longer.
How does the client behave when a server denies an Association request by the client?	The server is marked as offline. After a timeout of 15 seconds the client tries to connect the server again. The connect timeout is increased to 60 seconds after 3 failed connection requests. The client never stops the connect retries. Note: In case the connection to several servers are lost at the same time the actual reconnect timeouts can be longer.
Does the client automatically reconnect to the configured servers after start-up (Automatic start-up)?	Y

Table 42: PIXIT for Association model

11.5.3 PIXIT for Server model

Description	Value / Clarification
Maximum object identification length	129 octets: <64>/<64>
Does the client support auto-description?	The client support auto-description in the means of adaptation to minor configuration mismatches between the SCD configuration and the actual server data model. But the client needs a complete SCD configuration with all servers and there data models included as starting point. During the first connection establishment the client reads parts of the actual data model of a server and modifies (when possible) the model from the SCD configuration according the actual read data. The processing is then done on the corrected data model. At any further connection requests to a server (during the runtime of the client) the data model is not read again. Instead the client uses the data model read during the first connection establishment.
Describe how to view/display data values	The IEC 61850 data values are mapped to IEC 870-5-101 data values that can be viewed in the web server provided by the device.
What analogue value (MX) quality bits are used in the client	Y Good, Y Invalid, N Reserved, N Questionable Y Overflow Y OutofRange Y BadReference

Table 43: PIXIT for Server model

Description	Value / Clarification
	Y Oscillatory Y Failure Y OldData Y Inconsistent Y Inaccurate Y Process Y Substituted Y Test Y OperatorBlocked
Which status value (ST) quality bits are used in the client	Y Good, Y Invalid, N Reserved, N Questionable N BadReference N Oscillatory N Failure Y OldData N Inconsistent N Inaccurate Y Process Y Substituted Y Test Y OperatorBlocked
Describe how to view/display quality values	The IEC 61850 quality bits are mapped to IEC 870-5-101 like quality attributes that can be viewed in the web server provided by the device.
Which time quality bits are used in the client	N LeapSecondsKnown Y ClockFailure Y ClockNotSynchronized
Describe how to view/display time quality bits	The IEC 61850 time quality bit ClockNotSynchronized is mapped to a time invalid attribute that can be viewed in the web server provided by the device.

Table 43: PIXIT for Server model

Description	Value / Clarification
Describe how to force a SetDataValues request	Control an analogue or digital set-point that is mapped to an IEC 61850 data object with functional constraint SP.
Describe how to force GetDataValues request	Control a data object with control model 'sbo-with-normal-security'. The service 'Select' is defined as reading of the SBO data attribute with the ACSI GetDataValues service.
Describe how to force a GetAllDataValues request	The ACSI service GetAllDataValues is not supported by the client.
Does the Client support writing blkEna values?	N
Describe how the client behaves in case of: - GetServerDirectory response-	The ACSI service GetServerDirectory is not used by the client. The client gets the logical devices of a server from the configured SCD data model of that server. Differences between the configured and the actual data model of a server are not considered.
Describe how the client behaves in case of: - GetLogicalDeviceDirectory response-	The ACSI service GetLogicalDeviceDirectory is not used by the client. The client gets the logical node and data set information from the configured SCD data model of a server. Differences between the configured and the actual data model of a server are not considered.
Describe how the client behaves in case of: - GetLogicalNodeDirectory response-	The ACSI service GetLogicalNodeDirectory is not used by the client. The client gets the data set information from the configured SCD data model of a server. Differences between the configured and the actual data model of a server are not considered.
Describe how the client behaves in case of: - GetDataDirectory response- - GetDataDefinition response-	The ACSI services GetDataDirectory / GetDataDefinition are used by the client to read data model information of logical nodes during connection establishment. In case of a negative service response the association to the server is concluded. Afterwards The client tries to reconnect the server according the rules described in "PIXIT for Association model".
Describe how the client behaves in case of: - GetAllDataValues response-	The ACSI service GetAllDataValues is not supported by the client.
Describe how the client behaves in case of: - GetDataValues response-	The ACSI service GetDataValues is used by the client to read the actual server name plate configuration revision during connection establishment. In case of a negative service response an internal minor error is generated that can be seen with a device specific log tool. The internal minor error has no influence on the further connection establishment.
Describe how the client behaves in case of: - SetDataValues response-	The ACSI service SetDataValues is used by the client to write a data element with functional constraint SP (Set Point). The origin of this write request is a set point command from a

Table 43: PIXIT for Server model

Description	Value / Clarification
	host functionality within the client (e.g. IEC 870-5-104 connection to a network control center). In case of a negative service response from the server the set point command is confirmed negative.

Table 43: PIXIT for Server model

11.5.4 PIXIT for Dataset model

Description	Value / Clarification
Describe how to force a GetDataSetValues request	The ACSI service GetDataSetValues is not supported by the client.
Describe how to force a SetDataSetValues request	The ACSI service SetDataSetValues is not supported by the client.
Describe how to force a DeleteDataSet request	The ACSI service DeleteDataSet is not supported by the client.
Describe how the client handles following dataset mismatches between the SCL and the data sets exposed via MMS: (1) New dataset element (2) Missing dataset element (3) Dataset elements with different data type (4) Reordered dataset members in a dataset of a different data type (5) Reordered dataset members in a dataset of the same data type	With the first connection establishment the client reads the actual configuration of a dataset. This information is stored and used for the decoding of reports containing this dataset. The datasets read by the client are selected from the SCD configuration of the client. Afterwards the client reads for all known dataset elements the data structure and type. Known dataset elements are elements configured in the SCD (of the client) and mapped to an internal data objects. Dataset elements that are not mapped to an internal data object are not read from the server. The read data structure and type are used to map received dataset elements to internal data objects. (1) If a server dataset contains additional (new) elements, the elements are ignored by the client (internally trashed). All other known elements are processed as normal in this case. (2) If elements are missing in a server dataset, the internal data objects mapped to the missing dataset elements remain invalid. All other known elements are processed as normal in this case. If elements are missing that are not mapped to an internal data object nothing happens. (3) If server dataset elements have different data types than in the client configuration, the client tries to map the actual data type to the internal data object. That means the client decodes the received dataset elements according to the data types read from the

Table 44: PIXIT for Dataset model

Description	Value / Clarification
	actual server configuration and tries to map the information to the internal data objects. Whether the mapping is successful depends on the mismatch. For example a Boolean data type can be mapped to an integer type but the other way round information is lost. (4) If dataset elements are reordered in a server dataset all known elements are processed as normal. Unknown reordered dataset elements are ignored. Different data types are handled as described in (3). (5) If dataset elements are reordered in a server dataset all known elements are processed as normal. Unknown reordered dataset elements are ignored. CAUTION: The above describe configuration adjustments are done at the first connection establishment only. If a server disconnects and re-connects later the configuration of the server is not read again. In this case the client uses the read configuration from the first connection establishment. If the server communication part (e.g. datasets) is re-configured between two connection establishments the behavior of the client is undefined. After a server re-configuration (communication part) the client must be re-started in any case (see “PIXIT for Server model”).
Describe how the client behaves in case of: - GetLogicalNodeDirectory(DATA-SET) response-	The ACSI service GetLogicalNodeDirectory(DATA-SET) is not used by the client. The client gets the data sets of a logical node from the configured SCD data model of a server. Differences between the configured data sets and the actual data model of a server are not considered.
Describe how the client behaves in case of: - GetDataSetDirectory response-	The ACSI service GetDataSetDirectory is used by the client to read the FCDs of a data set during connection establishment. In case of a negative service response the association to the server is concluded. Afterwards The client tries to reconnect the server according the rules described in "PIXIT for Association model".
Maximum name length for dataset Maximum name length for dataset member including LD and FC	Dataset name: 32 characters (name only) Dataset member: 129 characters (whole object reference)
Does the client support the creation of: - persistent datasets - non-persistent datasets	N N

Table 44: PIXIT for Dataset model

Description	Value / Clarification
Describe how the client behaves in case of: - CreateDataSet response- - DeleteDataSet response-	The ACSI services CreateDataSet and DeleteDataSet are not supported by the client.
Describe how the client behaves when it receives a SetDataSetValues.Response-	The ACSI service SetDataSetValues is not supported by the client.
What is the maximum number of data elements in one server data set the client can process?	300

Table 44: PIXIT for Dataset model

11.5.5 PIXIT for Substitution model

Substitution is not supported by the client.

11.5.6 PIXIT for Setting group control model

Setting group control is not supported by the client.

11.5.7 PIXIT for Reporting model

Description	Value / Clarification
Does the client search for RCB in all logical nodes? When not specify the logical nodes	In the configuration process the tool searches in all logical nodes of a server for RCBs. If the RCB is assigned to the client and at least one dataset member is mapped to an internal data object, the RCB is configured and enabled independent from the logical node.
Which dynamic RCB attributes are/can be configured by the client	RptID Y DataSet N Optional fields Y Trigger conditions Y Buffer time Y Integrity period Y
Does the client supports IEDs with indexed and non-indexed report control blocks (RCB)	Buffered RCB indexed Y Buffered RCB not indexed Y Unbuffered RCB indexed Y Unbuffered RCB not indexed Y
The supported trigger conditions are	Integrity Y data change Y quality change Y

Table 45: PIXIT for Reporting model

Description	Value / Clarification
	data update Y general interrogation Y
The supported optional fields are	sequence-number Y report-time-stamp Y reason-for-inclusion Y data-set-name Y data-reference Y buffer-overflow Y entryID Y conf-rev Y
The minimum required optional fields are	sequence-number N report-time-stamp N reason-for-inclusion Y data-set-name N data-reference N buffer-overflow N entryID N conf-rev N
Does the client support segmented reports	Y
Does the client support pre-assigned RCB	Y (Pre-assigning is required for the client)
Does the client support indexed RCBs	Y
Does the client support reported data set containing structured data objects or data attributes?	reporting of data objects Y reporting of data attributes N (Note: Unstructured data attributes are processed by the client, but the other parts in the device doesn't support them. Therefore the usage of data attributes are permitted.)
Describe how the client does respond when an URCB is already reserved by another client for: • Indexed URCB with max>1 configured in SCL (static reporting) • Indexed URCD with max=1 configured in SCL (static reporting) • URCB not configured in SCL (dynamic reporting)	The client checks for each URCB whether this is already enabled (ACSI service GetURCB-Values). If the URCB is already enabled the client tries to disable the URCB by writing the flag “RptEna” with false. If this is success-ful the client continues with the URCB setup (reading and writing the URCB attributes) and enables the URCB at the end. If disabling of the URCB fails the client concludes the con-nection to the server and re-starts the con-nection according to the association model.

Table 45: PIXIT for Reporting model

Description	Value / Clarification
	For enabling the client tries to access the specific URCB instance according to the configuration in the SCD file. The URCB instance number is derived from the position of the client within the list of the "RptEnabled" tag. For example, if the client is configured at the second position of the list the URCB instance number 2 is used when accessing and enabling the URCB. That means: If the "max" attribute within the "RptEnabled" tag is greater 1 (max>1) the accessed instance number is determined from the client position in the list. If the "max" attribute within the "RptEnabled" tag is 1 (max=1) the client access the instance number 1 because the client position in the list is 1 also. In both cases, if the access with the determined instance number fails, the client tries to access the URCB without instance number. Dynamic reporting is not supported by the client. So, URCBs that are not configured in SCL are not accessed or enabled.
Describe how the client does respond when a BRCB is already reserved by another client for: • Indexed BRCB with max>1 configured in SCL (static reporting) • Indexed BRCD with max=1 configured in SCL (static reporting) • BRCB not configured in SCL (dynamic reporting)	The client checks for each BRCB whether this is already enabled (ACSI service GetURCB-Values). If the BRCB is already enabled the client tries to disable the BRCB by writing the flag "RptEna" with false. If this is successful the client continues with the BRCB setup (reading and writing the BRCB attributes) and enables the BRCB at the end. If disabling of the BRCB fails the client concludes the connection to the server and re-starts the connection according to the association model. For enabling the client tries to access the specific BRCB instance according to the configuration in the SCD file. The BRCB instance number is derived from the position of the client within the list of the "RptEnabled" tag. For example, if the client is configured at the second position of the list the BRCB instance number 2 is used when accessing and enabling the BRCB. That means: If the "max" attribute within the "RptEnabled" tag is greater 1 (max>1) the accessed instance number is determined from the client position in the list. If the "max" attribute within the "RptEnabled" tag is 1 (max=1) the client access the instance

Table 45: PIXIT for Reporting model

Description	Value / Clarification
	number 1 because the client position in the list is 1 also. In both cases, if the access with the determined instance number fails, the client tries to access the BRCB without instance number. Dynamic reporting is not supported by the client. So, BRCBs that are not configured in SCL are not accessed or enabled.
Describe how the client does respond on a SetBRCBValues(EntryID) respond-	If the service to write the EntryID fails an internal minor error is generated that can be seen with a device specific log tool. The internal minor error has no influence on the processing of the report control block.
Describe how the client does respond when a report has an unknown: dataset, RptID, unexpected number of dataset entries, and/or unexpected data type format entries	With the first connection establishment the client reads the actual configuration of a dataset. This information is stored and used for the decoding of reports containing this dataset. The datasets read by the client are selected from the SCD configuration of the client. That means: • Additional datasets configured in the server but not in the client are ignored. • Datasets missing in the server don't lead to an error and the processing continues with the next dataset. • Different named datasets are not detected and handled as missing datasets (continue with next dataset). For accessing and enabling of reports the clients uses the RptID from the SCD configuration. That means: • Additional reports configured in the server but not in the client are ignored. • Reports missing in the server lead to a conclusion of the connection. • Different named reports are not detected and handled as missing reports (connection conclude). For the handling of dataset configuration mismatches see "PIXIT for Dataset model".
Describe how the client detects reporting configuration changes (mismatches). Does it check the "configuration revision" attributes and/or does it check the dataset members? Is the dataset update done online or offline?	Report configuration mismatches are not detected by the client (see description above). During first connection establishment the actual dataset configuration is read. This allows adaptation to dataset configuration changes (for detailed information see "PIXIT for Dataset model"). The adaptation to dataset changes are done online but at the first connection establishment only.

Table 45: PIXIT for Reporting model

Description	Value / Clarification
	The "configuration revision" attribute is ignored.
Describe how to force the client to change the RCB BufTm	The buffer time is set to the value configured in the SCD file. By revising the SCD file and reconfiguring the client the buffer time can be changed.
Does the client set server trigger option GI prior to first issuance of GI command?	N
Describe how to force the client to send the GI request	During each connection establishment all correct configured RCBs are enabled by the client. If enabling is successful GI requests are send for the RCBs.
Describe how to force the client to enable a RCB	During each connection establishment all correct configured RCBs are enabled by the client.
Describe how the client does respond when a report control block is renamed or deleted: • Does it prevent reading the deleted RCB? • If is reads the missing RCB, how does it handle the GetXRCBValues response-?	For accessing and enabling of reports the clients uses the RptID from the SCD configuration always. The client doesn't detect when an RCB is renamed or deleted on the server. The client tries to access the RCB and concludes the connection as result of a negative response. Afterwards the connection is restarted according to the association model.
Describe how the client behaves when it receives a report that has the buffer overflow flag set?	The buffer overflow flag is ignored by the client.
Describe how to force the client to write a (valid) EntryID value.	Connect a server and send some reports to client with included EntryID. Then disconnect the server. With the following reconnect the client sets the last received EntryID before enabling the report.
Describe how to force the client to purge the report buffer.	The client purges the report buffer of a server during the first connection establishment after start-up only. At any further connection establishments during the runtime of the server the report buffer is not purged. To force the client to purge the report buffer of a server, reset the client and wait for the first connection establishment to the server.
Describe how the client responds when it receives a GetXRCBValues.response-	The ACSI services GetXRCBValues are used by the client to read the attributes of report control blocks. If reading of specific attributes fails with a negative response an internal minor error is generated that can be seen with a device specific log tool. The internal minor error has no influence on the processing of the report control block.
Describe how the client responds when it receives a SetXRCBValues.response-	The ACSI services SetXRCBValues are used by the client to write the attributes of report control blocks. If writing of specific attributes fails with a negative resposne (e.g. BufTm) an internal minor error is generated that can be

Table 45: PIXIT for Reporting model

Description	Value / Clarification
	seen with a device specific log tool. In most of the cases the internal minor error has no influence on the processing (enabling) of the report control block. But if the RptID cannot be written the actual RptId from the server is taken for enabling the report. And if the trigger options cannot be written at all (read back trigger options are 0) the connection is concluded.
Describe how the client responds when it tries to use a RCB that is reserved by another client	The client checks for each RCB whether this is already enabled by another client. If the RCB is already enabled the client tries to disable the RCB by writing the flag “RptEna” with false. If this is successful the client continues with the RCB setup (reading and writing the RCB attributes) and enables the RCB at the end. If disabling of the RCB fails the client concludes the connection to the server and re-starts the connection according to the association model.
Describe how the client behaves when it receives a report that contains optional fields that are not supported by the client	The client supports all optional fields (see above) but if reason-for-inclusion is missing in the report, not changed data elements (e.g. integrity report) are not processed.
Describe how the client behaves when it receives a report that was caused by one or more trigger conditions that are not supported by the client	All trigger options are supported by the client.
Describe how the client behaves when it encounters an RCB with a different confRev value than expected	During the connection establishment the client reads the report control block configuration revision from the data model of the server and compares the value with the revision from the SCD file. In case of a mismatch an internal minor error is generated that can be seen with a device specific log tool. The internal minor error has no influence on the processing of the report control block. The confRev value send in the actual report is ignored and the report is processed according the read data model information.
Describe how the client responds when it sets an EntryID value that is not recognized by the server.	The EntryID send by the server in an actual report is not checked by the client against the last set EntryID.
Are there a maximum number of report control blocks that the client can enable?	The maximum number of report control blocks per server are: - 1000 buffered reports - 1000 unbuffered reports (Practically the limitation is the number of data objects that can be handled by the client)

Table 45: PIXIT for Reporting model

Description	Value / Clarification
Does the client support writing resvTms?	N
Does the client support writing owner?	N

Table 45: PIXIT for Reporting model

11.5.8 PIXIT for Logging model

Logging is not supported by the client.

11.5.9 PIXIT for Generic substation events model

GOOSE communication is not supported by the client.

11.5.10 PIXIT for Control model

Description	Value / Clarification
What control modes are supported	Y status-only Y direct-with-normal-security Y sbo-with-normal-security Y direct-with-enhanced-security Y sbo-with-enhanced-security
Is Time activated operate (operTm) supported	N
Is “operate-many” supported	N
Can the client set the test flag?	Y
What check conditions can be set	Y synchrocheck Y interlock-check
Which originator categories are supported and what is the originator identification?	The supported originator categories are station-control and remote-control. The originator identification is an internal decimal number representing the functionality that is the origin of the command.
Describe if and how the client sets/increments the ctlNum	The control sequence number is set to 0 always.
What does the client do when it receives a LastApplicationError and describes how to view the additional cause?	The AddCause from the LastApplicationError is added to the negative command response and send to the originator. The AddCause can be accessed / processed in a user application program (PLC) only.
What does the client do when it receives a Select, SelectWithValue or Operate respond negative?	The negative command response is send to the originator. The further processing depends on the originator (e.g. host communication protocol or web server). In case the originator is the web server an error message is shown.

Table 46: PIXIT for Control model

Description	Value / Clarification
Can the client change the control model via online services?	N
What does the client do when the ctlModel is not initialized in the SCL?	It is not possible to configure the client when the control model (ctlModel) is not initialized.
What does the client when the ctlModel in the SCD and in the server is different?	The client uses the ctlModel configured in the SCD always. If the server with a different ctlModel responds negative to a control request the command originator (e.g. host communication protocol or web server) gets a negative command response. If the server with a different ctlModel responds positive to a control request the command is processed as normal.
Describe how the client responds when it receives a positive Command Termination	The positive command response is send to the originator. The further processing depends on the originator (e.g. host communication protocol or web server). In case the originator is the web server a success message is shown.
Describe how the client responds when it receives a negative Command Termination	The negative command response is send to the originator. The further processing depends on the originator (e.g. host communication protocol or web server). In case the originator is the web server an error message is shown.
Describe how the client responds when it receives a negative Operate response	The negative command response is send to the originator. The further processing depends on the originator (e.g. host communication protocol or web server). In case the originator is the web server an error message is shown.
Describe how the client responds when it receives a positive Cancel response	The positive command response is send to the originator. The further processing depends on the originator (e.g. host communication protocol).
Describe how the client responds when it receives a negative Command Termination	The negative command response is send to the originator. The further processing depends on the originator (e.g. host communication protocol).

Table 46: PIXIT for Control model

11.5.11 PIXIT for Time and time synchronization model

Description	Value / Clarification
Described how to view the internal time & quality or how to expose the timestamp and timestamp quality via the IEC 61850 interface	View: The internal time and quality (synchronized or not synchronized) can be Viewed in the web server provided by the Client.

Table 47: PIXIT for Time and time synchronization model

	Expose: The internal time is added to the Operate Request and can be exposed there.
What time quality bits are supported	Y LeapSecondsKnown Y ClockFailure Y ClockNotSynchronized
What is the behaviour when the time synchronization signal/messages are lost	Depending on the kind of time synchronization (e.g. internal real time clock, SNTP, host communication protocol) the internal time quality is set to not synchronized: • when the real time clock indicates a not reliable time • or after a configurable time (SNTP, host communication protocol.
When is the quality bit "ClockFailure" set?	The time quality bit "ClockFailure" is set: - At start-up before synchronization - When after synchronization for a configurable time (typical 10 minutes) no new synchronization is received.
When is the quality bit "ClockNotSynchronized" set?	The time quality bit "ClockNotSynchronized" is set: - At start-up before synchronization - When after synchronization for a configurable time (typical 10 minutes) no new synchronization is received.
When is the quality bit "LeapSecondsKnown" set?	The quality bit "LeapSecondsKnown" is set, when the internal time gets synchronized.

Table 47: PIXIT for Time and time synchronization model

11.5.12 PIXIT for File transfer model

Description	Value / Clarification
Describe when or how to force the client to request GetServerDirectory(FILE) and what it does with the responded filenames	After start-up and connection establishment the directories of all for file transfer configured servers are read. Afterwards the directories are requested in a time interval of 30 seconds. The responded filenames are used to extract a unique file number to determine whether the file was already transferred to the client. In case no file number is provided new files are identified by name, size and time of last modification. New detected files are then requested by the client.

Table 48: PIXIT for File transfer model

Description	Value / Clarification
Does the client uses a wildcard in the GetServerDirectory(FILE) request	The used wildcard depends on the configured server type. The client supports no wildcard, wildcard = “*” and wildcard = “*.*”.
Does the client support IEDs that include the path in the file name in the GetServerDirectory(FILE) respond?	Y* path included Y* path not included * the actual type must be configured
Does the client support IEDs that use the file separator	Y* “/” Y* “\” * the actual separator must be configured (defined by IED type)
What is the maximum file name size including path	255 characters
Can the client read a file with size 0	Y
Are directory/file name case sensitive	The directory/file name is used as it is received from the server. The extraction of the file number from the file name (server dependent) is case sensitive.
Maximum file size	512 Kbytes In case the files are zipped by the client during reading from server (server dependent) the maximum file size applies to the resulting ZIP file on the client. Note: If a file on the server exceeds the maximum size the client will not request any further files from the server till the file is removed.
Describe how the client behaves in case of: - GetFileAttributes response-	The request is discarded and the processing continues as normal. The affected server is requested again after the defined polling interval. Note: If a file on the server can not be accessed the client will not request any further files from the server till the access is possible again.

Table 48: PIXIT for File transfer model

11.5.13 PIXIT for Service Tracking model

Service tracking is not supported by the client.

11.6 SCL Implementation Conformance Statement (SICS)

This SICS is applicable for:

- Tool name: RTUtil500
- Main role: ICT
- Version: 12.4

The following tables contain mandatory and optional features of System Configuration tools and IED configuration tools. It is up to the tool manufacturer to decide to which extent his tool fulfills one or both roles. At least for one main role all mandatory features shall be supported.

The IED configurator features can also partly be implemented within the IED itself, if it can be configured by an SCD or CID file. In this case the conformance statement refers to the combination of IED and IED configurator tool. If an IED tool supports several IED types with different engineering capabilities, then for each combination of tool and IED type a separate IED configurator conformance statement should be given.

The features are grouped. If a group is mandatory, then at least all mandatory features of this group shall be implemented. If a group is optional, then either all features of this group shall be missing, or at least all mandatory ones shall be implemented.

The result of an export function can be checked in the generated SCL file. The result of an import can be checked by tool behaviour, and at the final configured IED, by browsing through it or by its communication behaviour.

		Mandatory/ optional	Value/ comments
ICD export		**M**	
I11	Fix ICD file (no adaptable export needed)	GC_1 (1)	NO
I12	Export of ICD file or IID file according to IED pre-configuration performed by tool	GC_1 (1)	YES
I13	State the data model name space (61850-7-3 subclause 7.2) within ICD file (LLN0.NamPlt.ldNs value)	M	YES
I14	State the data model version (61850-7-3 sub-clause 7.8.3) and any predefined / fixed configuration values within ICD file ([10] 9.5.4.4)	M	YES
I15	Version 2003 export	GC_1 (2)	YES
I16	Version 2007A export	GC_1 (2)	YES
I17	Predefined data sets	O	YES
I18	Predefined control blocks	O	YES
I19	Substation bay template with IED part	O	NO
I110	Communication section with default address	O	YES
I111	Export correct valKind value ([10] Table 46)	O	YES (RO)
I112	Exports internal addresses as InRef or Input section (subclause 285H 9.3.13)	O	NO
I113	Exports internal addresses in Input section with expected serviceType (subclause [10] 9.3.13)	O	NO
I114	Exports in UTF-8 coding	M	YES
SCD import		**M**	
I21	Identify IED to be configured in SCD file by IED name	M	YES

Table 49: IED configurator conformance statement

		Mandatory/ optional	Value/ comments
I22	Configure LD name (at least via ldInst, dependent on the IED capabilities) and IED addresses from SCD	M	YES
I23	Determine communication side addresses of IED inputs from SCD	C1	YES
I24	Determine and use clock communication addresses from SCD	C1	NO
I25	Configure values of (existing) control block from SCD([10] 9.3)	C3	NO
I26	Prepare (new) control block instances according to SCD file	C3	NO
I27	Prepare / configure data sets according to SCD file	C3	NO
I28	Modify predefined data sets according to SCD	C3	NO
I29	Interpret client references in the control blocks of other IEDs to find the control block instances allocated to this IED, and data sent to this IED.	C1	YES
I210	Set IED configuration values and parameter values as defined in SCD file	O	NO
I211	Support changed (reduced capability) valKind (e.g. from Set to RO or to Conf) ([10] Table 46)	O	NO
I212	Support ldName on other IEDs ([10] 9.3.4)	C3	NO
I213	Interpret input signal references to source control blocks (290H 9.3.13)	O	YES
I214	Imports UTF-8 coding of XML	M	YES
IID export after IED engineering			
I31	IED version and instance information: LPHD.PhyNam: hwRev, swRev, serNum, LLN0.NamPlt.configRev	O	NO
I32	Configuration values (fc=CF)	O	NO
I33	Setting Parameter values (fc=SP, SG)	O	NO
I34	SCL Header management ([10] 9.1)	C3	NO
I35	Modify IED data model (add LN/Data object/LD, or remove unused LD/LN/Data object)	O	NO
Tool functionality			
I41	Support MustUnderstand concept ([10] 8.2)	M	YES
I42	Bind incoming 61850 signals to IED internal (input) signals	C1	YES
I43	Use or create IED Input section for binding incoming (external) signals to internal signals, to document this binding	O	YES
I44	Create CID file for IED	O	NO
I45	Support ldName for LD name specification	C3	YES
I46	Modify LN prefixes or lnInst	O	YES (Both can be set as wanted)

Table 49: IED configurator conformance statement

	Mandatory/ optional	Value/ comments
C1 - Mandatory, if the IED can receive data from other IEDs, i.e. be either client or subscriber C2 - Mandatory, if any of the other features in this table section is supported. C3 - Mandatory, if the appropriate IED capability is claimed in PIXIT or IED capability section. GC_1 (n) - At least one of the elements of group n shall be available. O - Optional; should match the IED capabilities; i.e. if an IED claims that RCBs can be configured by SCL, then the IED tool shall support it. M - Mandatory		

Table 49: IED configurator conformance statement

12 Glossary

AMI	Analog Measured value Input
ASCI	Abstract Communication Service Interface
ASO	Analog Setpoint command Output
BSI	Bit String Input
BSO	Bit String Output
CF	Compact Flash
CMU	Communication and Data Processing Unit
CTS	Clear to Send
DCO	**D**ouble **C**ommand **O**utput
DMI	Digital Measured value Input (8, 16 bit)
DO	Digital Output
DPI	Double Point Input
DSO	Digital Setpoint command Output (8, 16 bit)
FC	Functional Constraint
FDR	File transfer directory
FSO	Floating Setpoint Command Output
FTR	File transfer file
GOOSE	Generic Object Oriented Substation Event
IED	Intelligent Electronic Device
ITI	Integrated Totals Input
MAX	Maximum
MFI	Analog Measured value Floating Input
Min	Minimum
OSI	Open Systems Interconnection Model
PC	Personal Computer
PDU	Protocol Data Unit
PLC	Programmable Logic Control
PRP	Parallel Redundancy Protocol
RCO	Regulation step Command Output
RTU	Remote Terminal Unit
SBO	Select before Operate
SCD	Substation Configuration Description

SCI	Sub-Device Communication Interface
SCL	Substation Configuration description Language
SCO	Single Command Output
SCSM	Specific Communication Service Mapping
SEV	System Event
SNTP	Simple Network Time Protocol (according to RFC 4330)
SPI	Single Point Input or Single point information
SPS	Programmable Logic Control (Speicherprogrammierbare Steuerung)
SSC	System Single Command
STI	Step position Input
TCP/IP	Transmission Control Protocol / Internet Protocol

Note:

The specifications, data, design or other information contained in this document (the “Brochure”) - together: the “Information” - shall only be for information purposes and shall in no respect be binding. The Brochure does not claim to be exhaustive. Technical data in the Information are only approximate figures. We reserve the right at any time to make technical changes or modify the contents of this document without prior notice. The user shall be solely responsible for the use of any application example or information described within this document. The described examples and solutions are examples only and do not represent any comprehensive or complete solution. The user shall determine at its sole discretion, or as the case may be, customize, program or add value to the ABB products including software by creating solutions for the end customer and to assess whether and to what extent the products are suitable and need to be adjusted or customized.

This product is designed to be connected to and to communicate information and data via a network interface. It is the users sole responsibility to provide and continuously ensure a secure connection between the product and users or end customers network or any other network (as the case may be). The user shall establish and maintain any appropriate measures (such as but not limited to the installation of firewalls, application of authentication measures, encryption of data, installation of anti-virus programs, etc) to protect the product, the network, its system and the interface against any kind of security breaches, unauthorized access, interference, intrusion, leakage and/or theft of data or information. ABB AG is not liable for any damages and/or losses related to such security breaches, any unauthorized access, interference, intrusion, leakage and/or theft of data or information.

ABB AG shall be under no warranty whatsoever whether express or implied and assumes no responsibility for the information contained in this document or for any errors that may appear in this document. ABB AG's liability under or in connection with this Brochure or the files included within the Brochure, irrespective of the legal ground towards any person or entity, to which the Brochure has been made available, in view of any damages including costs or losses shall be excluded. In particular ABB AG shall in no event be liable for any indirect, consequential or special damages, such as – but not limited to – loss of profit, loss of production, loss of revenue, loss of data, loss of use, loss of earnings, cost of capital or cost connected with an interruption of business or operation, third party claims. The exclusion of liability shall not apply in the case of intention or gross negligence. The present declaration shall be governed by and construed in accordance with the laws of Switzerland under exclusion of its conflict of laws rules and of the Vienna Convention on the International Sale of Goods (CISG).

Visit us

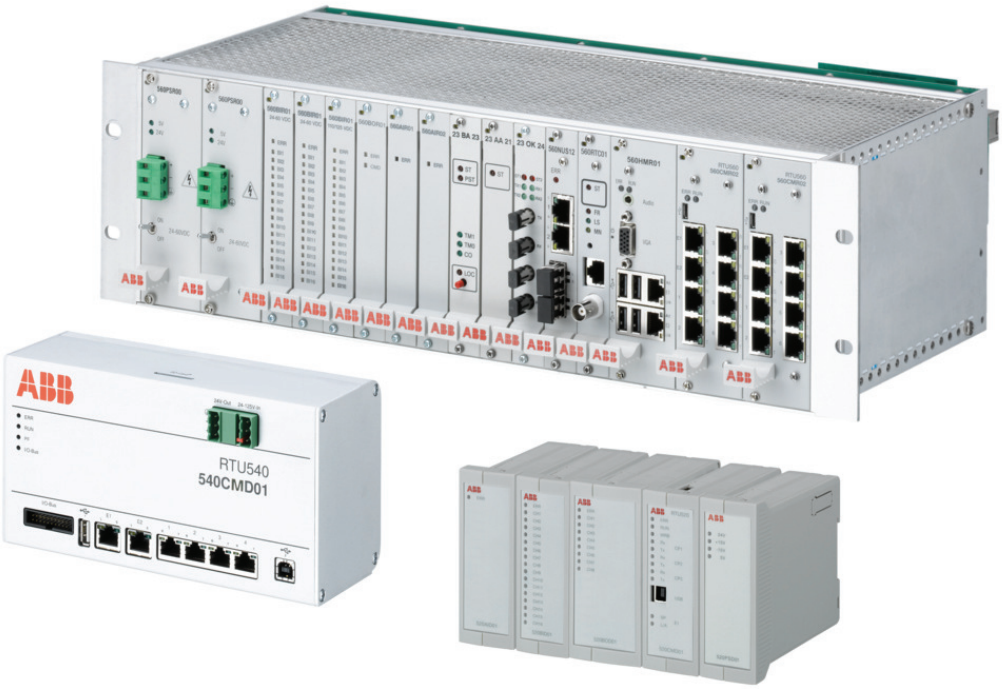
ABB AG
Power Grids
P.O. Box 10 03 51
68128 Mannheim, Germany

www.abb.com/remote-terminal-units

1KGT 150 590 V009 1

Power Grids

Remote Terminal Units
IEC 61850 Server
Protocol description



Revision

Document identity:		1KGT 150 702 V009 1
Revision:	**Date:**	**Changes:**
0	06/2009	Base version
1	01/2010	Corrections chapter 8 ‘Limits and recommendations’
2	08/2010	Multicast information added
3	10/2012	Revise document for KEMA Conformance test Add chapter 9.4 ‘Tissues Conformance statement (TICS)’ Add chapter 9.5 ‘Protocol Implementation extra Information for Testing (PIXIT)’
4	12/2013	System limit revised
5	08/2014	New layout
6	12/2014	Revise conversion of quality descriptors, add support of unbuffered report control blocks (URCBs) Include note about SCL2003 restriction, add missing mapping of data attribute stSeld
7	03/2015	Chapter Controlling Direction updated
8	08/2017	Model implementation conformance statement refered to out-dated ICD substation configuration file (PR#26101)
		Include descriptions and conformance statements for IEC 61850 Edition 2 server
9	03/2018	Chapter System limits updated (PR#22818, #36769)
		New layout

Contents

1 Introduction....3

1.1 Preface....3

1.2 References....3

1.3 Conventions....4

2 Physical Layer....5

3 Link Layer....7

3.1 General....7

3.2 Client/server services....7

4 Application Layer....9

4.1 Selection of protocol edition....9

4.2 Logical nodes and common data classes....9

5 Addressing....13

5.1 IEC 61850 Object References....13

5.2 GOOSE Multicast Addressing....13

6 Monitoring Direction....15

6.1 SPI – Single Point Information....15

6.2 DPI – Double Point Information....16

6.3 STI – Step Position Information....18

6.4 BSI – Bit String Information....19

6.5 ITI – Integrated Totals Information....21

6.6 DMI – Digital Measured Information....21

6.7 AMI – Analog Measured Information....23

6.8 MFI – Measured Float Information....25

7 Controlling Direction....27

7.1 SCO – Single Command Output....27

7.2 DCO – Double Command Output....27

7.3 RCO – Regulation Command Output....28

7.4 ASO – Analog Setpoint Output....29

7.5 DSO – Digital Setpoint Output....31

7.6 BSO – Bit String Output....32

8 Internal Functions....35

8.1 Startup log....35

8.2 Time Synchronization....35

8.3 General Interrogation....35

8.4 System Events....35

8.4.1 System Events of RTU500 series....35

8.4.2 System Events of GOOSE IEDs....36

8.5 System Commands....37

8.6 IEC 61850 server functionality....37

8.6.1 Logical node physical health identification....37

8.6.2 Time master supervision ... 38
8.6.3 Redundant physical communication channel supervision ... 38

9 Limits and Recommendations ... 41
9.1 System Limits ... 41
9.2 Mixed systems ... 42

10 Conformance Statements ... 43
10.1 Abstract Communication Service Interface (ACSI) ... 43
10.1.1 ACSI Basic Conformance Statement ... 43
10.1.2 ACSI Models Conformance Statement ... 44
10.1.3 ACSI Service Conformance Statement ... 45
10.1.4 Specific Communication Service Mapping (SCSM) ... 48
10.2 Protocol Implementation Conformance Statement (PICS) ... 48
10.2.1 Basic Profile Conformance ... 48
10.2.2 MMS Conformance ... 49
10.3 Model Implementation Conformance Statement (MICS) ... 49
10.3.1 Logical Node List ... 49
10.3.2 LN Group L: System logical nodes ... 51
10.3.3 LN Group C: Logical nodes for control ... 53
10.3.4 LN Group G: Logical nodes for generic references ... 55
10.3.5 LN Group M: Logical nodes for metering and measurement ... 70
10.3.6 LN Group P: Logical nodes for protection functions ... 73
10.3.7 LN Group R: Logical nodes for protection related functions ... 80
10.3.8 LN Group S: Logical Nodes for sensors and monitoring ... 82
10.3.9 LN Group X: Logical nodes for switchgear ... 84
10.3.10 LN Group Y: Logical nodes for power transformer ... 86
10.3.11 LN Group Z: Logical Nodes for further power system equipment ... 87
10.4 Tissues Conformance Statement (TICS) ... 88
10.4.1 Mandatory Edition 1 IntOp Tissues ... 88
10.4.2 Optional Edition 1 IntOp Tissues ... 90
10.4.3 Mandatory Edition 2 Tissues ... 91
10.5 Protocol Implementation extra Information for Testing (PIXIT) ... 99
10.5.1 PIXIT for Association model ... 100
10.5.2 PIXIT for Server model ... 100
10.5.3 PIXIT for Data set model ... 102
10.5.4 PIXIT for Substitution model ... 102
10.5.5 PIXIT for Setting group control model ... 102
10.5.6 PIXIT for Reporting model ... 102
10.5.7 PIXIT for Logging model ... 103
10.5.8 PIXIT for Generic substation events model ... 104
10.5.9 PIXIT for Control model ... 106
10.5.10 PIXIT for Time and time synchronisation model ... 108
10.5.11 PIXIT for File transfer model ... 109
10.6 SCL Implementation Conformance Statement (SICS) ... 109

11 Glossary ... 113

1 Introduction

1.1 Preface

This document describes the functions of the host communication interface in RTU500 series according to IEC 61850.

1.2 References

1 IEC 61850-6:2004(E)
Communication networks and systems in substations
Part 6: Configuration description language for communication in electrical substation related to IEDs
First edition 2004-03
2 IEC 61850-7-1:2003(E)
Communication networks and systems in substations
Part 7-1: Basic communication structure for substation and feeder equipment – Principles and models
First edition 2003-07
3 IEC 61850-7-2:2003(E)
Communication networks and systems in substations
Part 7-2: Basic communication structure for substation and feeder equipment – Abstract communication service interface (ACSI)
First edition 2003-05
4 IEC 61850-7-4:2003(E)
Communication networks and systems in substations
Part 7-4: Basic communication structure for substation and feeder equipment – Compatible logical node classes and data classes
First edition 2003-05
5 IEC 61850-8-1:2004(E)
Communication networks and systems in substations
Part 8-1: Specific communication service mapping (SCSM) – Mappings to MMS (ISO9506-1 and ISO9506-2) and to ISO/IEC 8802-3
First edition 2004-05
6 RTUtil500 users guide (1KGT 150 801)
7 RTU500 series interfaces and protocols (1KGT 150 853)
8 RTU500 series function description - part 6: RTU500 functions (1KGT 150 798)
9 RTU500 series function description - part 7: archive functions (1KGT 150 799)
10 IEC 61850-6:2009(E)
Communication networks and systems for power utility automation
Part 6: Configuration description language for communication in electrical substations related to IEDs
Edition 2.0 2009-12
11 IEC 61850-7-1:2011(E)
Communication networks and systems for power utility automation
Part 7-1: Basic communication structure – Principles and models
Edition 2.0 2011-07
12 IEC 61850-7-2:2010(E)
Communication networks and systems for power utility automation
Part 7-2: Basic information and communication structure – Abstract communication service interface (ACSI)
Edition 2.0 2010-08

13 IEC 61850-7-4:2010(E)
Communication networks and systems for power utility automation
Part 7-4: Basic communication structure – Compatible logical node classes and data object classes
Edition 2.0 2010-03

14 IEC 61850-8-1:2011(E)
Communication networks and systems for power utility automation
Part 8-1: Specific communication service mapping (SCSM) – Mappings to MMS (ISO 9506-1 and ISO 9506-2) and to ISO/IEC 8802-3
Edition 2.0 2011-06

1.3 Conventions

In this document function codes of data types according to IEC 61850 are marked with square brackets: <Function code>

Bold fonts with the table heading "Parameter name" are references to configuration parameters in RTUtil500. The parameter is followed by the parameter location where to find this parameter in RTUtil500. The first element of the parameter location defines the node in the hardware tree on the left side (e. g. RTU, CMU, line, IED) and the second element defines selected header control tab in the parameter window on the right side (e. g. general, interfaces, protocol).

Example:

Parameter name	Default	Parameter location
In Use	Enabled	data point (e.g. SPI) - line T101/104
Value range: enabled / disabled		
If enabled: Object is processed by HCI.		

In this document references to elements of the standard and other references will be printed in brackets. Example: [2, 7.4]

The tables in the next chapters include lists of the functions, options and message types supported according to the protocol structure given in IEC 60870-5 (EPA three layer model) for

- the physical layer
- the link layer
- the application layer

This layered model is valid for the protocol IEC 61850.

2 Physical Layer

For details see RTU500 series interfaces and protocols (1KGT 150 853).

3 Link Layer

3.1 General

The IEC 61850 Server provides support for Edition 1 and Edition 2 Client/Server services as described in [5] respectively [14]. GSE management and GOOSE services are available for the Server only. GSSE Services are not implemented.

Services like ‘Sampled Values’ described in IEC 61850-9 are not supported.

3.2 Client/server services

The IEC 61850 Server acts in IEC 61850 station bus as Edition 1 or Edition 2 server.

Following services as described in [3] respectively [12] are supported:

IEC 61850-7-2 model	IEC 61850-7-2 service	HCI support
Server	ServerDirectory	X
Association	Associate	X
	Abort	X
	Release	X
Logical Device	GetLogicalDeviceDirectory	X
Logical Node	GetLogicalNodeDirectory	X
	GetAllDataValues	X
Data	GetDataValues	X
	SetDataValues	
	GetDataDirectory	X
	GetDataDefinition	X
Data Set	GetDataSetValues	X
	SetDataSetValues	
	CreateDataSet	
	DeleteDataSet	
	GetDataSetDirectory	X
Substitution	GetDataValues	
	SetDataValues	
Setting Group Control Block	SelectActiveSG	
	SelectEditSG	
	SetSGValues	
	ConfirmEditSGValues	
	GetSGValues	
	GetSGCBValues	
Report Control Block	Report	X
	GetBRCBValues	X
	SetBRCBValues	X
	GetURCBValues	X
	SetURCBValues	X

Table 1: Supported IEC 61850-7-2 services

IEC 61850-7-2 model	IEC 61850-7-2 service	HCI support
LOG Control Block	GetLCBValues	
	SetLCBValues	
	GetLogStatusValues	
	QueryLogByTime	
	QueryLogAfter	
GOOSE	SendGOOSEMessage	X
	GetGoReference	X
	GetGOOSEElementNumber	X
	GetGoCBValues	
	SetGoCBValues	
GSSE	SendGSSEMessage	
	GetGsReference	
	GetGSSEElementNumber	
	GetGsCBValues	
	SetGsCBValues	
Control	Select	X
	SelectWithValue	X
	Cancel	X
	Operate	X
	CommandTermination	X
	TimeActivatedOperate	
FILE transfer	GetFile	
	SetFile	
	DeleteFile	
	GetFileAttributeValues	

Table 1: Supported IEC 61850-7-2 services

4 Application Layer

4.1 Selection of protocol edition

The RTU500 series IEC 61850 client and server supports Edition 1 and Edition 2 of the standard. For each RTU500 series client and server in a configuration the used protocol edition must be defined. Due to the differences in the data model between Edition 1 and Edition 2 the selected protocol edition cannot be changed anymore after an SCD import was done or after any data points are configured for the client or server. So be sure to select the protocol edition first when starting a configuration.

For details how to select the protocol edition in RTUtil500 see [6].

4.2 Logical nodes and common data classes

In IEC 61850 information are grouped according to the process needs in logical nodes. Logical nodes consist of attributes of common data classes. Conversion of information is done on common data class basis. This gives the possibility to support also logical nodes probably defined in the future or for special process purposes.

Compatible logical nodes and data classes can be found in [4] respectively [13]. The supported logical nodes types are listed in the table below. Detailed information about the logical node could be found in chapter '"9.3" "Model Implementation Conformance Statement (MICS)".

LN type	Description
LPHD	Physical device information
LLN0	Logical node zero
CSWI	Switch controller
CILO	Interlocking
CALH	Alarm handling
GAPC	Generic automatic process control
GGIO	Generic process I/O
MMTR	Metering
MMXN	Measurement
MMXU	Measurement
PTOC	Time over current protection
PDIS	Distance protection
PDIF	Differential protection
PTOF	Over frequency protection
PTUF	Under frequency protection
PTOV	Over voltage protection
PTUV	Under voltage protection
PSDE	Sensitive directional earth fault protection
PTEF	Transient earth fault protection
PSCH	Protection scheme

Table 2: Supported IEC 61850-7-4 logical node types

LN type	Description
PTRC	Protection trip conditioning
RBRF	Breaker failure
RREC	Auto reclosing
RSYN	Synchronism-check or synchronizing
SIMG	Insulation medium supervision (gas)
SIML	Insulation medium supervision (liquid)
XCBR	Circuit breaker
XSWI	Circuit switch
YLTC	Tap changer
YEFN	Earth fault neutralizer (Petersen coil)
ZAXN	Auxiliary network

Table 2: Supported IEC 61850-7-4 logical node types

The conversion of information is described in detail for every RTU500 series data point type in the chapters below. As reference the following table summarizes the supported common data classes, their attributes and the possible mappings to RTU500 series data point types.

Common Data Class	Attribute Name	Default RTU500 series data point type	Other RTU500 series data point type
ACD	dirGeneral	DPI	BSI
ACD	dirNeut	DPI	BSI
ACD	dirPhsA	DPI	BSI
ACD	dirPhsB	DPI	BSI
ACD	dirPhsC	DPI	BSI
ACD	general	SPI	DPI, SEV
ACD	neut	SPI	DPI, SEV
ACD	phsA	SPI	DPI, SEV
ACD	phsB	SPI	DPI, SEV
ACD	phsC	SPI	DPI, SEV
ACT	general	SPI	DPI, SEV
ACT	neut	SPI	DPI, SEV
ACT	phsA	SPI	DPI, SEV
ACT	phsB	SPI	DPI, SEV
ACT	phsC	SPI	DPI, SEV
BCR	actVal	ITI	-
BCR	frVal	ITI	-
BSC	Oper.ctlVal	RCO	-
BSC	valWTr.posVal	STI	-
CMV	cVal.mag.f	MFI	AMI
DPC	Oper.ctlVal	DCO	-
DPC	stVal	DPI	BSI
DPS	stVal	DPI	BSI
ENS[1]	stVal	BSI	DPI

Table 3: Mapping common data classes RTU500 series data point types

Common Data Class	Attribute Name	Default RTU500 series data point type	Other RTU500 series data point type
INC	Oper.ctlVal	ASO	BSO, DSO
INC	stVal	AMI	BSI, DMI, DPI, MFI
INS	stVal	AMI	BSI, DMI, DPI, MFI
ISC	Oper.ctlVal	BSO	-
ISC	valWTr.posVal	STI	-
MV	mag.f	MFI	AMI
SPC	Oper.ctlVal	SCO	-
SPC	stVal	SPI	DPI, SEV
SPS	stVal	SPI	DPI, SEV

Table 3: Mapping common data classes RTU500 series data point types

1 Available for IEC 61850 Edition 2 server only.

The common data classes WYE and DEL (Logical nodes MMXU) are not stated in the table above because the data attributes of these classes are modeled with the common data class CMV.

The data attribute stSeld of the controllable common data classes are handled by the host interface itself. There is no need (or possibility) to convert this data attribute to a RTU500 series data point.

5 Addressing

5.1 IEC 61850 Object References

For addressing of IEC 61850 object references are used. These references are a concatenation of the following names (see [2] respectively [11]):

LDName/LNName.DataName.DataAttribute[&FC]

Abbreviation	Name	Description
LDName	Logical device instance name	Unique name of a logical device
LNName	Logical node instance name	Concatenation of • LN Prefix • LN name • LN Instance number
DataName	Name of common data class in logical node	
DataAttribute	Attribute name in common data class	
FC	Functional Constraint	

References can not be modified with RTUtil500.

The GOOSE data points are synchronized from a SCD file to the Excel Import file of RTUtil500 without modifications. Beside the IEC 61850 object reference the address contains an 'In use' flag. This flag set in the Excel import file or RTUtil500 defines whether a data point is used in the IEC 61850 host interface or not. If not set the data point is no part of the IEC 61850 server data model.

The complete engineering process in RTUtil500 is described in [6].

5.2 GOOSE Multicast Addressing

For GOOSE communication within IEC 61850 a multicast association model is used. In this model the publisher of a GOOSE message sends the information to a group of destinations simultaneously. This group is defined as multicast group.

In order to increase the overall performance of multicast message reception the filtering possibilities of the Media Access Control hardware is used in IEC 61850 network. That means virtual MAC addresses are configured for each IED receiving or sending GOOSE messages. The virtual MAC address represents the multicast address or multicast group. The following MAC multicast addresses are recommended for an IEC 61850 network.

Service	Starting address (hexadecimal)	Ending address (hexadecimal)
GOOSE	01-0C-CD-01-00-00	01-0C-CD-01-FF-FF

There are limitations regarding multicast addressing for the different RTU500 series CMU modules. Please consider the following overview for the usage of multicast groups.

CMU hardware module	Limitations
CMU module based on ELAN520 processor (e.g. 560CMU05)	The ELAN520 Ethernet interface (Intel 82557) is limited to maximum 12 different multicast addresses (own address and 11 others). This is a limit of the hardware and could not be extended. For the ELAN520 based CMU modules a maximum number of 12 multicast groups are possible. If more IEDs are communicating via GOOSE several IEDs must be merged in the same multicast group.
CMU module based on Atmel AT91SAM processor (e.g. 520CMD01)	On the AT91SAM Ethernet interface the number of different multicast addresses are not limited per se. But each multicast address is detected by a 6-Bit hash calculated about the address. The outcome of this are 64 different hash values, where each value represents a large number of different multicast address. That means to get the desired behavior the multicast addresses must be chosen with care when a CMU module based on the Atmel AT91SAM is used.
CMU module based on TI AM335x processor (e.g. 560CMR01)	The AM335x Ethernet interface is limited to approximately 500 different multicast addresses. This shall be sufficient for all GOOSE configurations with the RTU500 series.

Please refer to the IEC 61850 standard for more information about the multicast association model.

6 Monitoring Direction

6.1 SPI – Single Point Information

Binary process information indicated by one bit:

Supported Data Types	Common Data Class	Attribute Name	Functional Constraint	Conversion of Value Type
	ACD	general	ST	A
	ACD	neut	ST	A
	ACD	phsA	ST	A
	ACD	phsB	ST	A
	ACD	phsC	ST	A
	ACT	general	ST	A
	ACT	neut	ST	A
	ACT	phsA	ST	A
	ACT	phsB	ST	A
	ACT	phsC	ST	A
	BSC	stSeld	ST	A
	DPC	stSeld	ST	A
	INC	stSeld	ST	A
	ISC	stSeld	ST	A
	SPC	stSeld	ST	A
	SPC	stVal	ST	A
	SPS	stVal	ST	A
Additional	**None**			

Conversion of value (Type A)

RTU500 series internal communication	Protocol specific (Attribute value)
Off	FALSE
On	TRUE

Conversion of quality descriptors

RTU500 series internal communication		Protocol specific
BL	Blocked	q.validity == questionable q.operatorBlocked == TRUE q.detailQual.oldData == TRUE (only if not invalid IV is set)
SB	Substituted	q.source == substituted
NT	Not Topical	q.validity == questionable q.detailQual.oldData == TRUE (only if not invalid IV is set)
IV	Invalid	q.validity == invalid

Conversion of cause of transmission

RTU500 series internal communication		Protocol specific
T	Test	q.test == TRUE
P/N	Positive/negative confirmation	- Irrelevant -
Cause	Spontaneous	-
	Requested	-
	Interrogated	-

6.2 DPI – Double Point Information

Binary process information indicated by two bits.

Supported Data Types	Common Data Class	Attribute Name	Functional Constraint	Conversion of Value Type
	ACD	dirGeneral	ST	A
	ACD	dirNeut	ST	B
	ACD	dirPhsA	ST	B
	ACD	dirPhsB	ST	B
	ACD	dirPhsC	ST	B
	DPC	stVal	ST	C
	DPS	stVal	ST	C
	ACD	general	ST	D
	ACD	neut	ST	D
	ACD	phsA	ST	D
	ACD	phsB	ST	D
	ACD	phsC	ST	D
	ACT	general	ST	D
	ACT	neut	ST	D
	ACT	phsA	ST	D
	ACT	phsB	ST	D
	ACT	phsC	ST	D
	SPC	stVal	ST	D
	SPS	stVal	ST	D
	ENS[1]	stVal	ST	E
Additional	**None**			

1 Available for IEC 61850 Edition 2 server only

Conversion of value (Type A)

RTU500 series internal communication	Protocol specific (Attribute value)
Intermediate	Unknown
Off	Forward
On	Backward
Indeterminate	Both

Conversion of value (Type B)

RTU500 series internal communication	Protocol specific (Attribute value)
Intermediate	Unknown
Off	Forward
On	Backward
Indeterminate	-

Conversion of value (Type C)

RTU500 series internal communication	Protocol specific (Attribute value)
Intermediate	intermediate-state
Off	Off
On	On
Indeterminate	bad-state

Conversion of value (Type D)

RTU500 series internal communication	Protocol specific (Attribute value)
Intermediate	Off
Off	Off
On	On
Indeterminate	Off

Conversion of value (Type E)

RTU500 series internal communication	Protocol specific (Attribute value)[1]
Intermediate	Enumeration value 0
Off	Enumeration value 1
On	Enumeration value 2
Indeterminate	Enumeration value 3

1 Shall be used only for enumerations with up to 4 values.

Conversion of quality descriptors

RTU500 series internal communication		Protocol specific
BL	Blocked	q.validity == questionable q.operatorBlocked == TRUE q.detailQual.oldData == TRUE (only if not invalid IV is set)
SB	Substituted	q.source == substituted
NT	Not Topical	q.validity == questionable q.detailQual.oldData == TRUE (only if not invalid IV is set)
IV	Invalid	q.validity == invalid

Conversion of cause of transmission

RTU500 series internal communication		Protocol specific
T	Test	q.test == TRUE
P/N	Positive/negative confirmation	- Irrelevant -
Cause	Spontaneous	-
	Requested	-
	Interrogated	-

6.3 STI – Step Position Information

Binary process information indicated by 8 bit.

Supported Data Types	Common Data Class	Attribute Name	Functional Constraint	Conversion of Value Type
	BSC	valWTr.posVal	ST	A
	ISC	valWTr.posVal	ST	A
Additional	**None**			

Conversion of value (Type A)

RTU500 series internal communication		Protocol specific (Attribute value)
Range min.	-63	-63
...	...	
Range max.	+63	+63

Conversion of quality descriptors

RTU500 series internal communication		Protocol specific
OV	Overflow	q.validity == invalid q.detailQual.overflow == TRUE q.detailQual.outOfRange == TRUE
BL	Blocked	q.validity == questionable q.operatorBlocked == TRUE q.detailQual.oldData == TRUE (only if not invalid IV is set)
SB	Substituted	q.source == substituted
NT	Not Topical	q.validity == questionable q.detailQual.oldData == TRUE (only if not invalid IV is set)
IV	Invalid	q.validity == invalid
T	Transient Bit	-

Conversion of cause of transmission

RTU500 series internal communication		Protocol specific
T	Test	q.test == TRUE
P/N	Positive/negative confirmation	- Irrelevant -
Cause	Spontaneous	-
	Requested	-
	Interrogated	-

6.4 BSI – Bit String Information

Binary process information indicated by 8, 16 or 32 bit.

Supported Data Types	Common Data Class	Attribute Name	Functional Constraint	Conversion of Value Type
	ACD	dirGeneral	ST	A
	ACD	dirNeut	ST	B
	ACD	dirPhsA	ST	B
	ACD	dirPhsB	ST	B
	ACD	dirPhsC	ST	B
	DPC	stVal	ST	C
	DPS	stVal	ST	C
	INC	stVal	ST	D
	INS	stVal	ST	D
	ENS[1]	stVal	ST	E
Additional	**None**			

1 Available for IEC 61850 Edition 2 server only

Conversion of value (Type A)

RTU500 series internal communication	Protocol specific (Attribute value)
0	unknown
1	forward
2	backward
3	both

Conversion of value (Type B)

RTU500 series internal communication	Protocol specific (Attribute value)
0	unknown
1	forward
2	backward

Conversion of value (Type C)

RTU500 series internal communication	Protocol specific (Attribute value)
0	intermediate-state
1	off
2	on

RTU500 series internal communication	Protocol specific (Attribute value)
3	bad-state

Conversion of value (Type D)

RTU500 series internal communication		Protocol specific (Attribute value)
Range min.	0	0
...	...	
Range max.	BSI8: Bit mask of 8 bit; range ... 255	255
	BSI16: Bit mask of 16 bit; range ... 65 535	65 535
	BSI32: Bit mask of 32 bit; range ... 4 294 967 295	4 294 967 295

Conversion of value (Type E)

RTU500 series internal communication		Protocol specific (Attribute value)
Range min.	0	Enumeration value 0
...	...	
Range max.	BSI8: Bit mask of 8 bit; range ... 255	Enumeration value 255
	BSI16: Bit mask of 16 bit; range ... 65 535	Enumeration value 65 535
	BSI32: Bit mask of 32 bit; range ... 4 294 967 295	Enumeration value 4 294 967 295

Conversion of quality descriptors

RTU500 series internal communication		Protocol specific
OV	Overflow	q.validity == invalid q.detailQual.overflow == TRUE q.detailQual.outOfRange == TRUE
BL	Blocked	q.validity == questionable q.operatorBlocked == TRUE q.detailQual.oldData == TRUE (only if not invalid IV is set)
SB	Substituted	q.source == substituted
NT	Not Topical	q.validity == questionable q.detailQual.oldData == TRUE (only if not invalid IV is set)
IV	Invalid	q.validity == invalid

Conversion of cause of transmission

RTU500 series internal communication		Protocol specific
T	Test	q.test == TRUE
P/N	Positive/negative confirmation	- Irrelevant -
Cause	Spontaneous	-
	Requested	-
	Interrogated	-

6.5 ITI – Integrated Totals Information

Binary process information indicated by 32 bit as a counted value.

Supported Data Types	Common Data Class	Attribute Name	Functional Constraint	Conversion of Value Type
	BCR	actVal	ST	A
	BCR	frVal	ST	A
Additional	**None**			

Conversion of value (Type A)

RTU500 series internal communication		Protocol specific (Attribute value)
Range min.	-2147483648	-2147483648
...	...	...
Range max.	+2147483647	+2147483647

Conversion of quality descriptors

RTU500 series internal communication		Protocol specific
SEQ	Sequence number	incremented with each new value (0 .. 31)
CY	Carry	set TRUE after rollover
CA	Adjusted	-
IV	Invalid	q.validity == invalid

Conversion of cause of transmission

RTU500 series internal communication		Protocol specific
T	Test	q.test == TRUE
P/N	Positive/negative confirmation	- Irrelevant -
Cause	Spontaneous	-
	Requested	-
	Interrogated	-

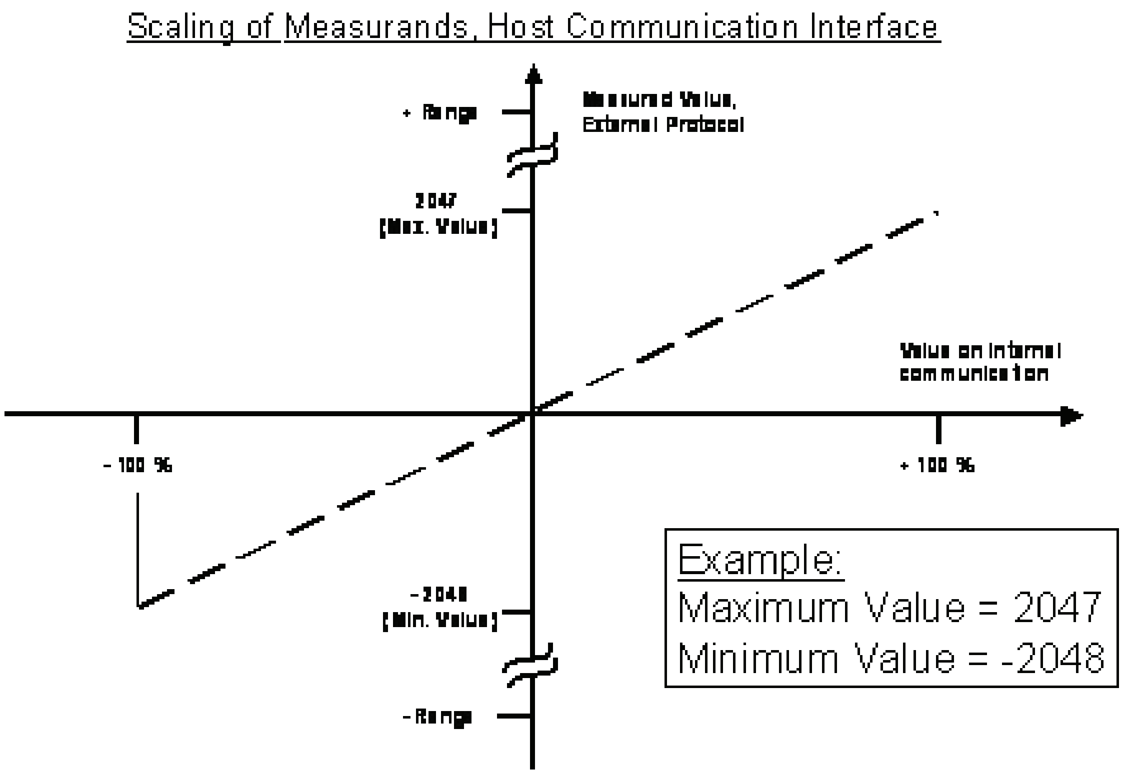
6.6 DMI – Digital Measured Information

Binary process information indicated by integer values, used as a measured value from digital inputs.

Supported Data Types	Common Data Class	Attribute Name	Functional Constraint	Conversion of Value Type
	INC	stVal	ST	A
	INS	stVal	ST	A
Additional	**Maximum Value** **Maximum Value in the external protocol to be converted to +100 % on RTU500 series internal communication** Parameter: Maximum Value (DMI – Protocol Address and Parameter) [Range: - 2147483648 .. 2147483647] **Minimum Value** **Minimum Value in the external protocol to be converted to -100 % on RTU500 series internal communication.** Parameter: Minimum Value (DMI- Protocol Address and Parameter) [Range: -2147483648 .. 2147483647]			

Conversion of value (Type A)

RTU500 series internal communication		Protocol specific (Attribute value)
Range min.	-100%	Parameter: Minimum Value
...	...	
Range max.	+100%	Parameter: Maximum Value



Conversion of qualitiy descriptors

RTU500 series internal communication		Protocol specific
OV	Overflow	q.validity == invalid q.detailQual.overflow == TRUE q.detailQual.outOfRange == TRUE
BL	Blocked	q.validity == questionable q.operatorBlocked == TRUE q.detailQual.oldData == TRUE (only if not invalid IV is set)
SB	Substituted	q.source == substituted
NT	Not Topical	q.validity == questionable q.detailQual.oldData == TRUE (only if not invalid IV is set)
IV	Invalid	q.validity == invalid
T	Transient Bit	valWTr.transInd

Conversion of cause of transmission

RTU500 series internal communication		Protocol specific
T	Test	q.test == TRUE
P/N	Positive/negative confirmation	- Irrelevant -
Cause	Spontaneous	-
	Requested	-
	Interrogated	-

6.7 AMI – Analog Measured Information

Analog process information indicated by integer or floating point values, used as a measured value from analog inputs.

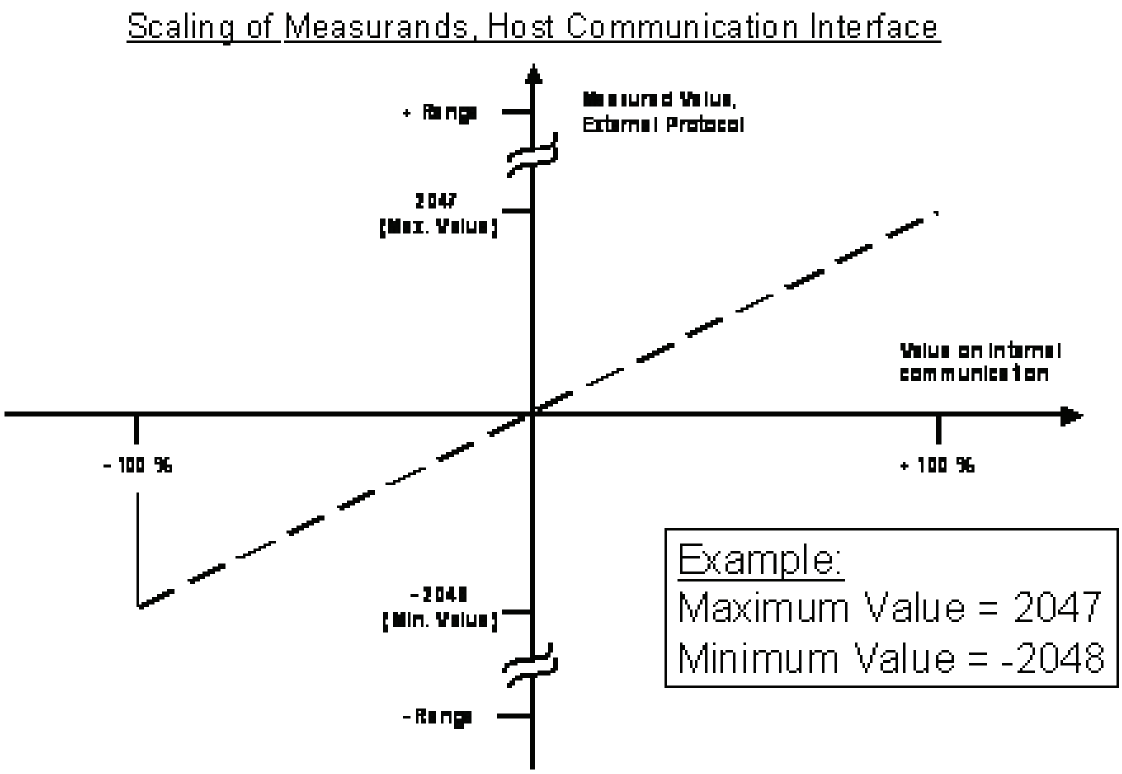
Supported Data Types	Common Data Class	Attribute Name	Functional Constraint	Conversion of Value Type
	CMV	cVal.mag.f	MX	A
	INC	stVal	ST	A
	INS	stVal	ST	A
	MV	mag.f	MX	A
Additional	**Maximum Value** **Maximum Value in the external protocol to be converted to +100 % on RTU500 series internal communication** Parameter: Maximum Value (AMI – Protocol Address and Parameter) [Range: - 2147483648 .. 2147483647]			

Minimum Value
Minimum Value in the external protocol to be converted to -100 % on RTU500 series internal communication.
Parameter:
Minimum Value (AMI- Protocol Address and Parameter)
[Range: -2147483648 .. 2147483647]

Conversion of value (Type A)

RTU500 series internal communication		Protocol specific (Attribute value)
Range min.	-100%	Parameter: Minimum Value
...	...	
Range max.	+100%	Parameter: Maximum Value

Conversion of quality descriptors



Conversion of quality descriptors

RTU500 series internal communication		Protocol specific
OV	Overflow	q.validity == invalid q.detailQual.overflow == TRUE q.detailQual.outOfRange == TRUE
BL	Blocked	q.validity == questionable q.operatorBlocked == TRUE q.detailQual.oldData == TRUE (only if not invalid IV is set)

RTU500 series internal communication		Protocol specific
SB	Substituted	q.source == substituted
NT	Not Topical	q.validity == questionable q.detailQual.oldData == TRUE (only if not invalid IV is set)
IV	Invalid	q.validity == invalid
T	Transient Bit	valWTr.transInd

Conversion of cause of transmission

RTU500 series internal communication		Protocol specific
T	Test	q.test == TRUE
P/N	Positive/negative confirma-tion	- Irrelevant -
Cause	Spontaneous	-
	Requested	-
	Interrogated	-

6.8 MFI – Measured Float Information

Analog process information indicated by 32 bit used as measured value from analog inputs in float format.

Supported Data Types	Common Data Class	Attribute Name	Functional Constraint	Conversion of Value Type
	CMV	cVal.mag.f	MX	B
	INC	stVal	ST	A
	INS	stVal	ST	A
	MV	mag.f	MX	B
Additional	**None**			

Conversion of value (Type A)

RTU500 series internal communication		Protocol specific (Attribute value)
Range min.	-3.410^{38} [1]	-2147483648
...		
Range max.	$+ 3.410^{38}$ [1]	+2147483647

1 Floating point value is truncated in the conversion

Conversion of value (Type B)

RTU500 series internal communication		Protocol specific (Attribute value)
Range min.	-3.410^{38}	-3.410^{38}
...		
Range max.	$+ 3.410^{38}$	$+ 3.410^{38}$

Conversion of quality descriptors

RTU500 series internal communication		Protocol specific
OV	Overflow	q.validity == invalid q.detailQual.overflow == TRUE q.detailQual.outOfRange == TRUE
BL	Blocked	q.validity == questionable q.operatorBlocked == TRUE q.detailQual.oldData == TRUE (only if not invalid IV is set)
SB	Substituted	q.source == substituted
NT	Not Topical	q.validity == questionable q.detailQual.oldData == TRUE (only if not invalid IV is set)
IV	Invalid	q.validity == invalid

Conversion of cause of transmission

RTU500 series internal communication		Protocol specific
T	Test	q.test == TRUE
P/N	Positive/negative confirmation	- Irrelevant -
Cause	Spontaneous	-
	Requested	-
	Interrogated	-

7 Controlling Direction

7.1 SCO – Single Command Output

Binary process command (one bit)

Supported Data Types	Common Data Class	Attribute Name	Functional Constraint	Conversion of Value Type
	SPC[1]	Oper.ctlVal	CO	A
Command Authority	**None**			
Additional	**None**			

1 Supported control model 'sbo-with-enhanced-security' only

Conversion of value (Type A)

RTU500 series internal communication	Protocol specific (Attribute value)
off	FALSE
on	TRUE

Conversion of quality descriptors

RTU500 series internal communication		Protocol specific
SE	Select / Execute	ACSI control service: SBO/SBOw request / ACSI control service: Operate request

Conversion of cause of transmission

RTU500 series internal communication		Protocol specific
T	Test	ACSI control service: Test parameter
P/N	Positive/negative confirmation	ACSI control service: response +/-
Cause	Activation	ACSI control service: Select/Operate request
	Activation Confirmation	ACSI control service: Select/Operate response
	Deactivation	ACSI control service: Cancel request
	Deactivation Confirmation	ACSI control service: Cancel response
	Activation Termination	Report with termination information

7.2 DCO – Double Command Output

Binary process command (two bits)

Supported Data Types	Common Data Class	Attribute Name	Functional Constraint	Conversion of Value Type
	DPC[1]	Oper.ctlVal	CO	A

Command Authority	**None**
Additional	**None**

1 Supported control model 'sbo-with-enhanced-security' only
Conversion of value (Type A)

RTU500 series internal communication	Protocol specific (Attribute value)
Off	FALSE
On	TRUE

Conversion of quality descriptors

RTU500 series internal communication		Protocol specific
SE	Select / Execute	ACSI control service: SBO/SBOw request / ACSI control service: Operate request

Conversion of cause of transmission

RTU500 series internal communication		Protocol specific
T	Test	ACSI control service: Test parameter
P/N	Positive/negative confirmation	ACSI control service: response +/-
Cause	Activation	ACSI control service: Select/Operate request
	Activation Confirmation	ACSI control service: Select/Operate response
	Deactivation	ACSI control service: Cancel request
	Deactivation Confirmation	ACSI control service: Cancel response
	Activation Termination	Report with termination information

7.3 RCO – Regulation Command Output

Regulation process command (two bits)

Supported Data Types	Common Data Class	Attribute Name	Functional Constraint	Conversion of Value Type
	BSC[1]	Oper.ctlVal	CO	A
Command Authority	**None**			
Additional	**None**			

1 Supported control model 'sbo-with-enhanced-security' only
Conversion of value (Type A)

RTU500 series internal communication	Protocol specific (Attribute value)
Lower	lower

RTU500 series internal communication	Protocol specific (Attribute value)
Higher	higher

Conversion of quality descriptors

RTU500 series internal communication		Protocol specific
SE	Select / Execute	ACSI control service: SBO/SBOw request / ACSI control service: Operate request

Conversion of cause of transmission

RTU500 series internal communication		Protocol specific
T	Test	ACSI control service: Test parameter
P/N	Positive/negative confirmation	ACSI control service: response +/-
Cause	Activation	ACSI control service: Select/Operate request
	Activation Confirmation	ACSI control service: Select/Operate response
	Deactivation	ACSI control service: Cancel request
	Deactivation Confirmation	ACSI control service: Cancel response
	Activation Termination	Report with termination information

7.4 ASO – Analog Setpoint Output

Analog process command (16 bit signed number)

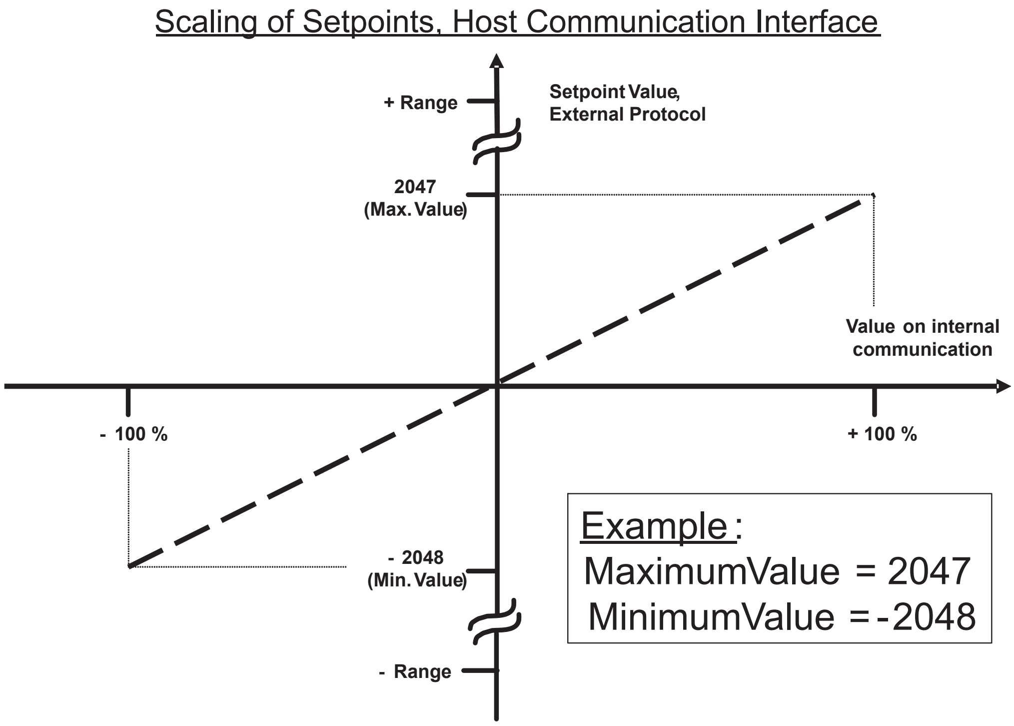
Supported Data Types	**Common Data Class**	**Attribute Name**	**Functional Constraint**	**Conversion of Value Type**
	INC[1]	Oper.ctlVal	CO	A
Command Authority	**None**			
Additional	**Maximum Value** **Maximum Value in the external protocol to be converted to +100 % on RTU500 series internal communication** Parameter: Maximum Value (ASO – Protocol Address and Parameter) [Range: -32768 .. 32767] **Minimum Value** **Minimum Value in the external protocol to be converted to -100 % on RTU500 series internal communication.** Parameter:			

	Minimum Value (ASO- Protocol Address and Parameter) [Range: -32768 .. 32767]

1 Supported control model 'direct-with-normal-security' only

Conversion of value (Type A)

RTU500 series internal communication		Protocol specific (Attribute value)
Range min.	-100%	Parameter: Minimum Value
...	...	
Range max.	+100%	Parameter: Maximum Value



Conversion of quality descriptors

RTU500 series internal communication		Protocol specific
SE	Execute	ACSI control service: Operate request

Conversion of cause of transmission

RTU500 series internal communication		Protocol specific
T	Test	ACSI control service: Test parameter
P/N	Positive/negative confirmation	ACSI control service: response +/-
Cause	Activation	ACSI control service: Select/Operate request
	Activation Confirmation	ACSI control service: Operate response
	Deactivation	-
	Deactivation Confirmation	-
	Activation Termination	-

7.5 DSO – Digital Setpoint Output

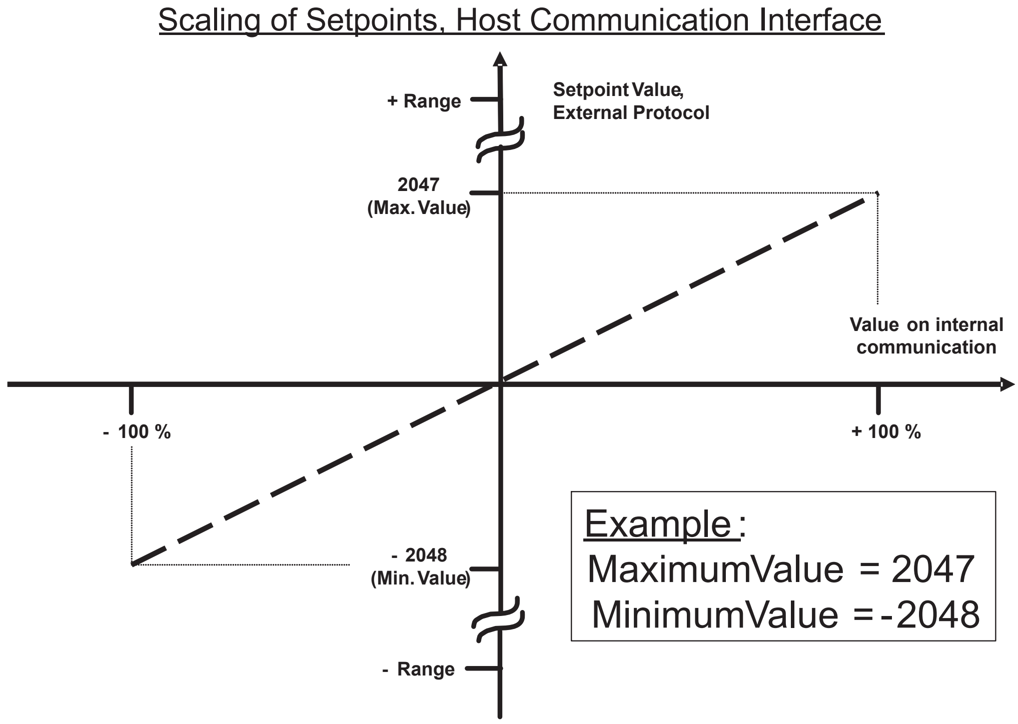
Binary process command (8 or 16 bit signed number)

Supported Data Types	**Common Data Class**	**Attribute Name**	**Functional Constraint**	**Conversion of Value Type**
	INC[1]	Oper.ctlVal	CO	A
Command Authority	**None**			
Additional	**Maximum Value** **Maximum Value in the external protocol to be converted to +100 % on RTU500 series internal communication** Parameter: Maximum Value (DSO – Protocol Address and Parameter) [Range: -32768 .. 32767] **Minimum Value** **Minimum Value in the external protocol to be converted to -100 % on RTU500 series internal communication.** Parameter: Minimum Value (DSO- Protocol Address and Parameter) [Range: -32768 .. 32767]			

1 Supported control model 'direct-with-normal-security' only

Conversion of value (Type A)

RTU500 series internal communication		Protocol specific (Attribute value)
Range min.	-100%	Parameter: Minimum Value
...	...	
Range max.	+100%	Parameter: Maximum Value



Conversion of quality descriptors

RTU500 series internal communication		Protocol specific
SE	Execute	ACSI control service: Operate request

Conversion of cause of transmission

RTU500 series internal communication		Protocol specific
T	Test	ACSI control service: Test parameter
P/N	Positive/negative confirmation	ACSI control service: response +/-
Cause	Activation	ACSI control service: Select/Operate request
	Activation Confirmation	ACSI control service: Operate response
	Deactivation	-
	Deactivation Confirmation	-
	Activation Termination	-

7.6 BSO – Bit String Output

Binary process command (1, 2, 8, 16 bit unsigned number)

Supported Data Types	Common Data Class	Attribute Name	Functional Constraint	Conversion of Value Type
	INC[1]	Oper.ctlVal	CO	A
	ISC[1]	Oper.ctlVal	CO	B

Command Authority	**None**
Additional	**None**

1 Supported control model 'direct-with-normal-security' only

Conversion of value (Type A)

RTU500 series internal communication		Protocol specific (Attribute value)
Range min.	0	0
...	...	…
	32767	32767
…	…	
	32768	-32768
…	…	…
Range max.	65535	-1

Protocol specific value range is mapped to BSO8 and BSO16 in 2´s complement format.

Conversion of value (Type A)

RTU500 series internal communication		Protocol specific (Attribute value)
Range min.	0	0
...	...	…
	63	63
…	…	
	65471	-64
…	…	…
Range max.	65535	-1

Protocol specific value range is mapped to BSO8 and BSO16 in 2´s complement format.

Conversion of quality descriptors

RTU500 series internal communication		Protocol specific
SE	Execute	ACSI control service: Operate request

Conversion of cause of transmission

RTU500 series internal communication		Protocol specific
T	Test	ACSI control service: Test parameter
P/N	Positive/negative confirma- tion	ACSI control service: response +/-
Cause	Activation	ACSI control service: Select/Operate request
	Activation Confirmation	ACSI control service: Operate response
	Deactivation	-
	Deactivation Confirmation	-
	Activation Termination	-

8 Internal Functions

8.1 Startup log

During startup of the HCI IEC 61850 detailed information about the configuration and initialization can be written to a startup log file. This file is placed on the compact flash card of a CMU and can be downloaded via the web server. The file is written after a CMU restart when the startup log was enabled before in the web server. Enabling the startup log and downloading the resulting file are found in the web server under 'Test & Simulation -> Logging and debugging'.

8.2 Time Synchronization

Time synchronization of subordinated devices is done using SNTP time synchronization protocol. SNTP time synchronization protocol is a general function of RTU500 series and must be configured with RTUtil500. The configuration of SNTP is described in document 'Function Description' (1KGT 150 582) of RTU500 series.

8.3 General Interrogation

The general interrogation to subordinated devices is part of the report control block handling defined in IEC 61850. There is no specific general interrogation command existing.

8.4 System Events

8.4.1 System Events of RTU500 series

The host communication interface manages internal status messages of the RTU500 series. These status messages can be created from the HCI itself or other activities of the RTU500 series. The system events of other activities are sent via internal communication and are processed by the HCI.

The system events could be mapped to IEC 61850 status data attributes of type BOOLEAN. See chapter '"3" "Logical nodes and common data classes"' for common data classes and attributes convertable to system events.

The following table shows the system events supported by the host communication interface IEC 61850:

Description of system event	Address offset
At least one indication faulty	SEV#016
At least one analog value faulty	SEV#017
At least one digital value faulty	SEV#018
At least one integrated total faulty	SEV#019
At least one object or regulation command faulty	SEV#020
At least one analog output faulty	SEV#021
At least one digital output faulty	SEV#022
RTU is faulty	SEV#023

Table 4: Description of system events

Description of system event	Address offset
Device/ RTU active	SEV#024
RTU synchronized	SEV#025
External clock inoperable	SEV#026
Local printer offline	SEV#027
At least one indication oscillating	SEV#028
Battery voltage low (RTU560E only)	SEV#029
AC power supply failure (RTU560E only)	SEV#030
Test mode active	SEV#042
At least one data object simulated	SEV#043
At least one data communication equipment (DCE) faulty	SEV#044
Device connected	SEV#045
At least one PLC function not running	SEV#046
At least one PLC function cycle time exceeded	SEV#047
Device/ RTU inoperable	SEV#048
Device/ RTU is out of service	SEV#049
Power supply failure in RTU central sub-rack	SEV#059
Command supervision circuit x disconnected or faulty, 1 ≤ x ≤ 32	SEV#064 ... #095
SNTP client 1 is synchronized	SEV#096
SNTP client 2 is synchronized	SEV#097
Local control authority active	SEV#100
Host x Online, 1 ≤ x ≤ 16	SEV#101 ... #116
Host interface x: At least one change of information lost, 1 ≤ x ≤ 16	SEV#117 ... #132
Host interface x: At least one pulse counter lost, 1 ≤ x ≤ 16	SEV#133 ... #148
CMU x is inoperable, 1 ≤ x ≤ 16	SEV#149 … #164
Database identity tag	SEV#174
Device reachable on redundant line x, 1 ≤ x ≤ 4	SEV#180 … #183
Device active on redundant line x, 1 ≤ x ≤ 4	SEV#184 … #187
Device preferred on redundant line x, 1 ≤ x ≤ 4	#SEV188 … #191
Network element x is operable, 1 ≤ x ≤ 32	SEV#192 … #223
CMU x is active, 1 ≤ x ≤ 16	SEV#224 … #239
Process command collision with host x, 1 ≤ x ≤ 16	SEV#242 ... #257
Command collision with Integrated HMI	SEV#258
Command collision with web server	SEV#259
Command collision with PLC	SEV#260
HMI Client x online,1 ≤ x ≤ 8	SEV#261 ... #268
PRP interface x: Network interface E1 link on, 1 ≤ x ≤ 8	SEV#277 ... #284
PRP interface x: Network interface E2 link on, 1 ≤ x ≤ 8	SEV#285 ... #292

Table 4: Description of system events

8.4.2 System Events of GOOSE IEDs

The host communication interface manages internal status messages for every GOOSE IED that sends data to the HCI. These status messages are created from the host communication interface itself for every GOOSE IED.

The host communication interface supports the following system events for GOOSE IEDs:

Description of system event	Shortcut
Device active	#024
Device inoperable	#048

Conversion of value

Description	RTU500 series internal	Protocol specific
Device active	off	Device not active
	on	Device active
Device inoperable	off	All GOOSE data points valid
	on	At least one GOOSE data point invalid

While initialization the value of system event ‘Device is active’ (#024) is set to ON. On a running system this system event doesn’t change anymore.

The system event ‘Device inoperable’ (#048) is set in dependency of the GOOSE data points received from the IED. If all data points are received and valid the system event is set to operable (state ‘off’). If at least one data point is not received or invalid the system event is set to inoperable (state ‘on’).

8.5 System Commands

System commands are not supported.

8.6 IEC 61850 server functionality

The RTU500 series IEC 61850 server provides internal functionality of the RTU500 serie interfaced as IEC 61850 server. The internal functions of the IEC 61850 hostcommunication interface of the RTU500 series are:

- Logical node physical health identification
- Time master supervision
- Redundant physical communication channel supervision

The next chapters describe the provided internal RTU500 series functions in detail. For information about the configuration aspects of the IEC 61850 server functionality see [6].

8.6.1 Logical node physical health identification

The physical health identification of the RTU500 series is provided in a standard data object of the logical node LPHD. The table below shows the relation between the data object and the RTU500 series functionality.

Logical Node	Data Object	RTU500 series functionality
LPHD	PhyHealth	Operable state of the RTU500 series. Derived from the system event “CMU operable/inoperable”. If operable

Table 5: Relation between Logical Node and RTU500 series functionality.

Logical Node	Data Object	RTU500 series functionality
		PhyHealth is set to Ok (value 1) otherwise set to Alarm (value 3).

Table 5: Relation between Logical Node and RTU500 series functionality.

To send the information about the physical health identification to clients on the station level the RTU500 series IEC 61850 server provides the predefined data set "StatNrmlA" with the data object "PhyHealth".

8.6.2 Time master supervision

The time master supervision of the RTU500 series is provided in standard data objects of the logical node LTMS. This logical node is available for Edition 2 client or server only. The table below shows the relation between the data objects and the RTU500 series functionality.

Logical Node	Data Object	RTU500 series functionality
LTMS	TmSyn	Status of the time synchronization in the RTU500 series. See table below for possible state values.
LTMS	TmChSt1	Shows as boolean value (up/down) the status of the SNTP time synchronization. If set ot true at least one SNTP client in the RTU500 series is synchronized.

Table 6: Relation between Logical Node and RTU500 series functionality.

The data objects "TmSyn" represents the actual time synchronization status in the following way:

TmSyn	Time synchronization status in RTU500 series
ExternalArea-Clock (Value 0)	The RTU500 series is not synchronized.
LocalAreaClock (Value 1)	The RTU500 series is synchronized by a local time source. Depending on the configuration this can be a local real time clock or a host communication interface.
GlobalAreaClock (Value 2)	The RTU500 series is synchronized by an SNTP server.

Table 7: Indication of time synchronization status

To send the information about time master supervision to clients on the station level the RTU500 series IEC 61850 server provides the predefined data set "StatNrmlA" with the data object "TmSyn".

The data object for the status of the SNTP time synchronization "TmChSt1" is not part of the data set per default. If required the data object can be added to a data set in the system configuration outside of RTUtil500.

8.6.3 Redundant physical communication channel supervision

The redundant physical communication channel supervision of the RTU500 series is provided in standard data objects of the logical node LCCH. This logical node is available for Edition 2 client or server only and if PRP is configured for the Ethernet interfaces. The table below shows the relation between the data objects and the RTU500 series functionality.

Logical Node	Data Object	RTU500 series functionality
LCCH	ChLiv	Physical channel status of redundant Ethernet interface 1. Derived from the system event “PRP interface no. X: network interface 1 link up”.
LCCH	RedChLiv	Physical channel status of redundant Ethernet interface 2. Derived from the system event “PRP interface no. X: network interface 2 link up”.
LCCH	FerCh	PRP frame error rate of redundant Ethernet interface 1.
LCCH	RedFerCh	PRP frame error rate of redundant Ethernet interface 2.

Table 8: Relation between Logical Node and RTU500 series functionality.

To send the information about the redundant physical communication channel supervision to clients on the station level the RTU500 series IEC 61850 server provides the predefined data set "StatNrmlA" with the data objects "ChLiv" and "RedChLiv".

The data objects for the PRP frame error rate "FerCh" and "RedFerCh" are not part of the data set per default. If required the data objects can be added to a data set in the system configuration outside of RTUtil500.

9 Limits and Recommendations

9.1 System Limits

The following table specifies the system limits of IEC 61850 Server in RTU500 series:

Description	Limit
Maximum number of IEC 61850 Server per RTU500 series	16
Maximum number of host communication interfaces IEC 61850 per CMU	1
Maximum number of control stations (IEC 61850 clients) per host communication interface IEC 61850	5[1]
Maximum number of process data points supported per RTU500 series	750
Maximum number of virtual MAC addresses per host communication interface IEC 61850	see detailed information in chapter "GOOSE Multicast Addressing"
Maximum number of data sets per host communication interface IEC 61850	48
Maximum number of report control blocks (RCBs) per host communication interface IEC 61850	48
Maximum number of GOOSE control blocks (GCBs) per host communication interface IEC 61850	8
Maximum number of entries per data set	150[2]
Maximum number of data attribute instances (DAIs) per host communication interface IEC 61850	21000[3]

Table 9: System limits

1 For a temporarily connected client like monitoring or engineering workplaces additional connections (besides the maximum number) are supported.

2 For performance reasons GOOSE datasets shall be as small as possible (maximum 30 entries). Nevertheless GOOSE datasets must not exceed the maximum size of 1500 Bytes defined in the standard. This size limit is met with the defined maximum number of entries per dataset.

3 All data attribute instances within a configured logical node count to the limit, whether these attribute instances are used as RTU500 data point or not. Therefore GGIO nodes with several indications (SP8GGIO and SP16GGIO) shall be used and the number of logical devices shall be as low as possible.

For detailed limits on the IEC 61850 protocol implementation see chapter "Protocol Implementation extra Information for Testing (PIXIT)".

The RTU500 series IEC 61850 server supports Edition 1 and Edition 2 of the standard. The used protocol edition must be defined for each server in the configuration. For more information see chapter "Selection of protocol edition" and the RTUtil500 documentation [6].

9.2 Mixed systems

The RTU500 series can work as IEC 61850 Edition 1 or Edition 2 client or server. The used protocol edition is defined for client and server in the configuration. In system with IEDs of one Edition only, no restrictions apply for the RTU500 series. But in mixed systems were IEDs of Edition 1 and Edition 2 are used together the following restrictions apply:

- For extensions of existing Edition 1 systems the RTU500 series must be configured as Edition 1 IED. The extension of Edition 1 system with Edition 2 devices is not supported.
- Mixed systems are supported for client/server communication. In mixed system the SCD file is Edition 2 including Edition 1 data models. There is one SCD file only for mixed systems.
- The RTU500 series doesn’t support GOOSE communication between editions. That means the GOOSE communication with the RTU500 series is restricted to IEDs of the same edition. The configuration tool RTUtil500 checks this restriction and GOOSE data points from IEDs with the wrong edition are ignored (Presenting a warning message for the user).

10 Conformance Statements

10.1 Abstract Communication Service Interface (ACSI)

The following ACSI conformance statements are used to provide an overview and details about RTU500 series IEC 61850 server :

- ASCI basic conformance statement,
- ACSI models conformance statement,
- ACSI service conformance statement

The statements specify the communication features mapped to IEC 61850-8-1 Edition 1 and Edition 2.

10.1.1 ACSI Basic Conformance Statement

The ACSI basic conformance statement for RTU500 series IEC 61850 server is defined in following table.

		Client/ sub-scriber	Server/ publisher	RTU500 series server
Client-server roles				
B11	Server side (of TWO-PARTYAPPLICATION-ASSOCIATION)	-	c1	YES
B12	Client side (of TWO-PARTYAPPLICATION-ASSOCIATION)	c1	-	-
SCSMs supported				
B21	SCSM: IEC 61850-8-1 used			YES
B22	SCSM: IEC 61850-9-1 used			-
B23	SCSM: IEC 61850-9-2 used			-
B24	SCSM: other			-
Generic substation event model (GSE)				
B31	Publisher side	-	O	YES (GOOSE only)
B32	Subscriber side	O	-	YES(GOOSE only)
Transmission of sampled value model (SVC)				
B41	Publisher side	-	O	-
B42	Subscriber side	O	-	-

c1 – shall be ‘M’ if support for LOGICAL-DEVICE model has been declared.

O – Optional

M – Mandatory

Table 10: ACSI basic conformance statement

10.1.2 ACSI Models Conformance Statement

The ACSI models conformance statement for RTU500 series IEC 61850 server is defined in following table.

		Client/ sub-scriber	Server/ publisher	RTU500 series server
If Server or Client side (B11/B12) supported				
M1	Logical device	c2	c2	YES
M2	Logical node	c3	c3	YES
M3	Data	c4	c4	YES
M4	Data set	c5	c5	YES
M5	Substitution	O	O	-
M6	Setting group control	O	O	-
	Reporting			
M7	Buffered report control	O	O	YES
M7-1	sequence-number			YES
M7-2	report-time-stamp			YES
M7-3	reason-for-inclusion			YES
M7-4	data-set-name			YES
M7-5	data-reference			YES
M7-6	buffer-overflow			YES
M7-7	entryID			YES
M7-8	BufTm			YES
M7-9	IntgPd			YES
M7-10	GI			YES
M7-11	conf-revision			YES
M8	Unbuffered report control	O	O	YES
M8-1	sequence-number			YES
M8-2	report-time-stamp			YES
M8-3	reason-for-inclusion			YES
M8-4	data-set-name			YES
M8-5	data-reference			YES
M8-6	BufTm			YES
M8-7	IntgPd			YES
M8-8	GI			YES
M8-9	conf-revision			YES
	Logging			
M9	Log control	O	O	-
M9-1	IntgPd			-
M10	Log	O	O	-
M11	Control	M	M	YES
If GSE (B31/B32) is supported				
M12	GOOSE	O	O	YES

Table 11: ACSI model conformance statement

		Client/ sub-scriber	Server/ publisher	RTU500 series server
M13	GSSE	O	O	-
If SVC (B41/B42) is supported				
M14	Multicast SVC	O	O	-
M15	Unicast SVC	O	O	-
For all IEDs				
M16	Time	M	M	YES
M17	File Transfer	O	O	-

c2 – shall be ‘M’ if support for LOGICAL-NODE model has been declared.

c3 – shall be ‘M’ if support for DATA model has been declared.

c4 – shall be ‘M’ if support for DATA-SET, Substitution, Report, Log Control, or Time model has been declared.

c5 – shall be ‘M’ if support for Report, GSE, or SV models has been declared.

O – Optional

M – Mandatory

Table 11: ACSI model conformance statement

10.1.3 ACSI Service Conformance Statement

The ACSI service conformance statement for RTU500 series IEC 61850 server is defined in following table (depending on the statements of table "Tab. 11: ACSI model conformance statement").

Services		AA: TP/MC	Client/ subscriber	Server/ publisher	RTU500 series server
Server (Clause 7)					
S1	ServerDirectory	TP		M	YES
Application association (Clause 8)					
S2	Associate		M	M	YES
S3	Abort		M	M	YES
S4	Release		M	M	YES
Logical device (Clause 9)					
S5	LogicalDeviceDirectory	TP	M	M	YES
Logical node (Clause 10)					
S6	GetLogicalNodeDirectory	TP	M	M	YES
S7	GetAllDataValues	TP	O	M	YES
Data (Clause 11)					
S8	GetDataValues	TP	M	M	YES
S9	SetDataValues	TP	O	O	-
S10	GetDataDirectory	TP	O	M	YES

Table 12: ACSI service conformance statement

	Services	AA: TP/MC	Client/ subscriber	Server/ publisher	RTU500 series server
S11	GetDataDefinition	TP	O	M	YES
Data set (Clause 12)					
S12	GetDataSetValues	TP	O	M	YES
S13	SetDataSetValues	TP	O	O	-
S14	CreateDataSet	TP	O	O	-
S15	DeleteDataSet	TP	O	O	-
S16	GetDataSetDirectory	TP	O	O	YES
Setting group control (Clause 16)					
S18	SelectActiveSG	TP	O	O	-
S19	SelectEditSG	TP	O	O	-
S20	SetEditSGValues	TP	O	O	-
S21	ConfirmEditSGValues	TP	O	O	-
S22	GetEditSGValues	TP	O	O	-
S23	GetSGCBValues	TP	O	O	-
Reporting (Clause 17)					
Buffered report control block (BRCB)					
S24	Report	TP	c6	c6	YES
S24-1	data-change (dchg)				YES
S24-2	qchg-change (qchg)				YES
S24-3	data-update (dupd)				YES
S25	GetBRCBValues	TP	c6	c6	YES
S26	SetBRCBValues	TP	c6	c6	YES
Unbuffered report control block (URCB)					
S27	Report	TP	c6	c6	YES
S27-1	data-change (dchg)				YES
S27-2	qchg-change (qchg)				YES
S27-3	data-update (dupd)				YES
S28	GetURCBValues	TP	c6	c6	YES
S29	SetURCBValues	TP	c6	c6	YES
Logging (Clause 17)					
Log control block					
S30	GetLCBValues	TP	M	M	-
S31	SetLCBValues	TP	O	M	-
Log					
S32	QueryLogByTime	TP	c7	M	-
S33	QueryLogAfter	TP	c7	M	-
S34	GetLogStatusValues	TP	M	M	-
Generic substation event model (GSE)					
GOOSE (Clause 18)					
S35	SendGOOSEMessage	MC	c8	c8	YES
S36	GetGoReference	TP	O	c9	YES

Table 12: ACSI service conformance statement

	Services	AA: TP/MC	Client/ subscriber	Server/ publisher	RTU500 series server
S37	GetGOOSEElementNumber	TP	O	c9	YES
S38	GetGoCBValues	TP	O	O	-
S39	SetGoCBValues	TP	O	O	-
GSSE (Annex C)					
S40	SendGSSEMessage	MC	c8	c8	-
S41	GetGsReference	TP	O	c9	-
S42	GetGSSEDataOffset	TP	O	c9	-
S43	GetGsCBValues	TP	O	O	-
S44	SetGsCBValues	TP	O	O	-
Transmission of sampled value model (SVC) (Clause 19)					
Multicast SVC					
S45	SendMSVMessage	MC	c10	c10	-
S46	GetMSVCBValues	TP	O	O	-
S47	SetMSVCBValues	TP	O	O	-
Unicast SVC					
S48	SendUSVMessage	TP	c10	c10	-
S49	GetUSVCBValues	TP	O	O	-
S50	SetUSVCBValues	TP	O	O	-
Control (Clause 20)					
S51	Select	TP	M	O	YES
S52	SelectWithValue	TP	M	O	YES
S53	Cancel	TP	O	O	YES
S54	Operate	TP	M	M	YES
S55	Command-Termination	TP	M	O	YES
S56	TimeActivated-Operate	TP	O	O	-
File transfer (Clause 23)					
S57	GetFile	TP	O	M	-
S58	SetFile	TP	O	O	-
S59	DeleteFile	TP	O	O	-
S60	GetFileAttributeValues	TP	O	M	-
Time (5.5)					
T1	Time resolution of internal clock				10 (1 msec)
T2	Time accuracy of internal clock				T1
T3	Supported TimeStamp resolution				10 (1 msec)

c6 – shall declare support for at least one (BRCB or URCB)

c7 – shall declare support for at least one (QueryLogByTime or QueryLogAfter)

c8 – shall declare support for at least one (SendGOOSEMessage or SendGSSEMessage)

c9 – shall declare support if TP association is available

Table 12: ACSI service conformance statement

Services	AA: TP/MC	Client/ subscriber	Server/ publisher	RTU500 series server
c10 – shall declare support for at least one (SendMSVMessage or SendUSVMessage)				
O – Optional				

Table 12: ACSI service conformance statement

10.1.4 Specific Communication Service Mapping (SCSM)

See B21 table "Tab. 10: ACSI basic conformance statement" and [IEC 61850-7-2].

10.2 Protocol Implementation Conformance Statement (PICS)

10.2.1 Basic Profile Conformance

10.2.1.1 PICS for A-Profile support

The PICS for A-Profile support for RTU500 series IEC 61850 server are defined in following table.

A-Profile shortcut	Profile Description	Client	Server	RTU500 series server
A1	Client/server A-Profile	c1	c1	YES
A2	GOOSE/GSE management A-Profile	c2	c2	YES (GOOSE only)
A3	GSSE A-Profile	c3	c3	-
A4	TimeSync A-Profile	c4	c4	YES

c1 Shall be ‘m’ if support for any service specified in [IEC 61850-8-1] Table 2 are declared within the ACSI basic conformance statement (see Table 5).

c2 Shall be ‘m’ if support for any service specified in [IEC 61850-8-1] Table 6 are declared within the ACSI basic conformance statement (see Table 5).

c3 Shall be ‘m’ if support for any service specified in [IEC 61850-8-1] Table 9 are declared within the ACSI basic conformance statement (see Table 5).

c4 Support for at least one other A-Profile shall be declared (e.g. in A1-A3) in order to claim conformance to [IEC 61850-8-1].[IEC 61850-8-1].

Table 13: PICS for A-Profile support

10.2.1.2 PICS for T-Profile support

The PICS for T-Profile support for RTU500 series IEC 61850 server are defined in following table.

T-Profile shortcut	Profile Description	Client	Server	RTU500 series server
T1	TCP/IP T-Profile	c1	c1	YES
T2	OSI T-Profile	c2	c2	-
T3	GOOSE/GSE T-Profile	c3	c3	YES (GOOSE only)
T4	GSSE T-Profile	c4	c4	-
T5	TimeSync T-Profile	O	O	YES

c1 Shall be ‘m’ if support for table 9-4 A1 is declared. Otherwise, shall be 'i'.

c2 Shall be ‘o’ if support for table 9-4 A1 is declared. Otherwise, shall be 'i'.

c3 Shall be ‘m’ if support for table 9-4 A2 is declared. Otherwise, shall be 'i'.

c4 Shall be ‘m’ if support for table 9-4 A3 is declared. Otherwise, shall be 'i'.

i – out-of-scope: The implementation of the item is not within the scope of this standard

O – Optional

Table 14: PICS for T-Profile support

10.2.2 MMS Conformance

All needed services supporting the ACSI services stated to be supported in chapter ’9.1.3 "ACSI Service Conformance Statement" ’ are supported by the MMS stack used.

10.3 Model Implementation Conformance Statement (MICS)

This model implementation conformance statement is applicable for RTU500 series IEC 61850 server:

This MICS document specifies the modelling implementations and extensions compared to IEC 61850 Edition 1 and Edition 2. For the exact details on the standardized model please compare the ICD substation configuration files generated by RTUtil500.

- Chapter 10.3.1 contains the list of implemented logical nodes.
- Chapters 10.3.2 to 10.3.14 describe the implemented logical nodes.

10.3.1 Logical Node List

Following table defines the list of logical nodes supported by RTU500 series IEC 61850 server.

LN Group L: System logical nodes	
LPHD	Physical device information
LLN0	Logical node zero
LCCH[1]	Physical communication channel supervision

Table 15: Logical nodes supported by the RTU500 series IEC 61850 server

LN Group L: System logical nodes	
LTMS[1]	Time master supervision
LN Group C: Logical nodes for control	
CSWI	Switch controller
CILO	Interlocking
CALH	Alarm handling
LN Group G: Logical nodes for generic references	
GAPC	Generic automatic process control
GGIO	Generic process I/O
LN Group M: Logical nodes for metering and measurement	
MMTR	Metering
MMXN	Measurement
MMXU	Measurement
LN Group P: Logical nodes for protection functions	
PTOC	Time over current
PDIS	Distance
PDIF	Differential
PTOF	Over frequency
PTUF	Under frequency
PTOV	Over voltage
PTUV	Under voltage
PSDE	Sensitive directional earth fault
PTEF	Transient earth fault
PSCH	Protection scheme
PTRC	Protection trip conditioning
LN Group R: Logical Nodes for protection related functions	
RBRF	Breaker failure
RREC	Auto reclosing
RSYN	Synchronism-check or synchronising
LN Group S: Logical Nodes for sensors and monitoring	
SIMG	Insulation medium supervision (gas)
SIML	Insulation medium supervision (liquid)
LN Group X: Logical Nodes for switchgear	
XCBR	Circuit breaker
XSWI	Circuit switch
LN Group Y: Logical Nodes for power transformer	
YLTC	Tap changer
YEFN	Earth fault neutralizer (Petersen coil)
LN Group Z: Logical Nodes for further power system equipment	
ZAXN	Auxiliary network

Table 15: Logical nodes supported by the RTU500 series IEC 61850 server

1 Supported for IEC 61850 Edition 2 client/server only

10.3.2 LN Group L: System logical nodes

10.3.2.1 LN type: LPHD

LPHD		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
PhyNam	DPL	Physical device name plate
PhyHealth	INS	Physical device health
Proxy	SPS	Indicates if this LN is a proxy

Table 16: Logical node type LPHD

LPHD		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
PhyNam	DPL	Physical device name plate
PhyHealth	ENS	Physical device health
Proxy	SPS	Indicates if this LN is a proxy

Table 17: Logical node type LPHD (Edition 2)

10.3.2.2 LN type: LLN0

LLN0		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
	Common logical node information	
Mod	INC	Mode
Beh	INS	Behaviour
Health	INS	Health
NamPlt	LPL	Name plate
Loc	SPS	Local operation for complete logical device

Table 18: Logical node type LLN0 (Edition 1)

LLN0		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
	Common logical node information	
Mod	ENC	Mode

Table 19: Logical node type LLN0 (Edition 2)

LLN0		
Beh	ENS	Behaviour
Health	ENS	Health
NamPlt	LPL	Name plate
Loc	SPS	Local operation for complete logical device

Table 19: Logical node type LLN0 (Edition 2)

10.3.2.3 LN Type LCCH

LCCH		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
	Common logical node information	
Beh	ENS	Behaviour
ChLiv	SPS	Physical channel status; true, if channel receives telegrams within a specified time interval.
RedChLiv	SPS	Physical channel status of redundant channel
FerCh	INS	Frame error rate on this channel; count of erroneous (or missed, in case of redundancy) messages for each 1 000 messages forwarded to the application.
RedFerCh	INS	Frame error rate on redundant channel; count of missed messages on this channel for each 1 000 messages forwarded to the application.

Table 20: Logical node type LCCH (Edition 2)

10.3.2.4 LN type LTMS

LTMS		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
	Common logical node information	
Beh	ENS	Behaviour
TmSrc	VSS	Current time source
TmSyn	ENS	Time synchronized according to IEC 61850-9-2
TmChSt1	SPS	Time channel status (up/down)

Table 21: Logical node type LTMS (Edition 2)

10.3.3 LN Group C: Logical nodes for control

10.3.3.1 LN type: CSWI

CSWI		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
		Common logical node information
Mod	INC	Mode
Beh	INS	Behaviour
Health	INS	Health
NamPlt	LPL	Name plate
Loc	SPS	Local operation
		Controls
Pos	DPC	Double point controllable status output

Table 22: Logical node type CSWI (Edition 1)

CSWI		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
		Common logical node information
Beh	ENS	Behaviour
Loc	SPS	Local operation
		Controls
Pos	DPC	Double point controllable status output

Table 23: Logical node type CSWI (Edition 2)

10.3.3.2 LN type: CILO

CILO		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
		Common logical node information
Mod	INC	Mode
Beh	INS	Behaviour
Health	INS	Health
NamPlt	LPL	Name plate
		Status Information
EnaOpn	SPS	Enable Open
EnaCls	SPS	Enable Close

Table 24: Logical node type CILO (Edition 1)

CILO		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
	Common logical node information	
Beh	ENS	Behaviour
	Status Information	
EnaOpn	SPS	Enable Open
EnaCls	SPS	Enable Close

Table 25: Logical node type CILO (Edition 2)

10.3.3.3 LN type: CALH

CALH		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
	Common logical node information	
Mod	INC	Mode
Beh	INS	Behaviour
Health	INS	Health
NamPlt	LPL	Name plate
	Status Information	
GrAlm	SPS	Group alarm

Table 26: Logical node type CALH (Edition 1)

CALH		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
	Common logical node information	
Beh	ENS	Behaviour
	Status Information	
GrAlm	SPS	Group alarm

Table 27: Logical node type CALH (Edition 2)

10.3.4 LN Group G: Logical nodes for generic references

10.3.4.1 LN type: GAPC

GAPC		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
	Common logical node information	
Mod	INC	Mode
Beh	INS	Behaviour
Health	INS	Health
NamPlt	LPL	Name plate
	Status information	
Str	ACD	Start
Op	ACT	Operate

Table 28: Logical node type GAPC (Edition 1)

GAPC		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
	Common logical node information	
Beh	ENS	Behaviour
	Status information	
Str	ACD	Start
Op	ACT	Operate

Table 29: Logical node type GAPC (Edition 2)

Following table defines the specific logical nodes extensions for generic process I/O.

LN Group G: Logical nodes for generic references			
GGIO: Generic process I/O			
LN Prefix	**LN Class**	**LN Type**	**Description**
		Status information	
SP	GGIO	SPGGIO	Generic single point status
SP8	GGIO	SP8GGIO	Generic single point status (8 inputs)
SP16	GGIO	SP16GGIO	Generic single point status (16 inputs)
DP	GGIO	DPGGIO	Generic double point status
DP8	GGIO	DP8GGIO	Generic double point status (8 inputs)
INS	GGIO	INSGGIO	Generic integer status
BCR	GGIO	BCRGGIO	Generic binary counter reading
ENS[1]	GGIO	ENSGGIO	Generic enumerated status
		Measured information	

Table 30: Generic logical node supported by RTU500 series server

LN Group G: Logical nodes for generic references			
GGIO: Generic process I/O			
MV	GGIO	MVGGIO	Generic measured value input
MV8	GGIO	MV8GGIO	Generic measured value input (8 inputs)
CMV	GGIO	CMVGGIO	Generic complex measured value input
		Controllable status information	
SC	GGIO	SCGGIO	Generic single command
SC8	GGIO	SC8GGIO	Generic single command (8 outputs)
SC16	GGIO	SC16GGIO	Generic single command (16 outputs)
DC	GGIO	DCGGIO	Generic double command
DC8	GGIO	DC8GGIO	Generic double command (8 outputs)
INC	GGIO	INCGGIO	Generic integer status output
BSC	GGIO	BSCGGIO	Generic binary controlled step position output

Table 30: Generic logical node supported by RTU500 series server

1 Supported for IEC 61850 Edition 2 client/server only

10.3.4.2 Monitoring status information

10.3.4.2.1 LN type: SPGGIO

SPGGIO		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
	Common logical node information	
Mod	INC	Mode
Beh	INS	Behaviour
Health	INS	Health
NamPlt	LPL	Name plate
	Status information	
Ind	SPS	General indication (binary input)

Table 31: Logical node type SPGGIO (Edition 1)

SPGGIO		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
	Common logical node information	
Beh	INS	Behaviour
	Status information	
Ind1	SPS	General indication (binary input)

Table 32: Logical node type SPGGIO (Edition 2)

10.3.4.2.2 LN type: SP8GGIO

SP8GGIO		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
	Common logical node information	
Mod	INC	Mode
Beh	INS	Behaviour
Health	INS	Health
NamPlt	LPL	Name plate
	Status information	
Ind1	SPS	General indication (binary input)
Ind2	SPS	General indication (binary input)
Ind3	SPS	General indication (binary input)
Ind4	SPS	General indication (binary input)
Ind5	SPS	General indication (binary input)
Ind6	SPS	General indication (binary input)
Ind7	SPS	General indication (binary input)
Ind8	SPS	General indication (binary input)

Table 33: Logical node type SP8GGIO (Edition 1)

SP8GGIO		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
	Common logical node information	
Beh	INS	Behaviour
	Status information	
Ind1	SPS	General indication (binary input)
Ind2	SPS	General indication (binary input)
Ind3	SPS	General indication (binary input)
Ind4	SPS	General indication (binary input)
Ind5	SPS	General indication (binary input)
Ind6	SPS	General indication (binary input)
Ind7	SPS	General indication (binary input)
Ind8	SPS	General indication (binary input)

Table 34: Logical node type SP8GGIO (Edition 2)

10.3.4.2.3 LN type: SP16GGIO

SP16GGIO		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
	Common logical node information	
Mod	INC	Mode
Beh	INS	Behaviour
Health	INS	Health
NamPlt	LPL	Name plate
	Status information	
Ind1	SPS	General indication (binary input)
Ind2	SPS	General indication (binary input)
Ind3	SPS	General indication (binary input)
Ind4	SPS	General indication (binary input)
Ind5	SPS	General indication (binary input)
Ind6	SPS	General indication (binary input)
Ind7	SPS	General indication (binary input)
Ind8	SPS	General indication (binary input)
Ind9	SPS	General indication (binary input)
Ind10	SPS	General indication (binary input)
Ind11	SPS	General indication (binary input)
Ind12	SPS	General indication (binary input)
Ind13	SPS	General indication (binary input)
Ind14	SPS	General indication (binary input)
Ind15	SPS	General indication (binary input)
Ind16	SPS	General indication (binary input)

Table 35: Logical node type SP16GGIO (Edition 1)

SP16GGIO		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
	Common logical node information	
Beh	INS	Behaviour
	Status information	
Ind1	SPS	General indication (binary input)
Ind2	SPS	General indication (binary input)
Ind3	SPS	General indication (binary input)
Ind4	SPS	General indication (binary input)
Ind5	SPS	General indication (binary input)
Ind6	SPS	General indication (binary input)

Table 36: Logical node type SP16GGIO (Edition 2)

SP16GGIO		
Ind7	SPS	General indication (binary input)
Ind8	SPS	General indication (binary input)
Ind9	SPS	General indication (binary input)
Ind10	SPS	General indication (binary input)
Ind11	SPS	General indication (binary input)
Ind12	SPS	General indication (binary input)
Ind13	SPS	General indication (binary input)
Ind14	SPS	General indication (binary input)
Ind15	SPS	General indication (binary input)
Ind16	SPS	General indication (binary input)

Table 36: Logical node type SP16GGIO (Edition 2)

10.3.4.2.4 LN type: DPGGIO

DPGGIO		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
	Common logical node information	
Mod	INC	Mode
Beh	INS	Behaviour
Health	INS	Health
NamPlt	LPL	Name plate
	Status information	
DPI	DPS	Double point input

Table 37: Logical node type DPGGIO (Edition 1)

DPGGIO		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
	Common logical node information	
Beh	INS	Behaviour
	Status information	
DPI1	DPS	Double point input

Table 38: Logical node type DPGGIO (Edition 2)

10.3.4.2.5 LN type: DP8GGIO

DP8GGIO		
Attribute Name	Attribute Type	Explanation

Table 39: Logical node type DP8GGIO (Edition 1)

DP8GGIO		
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
		Common logical node information
Mod	INC	Mode
Beh	INS	Behaviour
Health	INS	Health
NamPlt	LPL	Name plate
		Status information
DPI1	DPS	Double point input
DPI2	DPS	Double point input
DPI3	DPS	Double point input
DPI4	DPS	Double point input
DPI5	DPS	Double point input
DPI6	DPS	Double point input
DPI7	DPS	Double point input
DPI8	DPS	Double point input

Table 39: Logical node type DP8GGIO (Edition 1)

DP8GGIO		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
		Common logical node information
Beh	INS	Behaviour
		Status information
DPI1	DPS	Double point input
DPI2	DPS	Double point input
DPI3	DPS	Double point input
DPI4	DPS	Double point input
DPI5	DPS	Double point input
DPI6	DPS	Double point input
DPI7	DPS	Double point input
DPI8	DPS	Double point input

Table 40: Logical node type DP8GGIO (Edition 2)

10.3.4.2.6 LN type: INSGGIO

INSGGIO		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		

Table 41: Logical node type INSGGIO (Edition 1)

INSGGIO		
	Common logical node information	
Mod	INC	Mode
Beh	INS	Behaviour
Health	INS	Health
NamPlt	LPL	Name plate
	Status information	
IntIn	INS	Integer status input

Table 41: Logical node type INSGGIO (Edition 1)

INSGGIO		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
	Common logical node information	
Beh	INS	Behaviour
	Status information	
IntIn1	INS	Integer status input

Table 42: Logical node type INSGGIO (Edition 2)

10.3.4.2.7 LN type: BCRGGIO

BCRGGIO		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
	Common logical node information	
Mod	INC	Mode
Beh	INS	Behaviour
Health	INS	Health
NamPlt	LPL	Name plate
	Status information	
ITI	BCR[1]	Integrated totals input

Table 43: Logical node type BCRGGIO (Edition 1)

1 The data type behind BCR.actVal and BCR.frVal is INT32 and the limits are accordingly

BCRGGIO		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
	Common logical node information	
Beh	INS	Behaviour

Table 44: Logical node type BCRGGIO (Edition 2)

BCRGGIO		
		Status information
ITI1	BCR[1]	Integrated totals input

Table 44: Logical node type BCRGGIO (Edition 2)

1 The data type behind BCR.actVal and BCR.frVal is INT32 and the limits are accordingly

10.3.4.2.8 LN type: ENSGGIO

ENSGGIO		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
		Common logical node information
Beh	INS	Behaviour
		Status information
EEHealth	ENS	External equipment health

Table 45: Logical node type ENSGGIO (Edition 2)

10.3.4.3 Measured information

10.3.4.3.1 LN type: MVGGIO

MVGGIO		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
		Common logical node information
Mod	INC	Mode
Beh	INS	Behaviour
Health	INS	Health
NamPlt	LPL	Name plate
		Measured vlaues
AnIn	MV	Analog input

Table 46: Logical node type MVGGIO (Edition 1)

MVGGIO		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
		Common logical node information
Beh	INS	Behaviour
		Measured vlaues

Table 47: Logical node type MVGGIO (Edition 2)

MVGGIO		
AnIn1	MV	Analog input

Table 47: Logical node type MVGGIO (Edition 2)

10.3.4.3.2 LN type: MV8GGIO

MV8GGIO		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
		Common logical node information
Mod	INC	Mode
Beh	INS	Behaviour
Health	INS	Health
NamPlt	LPL	Name plate
		Measured vlaues
AnIn1	MV	Analog Input
AnIn2	MV	Analog Input
AnIn3	MV	Analog Input
AnIn4	MV	Analog Input
AnIn5	MV	Analog Input
AnIn6	MV	Analog Input
AnIn7	MV	Analog Input
AnIn8	MV	Analog Input

Table 48: Logical node type MV8GGIO (Edition 1)

MV8GGIO		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
		Common logical node information
Beh	INS	Behaviour
		Measured vlaues
AnIn1	MV	Analog Input
AnIn2	MV	Analog Input
AnIn3	MV	Analog Input
AnIn4	MV	Analog Input
AnIn5	MV	Analog Input
AnIn6	MV	Analog Input
AnIn7	MV	Analog Input
AnIn8	MV	Analog Input

Table 49: Logical node type MV8GGIO (Edition 2)

10.3.4.3.3 LN type: CMVGGIO

CMVGGIO		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
	Common logical node information	
Mod	INC	Mode
Beh	INS	Behaviour
Health	INS	Health
NamPlt	LPL	Name plate
	Measured vlaues	
CVIn	CMV	Complex analog value Input

Table 50: Logical node type CMVGGIO (Edition 1)

CMVGGIO		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
	Common logical node information	
Beh	INS	Behaviour
	Measured vlaues	
CVIn1	CMV	Complex analog value Input

Table 51: Logical node type CMVGGIO (Edition 2)

10.3.4.4 Controllable status information

10.3.4.4.1 LN type: SCGGIO

SCGGIO		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
	Common logical node information	
Mod	INC	Mode
Beh	INS	Behaviour
Health	INS	Health
NamPlt	LPL	Name plate
	Controls	
SPCSO	SPC	Single point controllable status output

Table 52: Logical node type SCGGIO (Edition 1)

SCGGIO		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
		Common logical node information
Beh	INS	Behaviour
		Controls
SPCSO1	SPC	Single point controllable status output

Table 53: Logical node type SCGGIO (Edition 2)

10.3.4.4.2 LN type: SC8GGIO

SC8GGIO		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
		Common logical node information
Mod	INC	Mode
Beh	INS	Behaviour
Health	INS	Health
NamPlt	LPL	Name plate
		Controls
SPCSO1	SPC	Single point controllable status output
SPCSO2	SPC	Single point controllable status output
SPCSO3	SPC	Single point controllable status output
SPCSO4	SPC	Single point controllable status output
SPCSO5	SPC	Single point controllable status output
SPCSO6	SPC	Single point controllable status output
SPCSO7	SPC	Single point controllable status output
SPCSO8	SPC	Single point controllable status output

Table 54: Logical node type SC8GGIO (Edition 1)

SC8GGIO		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
		Common logical node information
Beh	INS	Behaviour
		Controls
SPCSO1	SPC	Single point controllable status output
SPCSO2	SPC	Single point controllable status output
SPCSO3	SPC	Single point controllable status output

Table 55: Logical node type SC8GGIO (Edition 2)

SC8GGIO		
SPCSO4	SPC	Single point controllable status output
SPCSO5	SPC	Single point controllable status output
SPCSO6	SPC	Single point controllable status output
SPCSO7	SPC	Single point controllable status output
SPCSO8	SPC	Single point controllable status output

Table 55: Logical node type SC8GGIO (Edition 2)

10.3.4.4.3 LN type: SC16GGIO

SC16GGIO		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
	Common logical node information	
Mod	INC	Mode
Beh	INS	Behaviour
Health	INS	Health
NamPlt	LPL	Name plate
	Controls	
SPCSO1	SPC	Single point controllable status output
SPCSO2	SPC	Single point controllable status output
SPCSO3	SPC	Single point controllable status output
SPCSO4	SPC	Single point controllable status output
SPCSO5	SPC	Single point controllable status output
SPCSO6	SPC	Single point controllable status output
SPCSO7	SPC	Single point controllable status output
SPCSO8	SPC	Single point controllable status output
SPCSO9	SPC	Single point controllable status output
SPCSO10	SPC	Single point controllable status output
SPCSO11	SPC	Single point controllable status output
SPCSO12	SPC	Single point controllable status output
SPCSO13	SPC	Single point controllable status output
SPCSO14	SPC	Single point controllable status output
SPCSO15	SPC	Single point controllable status output
SPCSO16	SPC	Single point controllable status output

Table 56: Logical node type SC16GGIO (Edition 1)

SC16GGIO		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		

Table 57: Logical node type SC16GGIO (Edition 2)

SC16GGIO		
	Common logical node information	
Beh	INS	Behaviour
	Controls	
SPCSO1	SPC	Single point controllable status output
SPCSO2	SPC	Single point controllable status output
SPCSO3	SPC	Single point controllable status output
SPCSO4	SPC	Single point controllable status output
SPCSO5	SPC	Single point controllable status output
SPCSO6	SPC	Single point controllable status output
SPCSO7	SPC	Single point controllable status output
SPCSO8	SPC	Single point controllable status output
SPCSO9	SPC	Single point controllable status output
SPCSO10	SPC	Single point controllable status output
SPCSO11	SPC	Single point controllable status output
SPCSO12	SPC	Single point controllable status output
SPCSO13	SPC	Single point controllable status output
SPCSO14	SPC	Single point controllable status output
SPCSO15	SPC	Single point controllable status output
SPCSO16	SPC	Single point controllable status output

Table 57: Logical node type SC16GGIO (Edition 2)

10.3.4.4.4 LN type: DCGGIO

DCGGIO		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
	Common logical node information	
Mod	INC	Mode
Beh	INS	Behaviour
Health	INS	Health
NamPlt	LPL	Name plate
	Controls	
DPCSO	DPC	Double point controllable status output

Table 58: Logical node type DCGGIO (Edition 1)

DCGGIO		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
	Common logical node information	

Table 59: Logical node type DCGGIO (Edition 2)

DCGGIO		
Beh	INS	Behaviour
		Controls
DPCSO1	DPC	Double point controllable status output

Table 59: Logical node type DCGGIO (Edition 2)

10.3.4.4.5 LN type: DC8GGIO

DC8GGIO		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
		Common logical node information
Mod	INC	Mode
Beh	INS	Behaviour
Health	INS	Health
NamPlt	LPL	Name plate
		Controls
DPCSO1	DPC	Double point controllable status output
DPCSO2	DPC	Double point controllable status output
DPCSO3	DPC	Double point controllable status output
DPCSO4	DPC	Double point controllable status output
DPCSO5	DPC	Double point controllable status output
DPCSO6	DPC	Double point controllable status output
DPCSO7	DPC	Double point controllable status output
DPCSO8	DPC	Double point controllable status output

Table 60: Logical node type DC8GGIO (Edition 1)

DC8GGIO		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
		Common logical node information
Beh	INS	Behaviour
		Controls
DPCSO1	DPC	Double point controllable status output
DPCSO2	DPC	Double point controllable status output
DPCSO3	DPC	Double point controllable status output
DPCSO4	DPC	Double point controllable status output
DPCSO5	DPC	Double point controllable status output
DPCSO6	DPC	Double point controllable status output
DPCSO7	DPC	Double point controllable status output
DPCSO8	DPC	Double point controllable status output

Table 61: Logical node type DC8GGIO (Edition 2)

10.3.4.4.6 LN type: INCGGIO

INCGGIO		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
	Common logical node information	
Mod	INC	Mode
Beh	INS	Behaviour
Health	INS	Health
NamPlt	LPL	Name plate
	Controls	
ISCSO	INC	Integer status controllable status output

Table 62: Logical node type INCGGIO (Edition 1)

INCGGIO		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
	Common logical node information	
Beh	INS	Behaviour
	Controls	
ISCSO1	INC	Integer status controllable status output

Table 63: Logical node type INCGGIO (Edition 2)

10.3.4.4.7 LN type: BSCGGIO

BSCGGIO		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
	Common logical node information	
Mod	INC	Mode
Beh	INS	Behaviour
Health	INS	Health
NamPlt	LPL	Name plate
	Controls	
RCO	BSC	Regulation step command output

Table 64: Logical node type BSCGGIO (Edition 1)

BSCGGIO		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
	Common logical node information	
Beh	INS	Behaviour
	Controls	
RCO1	BSC	Regulation step command output

Table 65: Logical node type BSCGGIO (Edition 2)

10.3.5 LN Group M: Logical nodes for metering and measurement

10.3.5.1 LN type: MMTR

MMTR		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
	Common logical node information	
Mod	INC	Mode
Beh	INS	Behaviour
Health	INS	Health
NamPlt	LPL	Name plate
	Metered values	
TotVAh	BCR[1]	Net apparent energy since last reset
TotWh	BCR[1]	Net Real energy since last reset
TotVArh	BCR[1]	Net Reactive energy since last reset

Table 66: Logical node type MMTR (Edition 1)

1 The data type behind BCR.actVal and BCR.frVal is INT32 and the limits are accordingly

MMTR		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
	Common logical node information	
Beh	ENS	Behaviour
	Metered values	
TotVAh	BCR[1]	Net apparent energy since last reset
TotWh	BCR[1]	Net Real energy since last reset
TotVArh	BCR[1]	Net Reactive energy since last reset

Table 67: Logical node type MMTR (Edition 2)

1 The data type behind BCR.actVal and BCR.frVal is INT32 and the limits are accordingly

10.3.5.2 LN type: MMXN

MMXN		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
	Common logical node information	
Mod	INC	Mode
Beh	INS	Behaviour
Health	INS	Health
NamPlt	LPL	Name plate
	Measured values	
Amp	MV	Current I (rms) not allocated to a phase
Vol	MV	Voltage V (rms) not allocated to a phase
Watt	MV	Power (P) not allocated to a phase
VolAmpr	MV	Reactive Power (Q) not allocated to a phase
VolAmp	MV	Apparent Power (S) not allocated to a phase
PwrFact	MV	Power Factor not allocated to a phase
Imp	CMV	Impedance
Hz	MV	Frequency

Table 68: Logical node type MMXN (Edition 1)

MMXN		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
	Common logical node information	
Beh	ENS	Behaviour
	Measured values	
Amp	MV	Current I (rms) not allocated to a phase
Vol	MV	Voltage V (rms) not allocated to a phase
Watt	MV	Power (P) not allocated to a phase
VolAmpr	MV	Reactive Power (Q) not allocated to a phase
VolAmp	MV	Apparent Power (S) not allocated to a phase
PwrFact	MV	Power Factor not allocated to a phase
Imp	CMV	Impedance
Hz	MV	Frequency

Table 69: Logical node type MMXN (Edition 2)

10.3.5.3 LN type: MMXU

MMXU		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
	Common logical node information	
Mod	INC	Mode
Beh	INS	Behaviour
Health	INS	Health
NamPlt	LPL	Name plate
	Measured values	
TotW	MV	Total Active Power (Total P)
TotVAr	MV	Total Reactive Power (Total Q)
TotVA	MV	Total Apparent Power (Total S)
TotPF	MV	Average Power factor (Total PF)
Hz	MV	Frequency
PPV	DEL	Phase to phase voltages (VL1VL2, …)
PhV	WYE	Phase to ground voltages (VL1ER, …)
A	WYE	Phase currents (IL1, IL2, IL3)
W	WYE	Phase active power (P)
Var	WYE	Phase reactive power (Q)
VA	WYE	Phase apparent power (S)
PF	WYE	Phase power factor
Z	WYE	Phase Impedance

Table 70: Logical node type MMXU (Edition 1)

MMXU		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
	Common logical node information	
Beh	ENS	Behaviour
	Measured values	
TotW	MV	Total Active Power (Total P)
TotVAr	MV	Total Reactive Power (Total Q)
TotVA	MV	Total Apparent Power (Total S)
TotPF	MV	Average Power factor (Total PF)
Hz	MV	Frequency
PPV	DEL	Phase to phase voltages (VL1VL2, …)
PhV	WYE	Phase to ground voltages (VL1ER, …)
A	WYE	Phase currents (IL1, IL2, IL3)
W	WYE	Phase active power (P)

Table 71: Logical node type MMXU (Edition 2)

MMXU		
Var	WYE	Phase reactive power (Q)
VA	WYE	Phase apparent power (S)
PF	WYE	Phase power factor
Z	WYE	Phase Impedance

Table 71: Logical node type MMXU (Edition 2)

10.3.6 LN Group P: Logical nodes for protection functions

10.3.6.1 LN type: PTOC

PTOC		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
	Common logical node information	
Mod	INC	Mode
Beh	INS	Behaviour
Health	INS	Health
NamPlt	LPL	Name plate
	Status information	
Str	ACD	Start
Op	ACT	Operate

Table 72: Logical node type PTOC (Edition 1)

PTOC		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
	Common logical node information	
Beh	ENS	Behaviour
	Status information	
Str	ACD	Start
Op	ACT	Operate

Table 73: Logical node type PTOC (Edition 2)

10.3.6.2 LN type: PDIS

PDIS		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		

Table 74: Logical node type PDIS (Edition 1)

PDIS		
	Common logical node information	
Mod	INC	Mode
Beh	INS	Behaviour
Health	INS	Health
NamPlt	LPL	Name plate
	Status information	
Str	ACD	Start
Op	ACT	Operate

Table 74: Logical node type PDIS (Edition 1)

PDIS		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
	Common logical node information	
Beh	ENS	Behaviour
	Status information	
Str	ACD	Start
Op	ACT	Operate

Table 75: Logical node type PDIS (Edition 2)

10.3.6.3 LN type: PDIF

PDIF		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
	Common logical node information	
Mod	INC	Mode
Beh	INS	Behaviour
Health	INS	Health
NamPlt	LPL	Name plate
	Status information	
Op	ACT	Operate

Table 76: Logical node type PDIF (Edition 1)

PDIF		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
	Common logical node information	

Table 77: Logical node type PDIF (Edition 2)

PDIF		
Beh	ENS	Behaviour
		Status information
Op	ACT	Operate

Table 77: Logical node type PDIF (Edition 2)

10.3.6.4 LN type: PTOF

PTOF		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
		Common logical node information
Mod	INC	Mode
Beh	INS	Behaviour
Health	INS	Health
NamPlt	LPL	Name plate
		Status information
Str	ACD	Start
Op	ACT	Operate

Table 78: Logical node type PTOF (Edition 1)

PTOF		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
		Common logical node information
Beh	ENS	Behaviour
		Status information
Str	ACD	Start
Op	ACT	Operate

Table 79: Logical node type PTOF (Edition 2)

10.3.6.5 LN type: PTUF

PTUF		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
		Common logical node information
Mod	INC	Mode
Beh	INS	Behaviour

Table 80: Logical node type PTUF (Edition 1)

PTUF		
Health	INS	Health
NamPlt	LPL	Name plate
		Status information
Str	ACD	Start
Op	ACT	Operate

Table 80: Logical node type PTUF (Edition 1)

PTUF		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
		Common logical node information
Beh	ENS	Behaviour
		Status information
Str	ACD	Start
Op	ACT	Operate

Table 81: Logical node type PTUF (Edition 2)

10.3.6.6 LN type: PTOV

PTOV		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
		Common logical node information
Mod	INC	Mode
Beh	INS	Behaviour
Health	INS	Health
NamPlt	LPL	Name plate
		Status information
Str	ACD	Start
Op	ACT	Operate

Table 82: Logical node type PTOV (Edition 1)

PTOV		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
		Common logical node information
Beh	ENS	Behaviour
		Status information

Table 83: Logical node type PTOV (Edition 2)

PTOV		
Str	ACD	Start
Op	ACT	Operate

Table 83: Logical node type PTOV (Edition 2)

10.3.6.7 LN type: PTUV

PTUV		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
	Common logical node information	
Mod	INC	Mode
Beh	INS	Behaviour
Health	INS	Health
NamPlt	LPL	Name plate
	Status information	
Str	ACD	Start
Op	ACT	Operate

Table 84: Logical node type PTUV (Edition 1)

PTUV		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
	Common logical node information	
Beh	ENS	Behaviour
	Status information	
Str	ACD	Start
Op	ACT	Operate

Table 85: Logical node type PTUV (Edition 2)

10.3.6.8 LN type: PSDE

PSDE		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
	Common logical node information	
Mod	INC	Mode
Beh	INS	Behaviour
Health	INS	Health

Table 86: Logical node type PSDE (Edition 1)

PSDE		
NamPlt	LPL	Name plate
		Status information
Str	ACD	Start
Op	ACT	Operate

Table 86: Logical node type PSDE (Edition 1)

PSDE		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
		Common logical node information
Beh	ENS	Behaviour
		Status information
Str	ACD	Start
Op	ACT	Operate

Table 87: Logical node type PSDE (Edition 2)

10.3.6.9 LN type: PTEF

PTEF		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
		Common logical node information
Mod	INC	Mode
Beh	INS	Behaviour
Health	INS	Health
NamPlt	LPL	Name plate
		Status information
Str	ACD	Start
Op	ACT	Operate

Table 88: Logical node type PTEF (Edition 1)

PTEF		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
		Common logical node information
Beh	ENS	Behaviour
		Status information
Str	ACD	Start

Table 89: Logical node type PTEF (Edition 2)

PTEF		
Op	ACT	Operate

Table 89: Logical node type PTEF (Edition 2)

10.3.6.10 LN type: PSCH

PSCH		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
		Common logical node information
Mod	INC	Mode
Beh	INS	Behaviour
Health	INS	Health
NamPlt	LPL	Name plate
		Status information
ProTx	SPS	Teleprotection signal transmitted
ProRx	SPS	Teleprotection signal received
Str	ACD	Carrier Send
Op	ACT	Operate

Table 90: Logical node type PSCH (Edition 1)

PSCH		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
		Common logical node information
Beh	ENS	Behaviour
		Status information
Op	ACT	Operate

Table 91: Logical node type PSCH (Edition 2)

10.3.6.11 LN type: PTRC

PTRC		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
		Common logical node information
Mod	INC	Mode
Beh	INS	Behaviour
Health	INS	Health

Table 92: Logical node type PTRC (Edition 1)

PTRC		
NamPlt	LPL	Name plate
		Status information
Op	ACT	Operate (combination of subscribed Op from protection functions)
Str	ACD	Sum of all starts of all connected Logical Nodes

Table 92: Logical node type PTRC (Edition 1)

PTRC		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
	Common logical node information	
Beh	ENS	Behaviour
		Status information
Op	ACT	Operate (combination of subscribed Op from protection functions)
Str	ACD	Sum of all starts of all connected Logical Nodes

Table 93: Logical node type PTRC (Edition 2)

10.3.7 LN Group R: Logical nodes for protection related functions

10.3.7.1 LN type: RBRF

RBRF		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
	Common logical node information	
Mod	INC	Mode
Beh	INS	Behaviour
Health	INS	Health
NamPlt	LPL	Name plate
		Status information
OpEx	ACT	Breaker failure trip (“external trip”)
OpIn	ACT	Operate, retrip (“internal trip”)

Table 94: Logical node type RBRF (Edition 1)

RBRF		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
	Common logical node information	

Table 95: Logical node type RBRF (Edition 2)

RBRF		
Beh	ENS	Behaviour
		Status information
OpEx	ACT	Breaker failure trip (“external trip”)
OpIn	ACT	Operate, retrip (“internal trip”)

Table 95: Logical node type RBRF (Edition 2)

10.3.7.2 LN type: RREC

RREC		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
		Common logical node information
Mod	INC	Mode
Beh	INS	Behaviour
Health	INS	Health
NamPlt	LPL	Name plate
		Status information
Op	ACT	Operate (used here to provide close to XCBR)
AutoRecSt	INS	Auto Reclosing Status

Table 96: Logical node type RREC (Edition 1)

RREC		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
		Common logical node information
Beh	ENS	Behaviour
		Status information
OpCls	ACT	Operation ”close switch” issued to close the XCBR
AutoRecSt	ENS	Auto Reclosing Status

Table 97: Logical node type RREC (Edition 2)

10.3.7.3 LN type: RSYN

RSYN		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
		Common logical node information
Mod	INC	Mode

Table 98: Logical node type RSYN (Edition 1)

RSYN		
Beh	INS	Behaviour
Health	INS	Health
NamPlt	LPL	Name plate
		Status information
Rel	SPS	Release

Table 98: Logical node type RSYN (Edition 1)

RSYN		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
		Common logical node information
Beh	ENS	Behaviour
		Status information
Rel	SPS	Release

Table 99: Logical node type RSYN (Edition 2)

10.3.8 LN Group S: Logical Nodes for sensors and monitoring

10.3.8.1 LN type: SIMG

SIMG		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
		Common logical node information
Mod	INC	Mode
Beh	INS	Behaviour
Health	INS	Health
NamPlt	LPL	Name plate
		Status information
InsAlm	SPS	Insulation gas critical (refill isolation medium)
PresAlm	SPS	Isolation gas pressure alarm
DenAlm	SPS	Isolation gas density alarm
TmpAlm	SPS	Isolation gas temperature alarm

Table 100: Logical node type SIMG (Edition 1)

SIMG		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		

Table 101: Logical node type SIMG (Edition 2)

SIMG		
	Common logical node information	
Beh	ENS	Behaviour
	Status information	
InsAlm	SPS	Insulation gas critical (refill isolation medium)
PresAlm	SPS	Isolation gas pressure alarm
DenAlm	SPS	Isolation gas density alarm
TmpAlm	SPS	Isolation gas temperature alarm

Table 101: Logical node type SIMG (Edition 2)

10.3.8.2 LN type: SIML

SIML		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
	Common logical node information	
Mod	INC	Mode
Beh	INS	Behaviour
Health	INS	Health
NamPlt	LPL	Name plate
	Status information	
InsAlm	SPS	Insulation gas critical (refill isolation medium)
TmpAlm	SPS	Insulation liquid temperature alarm
PresTr	SPS	Insulation liquid pressure trip
PresAlm	SPS	Insulation liquid pressure alarm

Table 102: Logical node type SIML (Edition 1)

SIML		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
	Common logical node information	
Beh	ENS	Behaviour
	Status information	
InsAlm	SPS	Insulation gas critical (refill isolation medium)
TmpAlm	SPS	Insulation liquid temperature alarm
GasInsAlm	SPS	If true, the gas in the insulation liquid abnormal condition has been detected
GasInsTr	SPS	If true, the gas in the insulation liquid dangerous condition has been detected

Table 103: Logical node type SIML (Edition 2)

10.3.9 LN Group X: Logical nodes for switchgear

10.3.9.1 LN type: XCBR

XCBR		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
	Common logical node information	
Mod	INC	Mode
Beh	INS	Behaviour
Health	INS	Health
NamPlt	LPL	Name plate
Loc	SPS	Local operation (local means without substation automation communication, hardwired direct control)
EEHealth	INS	External equipment health
OpCnt	INS	Operation counter
	Controls	
Pos	DPC	Switch position
BlkOpn	SPC	Block opening
BlkCls	SPC	Block closing
	Status information	
CBOpCap	INS	Circuit breaker operating capability

Table 104: Logical node type XCBR (Edition 1)

XCBR		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
	Common logical node information	
Beh	ENS	Behaviour
Loc	SPS	Local operation (local means without substation automation communication, hardwired direct control)
EEHealth	ENS	External equipment health
OpCnt	INS	Operation counter
	Controls	
Pos	DPC	Switch position
BlkOpn	SPC	Block opening
BlkCls	SPC	Block closing
	Status information	
CBOpCap	ENS	Circuit breaker operating capability

Table 105: Logical node type XCBR (Edition 2)

10.3.9.2 LN type: XSWI

XSWI		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
		Common logical node information
Mod	INC	Mode
Beh	INS	Behaviour
Health	INS	Health
NamPlt	LPL	Name plate
Loc	SPS	Local operation (local means without substation automation communication, hardwired direct control)
EEHealth	INS	External equipment health
OpCnt	INS	Operation counter
		Controls
Pos	DPC	Switch position
BlkOpn	SPC	Block opening
BlkCls	SPC	Block closing
		Status informaton
SwTyp	INS	Switch type
SwOpCap	INS	Switch operating capability

Table 106: Logical node type XSWI (Edition 1)

XSWI		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
		Common logical node information
Beh	ENS	Behaviour
Loc	SPS	Local operation (local means without substation automation communication, hardwired direct control)
EEHealth	ENS	External equipment health
OpCnt	INS	Operation counter
		Controls
Pos	DPC	Switch position
BlkOpn	SPC	Block opening
BlkCls	SPC	Block closing
		Status informaton
SwTyp	ENS	Switch type

Table 107: Logical node type XSWI (Edition 2)

XSWI		
SwOpCap	ENS	Switch operating capability

Table 107: Logical node type XSWI (Edition 2)

10.3.10 LN Group Y: Logical nodes for power transformer

10.3.10.1 LN type: YLTC

YLTC		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
		Common logical node information
Mod	INC	Mode
Beh	INS	Behaviour
Health	INS	Health
NamPlt	LPL	Name plate
EEHealth	INS	External equipment health
		Controls
TapChg	BSC	Change Tap Position (stop, higher, lower)
		Status informaton
EndPosR	SPS	End position raise reached
EndPosL	SPS	End position lower reached

Table 108: Logical node type YLTC (Edition 1)

YLTC		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
		Common logical node information
Beh	ENS	Behaviour
EEHealth	ENS	External equipment health
		Controls
TapChg	BSC	Change Tap Position (stop, higher, lower)
		Status informaton
EndPosR	SPS	End position raise reached
EndPosL	SPS	End position lower reached

Table 109: Logical node type YLTC (Edition 2)

10.3.10.2 LN type: YEFN

YEFN		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
		Common logical node information
Mod	INC	Mode
Beh	INS	Behaviour
Health	INS	Health
NamPlt	LPL	Name plate
EEHealth	INS	External equipment health
Loc	SPS	Local operation
		Measured Values
ECA	MV	Earth coil current
		Controls
ColTapPos	ISC	End position raise reached

Table 110: Logical node type YEFN (Edition 1)

YEFN		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
		Common logical node information
Beh	ENS	Behaviour
EEHealth	ENS	External equipment health
Loc	SPS	Local operation
		Measured Values
ColPosA	MV	Coil position derived from the air gap
		Controls
ColTapPos	ISC	End position raise reached

Table 111: Logical node type YEFN (Edition 2)

10.3.11 LN Group Z: Logical Nodes for further power system equipment

10.3.11.1 LN type: ZAXN

ZAXN		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
		Common logical node information
Mod	INC	Mode

Table 112: Logical node type ZAXN (Edition 1)

ZAXN		
Beh	INS	Behaviour
Health	INS	Health
NamPlt	LPL	Name plate
EEHealth	INS	External equipment health

Table 112: Logical node type ZAXN (Edition 1)

ZAXN		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
	Common logical node information	
Beh	ENS	Behaviour
EEHealth	ENS	External equipment health

Table 113: Logical node type ZAXN (Edition 2)

10.4 Tissues Conformance Statement (TICS)

This chapter contains the technical issues (tissues) conformance statement. According to the UCA IUG QAP the tissue conformance statement is required to perform a conformance test and is referenced on the certificate.

The tissues are grouped in mandatory interoperability tissues (IntOp tissues), optional interoperability tissues and other tissues. The following tables are structured in the columns:

Part: Section of the IEC 61850 standard the tissue belongs to

Tissue Nr: Number of the tissue according to the database provided under http://www.tissues.iec61850.com

Description: Short description of the tissue

Implemented: Indicates whether the tissue is implemented in the device. The meaning of the abbreviations are
Y = Yes the tissue is implemented in the device
N = No the tissue is not implemented in the device
na = Not applicable, the tissue is not applicable for the device

The following chapters are applicable for RTU500 series IEC 61850 Edition 1 and Edition 2 server.

10.4.1 Mandatory Edition 1 IntOp Tissues

During the October 2006 meeting IEC TC57 working group 10 decided that:

- green Tissues with the category “IntOp¨ are mandatory for IEC 61850 edition 1
- Tissues with the category “Ed.2¨ Tissues should not be implemented.

Below table gives an overview of the implemented Edition 1 IntOp Tissues.

Part	Tissue Nr	Description	Implemented Y/na
8-1	116	GetNameList with empty response?	Y
	165	Improper Error Response for GetDataSetValues	Y
	183	GetNameList error handling	Y
7-4	252	PTTR.AlmThm	na
7-3	28	Definition of APC	na
	54	Point def xVal, not cVal	na
	55	Ineut = Ires ?	na
	63	mag in CDC CMV	na
	219	operTm in ACT	na
	270	WYE and DEL rms values	na
	1199	Allow INT32 for CDC BCR	Y
7-2	30	control parameter T	Y
	31	Typo	na
	32	Typo in syntax	na
	35	Typo Syntax Control time	na
	36	Syntax parameter DSet-Ref missing	na
	37	Syntax GOOSE "T" type	Y
	39	Add DstAddr to GoCB	Y
	40	GOOSE Message “AppID” to “GoID”	Y
	41	GsCB “AppID” to “GsID”	na
	42	SV timestamp: “EntryTime” to “TimeStamp"	na
	43	Control "T" semantic	Y
	44	AddCause - Object not sel	Y
	45	Missing AddCauses (neg range)	na
	46	Synchro check cancel	Y
	47	"." in LD Name?	na
	49	BRCB TimeOfEntry (part of #453)	Y
	50	LNName start with number?	na
	51	ARRAY [0..num] missing	na
	52	Ambiguity GOOSE SqNum	Y
	53	Add DstAddr to GsCB, SV	na

Table 114: Mandatory Edition 1 IntOp Tissues

Part	Tissue Nr	Description	Implemented Y/na
	151	Name constraint for control blocks etc.	na
	166	DataRef attribute in Log	na
	185	Logging - Integrity periode	na
	189	SV Format	na
	190	BRCB: EntryId and TimeOfEntry (part of #453)	Y
	191	BRCB: Integrity and buffering reports (part of #453)	Y
	234	New type CtxInt (Enums are mapped to 8 bit integer)	na
	275	Confusing statement on GI usage (part of #453)	Y
	278	EntryId not valid for a server (part of #453)	Y
	297	Sequence number (part of #453)	Y
	298	Type of SqNum (part of #453)	Y
	305	Reporting with BufTm=0 (part of #453)	Y
	322	Write Configuration attribute of BRCBs (part of #453)	Y
	329	Reporting and BufOvl (part of #453)	Y
	333	Enabling of an incomplete GoCB	na
	335	Clearing of Bufovfl (part of #453)	Y
	348	URCB class and report (part of #453)	Y
	349	BRCB TimeOfEntry has two definitions (part of #453)	Y
	1281	Default for TrgOps.GI is TRUE	Y
6	1	Syntax	na
	5	tExtensionAttributeNameEnum is restricted	na
	8	SIUnit enumeration for W	Y
	10	Base type for bitstring usage	Y
	17	DAI/SDI elements syntax	na
	169	Ordering of enum differs from 7-3	na
NOTE: Tissue 49, 190, 191, 275 and 278 are part of the optional tissue #453, all other technical tissues in the table are mandatory if applicable.			
NOTE: Editorial tissues are marked as “na”.			
NOTE: Final proposal on tissue 45 is not defined yet			

Table 114: Mandatory Edition 1 IntOp Tissues

10.4.2 Optional Edition 1 IntOp Tissues

After the approval of the server conformance test procedures version 2.2 the following IntOp tissues were added or changed. It is optional to implement these tissues.

Part	Tissue Nr	Description	Implemented Y/N/na
8-1	246	Control negative response (SBOns) with LastApplError	N
	545	Skip file directories with no files	na
7-2	333	Enabling of an incomplete GoCB	na
	453	Combination of all reporting and logging tissues	Y
6	245	Attribute RptId in SCL is optional	na
	526	Replace sev - Unknown by unknown	na

Table 115: Optional Edition 1 IntOp Tissues

10.4.3 Mandatory Edition 2 Tissues

Below table gives an overview of the implemented Edition 2 Tissues.

Part	Tissue Nr	Description	Implemented Y/na
8-1	753	Whether "GoID" and "DatSet" in GoCB are writable?	na
	770	GoID type mitmatch 18.1.1 and 18.1.2.5.2	na
	777	AddCause values	na
	784	Tracking of control (CTS)	na
	817	Fixed-length GOOSE float encoding	na
	821	AlternateAccess in GetAllDataValues	na
	827	Mandatory ACSI services	na
	834	File dir name length 64	na
	851	bType wrong for "check" in sample SCL file	na
	854	GetDataValues - single or multiple objects	Y
	935	Typing error in table 101	na
	942	Wrong description of S bit in reserved word	na
	951	Encoding of Owner attribute	na
	1036	FileDirectory response	na
	1037	GetDataSetValues SpecWithResult	Y
	1040	More associate error codes	Y
	1041	LTS and OTS mapping	na
	1042	SGCB definition includes information that is not mapping specific	na
	1043	SetEditSGValues should not detail nothing about non-volatile storage	na
	1047		na

Table 116: Mandatory Edition 2 Tissues

Part	Tissue Nr	Description	Implemented Y/na
	1058	"Currency" basictype is not mapped	Y
	1066	OSI-AP-Title value	na
	1155	UtcTime wrong referecne	Y
	1164	ResvTms definition should be integer in the BRCB structure	na
	1178	DeleteDataSet response- refers to wrong clause	Y
	1181	Select Response+ is non-null value	na
	1192	Conformance requirement for InformationReport Ambiguous	na
	1274	GoCB MinTime/MaxTime size	na
	1285	GetServerDirectory(FILE) typo	Y
	1287	ICD file must have a communication section for 8-1 implementation	na
	1289	COMTRADE zip file contents	na
	1299	typo: LLNO -> LLN0	na
	1300	Missing semantics for localDetailCalling	na
	1309	Behavior for a ContimueAfter where the File no longer exists	na
	1324	Extraneous normative reference:10608-1 and -2	na
	1336	The response- for DeleteNamedVariableList is not defined	na
	1361	enhanced the mapping text for the setValues.	Y
	1441	Variable length Quality encoding	Y
	1442	Optonal fields in buffered reports	Y
	1443	Journal variableTag for ReasonCode	na
	1453	Reading SE when EditSG=0	Y
	1454	Purge buffer on write to BRCB	Y
	1462	Reports can be generated before write(RptEna=true) is confirmed	na
	1495	SNTP references to RFCs are different	na
		GetVariableAccessAttributes error code	
7-4	671	Mistake in definition of Mod & Beh	Y
	674	CDC of ZRRC.LocSta is wrong	na
	675	SIML LN	Y

Table 116: Mandatory Edition 2 Tissues

Part	Tissue Nr	Description	Implemented Y/na
	676	Same data object name used with different CDC	na
	677	MotStr is used with different CDC in PMMS and SOPM LN classes	na
	679	Remove CycTrMod Enum	na
	680	SI unit for MHYD.Cndct	na
	681	Enum PIDAlg	na
	682	ANCR.ParColMod	na
	683	Enum QVVR.IntrDetMth	na
	685	Enum ParTraMod	na
	686	New annex H - enums types in XML	Y
	689	RREC - diagram	na
	693	Description of LTMS.TmChSt1	Y
	694	Data object CmdBlk	na
	695	ARIS.Auto	na
	696	LSVS.St (Status of subscription)	na
	712	Interpretation of quality operatorBlocked	na
	713	DO Naming of time constants in FFIL	na
	714	Enums for ShOpCap and SwOpCap	N
	715	RBDR.ChNum1	na
	716	TAXD text for condition	na
	724	ANCR.Auto	na
	725	Loc in LN A-group	na
	727	RREC - diagram	na
	734	LLN0.OpTmh vs. LPHD.OpTmh	na
	735	ISAF.Alm and ISAF.AlmReset	na
	736	PFSign	na
	742	GAPC.Str, GAPC.Op and GAPC.StrVal	Y
	743	CCGR.PmpCtl and CCGR.FanCtl	na
	744	LN STMP, EEHealth and EEName	na
	748	CBOpCap	na
	749	Description BndCtrChg	na
	772		na

Table 116: Mandatory Edition 2 Tissues

Part	Tissue Nr	Description	Implemented Y/na
	773	LPHD.PwrUp/PwrDn shall be transient	N
	774	Loc, LocKey and LocSta YPSH and YLTC	na
	775	ITCI.LocKey	na
	776	KVLV.ClsLim and OpnLim	na
	790	LPHD.OutOv/InOv and LCCH.OutOv/InOv	na
	800	TVTR.VolSv not in table 10	na
	802	Misspelling in CSYN	na
	808	CCGR and Harmonized control authority	na
	830	Presence condition of ZMOT.DExt and new DOs	na
	831	Mode/Behaviour & Quality	na
	838	Setting of ConfRevNum in LGOS	na
	842	Testing in Beh=Blocked	na
	843	GAPC.Auto change type to SPS	na
	844	GGIO.AnOut1 move to Controls	na
	849	MFLK.PhPiMax, MFLK.PhPiLoFil, MFLK.PhPiRoot DEL->WYE	na
		Presence conditions re-assessing in case of derived statistical calculation	
7-4	877	QVUB -settings should be optional	na
	879	Duplicate definition of HzChr	na
	902	Control Blocks in CommonLN	na
	908	ARIS.StrSeq - transient	na
	909	Remove ANCR.ColOpR and ColOpL	na
	912	Clarification of PwrRtg/VARtg	na
	920	Resetable Counter is NOT resetable	na
	932	Rename AVCO.SptVol to AVCO.VolSpt	na
	933	Presence of LCCH.RedFerCh and RedRxCnt	Y
	939	Change CDC for ANCR.FixCol	na
	940	Clarification of feedback MX for DO with CDC APC	na
	967	Statistical calculation and "M" attributes	na
	991	LGOS: GoCBRef (as well as LSVS.SvCBRef) should be mandatory	na
	1007		na

Table 116: Mandatory Edition 2 Tissues

Part	Tissue Nr	Description	Implemented Y/na
	1044	PTRC as fault indicator - Update of description required	na
	1077	TapChg in AVCO	na
	1177	Rename DOnames within LTIM	na
	1273	Winding ratio for TCTR and TVTR	na
	1294	Behavior of DOI "Beh" due internal condition	Y
	1330	Description of SIML.GasInsAlm reg. Buchholz	na
	1331	proposal in tissue 830 seems not consistent with 7-3 Ed2	na
	1333		na
	1456	Mod, Beh and Health with q=TEST, client can't receive their states	na
	1568	SPS datapoint for Select is not present in LN ATCC for process bus	na
		Annex A and Mod/Beh/Health	
		ISAF.AlmReset ->transient	
7-3	697	persistent command / PulseConfig	na
	698	Wrong case is BAC.dB attribute	na
	709	Semantic of tstEna	na
	722	Units for 'h' and 'min' not in UnitKind enumeration.	Y
	814	subQ bit used	na
	819	APC and ASG	na
	832	Data attribute semantic of minVal & maxVal	na
	839	Use of opRcvd also in Blocked	na
	887	Data semantics for q and t	na
	919	Presence Condition for sVC	na
	924	Missing curve characteristics	na
	925	Presence of i or f attribute - Problem with writing	na
	926	Presence Conditions within RangeConfig	na
	929	condition AC_SCAV unclear	na
	953	missing trigger option forCSG units	na
	954	Data attributes with FC=CF should have trgOp=dchg	na
	962	instMag optional?	na
	968	BCR value range	N

Table 116: Mandatory Edition 2 Tissues

Part	Tissue Nr	Description	Implemented Y/na
	1078	CMV.t update if rangeAng changed	na
	1079	q and t semantic syntax errors	na
	1187	ldNs example value shal be 2007A	na
	1253	Can CDC ACT be used for 3-phase indication?	Y
	1387	Default value of SboClasses	na
	1430	opRcvd for controllable object	na
	1481	configRev presence condition	Y
7-2	728	BRCB: could PurgeBuf be set when RptEna=TRUE?	Y
	778	AddCause values	Y
	780	What are unsupported trigger option at a control block?	Y
	783	TimOper Resp- ; add Authorization check	na
	786	AddCause values 26 and 27 are switched	Y
	813	TimeAccuracy choices	na
	820	Mandatory ACSI services (use for PICS template)	Y
	850	Report Value needs a corresponding index when data-FALSE	Y
	852		na
	858	Check condition type - parameter type wrong	Y
	861	Typo in enumeration ServiceType	na
	869	dchg of ConfRev attribute	na
	875	Grammer/spelling error	na
	876	GenLogiclNodeClass and compatible LN Classes	na
	943	GenLogiclNodeClass and SGCB, GoCB, MsvCB, UsvCB	na
	970	control model change to "local" when TimeActivated-Operate	na
	1038	Wrong reference to GSSE	na
	1050	Loss of Info Detection After Resynch	na
	1061	GTS Phycomaddr definition in SCL	na
	1062	EntryTime wrongly appllied	na
	1071	Entrytime not used in CDC	Y
	1091	Length of DO name	na
	1092		na
	1116	The sentence "The initial value of EditSG shall be 0" in 7.2	na

Table 116: Mandatory Edition 2 Tissues

Part	Tissue Nr	Description	Implemented Y/na
	1127	NewEntrTm and OldEntrTm Type in LOG Class	na
	1145	CONTROL service(s) parameter 'orgin' misspelled	na
	1154	Missing owner attribute in BTS and UTS	na
	1202	T – control time-stamp	Y
	1232	Inconistent Definition for Response Parameter	Y
	1242	GI not optional	na
	1252	EntryID needs clarification	na
	1283	NTS definiton	na
	1307	Data-Instance-ID: is 01 allowed?	Y
	1341	pleonasm "qchg-change" (for Ed.2)	Y
	1428	Segemented report with Buffer overflow	na
	1569	Attribute Owner is missing in GetBRCBValues services	na
		MTS and NTS should use svOptFlds	
		How to track Select service in service tracking?	
7-1	828	Data model namespace revision IEC 61850-7-4:2007[A]	Y
	874	Logical Node Class needs to be updated	na
	948	Enumeration (string) values format	na
	1060	Error in encoding in Figure F.9	na
	1072	Statistical Data and Reporting	na
	1129	Rules for extending nameplate information	na
	1151	Simulated GOOSE disappears after 1st appearance	na
	1251	All "L" logical nodes shall be in the same LD - except for gateways	Y
	1268	Assigment of single CDC to DOclass	na
	1312	Presence condition of lnNs and dataNs	Y
	1396	The use and configuration flow of LGOS and LSVS is Unclear	na
	1491	CmdBlk blocks itself?	na
6	658	Tracking related features	na
	660	XML encoding header repeat	na
	663	FCDA element cannot "functionally constrained logical node"	Y
	668	Autotransformer modeling	na

Table 116: Mandatory Edition 2 Tissues

Part	Tissue Nr	Description	Implemented Y/na
	687	SGCB ResvTms	na
	699	DO type description table	na
	719	ConfDataSet - maxAttributes definition is confusing	Y
	721	Log element name	na
	731	quoted SCL inconsistant with annex.	na
	752	Input Section/ Inputs Section	na
	768	bType VisString65 is missing	na
	779	Object references	Y
	787	SICS I45 inconsistency	Y
	788	SICS S56 from optional to mandatory	na
	789	ConfLdName as services applies to both server and client	Y
	804	valKind and IED versus System configuration	na
	806	Max length of log name inconsistent between -6 and -7-2	na
	807		Y
	823	Need a way to indicate if "Owner" present in RCB	Y
	824	ValKind for structured data attributes	na
	825	Short addresses on structured data attributes	na
	845	Floating point value	na
	853	SGCB ResvTms	na
	855	SBO and ProtNs	N
	856	Recursive SubFunction	na
	857	VoltageLevel frequency and phases	Y
	873	Function/SubFunction for ConductingEquipment	na
	886	Examples for "curvPts"	na
	901	Missing 8-1 P-types	na
	936	tServices as AP or as IED element	na
	949	SupSubscription parameter usage is difficult	na
	1118	type of LN inst is ambiguous	na
	1147	Clarification of how tClientLN is used to enable Report Control Blocks	na
	1175	tServices - FileHandling not consistent with -7-2	na
	1185		na

Table 116: Mandatory Edition 2 Tissues

Part	Tissue Nr	Description	Implemented Y/na
	1195	IPv6 address lowercase only na	na
	1208	Valkind value Conf for EX FC data	na
	1284	Typographical Error	Y
	1298	IPv6 Address format	na
	1304	SCSM mapping may require a communication section in an ICD file	na
	1318	How to differentiate preconfigured Report Datasets and generated ones	na
	1328	Error in the SCL object model	Y
	1354	SSD will not validate against XSD	Y
	1365	Limitation on the size of data type templates identifiers	N
	1397	Changes to SICS Template	na
	1398	Need to tighten up the XSD in regards to IEDName usage	N
	1415	Subscription limitation visible in IxD file	na
	1444	originalSclVersion management in SCT	Y
	1445	SICS-S110 IID import mandatory for Edition2	Y
		Need to support fixed and SCT controlled Datasets	
		ConfReportControl and a fixed ReportSettings	
6	1447	Restriction on ENUMtypes in SCL	Y
	1450	originalSclXxx computation rules	N
	1451	Services section-"client" is confusing	na
	1457	Multiple DOI nodes with the same name.	Y
NOTE: Editorial tissues are marked as “na”.			

Table 116: Mandatory Edition 2 Tissues

10.5 Protocol Implementation extra Information for Testing (PIXIT)

This document specifies the protocol implementation extra information for testing (PIXIT) of the IEC 61850 interface in RTU500 series IEC 61850 server, version 10.6.

Together with the PICS and the MICS the PIXIT forms the basis for a conformance test according to IEC 61850-10.

Each chapter specifies the PIXIT for each applicable ACSI service model as structured in IEC 61850-10.

10.5.1 PIXIT for Association model

ID	Description	Value / Clarification
As1	Maximum number of clients that can set-up an association simultaneously	8 (The number of clients that are able to enable reports is restricted to 5, these clients must be pre-assigned in the SCD file)
As2	TCP_KEEPALIVE value	5 seconds
As3	Lost connection detection time	TCP_KEEPIDLE = 10 s TCP_KEEPCNT = 3 TCP_KEEPINIT = 10 s TCP_KEEPINTVL = 5s 10s after association start to begin sending keepalive, and 15s (3 * 5s) to detect lost connection.
As4	Is authentication supported	N
As5	What association parameters are necessary for successful association	Transport selector Y Session selector Y Presentation selector Y AP Title N AE Qualifier N
As6	If association parameters are necessary for association, describe the correct values e.g.	Transport selector 0001 (default) Session selector 0001 (default) Presentation selector 00000001 (default) AP Title n/a AE Qualifier n/a
As7	What is the maximum and minimum MMS PDU size	Max MMS PDU size 32000 bytes Min MMS PDU size 1024 bytes
As8	What is the maximum start up time after a power supply interrupt	That depends on the other functionalities that are configured for the device. Typical value are 2..3 minutes.

Table 117: PIXIT for Association model

10.5.2 PIXIT for Server model

ID	Description	Value / Clarification
Sr1	Which analogue value (MX) quality bits are supported (can be set by server)	Validity: Y Good, Y Invalid,

Table 118: PIXIT for Server model

ID	Description	Value / Clarification
		N Reserved, N Questionable Y Overflow Y OutofRange N BadReference N Oscillatory N Failure Y OldData N Inconsistent N Inaccurate Source: Y Process Y Substituted Y Test Y OperatorBlocked
Sr2	Which status value (ST) quality bits are supported (can be set by server)	Validity: Y Good, Y Invalid, N Reserved, N Questionable N BadReference N Oscillatory N Failure Y OldData N Inconsistent N Inaccurate Source: Y Process Y Substituted Y Test Y OperatorBlocked

Table 118: PIXIT for Server model

ID	Description	Value / Clarification
Sr3	What is the maximum number of data values in one GetDataValues request	Limited to a MMS read request (GetDataValues) containing a list of maximum 20 entries.
Sr4	What is the maximum number of data values in one SetDataValues request	Service SetDataValues is not supported by the device.
Sr5	Which Mode / Behaviour values are supported	Mode / Behaviour handling is not supported by the device. Therefore the value is “on” always.

Table 118: PIXIT for Server model

10.5.3 PIXIT for Data set model

ID	Description	Value / Clarification
Ds1	What is the maximum number of data elements in one data set (compare ICD setting)	Maximum FCDAs = 150 Maximum Data Attributes = 450 Note: The data elements can be defined on data object level only.
Ds2	How many persistent data sets can be created by one or more clients	Creating data sets by a client online is not supported by the device.
Ds3	How many non-persistent data sets can be created by one or more clients	Creating data sets by a client online is not supported by the device.

Table 119: PIXIT for Data set model

10.5.4 PIXIT for Substitution model

Substitution of values is not supported by the device.

10.5.5 PIXIT for Setting group control model

Setting groups are not supported by the device.

10.5.6 PIXIT for Reporting model

ID	Description	Value / Clarification
Rp1	The supported trigger conditions are (compare PICS)	Integrity Y* data change Y quality change Y data update N general interrogation Y * It is not possible to configure an integrity report for the device and the possible online change is a not supported operating mode

Table 120: PIXIT for Reporting model

ID	Description	Value / Clarification
Rp2	The supported optional fields are	sequence-number Y report-time-stamp Y reason-for-inclusion Y data-set-name Y data-reference Y buffer-overflow Y entryID Y conf-rev Y segmentation Y
Rp3	Can the server send segmented reports	Y
Rp4	Mechanism on second internal data change notification of the same analogue data value within buffer period (Compare IEC 61850-7-2 $14.2.2.9)	Send report immediately
Rp5	Multi client URCB approach (compare IEC 61850-7-2 $14.2.1)	N
Rp6	What is the format of EntryID	Octet string 8
Rp7	What is the buffer size for each BRCB or how many reports can be buffered	50000 bytes for each used BRCB (max. 48 BRCBs a 5 clients = max. 240 BRCB instances)
Rp8	Pre-configured RCB attributes that cannot be changed online when RptEna = FALSE (see also the ICD report settings)	- DatSet - ConfRev - SqNum - TimeofEntry
Rp9	May the reported data set contain: - structured data objects? - data attributes?	Y N
Rp10	What is the scan cycle for binary events? Is this fixed, configurable	The assured accuracy for capturing binary event is +/- 5 milliseconds Fixed
Rp11	Does the device support to pre-assign a RCB to a specific client in the SCL	N

Table 120: PIXIT for Reporting model

10.5.7 PIXIT for Logging model

Logging is not supported by the device.

10.5.8 PIXIT for Generic substation events model

ID	Description	Value / Clarification
Go1	What elements of a subscribed GOOSE header are checked to decide the message is valid and that all data values are accepted? If yes, describe the conditions. Note: the VLAN tag may be removed by a Ethernet switch and should not be checked	N source MAC address Y destination MAC address Y Ethertype = 0x88B8 Y APPID Y gocbRef N/Y timeAllowedtoLive* Y datSet Y goID N t Y stNum Y sqNum Y test Y confRev Y ndsCom Y numDatSetEntries * An invalid TAL value (e.g. TAL=0) doesn't lead to invalidated data but GOOSE telegrams are supervised according to TAL (see Go4)
Go2	Can the test flag in the published GOOSE be turned on / off	N
Go3	What is the behaviour when the GOOSE publish configuration is incorrect	n/a (It is not possible to setup an incorrect GOOSE publish configuration)
Go4	When is a subscribed GOOSE marked as lost? (TAL = time allowed to live value from the last received GOOSE message)	Message does not arrive prior to 2*TAL, then the message is marked as lost at the receiver. (Time allowed to live = Max-Time as defined in IEC 61850 part 6). Note that erroneous GOOSE telegrams are discarded, and valid telegrams are supervised according to TAL.
Go5	What is the behaviour when one or more subscribed GOOSE messages isn't received or syntactically incorrect (missing GOOSE)	Is ignored. The data value of this data are set to invalid if time allowed to live times out.
Go6	What is the behaviour when a subscribed GOOSE message is out-of-order	Is ignored.
Go7	What is the behaviour when a subscribed GOOSE message is duplicated	Is ignored.

Table 121: PIXIT for Generic substation events model

ID	Description	Value / Clarification
Go8	Does the device subscribe to GOOSE messages with/without the VLAN tag?	Y, with the VLAN tag Y, without the VLAN tag
Go9	May the GOOSE data set contain: - structured data objects (FCD)? - timestamp data attributes? Note: data attributes (FCDA) is mandatory	Subscribed Published N N Y N
Go10	Published FCD supported common data classes are	Structured data objects are not supported in GOOSE data sets.
Go11	Subscribed FCD supported common data classes are	Structured data objects are not supported in GOOSE data sets.
Go12	What is the slow retransmission time? Is it fixed or configurable?	The time (MinTime) is configured by the SCD file. Typical values are 1000 ... 10000 mseconds
Go13	What is the fast retransmission scheme? Is it fixed or configurable?	The time (MaxTime) is configured by the SCD file. A typical value is 4 mseconds. The fast retransmission scheme is fix implemented. For e.g. MinTime = 4 mseconds and MaxTime = 10000 mseconds the scheme works as follows: 1. 0ms (SqNum = 0) GOOSE change, 2. 4ms later (SqNum = 1), 3. 4ms later (SqNum = 2), 4. 8ms later (SqNum = 3), 5. 32ms later (SqNum = 4), 6. 128ms later (SqNum = 5), 7. 512ms later (SqNum = 6), 8. 2048ms later (SqNum = 7), 9. 8192ms later (SqNum = 8), 10. 10000ms later (SqNum = 9) and then after every 10000ms (++SqNum) retransmission happens.
Go14	Can the Goose publish be turned on / off by using SetGoCBValues(GoEna)	N
Go15	What is the initial value of the GOOSE telegram sequence number (sqNum)?	The initial sequence number in a GOOSE telegram is defined as follows: • Initial GOOSE send, sqNum = 1 • After GOOSE change, sqNum = 0

TAL = Time Allowed to Live

Table 121: PIXIT for Generic substation events model

10.5.9 PIXIT for Control model

ID	Description	Value / Clarification
Ct1	What control models are supported (compare PICS)	Y status-only Y direct-with-normal-security* N sbo-with-normal-security N direct-with-enhanced-security Y sbo-with-enhanced-security** * The control model DOns is supported for the common data classes INC and ISC ** The control model SBOes is supported for the common data classes DPC, SPC and BSC.
Ct2	Is the control model fixed, configurable and/or online changeable?	Fixed defined for the supported common data classes.
Ct3	Is TimeActivatedOperate supported	N
Ct4	Is “operate-many” supported	N
Ct5	Will the DUT activate the control output when the test attribute is set in the SelectWithValue and/or Operate request (when N test procedure Ctl2 is applicable)	The test mode is not supported by the device.
Ct6	What are the conditions for the time (T) attribute in the SelectWithValue and/or Operate request?	The device ignores the time value and executes the command as defined.
Ct7	Is pulse configuration supported	N
Ct8	What is the behaviour of the DUT when the check conditions are set? Is this behaviour fixed, configurable, online changeable?	N synchrocheck N interlock-check The device ignores the check value Fixed
Ct9	What additional cause diagnosis are supported	Y Blocked-by-switching-hierarchy Y* Select-failed Y* Invalid-position Y* Position-reached Y* Parameter-change-in-execution Y* Step-limit Y* Blocked-by-Mode Y* Blocked-by-process Y* Blocked-by-interlocking Y* Blocked-by-synchrocheck

Table 122: PIXIT for Control model

ID	Description	Value / Clarification
		Y Command-already-in-execution Y* Blocked-by-health Y* 1-of-n-control Y* Abortion-by-cancel Y* Time-limit-over Y* Abortion-by-trip Y Object-not-selected * supported by user created application program (PLC) only
Ct10	How to force a “test-not-ok” respond with SelectWithValue request?	Send a request for the same command already selected or Acquire control authority with local HMI and send a request
Ct11	How to force a “test-not-ok” respond with Select request?	The Select request (SBOns) is not supported by the device
Ct12	How to force a “test-not-ok” respond with Operate request?	DOns: Acquire control authority with local HMI and send a request SBOns: Not supported DOes: Not supported SBOes: Send Operate request for not selected control object
Ct13	Which origin categories are supported?	The device ignores received origin categories and replies with categorie Remote-Control always.
Ct14	What happens if the orCat value is not supported?	DOns: orCat is ignored SBOns: Not supported DOes: Not supported SBOes: orCat is ignored
Ct15	Does the IED accept a SelectWith-Value/Operate with the same ctlVal as the current status value?	DOns: Y SBOns: Not supported DOes: Not supported SBOes: Y
Ct16	Does the IED accept a select/operate on the same control object from 2 different clients at the same time?	DOns: N SBOns: Not supported

Table 122: PIXIT for Control model

ID	Description	Value / Clarification
		DOes: Not supported SBOes: N
Ct17	Does the IED accept a Select/ SelectWithValue from the same client when the control object is already selected (tissue 334)	SBOns: Not supported SBOes: N
Ct18	Is for SBOes the internal validation performed during the SelectWithValue and/ or Operate step?	SelectWithValue and Operate
Ct19	Can a control operation be blocked by Mod=Off or Blocked	Mode / Behaviour handling is not supported by the device.
Ct20	Does the IED support local / remote operation?	Local / remote operations are supported by the means of control authority. When the local HMI holds the control authority, controlling via the IEC 61850 server is blocked (if configured).
Ct21	Does the IED send an InformationReport with LastApplError as part of the Operate response- for control with normal security?	SBOns: Not supported DOns: N

Table 122: PIXIT for Control model

10.5.10 PIXIT for Time and time synchronisation model

ID	Description	Value / Clarification
Tm1	What quality bits are supported (may be set by the IED)	N LeapSecondsKnown N ClockFailure Y ClockNotSynchronized
Tm2	Describe the behaviour when the time synchronization signal/messages are lost	Request of up to 5 SNTP server in unicast mode with a configurable polling interval between 1 and 1440 minutes (one day). In each interval the SNTP client tries to request every configured server two times. If both accesses fail the server is defined as not available. Are the received time from the available servers is significant different (> 1 minute) no time will be accepted. If more than one server is available the sntp client uses for synchronization the time from the server with the lowest transmission delay. Two successful SNTP requests (two intervals) are required to set the internal clock to synchronized.

Table 123: PIXIT for Time and time synchronisation model

ID	Description	Value / Clarification
		Once synchronized the clock is set to not synchronized when for a configurable time (typical 10 minutes) no new synchronization is received.
Tm3	When is the time quality bit "ClockFailure" set?	The quality bit "ClockFailure" is never set.
Tm4	When is the time quality bit "Clock not synchronised" set?	The time quality bit "Clock not synchronised" is set: - At start-up before synchronization - When after synchronization for a configurable time (typical 10 minutes) no new synchronization is received.
Tm5	Is the timestamp of a binary event adjusted to the configured scan cycle?	N
Tm6	Does the device support time zone and daylight saving?	Y
Tm7	Which attributes of the SNTP response packet are validated?	N Leap indicator not equal to 3? Y Mode is equal to SERVER Y OriginateTimestamp is equal to value sent by the SNTP client as Transmit Timestamp Y RX/TX timestamp fields are checked for reasonableness Y SNTP version > 1 and <= 4

Table 123: PIXIT for Time and time synchronisation model

10.5.11 PIXIT for File transfer model

File transfer is not supported by the device.

10.6 SCL Implementation Conformance Statement (SICS)

This SICS is applicable for:

- Tool name: RTUtil500
- Main role: ICT
- Version: 12.2

The following tables contain mandatory and optional features of System Configuration tools and IED configuration tools. It is up to the tool manufacturer to decide to which extent his tool fulfills one or both roles. At least for one main role all mandatory features shall be supported.

The IED configurator features can also partly be implemented within the IED itself, if it can be configured by an SCD or CID file. In this case the conformance statement refers to the combination of IED and IED configurator tool. If an IED tool supports several IED types with different engineering capabilities, then for each combination of tool and IED type a separate IED configurator conformance statement should be given.

The features are grouped. If a group is mandatory, then at least all mandatory features of this group shall be implemented. If a group is optional, then either all features of this group shall be missing, or at least all mandatory ones shall be implemented.

The result of an export function can be checked in the generated SCL file. The result of an import can be checked by tool behaviour, and at the final configured IED, by browsing through it or by its communication behaviour.

		Mandatory/ optional	Value/ comments
ICD export		**M**	
I11	Fix ICD file (no adaptable export needed)	GC_1 (1)	NO
I12	Export of ICD file or IID file according to IED pre-configuration performed by tool	GC_1 (1)	YES
I13	State the data model name space (61850-7-3 subclause 7.2) within ICD file (LLN0.NamPlt.ldNs value)	M	YES
I14	State the data model version (61850-7-3 sub-clause 7.8.3) and any predefined / fixed configuration values within ICD file ([10] 9.5.4.4)	M	YES
I15	Version 2003 export	GC_1 (2)	YES
I16	Version 2007A export	GC_1 (2)	YES
I17	Predefined data sets	O	YES
I18	Predefined control blocks	O	YES
I19	Substation bay template with IED part	O	NO
I110	Communication section with default address	O	YES
I111	Export correct valKind value ([10] Table 46)	O	YES (RO)
I112	Exports internal addresses as InRef or Input section (subclause 285H 9.3.13)	O	NO
I113	Exports internal addresses in Input section with expected serviceType (subclause [10] 9.3.13)	O	NO
I114	Exports in UTF-8 coding	M	YES
SCD import		**M**	
I21	Identify IED to be configured in SCD file by IED name	M	YES
I22	Configure LD name (at least via ldInst, dependent on the IED capabilities) and IED addresses from SCD	M	YES
I23	Determine communication side addresses of IED inputs from SCD	C1	YES
I24	Determine and use clock communication addresses from SCD	C1	NO
I25	Configure values of (existing) control block from SCD([10] 9.3)	C3	NO

Table 124: IED configurator conformance statement

		Mandatory/ optional	Value/ comments
I26	Prepare (new) control block instances according to SCD file	C3	NO
I27	Prepare / configure data sets according to SCD file	C3	NO
I28	Modify predefined data sets according to SCD	C3	NO
I29	Interpret client references in the control blocks of other IEDs to find the control block instances allocated to this IED, and data sent to this IED.	C1	YES
I210	Set IED configuration values and parameter values as defined in SCD file	O	NO
I211	Support changed (reduced capability) valKind (e.g. from Set to RO or to Conf) ([10] Table 46)	O	NO
I212	Support ldName on other IEDs ([10] 9.3.4)	C3	NO
I213	Interpret input signal references to source control blocks (290H 9.3.13)	O	YES
I214	Imports UTF-8 coding of XML	M	YES
IID export after IED engineering			
I31	IED version and instance information: LPHD.PhyNam: hwRev, swRev, serNum, LLN0.NamPlt.configRev	O	NO
I32	Configuration values (fc=CF)	O	NO
I33	Setting Parameter values (fc=SP, SG)	O	NO
I34	SCL Header management ([10] 9.1)	C3	NO
I35	Modify IED data model (add LN/Data object/LD, or remove unused LD/LN/Data object)	O	NO
Tool functionality			
I41	Support MustUnderstand concept ([10] 8.2)	M	YES
I42	Bind incoming 61850 signals to IED internal (input) signals	C1	YES
I43	Use or create IED Input section for binding incoming (external) signals to internal signals, to document this binding	O	YES
I44	Create CID file for IED	O	NO
I45	Support ldName for LD name specification	C3	YES
I46	Modify LN prefixes or lnInst	O	YES (Both can be set as wanted)

C1 - Mandatory, if the IED can receive data from other IEDs, i.e. be either client or subscriber

C2 - Mandatory, if any of the other features in this table section is supported.

C3 - Mandatory, if the appropriate IED capability is claimed in PIXIT or IED capability section.

GC_1 (n) - At least one of the elements of group n shall be available.

Table 124: IED configurator conformance statement

	Mandatory/ optional	Value/ comments
O - Optional; should match the IED capabilities; i.e. if an IED claims that RCBs can be configured by SCL, then the IED tool shall support it. M - Mandatory		

Table 124: IED configurator conformance statement

11 Glossary

AMI	Analog Measured value Input
ASCI	Abstract Communication Service Interface
ASO	Analog Setpoint command Output
BSI	Bit String Input
BSO	Bit String Output
CF	Compact Flash
CMU	Communication and Data Processing Unit
DCE	Data Communication Equipment
DCO	**D**ouble **C**ommand **O**utput
DMI	Digital Measured value Input (8, 16 bit)
DPI	Double Point Input
DSO	Digital Setpoint command Output (8, 16 bit)
FC	Functional Constraint
GOOSE	Generic Object Oriented Substation Event
HCI	Human Maschine Interface (here Integrated HMI function of the RTU500 series)
IED	Intelligent Electronic Device
ITI	Integrated Totals Input
MFI	Analog Measured value Floating Input
OSI	Open Systems Interconnection Model
PDU	Protocol Data Unit
PLC	Programmable Logic Control
PRP	Parallel Redundancy Protocol
RCO	Regulation step Command Output
RTU	Remote Terminal Unit
SBO	Select before Operate
SCD	Substation Configuration Description
SCL	Substation Configuration description Language
SCO	Single Command Output
SCSM	Specific Communication Service Mapping
SEV	System Event
SNTP	Simple Network Time Protocol (according to RFC 4330)

SPI	Single Point Input or Single point information
STI	Step position Input
VLAN	Virtual Local Area Network

Visit us

ABB AG
Power Grids
P.O. Box 10 03 51
68128 Mannheim, Germany

www.abb.com/remote-terminal-units

1KGT 150 702 V009 1

10 Conformance Statements

10.1 Abstract Communication Service Interface (ACSI)

The following ACSI conformance statements are used to provide an overview and details about RTU500 series IEC 61850 server :

- ASCI basic conformance statement,
- ACSI models conformance statement,
- ACSI service conformance statement

The statements specify the communication features mapped to IEC 61850-8-1 Edition 1 and Edition 2.

10.1.1 ACSI Basic Conformance Statement

The ACSI basic conformance statement for RTU500 series IEC 61850 server is defined in following table.

		Client/ sub-scriber	Server/ publisher	RTU500 series server
Client-server roles				
B11	Server side (of TWO-PARTYAPPLICATION-ASSOCIATION)	-	c1	YES
B12	Client side (of TWO-PARTYAPPLICATION-ASSOCIATION)	c1	-	-
SCSMs supported				
B21	SCSM: IEC 61850-8-1 used			YES
B22	SCSM: IEC 61850-9-1 used			-
B23	SCSM: IEC 61850-9-2 used			-
B24	SCSM: other			-
Generic substation event model (GSE)				
B31	Publisher side	-	O	YES (GOOSE only)
B32	Subscriber side	O	-	YES(GOOSE only)
Transmission of sampled value model (SVC)				
B41	Publisher side	-	O	-
B42	Subscriber side	O	-	-

c1 – shall be ‘M’ if support for LOGICAL-DEVICE model has been declared.

O – Optional

M – Mandatory

Table 10: ACSI basic conformance statement

10.1.2 ACSI Models Conformance Statement

The ACSI models conformance statement for RTU500 series IEC 61850 server is defined in following table.

		Client/ sub-scriber	Server/ publisher	RTU500 series server
If Server or Client side (B11/B12) supported				
M1	Logical device	c2	c2	YES
M2	Logical node	c3	c3	YES
M3	Data	c4	c4	YES
M4	Data set	c5	c5	YES
M5	Substitution	O	O	-
M6	Setting group control	O	O	-
	Reporting			
M7	Buffered report control	O	O	YES
M7-1	sequence-number			YES
M7-2	report-time-stamp			YES
M7-3	reason-for-inclusion			YES
M7-4	data-set-name			YES
M7-5	data-reference			YES
M7-6	buffer-overflow			YES
M7-7	entryID			YES
M7-8	BufTm			YES
M7-9	IntgPd			YES
M7-10	GI			YES
M7-11	conf-revision			YES
M8	Unbuffered report control	O	O	YES
M8-1	sequence-number			YES
M8-2	report-time-stamp			YES
M8-3	reason-for-inclusion			YES
M8-4	data-set-name			YES
M8-5	data-reference			YES
M8-6	BufTm			YES
M8-7	IntgPd			YES
M8-8	GI			YES
M8-9	conf-revision			YES
	Logging			
M9	Log control	O	O	-
M9-1	IntgPd			-
M10	Log	O	O	-
M11	Control	M	M	YES
If GSE (B31/B32) is supported				
M12	GOOSE	O	O	YES

Table 11: ACSI model conformance statement

		Client/ sub-scriber	Server/ publisher	RTU500 series server
M13	GSSE	O	O	-
If SVC (B41/B42) is supported				
M14	Multicast SVC	O	O	-
M15	Unicast SVC	O	O	-
For all IEDs				
M16	Time	M	M	YES
M17	File Transfer	O	O	-

c2 – shall be ‘M’ if support for LOGICAL-NODE model has been declared.

c3 – shall be ‘M’ if support for DATA model has been declared.

c4 – shall be ‘M’ if support for DATA-SET, Substitution, Report, Log Control, or Time model has been declared.

c5 – shall be ‘M’ if support for Report, GSE, or SV models has been declared.

O – Optional

M – Mandatory

Table 11: ACSI model conformance statement

10.1.3 ACSI Service Conformance Statement

The ACSI service conformance statement for RTU500 series IEC 61850 server is defined in following table (depending on the statements of table "Tab. 11: ACSI model conformance statement").

Services		AA: TP/MC	Client/ subscriber	Server/ publisher	RTU500 series server
Server (Clause 7)					
S1	ServerDirectory	TP		M	YES
Application association (Clause 8)					
S2	Associate		M	M	YES
S3	Abort		M	M	YES
S4	Release		M	M	YES
Logical device (Clause 9)					
S5	LogicalDeviceDirectory	TP	M	M	YES
Logical node (Clause 10)					
S6	GetLogicalNodeDirectory	TP	M	M	YES
S7	GetAllDataValues	TP	O	M	YES
Data (Clause 11)					
S8	GetDataValues	TP	M	M	YES
S9	SetDataValues	TP	O	O	-
S10	GetDataDirectory	TP	O	M	YES

Table 12: ACSI service conformance statement

Services		AA: TP/MC	Client/ subscriber	Server/ publisher	RTU500 series server
S11	GetDataDefinition	TP	O	M	YES
Data set (Clause 12)					
S12	GetDataSetValues	TP	O	M	YES
S13	SetDataSetValues	TP	O	O	-
S14	CreateDataSet	TP	O	O	-
S15	DeleteDataSet	TP	O	O	-
S16	GetDataSetDirectory	TP	O	O	YES
Setting group control (Clause 16)					
S18	SelectActiveSG	TP	O	O	-
S19	SelectEditSG	TP	O	O	-
S20	SetEditSGValues	TP	O	O	-
S21	ConfirmEditSGValues	TP	O	O	-
S22	GetEditSGValues	TP	O	O	-
S23	GetSGCBValues	TP	O	O	-
Reporting (Clause 17)					
Buffered report control block (BRCB)					
S24	Report	TP	c6	c6	YES
S24-1	data-change (dchg)				YES
S24-2	qchg-change (qchg)				YES
S24-3	data-update (dupd)				YES
S25	GetBRCBValues	TP	c6	c6	YES
S26	SetBRCBValues	TP	c6	c6	YES
Unbuffered report control block (URCB)					
S27	Report	TP	c6	c6	YES
S27-1	data-change (dchg)				YES
S27-2	qchg-change (qchg)				YES
S27-3	data-update (dupd)				YES
S28	GetURCBValues	TP	c6	c6	YES
S29	SetURCBValues	TP	c6	c6	YES
Logging (Clause 17)					
Log control block					
S30	GetLCBValues	TP	M	M	-
S31	SetLCBValues	TP	O	M	-
Log					
S32	QueryLogByTime	TP	c7	M	-
S33	QueryLogAfter	TP	c7	M	-
S34	GetLogStatusValues	TP	M	M	-
Generic substation event model (GSE)					
GOOSE (Clause 18)					
S35	SendGOOSEMessage	MC	c8	c8	YES
S36	GetGoReference	TP	O	c9	YES

Table 12: ACSI service conformance statement

	Services	AA: TP/MC	Client/ subscriber	Server/ publisher	RTU500 series server
S37	GetGOOSEElementNumber	TP	O	c9	YES
S38	GetGoCBValues	TP	O	O	-
S39	SetGoCBValues	TP	O	O	-
GSSE (Annex C)					
S40	SendGSSEMessage	MC	c8	c8	-
S41	GetGsReference	TP	O	c9	-
S42	GetGSSEDataOffset	TP	O	c9	-
S43	GetGsCBValues	TP	O	O	-
S44	SetGsCBValues	TP	O	O	-
Transmission of sampled value model (SVC) (Clause 19)					
Multicast SVC					
S45	SendMSVMessage	MC	c10	c10	-
S46	GetMSVCBValues	TP	O	O	-
S47	SetMSVCBValues	TP	O	O	-
Unicast SVC					
S48	SendUSVMessage	TP	c10	c10	-
S49	GetUSVCBValues	TP	O	O	-
S50	SetUSVCBValues	TP	O	O	-
Control (Clause 20)					
S51	Select	TP	M	O	YES
S52	SelectWithValue	TP	M	O	YES
S53	Cancel	TP	O	O	YES
S54	Operate	TP	M	M	YES
S55	Command-Termination	TP	M	O	YES
S56	TimeActivated-Operate	TP	O	O	-
File transfer (Clause 23)					
S57	GetFile	TP	O	M	-
S58	SetFile	TP	O	O	-
S59	DeleteFile	TP	O	O	-
S60	GetFileAttributeValues	TP	O	M	-
Time (5.5)					
T1	Time resolution of internal clock				10 (1 msec)
T2	Time accuracy of internal clock				T1
T3	Supported TimeStamp resolution				10 (1 msec)
c6 – shall declare support for at least one (BRCB or URCB)					
c7 – shall declare support for at least one (QueryLogByTime or QueryLogAfter)					
c8 – shall declare support for at least one (SendGOOSEMessage or SendGSSEMessage)					
c9 – shall declare support if TP association is available					

Table 12: ACSI service conformance statement

Services	AA: TP/MC	Client/ subscriber	Server/ publisher	RTU500 series server
c10 – shall declare support for at least one (SendMSVMessage or SendUSVMessage)				
O – Optional				

Table 12: ACSI service conformance statement

10.1.4 Specific Communication Service Mapping (SCSM)

See B21 table "Tab. 10: ACSI basic conformance statement" and [IEC 61850-7-2].

10.2 Protocol Implementation Conformance Statement (PICS)

10.2.1 Basic Profile Conformance

10.2.1.1 PICS for A-Profile support

The PICS for A-Profile support for RTU500 series IEC 61850 server are defined in following table.

A-Profile shortcut	Profile Description	Client	Server	RTU500 series server
A1	Client/server A-Profile	c1	c1	YES
A2	GOOSE/GSE management A-Profile	c2	c2	YES (GOOSE only)
A3	GSSE A-Profile	c3	c3	-
A4	TimeSync A-Profile	c4	c4	YES

c1 Shall be ‘m’ if support for any service specified in [IEC 61850-8-1] Table 2 are declared within the ACSI basic conformance statement (see Table 5).

c2 Shall be ‘m’ if support for any service specified in [IEC 61850-8-1] Table 6 are declared within the ACSI basic conformance statement (see Table 5).

c3 Shall be ‘m’ if support for any service specified in [IEC 61850-8-1] Table 9 are declared within the ACSI basic conformance statement (see Table 5).

c4 Support for at least one other A-Profile shall be declared (e.g. in A1-A3) in order to claim conformance to [IEC 61850-8-1].[IEC 61850-8-1].

Table 13: PICS for A-Profile support

10.2.1.2 PICS for T-Profile support

The PICS for T-Profile support for RTU500 series IEC 61850 server are defined in following table.

T-Profile shortcut	Profile Description	Client	Server	RTU500 series server
T1	TCP/IP T-Profile	c1	c1	YES
T2	OSI T-Profile	c2	c2	-
T3	GOOSE/GSE T-Profile	c3	c3	YES (GOOSE only)
T4	GSSE T-Profile	c4	c4	-
T5	TimeSync T-Profile	O	O	YES

c1 Shall be 'm' if support for table 9-4 A1 is declared. Otherwise, shall be 'i'.

c2 Shall be 'o' if support for table 9-4 A1 is declared. Otherwise, shall be 'i'.

c3 Shall be 'm' if support for table 9-4 A2 is declared. Otherwise, shall be 'i'.

c4 Shall be 'm' if support for table 9-4 A3 is declared. Otherwise, shall be 'i'.

i – out-of-scope: The implementation of the item is not within the scope of this standard

O – Optional

Table 14: PICS for T-Profile support

10.2.2 MMS Conformance

All needed services supporting the ACSI services stated to be supported in chapter '9.1.3 "ACSI Service Conformance Statement" ' are supported by the MMS stack used.

10.3 Model Implementation Conformance Statement (MICS)

This model implementation conformance statement is applicable for RTU500 series IEC 61850 server:

This MICS document specifies the modelling implementations and extensions compared to IEC 61850 Edition 1 and Edition 2. For the exact details on the standardized model please compare the ICD substation configuration files generated by RTUtil500.

- Chapter 10.3.1 contains the list of implemented logical nodes.
- Chapters 10.3.2 to 10.3.14 describe the implemented logical nodes.

10.3.1 Logical Node List

Following table defines the list of logical nodes supported by RTU500 series IEC 61850 server.

LN Group L: System logical nodes	
LPHD	Physical device information
LLN0	Logical node zero
LCCH[1]	Physical communication channel supervision

Table 15: Logical nodes supported by the RTU500 series IEC 61850 server

LN Group L: System logical nodes	
LTMS[1]	Time master supervision
LN Group C: Logical nodes for control	
CSWI	Switch controller
CILO	Interlocking
CALH	Alarm handling
LN Group G: Logical nodes for generic references	
GAPC	Generic automatic process control
GGIO	Generic process I/O
LN Group M: Logical nodes for metering and measurement	
MMTR	Metering
MMXN	Measurement
MMXU	Measurement
LN Group P: Logical nodes for protection functions	
PTOC	Time over current
PDIS	Distance
PDIF	Differential
PTOF	Over frequency
PTUF	Under frequency
PTOV	Over voltage
PTUV	Under voltage
PSDE	Sensitive directional earth fault
PTEF	Transient earth fault
PSCH	Protection scheme
PTRC	Protection trip conditioning
LN Group R: Logical Nodes for protection related functions	
RBRF	Breaker failure
RREC	Auto reclosing
RSYN	Synchronism-check or synchronising
LN Group S: Logical Nodes for sensors and monitoring	
SIMG	Insulation medium supervision (gas)
SIML	Insulation medium supervision (liquid)
LN Group X: Logical Nodes for switchgear	
XCBR	Circuit breaker
XSWI	Circuit switch
LN Group Y: Logical Nodes for power transformer	
YLTC	Tap changer
YEFN	Earth fault neutralizer (Petersen coil)
LN Group Z: Logical Nodes for further power system equipment	
ZAXN	Auxiliary network

Table 15: Logical nodes supported by the RTU500 series IEC 61850 server

1 Supported for IEC 61850 Edition 2 client/server only

10.3.2 LN Group L: System logical nodes

10.3.2.1 LN type: LPHD

LPHD		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
PhyNam	DPL	Physical device name plate
PhyHealth	INS	Physical device health
Proxy	SPS	Indicates if this LN is a proxy

Table 16: Logical node type LPHD

LPHD		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
PhyNam	DPL	Physical device name plate
PhyHealth	ENS	Physical device health
Proxy	SPS	Indicates if this LN is a proxy

Table 17: Logical node type LPHD (Edition 2)

10.3.2.2 LN type: LLN0

LLN0		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
	Common logical node information	
Mod	INC	Mode
Beh	INS	Behaviour
Health	INS	Health
NamPlt	LPL	Name plate
Loc	SPS	Local operation for complete logical device

Table 18: Logical node type LLN0 (Edition 1)

LLN0		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
	Common logical node information	
Mod	ENC	Mode

Table 19: Logical node type LLN0 (Edition 2)

LLN0		
Beh	ENS	Behaviour
Health	ENS	Health
NamPlt	LPL	Name plate
Loc	SPS	Local operation for complete logical device

Table 19: Logical node type LLN0 (Edition 2)

10.3.2.3 LN Type LCCH

LCCH		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
	Common logical node information	
Beh	ENS	Behaviour
ChLiv	SPS	Physical channel status; true, if channel receives telegrams within a specified time interval.
RedChLiv	SPS	Physical channel status of redundant channel
FerCh	INS	Frame error rate on this channel; count of erroneous (or missed, in case of redundancy) messages for each 1 000 messages forwarded to the application.
RedFerCh	INS	Frame error rate on redundant channel; count of missed messages on this channel for each 1 000 messages forwarded to the application.

Table 20: Logical node type LCCH (Edition 2)

10.3.2.4 LN type LTMS

LTMS		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
	Common logical node information	
Beh	ENS	Behaviour
TmSrc	VSS	Current time source
TmSyn	ENS	Time synchronized according to IEC 61850-9-2
TmChSt1	SPS	Time channel status (up/down)

Table 21: Logical node type LTMS (Edition 2)

10.3.3 LN Group C: Logical nodes for control

10.3.3.1 LN type: CSWI

CSWI		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
		Common logical node information
Mod	INC	Mode
Beh	INS	Behaviour
Health	INS	Health
NamPlt	LPL	Name plate
Loc	SPS	Local operation
		Controls
Pos	DPC	Double point controllable status output

Table 22: Logical node type CSWI (Edition 1)

CSWI		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
		Common logical node information
Beh	ENS	Behaviour
Loc	SPS	Local operation
		Controls
Pos	DPC	Double point controllable status output

Table 23: Logical node type CSWI (Edition 2)

10.3.3.2 LN type: CILO

CILO		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
		Common logical node information
Mod	INC	Mode
Beh	INS	Behaviour
Health	INS	Health
NamPlt	LPL	Name plate
		Status Information
EnaOpn	SPS	Enable Open
EnaCls	SPS	Enable Close

Table 24: Logical node type CILO (Edition 1)

CILO		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
	Common logical node information	
Beh	ENS	Behaviour
	Status Information	
EnaOpn	SPS	Enable Open
EnaCls	SPS	Enable Close

Table 25: Logical node type CILO (Edition 2)

10.3.3.3 LN type: CALH

CALH		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
	Common logical node information	
Mod	INC	Mode
Beh	INS	Behaviour
Health	INS	Health
NamPlt	LPL	Name plate
	Status Information	
GrAlm	SPS	Group alarm

Table 26: Logical node type CALH (Edition 1)

CALH		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
	Common logical node information	
Beh	ENS	Behaviour
	Status Information	
GrAlm	SPS	Group alarm

Table 27: Logical node type CALH (Edition 2)

10.3.4 LN Group G: Logical nodes for generic references

10.3.4.1 LN type: GAPC

GAPC		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
		Common logical node information
Mod	INC	Mode
Beh	INS	Behaviour
Health	INS	Health
NamPlt	LPL	Name plate
		Status information
Str	ACD	Start
Op	ACT	Operate

Table 28: Logical node type GAPC (Edition 1)

GAPC		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
		Common logical node information
Beh	ENS	Behaviour
		Status information
Str	ACD	Start
Op	ACT	Operate

Table 29: Logical node type GAPC (Edition 2)

Following table defines the specific logical nodes extensions for generic process I/O.

LN Group G: Logical nodes for generic references			
GGIO: Generic process I/O			
LN Prefix	**LN Class**	**LN Type**	**Description**
			Status information
SP	GGIO	SPGGIO	Generic single point status
SP8	GGIO	SP8GGIO	Generic single point status (8 inputs)
SP16	GGIO	SP16GGIO	Generic single point status (16 inputs)
DP	GGIO	DPGGIO	Generic double point status
DP8	GGIO	DP8GGIO	Generic double point status (8 inputs)
INS	GGIO	INSGGIO	Generic integer status
BCR	GGIO	BCRGGIO	Generic binary counter reading
ENS[1]	GGIO	ENSGGIO	Generic enumerated status
			Measured information

Table 30: Generic logical node supported by RTU500 series server

LN Group G: Logical nodes for generic references			
GGIO: Generic process I/O			
MV	GGIO	MVGGIO	Generic measured value input
MV8	GGIO	MV8GGIO	Generic measured value input (8 inputs)
CMV	GGIO	CMVGGIO	Generic complex measured value input
		Controllable status information	
SC	GGIO	SCGGIO	Generic single command
SC8	GGIO	SC8GGIO	Generic single command (8 outputs)
SC16	GGIO	SC16GGIO	Generic single command (16 outputs)
DC	GGIO	DCGGIO	Generic double command
DC8	GGIO	DC8GGIO	Generic double command (8 outputs)
INC	GGIO	INCGGIO	Generic integer status output
BSC	GGIO	BSCGGIO	Generic binary controlled step position output

Table 30: Generic logical node supported by RTU500 series server

1 Supported for IEC 61850 Edition 2 client/server only

10.3.4.2 Monitoring status information

10.3.4.2.1 LN type: SPGGIO

SPGGIO		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
	Common logical node information	
Mod	INC	Mode
Beh	INS	Behaviour
Health	INS	Health
NamPlt	LPL	Name plate
	Status information	
Ind	SPS	General indication (binary input)

Table 31: Logical node type SPGGIO (Edition 1)

SPGGIO		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
	Common logical node information	
Beh	INS	Behaviour
	Status information	
Ind1	SPS	General indication (binary input)

Table 32: Logical node type SPGGIO (Edition 2)

10.3.4.2.2 LN type: SP8GGIO

SP8GGIO		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
		Common logical node information
Mod	INC	Mode
Beh	INS	Behaviour
Health	INS	Health
NamPlt	LPL	Name plate
		Status information
Ind1	SPS	General indication (binary input)
Ind2	SPS	General indication (binary input)
Ind3	SPS	General indication (binary input)
Ind4	SPS	General indication (binary input)
Ind5	SPS	General indication (binary input)
Ind6	SPS	General indication (binary input)
Ind7	SPS	General indication (binary input)
Ind8	SPS	General indication (binary input)

Table 33: Logical node type SP8GGIO (Edition 1)

SP8GGIO		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
		Common logical node information
Beh	INS	Behaviour
		Status information
Ind1	SPS	General indication (binary input)
Ind2	SPS	General indication (binary input)
Ind3	SPS	General indication (binary input)
Ind4	SPS	General indication (binary input)
Ind5	SPS	General indication (binary input)
Ind6	SPS	General indication (binary input)
Ind7	SPS	General indication (binary input)
Ind8	SPS	General indication (binary input)

Table 34: Logical node type SP8GGIO (Edition 2)

10.3.4.2.3 LN type: SP16GGIO

SP16GGIO		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
		Common logical node information
Mod	INC	Mode
Beh	INS	Behaviour
Health	INS	Health
NamPlt	LPL	Name plate
		Status information
Ind1	SPS	General indication (binary input)
Ind2	SPS	General indication (binary input)
Ind3	SPS	General indication (binary input)
Ind4	SPS	General indication (binary input)
Ind5	SPS	General indication (binary input)
Ind6	SPS	General indication (binary input)
Ind7	SPS	General indication (binary input)
Ind8	SPS	General indication (binary input)
Ind9	SPS	General indication (binary input)
Ind10	SPS	General indication (binary input)
Ind11	SPS	General indication (binary input)
Ind12	SPS	General indication (binary input)
Ind13	SPS	General indication (binary input)
Ind14	SPS	General indication (binary input)
Ind15	SPS	General indication (binary input)
Ind16	SPS	General indication (binary input)

Table 35: Logical node type SP16GGIO (Edition 1)

SP16GGIO		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
		Common logical node information
Beh	INS	Behaviour
		Status information
Ind1	SPS	General indication (binary input)
Ind2	SPS	General indication (binary input)
Ind3	SPS	General indication (binary input)
Ind4	SPS	General indication (binary input)
Ind5	SPS	General indication (binary input)
Ind6	SPS	General indication (binary input)

Table 36: Logical node type SP16GGIO (Edition 2)

SP16GGIO		
Ind7	SPS	General indication (binary input)
Ind8	SPS	General indication (binary input)
Ind9	SPS	General indication (binary input)
Ind10	SPS	General indication (binary input)
Ind11	SPS	General indication (binary input)
Ind12	SPS	General indication (binary input)
Ind13	SPS	General indication (binary input)
Ind14	SPS	General indication (binary input)
Ind15	SPS	General indication (binary input)
Ind16	SPS	General indication (binary input)

Table 36: Logical node type SP16GGIO (Edition 2)

10.3.4.2.4 LN type: DPGGIO

DPGGIO		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
	Common logical node information	
Mod	INC	Mode
Beh	INS	Behaviour
Health	INS	Health
NamPlt	LPL	Name plate
		Status information
DPI	DPS	Double point input

Table 37: Logical node type DPGGIO (Edition 1)

DPGGIO		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
	Common logical node information	
Beh	INS	Behaviour
		Status information
DPI1	DPS	Double point input

Table 38: Logical node type DPGGIO (Edition 2)

10.3.4.2.5 LN type: DP8GGIO

DP8GGIO		
Attribute Name	Attribute Type	Explanation

Table 39: Logical node type DP8GGIO (Edition 1)

DP8GGIO		
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
		Common logical node information
Mod	INC	Mode
Beh	INS	Behaviour
Health	INS	Health
NamPlt	LPL	Name plate
		Status information
DPI1	DPS	Double point input
DPI2	DPS	Double point input
DPI3	DPS	Double point input
DPI4	DPS	Double point input
DPI5	DPS	Double point input
DPI6	DPS	Double point input
DPI7	DPS	Double point input
DPI8	DPS	Double point input

Table 39: Logical node type DP8GGIO (Edition 1)

DP8GGIO		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
		Common logical node information
Beh	INS	Behaviour
		Status information
DPI1	DPS	Double point input
DPI2	DPS	Double point input
DPI3	DPS	Double point input
DPI4	DPS	Double point input
DPI5	DPS	Double point input
DPI6	DPS	Double point input
DPI7	DPS	Double point input
DPI8	DPS	Double point input

Table 40: Logical node type DP8GGIO (Edition 2)

10.3.4.2.6 LN type: INSGGIO

INSGGIO		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		

Table 41: Logical node type INSGGIO (Edition 1)

INSGGIO		
	Common logical node information	
Mod	INC	Mode
Beh	INS	Behaviour
Health	INS	Health
NamPlt	LPL	Name plate
	Status information	
IntIn	INS	Integer status input

Table 41: Logical node type INSGGIO (Edition 1)

INSGGIO		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
	Common logical node information	
Beh	INS	Behaviour
	Status information	
IntIn1	INS	Integer status input

Table 42: Logical node type INSGGIO (Edition 2)

10.3.4.2.7 LN type: BCRGGIO

BCRGGIO		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
	Common logical node information	
Mod	INC	Mode
Beh	INS	Behaviour
Health	INS	Health
NamPlt	LPL	Name plate
	Status information	
ITI	BCR[1]	Integrated totals input

Table 43: Logical node type BCRGGIO (Edition 1)

1 The data type behind BCR.actVal and BCR.frVal is INT32 and the limits are accordingly

BCRGGIO		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
	Common logical node information	
Beh	INS	Behaviour

Table 44: Logical node type BCRGGIO (Edition 2)

BCRGGIO		
	Status information	
ITI1	BCR[1]	Integrated totals input

Table 44: Logical node type BCRGGIO (Edition 2)

1 The data type behind BCR.actVal and BCR.frVal is INT32 and the limits are accordingly

10.3.4.2.8 LN type: ENSGGIO

ENSGGIO		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
	Common logical node information	
Beh	INS	Behaviour
	Status information	
EEHealth	ENS	External equipment health

Table 45: Logical node type ENSGGIO (Edition 2)

10.3.4.3 Measured information

10.3.4.3.1 LN type: MVGGIO

MVGGIO		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
	Common logical node information	
Mod	INC	Mode
Beh	INS	Behaviour
Health	INS	Health
NamPlt	LPL	Name plate
	Measured vlaues	
AnIn	MV	Analog input

Table 46: Logical node type MVGGIO (Edition 1)

MVGGIO		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
	Common logical node information	
Beh	INS	Behaviour
	Measured vlaues	

Table 47: Logical node type MVGGIO (Edition 2)

MVGGIO		
AnIn1	MV	Analog input

Table 47: Logical node type MVGGIO (Edition 2)

10.3.4.3.2 LN type: MV8GGIO

MV8GGIO		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
		Common logical node information
Mod	INC	Mode
Beh	INS	Behaviour
Health	INS	Health
NamPlt	LPL	Name plate
		Measured vlaues
AnIn1	MV	Analog Input
AnIn2	MV	Analog Input
AnIn3	MV	Analog Input
AnIn4	MV	Analog Input
AnIn5	MV	Analog Input
AnIn6	MV	Analog Input
AnIn7	MV	Analog Input
AnIn8	MV	Analog Input

Table 48: Logical node type MV8GGIO (Edition 1)

MV8GGIO		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
		Common logical node information
Beh	INS	Behaviour
		Measured vlaues
AnIn1	MV	Analog Input
AnIn2	MV	Analog Input
AnIn3	MV	Analog Input
AnIn4	MV	Analog Input
AnIn5	MV	Analog Input
AnIn6	MV	Analog Input
AnIn7	MV	Analog Input
AnIn8	MV	Analog Input

Table 49: Logical node type MV8GGIO (Edition 2)

10.3.4.3.3 LN type: CMVGGIO

CMVGGIO		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
	Common logical node information	
Mod	INC	Mode
Beh	INS	Behaviour
Health	INS	Health
NamPlt	LPL	Name plate
	Measured vlaues	
CVIn	CMV	Complex analog value Input

Table 50: Logical node type CMVGGIO (Edition 1)

CMVGGIO		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
	Common logical node information	
Beh	INS	Behaviour
	Measured vlaues	
CVIn1	CMV	Complex analog value Input

Table 51: Logical node type CMVGGIO (Edition 2)

10.3.4.4 Controllable status information

10.3.4.4.1 LN type: SCGGIO

SCGGIO		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
	Common logical node information	
Mod	INC	Mode
Beh	INS	Behaviour
Health	INS	Health
NamPlt	LPL	Name plate
	Controls	
SPCSO	SPC	Single point controllable status output

Table 52: Logical node type SCGGIO (Edition 1)

SCGGIO		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
	Common logical node information	
Beh	INS	Behaviour
	Controls	
SPCSO1	SPC	Single point controllable status output

Table 53: Logical node type SCGGIO (Edition 2)

10.3.4.4.2 LN type: SC8GGIO

SC8GGIO		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
	Common logical node information	
Mod	INC	Mode
Beh	INS	Behaviour
Health	INS	Health
NamPlt	LPL	Name plate
	Controls	
SPCSO1	SPC	Single point controllable status output
SPCSO2	SPC	Single point controllable status output
SPCSO3	SPC	Single point controllable status output
SPCSO4	SPC	Single point controllable status output
SPCSO5	SPC	Single point controllable status output
SPCSO6	SPC	Single point controllable status output
SPCSO7	SPC	Single point controllable status output
SPCSO8	SPC	Single point controllable status output

Table 54: Logical node type SC8GGIO (Edition 1)

SC8GGIO		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
	Common logical node information	
Beh	INS	Behaviour
	Controls	
SPCSO1	SPC	Single point controllable status output
SPCSO2	SPC	Single point controllable status output
SPCSO3	SPC	Single point controllable status output

Table 55: Logical node type SC8GGIO (Edition 2)

SC8GGIO		
SPCSO4	SPC	Single point controllable status output
SPCSO5	SPC	Single point controllable status output
SPCSO6	SPC	Single point controllable status output
SPCSO7	SPC	Single point controllable status output
SPCSO8	SPC	Single point controllable status output

Table 55: Logical node type SC8GGIO (Edition 2)

10.3.4.4.3 LN type: SC16GGIO

SC16GGIO		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
	Common logical node information	
Mod	INC	Mode
Beh	INS	Behaviour
Health	INS	Health
NamPlt	LPL	Name plate
	Controls	
SPCSO1	SPC	Single point controllable status output
SPCSO2	SPC	Single point controllable status output
SPCSO3	SPC	Single point controllable status output
SPCSO4	SPC	Single point controllable status output
SPCSO5	SPC	Single point controllable status output
SPCSO6	SPC	Single point controllable status output
SPCSO7	SPC	Single point controllable status output
SPCSO8	SPC	Single point controllable status output
SPCSO9	SPC	Single point controllable status output
SPCSO10	SPC	Single point controllable status output
SPCSO11	SPC	Single point controllable status output
SPCSO12	SPC	Single point controllable status output
SPCSO13	SPC	Single point controllable status output
SPCSO14	SPC	Single point controllable status output
SPCSO15	SPC	Single point controllable status output
SPCSO16	SPC	Single point controllable status output

Table 56: Logical node type SC16GGIO (Edition 1)

SC16GGIO		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		

Table 57: Logical node type SC16GGIO (Edition 2)

SC16GGIO		
	Common logical node information	
Beh	INS	Behaviour
	Controls	
SPCSO1	SPC	Single point controllable status output
SPCSO2	SPC	Single point controllable status output
SPCSO3	SPC	Single point controllable status output
SPCSO4	SPC	Single point controllable status output
SPCSO5	SPC	Single point controllable status output
SPCSO6	SPC	Single point controllable status output
SPCSO7	SPC	Single point controllable status output
SPCSO8	SPC	Single point controllable status output
SPCSO9	SPC	Single point controllable status output
SPCSO10	SPC	Single point controllable status output
SPCSO11	SPC	Single point controllable status output
SPCSO12	SPC	Single point controllable status output
SPCSO13	SPC	Single point controllable status output
SPCSO14	SPC	Single point controllable status output
SPCSO15	SPC	Single point controllable status output
SPCSO16	SPC	Single point controllable status output

Table 57: Logical node type SC16GGIO (Edition 2)

10.3.4.4.4 LN type: DCGGIO

DCGGIO		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
	Common logical node information	
Mod	INC	Mode
Beh	INS	Behaviour
Health	INS	Health
NamPlt	LPL	Name plate
	Controls	
DPCSO	DPC	Double point controllable status output

Table 58: Logical node type DCGGIO (Edition 1)

DCGGIO		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
	Common logical node information	

Table 59: Logical node type DCGGIO (Edition 2)

DCGGIO		
Beh	INS	Behaviour
	Controls	
DPCSO1	DPC	Double point controllable status output

Table 59: Logical node type DCGGIO (Edition 2)

10.3.4.4.5 LN type: DC8GGIO

DC8GGIO		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
	Common logical node information	
Mod	INC	Mode
Beh	INS	Behaviour
Health	INS	Health
NamPlt	LPL	Name plate
	Controls	
DPCSO1	DPC	Double point controllable status output
DPCSO2	DPC	Double point controllable status output
DPCSO3	DPC	Double point controllable status output
DPCSO4	DPC	Double point controllable status output
DPCSO5	DPC	Double point controllable status output
DPCSO6	DPC	Double point controllable status output
DPCSO7	DPC	Double point controllable status output
DPCSO8	DPC	Double point controllable status output

Table 60: Logical node type DC8GGIO (Edition 1)

DC8GGIO		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
	Common logical node information	
Beh	INS	Behaviour
	Controls	
DPCSO1	DPC	Double point controllable status output
DPCSO2	DPC	Double point controllable status output
DPCSO3	DPC	Double point controllable status output
DPCSO4	DPC	Double point controllable status output
DPCSO5	DPC	Double point controllable status output
DPCSO6	DPC	Double point controllable status output
DPCSO7	DPC	Double point controllable status output
DPCSO8	DPC	Double point controllable status output

Table 61: Logical node type DC8GGIO (Edition 2)

10.3.4.4.6 LN type: INCGGIO

INCGGIO		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
	Common logical node information	
Mod	INC	Mode
Beh	INS	Behaviour
Health	INS	Health
NamPlt	LPL	Name plate
	Controls	
ISCSO	INC	Integer status controllable status output

Table 62: Logical node type INCGGIO (Edition 1)

INCGGIO		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
	Common logical node information	
Beh	INS	Behaviour
	Controls	
ISCSO1	INC	Integer status controllable status output

Table 63: Logical node type INCGGIO (Edition 2)

10.3.4.4.7 LN type: BSCGGIO

BSCGGIO		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
	Common logical node information	
Mod	INC	Mode
Beh	INS	Behaviour
Health	INS	Health
NamPlt	LPL	Name plate
	Controls	
RCO	BSC	Regulation step command output

Table 64: Logical node type BSCGGIO (Edition 1)

BSCGGIO		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
	Common logical node information	
Beh	INS	Behaviour
	Controls	
RCO1	BSC	Regulation step command output

Table 65: Logical node type BSCGGIO (Edition 2)

10.3.5 LN Group M: Logical nodes for metering and measurement

10.3.5.1 LN type: MMTR

MMTR		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
	Common logical node information	
Mod	INC	Mode
Beh	INS	Behaviour
Health	INS	Health
NamPlt	LPL	Name plate
	Metered values	
TotVAh	BCR[1]	Net apparent energy since last reset
TotWh	BCR[1]	Net Real energy since last reset
TotVArh	BCR[1]	Net Reactive energy since last reset

Table 66: Logical node type MMTR (Edition 1)

1 The data type behind BCR.actVal and BCR.frVal is INT32 and the limits are accordingly

MMTR		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
	Common logical node information	
Beh	ENS	Behaviour
	Metered values	
TotVAh	BCR[1]	Net apparent energy since last reset
TotWh	BCR[1]	Net Real energy since last reset
TotVArh	BCR[1]	Net Reactive energy since last reset

Table 67: Logical node type MMTR (Edition 2)

1 The data type behind BCR.actVal and BCR.frVal is INT32 and the limits are accordingly

10.3.5.2 LN type: MMXN

MMXN		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
	Common logical node information	
Mod	INC	Mode
Beh	INS	Behaviour
Health	INS	Health
NamPlt	LPL	Name plate
	Measured values	
Amp	MV	Current I (rms) not allocated to a phase
Vol	MV	Voltage V (rms) not allocated to a phase
Watt	MV	Power (P) not allocated to a phase
VolAmpr	MV	Reactive Power (Q) not allocated to a phase
VolAmp	MV	Apparent Power (S) not allocated to a phase
PwrFact	MV	Power Factor not allocated to a phase
Imp	CMV	Impedance
Hz	MV	Frequency

Table 68: Logical node type MMXN (Edition 1)

MMXN		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
	Common logical node information	
Beh	ENS	Behaviour
	Measured values	
Amp	MV	Current I (rms) not allocated to a phase
Vol	MV	Voltage V (rms) not allocated to a phase
Watt	MV	Power (P) not allocated to a phase
VolAmpr	MV	Reactive Power (Q) not allocated to a phase
VolAmp	MV	Apparent Power (S) not allocated to a phase
PwrFact	MV	Power Factor not allocated to a phase
Imp	CMV	Impedance
Hz	MV	Frequency

Table 69: Logical node type MMXN (Edition 2)

10.3.5.3 LN type: MMXU

MMXU		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
		Common logical node information
Mod	INC	Mode
Beh	INS	Behaviour
Health	INS	Health
NamPlt	LPL	Name plate
		Measured values
TotW	MV	Total Active Power (Total P)
TotVAr	MV	Total Reactive Power (Total Q)
TotVA	MV	Total Apparent Power (Total S)
TotPF	MV	Average Power factor (Total PF)
Hz	MV	Frequency
PPV	DEL	Phase to phase voltages (VL1VL2, …)
PhV	WYE	Phase to ground voltages (VL1ER, …)
A	WYE	Phase currents (IL1, IL2, IL3)
W	WYE	Phase active power (P)
Var	WYE	Phase reactive power (Q)
VA	WYE	Phase apparent power (S)
PF	WYE	Phase power factor
Z	WYE	Phase Impedance

Table 70: Logical node type MMXU (Edition 1)

MMXU		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
		Common logical node information
Beh	ENS	Behaviour
		Measured values
TotW	MV	Total Active Power (Total P)
TotVAr	MV	Total Reactive Power (Total Q)
TotVA	MV	Total Apparent Power (Total S)
TotPF	MV	Average Power factor (Total PF)
Hz	MV	Frequency
PPV	DEL	Phase to phase voltages (VL1VL2, …)
PhV	WYE	Phase to ground voltages (VL1ER, …)
A	WYE	Phase currents (IL1, IL2, IL3)
W	WYE	Phase active power (P)

Table 71: Logical node type MMXU (Edition 2)

MMXU		
Var	WYE	Phase reactive power (Q)
VA	WYE	Phase apparent power (S)
PF	WYE	Phase power factor
Z	WYE	Phase Impedance

Table 71: Logical node type MMXU (Edition 2)

10.3.6 LN Group P: Logical nodes for protection functions

10.3.6.1 LN type: PTOC

PTOC		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
		Common logical node information
Mod	INC	Mode
Beh	INS	Behaviour
Health	INS	Health
NamPlt	LPL	Name plate
		Status information
Str	ACD	Start
Op	ACT	Operate

Table 72: Logical node type PTOC (Edition 1)

PTOC		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
		Common logical node information
Beh	ENS	Behaviour
		Status information
Str	ACD	Start
Op	ACT	Operate

Table 73: Logical node type PTOC (Edition 2)

10.3.6.2 LN type: PDIS

PDIS		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		

Table 74: Logical node type PDIS (Edition 1)

PDIS		
	Common logical node information	
Mod	INC	Mode
Beh	INS	Behaviour
Health	INS	Health
NamPlt	LPL	Name plate
	Status information	
Str	ACD	Start
Op	ACT	Operate

Table 74: Logical node type PDIS (Edition 1)

PDIS		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
	Common logical node information	
Beh	ENS	Behaviour
	Status information	
Str	ACD	Start
Op	ACT	Operate

Table 75: Logical node type PDIS (Edition 2)

10.3.6.3 LN type: PDIF

PDIF		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
	Common logical node information	
Mod	INC	Mode
Beh	INS	Behaviour
Health	INS	Health
NamPlt	LPL	Name plate
	Status information	
Op	ACT	Operate

Table 76: Logical node type PDIF (Edition 1)

PDIF		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
	Common logical node information	

Table 77: Logical node type PDIF (Edition 2)

PDIF		
Beh	ENS	Behaviour
	Status information	
Op	ACT	Operate

Table 77: Logical node type PDIF (Edition 2)

10.3.6.4 LN type: PTOF

PTOF		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
	Common logical node information	
Mod	INC	Mode
Beh	INS	Behaviour
Health	INS	Health
NamPlt	LPL	Name plate
	Status information	
Str	ACD	Start
Op	ACT	Operate

Table 78: Logical node type PTOF (Edition 1)

PTOF		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
	Common logical node information	
Beh	ENS	Behaviour
	Status information	
Str	ACD	Start
Op	ACT	Operate

Table 79: Logical node type PTOF (Edition 2)

10.3.6.5 LN type: PTUF

PTUF		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
	Common logical node information	
Mod	INC	Mode
Beh	INS	Behaviour

Table 80: Logical node type PTUF (Edition 1)

PTUF		
Health	INS	Health
NamPlt	LPL	Name plate
		Status information
Str	ACD	Start
Op	ACT	Operate

Table 80: Logical node type PTUF (Edition 1)

PTUF		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
		Common logical node information
Beh	ENS	Behaviour
		Status information
Str	ACD	Start
Op	ACT	Operate

Table 81: Logical node type PTUF (Edition 2)

10.3.6.6 LN type: PTOV

PTOV		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
		Common logical node information
Mod	INC	Mode
Beh	INS	Behaviour
Health	INS	Health
NamPlt	LPL	Name plate
		Status information
Str	ACD	Start
Op	ACT	Operate

Table 82: Logical node type PTOV (Edition 1)

PTOV		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
		Common logical node information
Beh	ENS	Behaviour
		Status information

Table 83: Logical node type PTOV (Edition 2)

PTOV		
Str	ACD	Start
Op	ACT	Operate

Table 83: Logical node type PTOV (Edition 2)

10.3.6.7 LN type: PTUV

PTUV		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
	Common logical node information	
Mod	INC	Mode
Beh	INS	Behaviour
Health	INS	Health
NamPlt	LPL	Name plate
	Status information	
Str	ACD	Start
Op	ACT	Operate

Table 84: Logical node type PTUV (Edition 1)

PTUV		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
	Common logical node information	
Beh	ENS	Behaviour
	Status information	
Str	ACD	Start
Op	ACT	Operate

Table 85: Logical node type PTUV (Edition 2)

10.3.6.8 LN type: PSDE

PSDE		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
	Common logical node information	
Mod	INC	Mode
Beh	INS	Behaviour
Health	INS	Health

Table 86: Logical node type PSDE (Edition 1)

PSDE		
NamPlt	LPL	Name plate
		Status information
Str	ACD	Start
Op	ACT	Operate

Table 86: Logical node type PSDE (Edition 1)

PSDE		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
		Common logical node information
Beh	ENS	Behaviour
		Status information
Str	ACD	Start
Op	ACT	Operate

Table 87: Logical node type PSDE (Edition 2)

10.3.6.9 LN type: PTEF

PTEF		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
		Common logical node information
Mod	INC	Mode
Beh	INS	Behaviour
Health	INS	Health
NamPlt	LPL	Name plate
		Status information
Str	ACD	Start
Op	ACT	Operate

Table 88: Logical node type PTEF (Edition 1)

PTEF		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
		Common logical node information
Beh	ENS	Behaviour
		Status information
Str	ACD	Start

Table 89: Logical node type PTEF (Edition 2)

PTEF		
Op	ACT	Operate

Table 89: Logical node type PTEF (Edition 2)

10.3.6.10 LN type: PSCH

PSCH		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
	Common logical node information	
Mod	INC	Mode
Beh	INS	Behaviour
Health	INS	Health
NamPlt	LPL	Name plate
	Status information	
ProTx	SPS	Teleprotection signal transmitted
ProRx	SPS	Teleprotection signal received
Str	ACD	Carrier Send
Op	ACT	Operate

Table 90: Logical node type PSCH (Edition 1)

PSCH		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
	Common logical node information	
Beh	ENS	Behaviour
	Status information	
Op	ACT	Operate

Table 91: Logical node type PSCH (Edition 2)

10.3.6.11 LN type: PTRC

PTRC		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
	Common logical node information	
Mod	INC	Mode
Beh	INS	Behaviour
Health	INS	Health

Table 92: Logical node type PTRC (Edition 1)

PTRC		
NamPlt	LPL	Name plate
		Status information
Op	ACT	Operate (combination of subscribed Op from protection functions)
Str	ACD	Sum of all starts of all connected Logical Nodes

Table 92: Logical node type PTRC (Edition 1)

PTRC		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
		Common logical node information
Beh	ENS	Behaviour
		Status information
Op	ACT	Operate (combination of subscribed Op from protection functions)
Str	ACD	Sum of all starts of all connected Logical Nodes

Table 93: Logical node type PTRC (Edition 2)

10.3.7 LN Group R: Logical nodes for protection related functions

10.3.7.1 LN type: RBRF

RBRF		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
		Common logical node information
Mod	INC	Mode
Beh	INS	Behaviour
Health	INS	Health
NamPlt	LPL	Name plate
		Status information
OpEx	ACT	Breaker failure trip (“external trip”)
OpIn	ACT	Operate, retrip (“internal trip”)

Table 94: Logical node type RBRF (Edition 1)

RBRF		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
		Common logical node information

Table 95: Logical node type RBRF (Edition 2)

RBRF		
Beh	ENS	Behaviour
		Status information
OpEx	ACT	Breaker failure trip (“external trip”)
OpIn	ACT	Operate, retrip (“internal trip”)

Table 95: Logical node type RBRF (Edition 2)

10.3.7.2 LN type: RREC

RREC		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
	Common logical node information	
Mod	INC	Mode
Beh	INS	Behaviour
Health	INS	Health
NamPlt	LPL	Name plate
		Status information
Op	ACT	Operate (used here to provide close to XCBR)
AutoRecSt	INS	Auto Reclosing Status

Table 96: Logical node type RREC (Edition 1)

RREC		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
	Common logical node information	
Beh	ENS	Behaviour
		Status information
OpCls	ACT	Operation ”close switch” issued to close the XCBR
AutoRecSt	ENS	Auto Reclosing Status

Table 97: Logical node type RREC (Edition 2)

10.3.7.3 LN type: RSYN

RSYN		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
	Common logical node information	
Mod	INC	Mode

Table 98: Logical node type RSYN (Edition 1)

RSYN		
Beh	INS	Behaviour
Health	INS	Health
NamPlt	LPL	Name plate
		Status information
Rel	SPS	Release

Table 98: Logical node type RSYN (Edition 1)

RSYN		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
		Common logical node information
Beh	ENS	Behaviour
		Status information
Rel	SPS	Release

Table 99: Logical node type RSYN (Edition 2)

10.3.8 LN Group S: Logical Nodes for sensors and monitoring

10.3.8.1 LN type: SIMG

SIMG		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
		Common logical node information
Mod	INC	Mode
Beh	INS	Behaviour
Health	INS	Health
NamPlt	LPL	Name plate
		Status information
InsAlm	SPS	Insulation gas critical (refill isolation medium)
PresAlm	SPS	Isolation gas pressure alarm
DenAlm	SPS	Isolation gas density alarm
TmpAlm	SPS	Isolation gas temperature alarm

Table 100: Logical node type SIMG (Edition 1)

SIMG		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		

Table 101: Logical node type SIMG (Edition 2)

SIMG		
	Common logical node information	
Beh	ENS	Behaviour
	Status information	
InsAlm	SPS	Insulation gas critical (refill isolation medium)
PresAlm	SPS	Isolation gas pressure alarm
DenAlm	SPS	Isolation gas density alarm
TmpAlm	SPS	Isolation gas temperature alarm

Table 101: Logical node type SIMG (Edition 2)

10.3.8.2 LN type: SIML

SIML		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
	Common logical node information	
Mod	INC	Mode
Beh	INS	Behaviour
Health	INS	Health
NamPlt	LPL	Name plate
	Status information	
InsAlm	SPS	Insulation gas critical (refill isolation medium)
TmpAlm	SPS	Insulation liquid temperature alarm
PresTr	SPS	Insulation liquid pressure trip
PresAlm	SPS	Insulation liquid pressure alarm

Table 102: Logical node type SIML (Edition 1)

SIML		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
	Common logical node information	
Beh	ENS	Behaviour
	Status information	
InsAlm	SPS	Insulation gas critical (refill isolation medium)
TmpAlm	SPS	Insulation liquid temperature alarm
GasInsAlm	SPS	If true, the gas in the insulation liquid abnormal condition has been detected
GasInsTr	SPS	If true, the gas in the insulation liquid dangerous condition has been detected

Table 103: Logical node type SIML (Edition 2)

10.3.9 LN Group X: Logical nodes for switchgear

10.3.9.1 LN type: XCBR

XCBR		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
		Common logical node information
Mod	INC	Mode
Beh	INS	Behaviour
Health	INS	Health
NamPlt	LPL	Name plate
Loc	SPS	Local operation (local means without substation automation communication, hardwired direct control)
EEHealth	INS	External equipment health
OpCnt	INS	Operation counter
		Controls
Pos	DPC	Switch position
BlkOpn	SPC	Block opening
BlkCls	SPC	Block closing
		Status information
CBOpCap	INS	Circuit breaker operating capability

Table 104: Logical node type XCBR (Edition 1)

XCBR		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
		Common logical node information
Beh	ENS	Behaviour
Loc	SPS	Local operation (local means without substation automation communication, hardwired direct control)
EEHealth	ENS	External equipment health
OpCnt	INS	Operation counter
		Controls
Pos	DPC	Switch position
BlkOpn	SPC	Block opening
BlkCls	SPC	Block closing
		Status information
CBOpCap	ENS	Circuit breaker operating capability

Table 105: Logical node type XCBR (Edition 2)

10.3.9.2 LN type: XSWI

XSWI		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
	Common logical node information	
Mod	INC	Mode
Beh	INS	Behaviour
Health	INS	Health
NamPlt	LPL	Name plate
Loc	SPS	Local operation (local means without substation automation communication, hardwired direct control)
EEHealth	INS	External equipment health
OpCnt	INS	Operation counter
	Controls	
Pos	DPC	Switch position
BlkOpn	SPC	Block opening
BlkCls	SPC	Block closing
	Status informaton	
SwTyp	INS	Switch type
SwOpCap	INS	Switch operating capability

Table 106: Logical node type XSWI (Edition 1)

XSWI		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
	Common logical node information	
Beh	ENS	Behaviour
Loc	SPS	Local operation (local means without substation automation communication, hardwired direct control)
EEHealth	ENS	External equipment health
OpCnt	INS	Operation counter
	Controls	
Pos	DPC	Switch position
BlkOpn	SPC	Block opening
BlkCls	SPC	Block closing
	Status informaton	
SwTyp	ENS	Switch type

Table 107: Logical node type XSWI (Edition 2)

XSWI		
SwOpCap	ENS	Switch operating capability

Table 107: Logical node type XSWI (Edition 2)

10.3.10 LN Group Y: Logical nodes for power transformer

10.3.10.1 LN type: YLTC

YLTC		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
	Common logical node information	
Mod	INC	Mode
Beh	INS	Behaviour
Health	INS	Health
NamPlt	LPL	Name plate
EEHealth	INS	External equipment health
	Controls	
TapChg	BSC	Change Tap Position (stop, higher, lower)
	Status informaton	
EndPosR	SPS	End position raise reached
EndPosL	SPS	End position lower reached

Table 108: Logical node type YLTC (Edition 1)

YLTC		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
	Common logical node information	
Beh	ENS	Behaviour
EEHealth	ENS	External equipment health
	Controls	
TapChg	BSC	Change Tap Position (stop, higher, lower)
	Status informaton	
EndPosR	SPS	End position raise reached
EndPosL	SPS	End position lower reached

Table 109: Logical node type YLTC (Edition 2)

10.3.10.2 LN type: YEFN

YEFN		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
	Common logical node information	
Mod	INC	Mode
Beh	INS	Behaviour
Health	INS	Health
NamPlt	LPL	Name plate
EEHealth	INS	External equipment health
Loc	SPS	Local operation
	Measured Values	
ECA	MV	Earth coil current
	Controls	
ColTapPos	ISC	End position raise reached

Table 110: Logical node type YEFN (Edition 1)

YEFN		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
	Common logical node information	
Beh	ENS	Behaviour
EEHealth	ENS	External equipment health
Loc	SPS	Local operation
	Measured Values	
ColPosA	MV	Coil position derived from the air gap
	Controls	
ColTapPos	ISC	End position raise reached

Table 111: Logical node type YEFN (Edition 2)

10.3.11 LN Group Z: Logical Nodes for further power system equipment

10.3.11.1 LN type: ZAXN

ZAXN		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
	Common logical node information	
Mod	INC	Mode

Table 112: Logical node type ZAXN (Edition 1)

ZAXN		
Beh	INS	Behaviour
Health	INS	Health
NamPlt	LPL	Name plate
EEHealth	INS	External equipment health

Table 112: Logical node type ZAXN (Edition 1)

ZAXN		
Attribute Name	Attribute Type	Explanation
LNName		Shall be inherited from LN Class (see [IEC 61850-7-2])
Data		
	Common logical node information	
Beh	ENS	Behaviour
EEHealth	ENS	External equipment health

Table 113: Logical node type ZAXN (Edition 2)

10.4 Tissues Conformance Statement (TICS)

This chapter contains the technical issues (tissues) conformance statement. According to the UCA IUG QAP the tissue conformance statement is required to perform a conformance test and is referenced on the certificate.

The tissues are grouped in mandatory interoperability tissues (IntOp tissues), optional interoperability tissues and other tissues. The following tables are structured in the columns:

Part: Section of the IEC 61850 standard the tissue belongs to

Tissue Nr: Number of the tissue according to the database provided under http://www.tissues.iec61850.com

Description: Short description of the tissue

Implemented: Indicates whether the tissue is implemented in the device. The meaning of the abbreviations are
Y = Yes the tissue is implemented in the device
N = No the tissue is not implemented in the device
na = Not applicable, the tissue is not applicable for the device

The following chapters are applicable for RTU500 series IEC 61850 Edition 1 and Edition 2 server.

10.4.1 Mandatory Edition 1 IntOp Tissues

During the October 2006 meeting IEC TC57 working group 10 decided that:

- green Tissues with the category “IntOp¨ are mandatory for IEC 61850 edition 1
- Tissues with the category “Ed.2¨ Tissues should not be implemented.

Below table gives an overview of the implemented Edition 1 IntOp Tissues.

Part	Tissue Nr	Description	Implemented Y/na
8-1	116	GetNameList with empty response?	Y
	165	Improper Error Response for GetDataSetValues	Y
	183	GetNameList error handling	Y
7-4	252	PTTR.AlmThm	na
7-3	28	Definition of APC	na
	54	Point def xVal, not cVal	na
	55	Ineut = Ires ?	na
	63	mag in CDC CMV	na
	219	operTm in ACT	na
	270	WYE and DEL rms values	na
	1199	Allow INT32 for CDC BCR	Y
7-2	30	control parameter T	Y
	31	Typo	na
	32	Typo in syntax	na
	35	Typo Syntax Control time	na
	36	Syntax parameter DSet-Ref missing	na
	37	Syntax GOOSE "T" type	Y
	39	Add DstAddr to GoCB	Y
	40	GOOSE Message “AppID” to “GoID”	Y
	41	GsCB “AppID” to “GsID”	na
	42	SV timestamp: “EntryTime” to “TimeStamp"	na
	43	Control "T" semantic	Y
	44	AddCause - Object not sel	Y
	45	Missing AddCauses (neg range)	na
	46	Synchro check cancel	Y
	47	"." in LD Name?	na
	49	BRCB TimeOfEntry (part of #453)	Y
	50	LNName start with number?	na
	51	ARRAY [0..num] missing	na
	52	Ambiguity GOOSE SqNum	Y
	53	Add DstAddr to GsCB, SV	na

Table 114: Mandatory Edition 1 IntOp Tissues

Part	Tissue Nr	Description	Implemented Y/na
	151	Name constraint for control blocks etc.	na
	166	DataRef attribute in Log	na
	185	Logging - Integrity periode	na
	189	SV Format	na
	190	BRCB: EntryId and TimeOfEntry (part of #453)	Y
	191	BRCB: Integrity and buffering reports (part of #453)	Y
	234	New type CtxInt (Enums are mapped to 8 bit integer)	na
	275	Confusing statement on GI usage (part of #453)	Y
	278	EntryId not valid for a server (part of #453)	Y
	297	Sequence number (part of #453)	Y
	298	Type of SqNum (part of #453)	Y
	305	Reporting with BufTm=0 (part of #453)	Y
	322	Write Configuration attribute of BRCBs (part of #453)	Y
	329	Reporting and BufOvl (part of #453)	Y
	333	Enabling of an incomplete GoCB	na
	335	Clearing of Bufovfl (part of #453)	Y
	348	URCB class and report (part of #453)	Y
	349	BRCB TimeOfEntry has two definitions (part of #453)	Y
	1281	Default for TrgOps.GI is TRUE	Y
6	1	Syntax	na
	5	tExtensionAttributeNameEnum is restricted	na
	8	SIUnit enumeration for W	Y
	10	Base type for bitstring usage	Y
	17	DAI/SDI elements syntax	na
	169	Ordering of enum differs from 7-3	na
NOTE: Tissue 49, 190, 191, 275 and 278 are part of the optional tissue #453, all other technical tissues in the table are mandatory if applicable.			
NOTE: Editorial tissues are marked as “na”.			
NOTE: Final proposal on tissue 45 is not defined yet			

Table 114: Mandatory Edition 1 IntOp Tissues

10.4.2 Optional Edition 1 IntOp Tissues

After the approval of the server conformance test procedures version 2.2 the following IntOp tissues were added or changed. It is optional to implement these tissues.

Part	Tissue Nr	Description	Implemented Y/N/na
8-1	246	Control negative response (SBOns) with LastApplError	N
	545	Skip file directories with no files	na
7-2	333	Enabling of an incomplete GoCB	na
	453	Combination of all reporting and logging tissues	Y
6	245	Attribute RptId in SCL is optional	na
	526	Replace sev - Unknown by unknown	na

Table 115: Optional Edition 1 IntOp Tissues

10.4.3 Mandatory Edition 2 Tissues

Below table gives an overview of the implemented Edition 2 Tissues.

Part	Tissue Nr	Description	Implemented Y/na
8-1	753	Whether "GoID" and "DatSet" in GoCB are writable?	na
	770	GoID type mitmatch 18.1.1 and 18.1.2.5.2	na
	777	AddCause values	na
	784	Tracking of control (CTS)	na
	817	Fixed-length GOOSE float encoding	na
	821	AlternateAccess in GetAllDataValues	na
	827	Mandatory ACSI services	na
	834	File dir name length 64	na
	851	bType wrong for "check" in sample SCL file	na
	854	GetDataValues - single or multiple objects	Y
	935	Typing error in table 101	na
	942	Wrong description of S bit in reserved word	na
	951	Encoding of Owner attribute	na
	1036	FileDirectory response	na
	1037	GetDataSetValues SpecWithResult	Y
	1040	More associate error codes	Y
	1041	LTS and OTS mapping	na
	1042	SGCB definition includes information that is not mapping specific	na
	1043		na
	1047	SetEditSGValues should not detail nothing about non-volatile storage	na

Table 116: Mandatory Edition 2 Tissues

Part	Tissue Nr	Description	Implemented Y/na
	1058	"Currency" basictype is not mapped	Y
	1066	OSI-AP-Title value	na
	1155	UtcTime wrong referecne	Y
	1164	ResvTms definition should be integer in the BRCB structure	na
	1178	DeleteDataSet response- refers to wrong clause	Y
	1181	Select Response+ is non-null value	na
	1192	Conformance requirement for InformationReport Ambiguous	na
	1274	GoCB MinTime/MaxTime size	na
	1285	GetServerDirectory(FILE) typo	Y
	1287	ICD file must have a communication section for 8-1 implementation	na
	1289	COMTRADE zip file contents	na
	1299	typo: LLNO -> LLN0	na
	1300	Missing semantics for localDetailCalling	na
	1309	Behavior for a ContimueAfter where the File no longer exists	na
	1324	Extraneous normative reference:10608-1 and -2	na
	1336	The response- for DeleteNamedVariableList is not defined	na
	1361	enhanced the mapping text for the setValues.	Y
	1441	Variable length Quality encoding	Y
	1442	Optonal fields in buffered reports	Y
	1443	Journal variableTag for ReasonCode	na
	1453	Reading SE when EditSG=0	Y
	1454	Purge buffer on write to BRCB	Y
	1462	Reports can be generated before write(RptEna=true) is confirmed	na
	1495	SNTP references to RFCs are different	na
		GetVariableAccessAttributes error code	
7-4	671	Mistake in definition of Mod & Beh	Y
	674	CDC of ZRRC.LocSta is wrong	na
	675	SIML LN	Y

Table 116: Mandatory Edition 2 Tissues

Part	Tissue Nr	Description	Implemented Y/na
	676	Same data object name used with different CDC	na
	677	MotStr is used with different CDC in PMMS and SOPM LN classes	na
	679	Remove CycTrMod Enum	na
	680	SI unit for MHYD.Cndct	na
	681	Enum PIDAlg	na
	682	ANCR.ParColMod	na
	683	Enum QVVR.IntrDetMth	na
	685	Enum ParTraMod	na
	686	New annex H - enums types in XML	Y
	689	RREC - diagram	na
	693	Description of LTMS.TmChSt1	Y
	694	Data object CmdBlk	na
	695	ARIS.Auto	na
	696	LSVS.St (Status of subscription)	na
	712	Interpretation of quality operatorBlocked	na
	713	DO Naming of time constants in FFIL	na
	714	Enums for ShOpCap and SwOpCap	N
	715	RBDR.ChNum1	na
	716	TAXD text for condition	na
	724	ANCR.Auto	na
	725	Loc in LN A-group	na
	727	RREC - diagram	na
	734	LLN0.OpTmh vs. LPHD.OpTmh	na
	735	ISAF.Alm and ISAF.AlmReset	na
	736	PFSign	na
	742	GAPC.Str, GAPC.Op and GAPC.StrVal	Y
	743	CCGR.PmpCtl and CCGR.FanCtl	na
	744	LN STMP, EEHealth and EEName	na
	748	CBOpCap	na
	749	Description BndCtrChg	na
	772		na

Table 116: Mandatory Edition 2 Tissues

Part	Tissue Nr	Description	Implemented Y/na
	773	LPHD.PwrUp/PwrDn shall be transient	N
	774	Loc, LocKey and LocSta YPSH and YLTC	na
	775	ITCI.LocKey	na
	776	KVLV.ClsLim and OpnLim	na
	790	LPHD.OutOv/InOv and LCCH.OutOv/InOv	na
	800	TVTR.VolSv not in table 10	na
	802	Misspelling in CSYN	na
	808	CCGR and Harmonized control authority	na
	830	Presence condition of ZMOT.DExt and new DOs	na
	831	Mode/Behaviour & Quality	na
	838	Setting of ConfRevNum in LGOS	na
	842	Testing in Beh=Blocked	na
	843	GAPC.Auto change type to SPS	na
	844	GGIO.AnOut1 move to Controls	na
	849	MFLK.PhPiMax, MFLK.PhPiLoFil, MFLK.PhPiRoot DEL->WYE	na
		Presence conditions re-assessing in case of derived statistical calculation	
7-4	877	QVUB -settings should be optional	na
	879	Duplicate definition of HzChr	na
	902	Control Blocks in CommonLN	na
	908	ARIS.StrSeq - transient	na
	909	Remove ANCR.ColOpR and ColOpL	na
	912	Clarification of PwrRtg/VARtg	na
	920	Resetable Counter is NOT resetable	na
	932	Rename AVCO.SptVol to AVCO.VolSpt	na
	933	Presence of LCCH.RedFerCh and RedRxCnt	Y
	939	Change CDC for ANCR.FixCol	na
	940	Clarification of feedback MX for DO with CDC APC	na
	967	Statistical calculation and "M" attributes	na
	991	LGOS: GoCBRef (as well as LSVS.SvCBRef) should be mandatory	na
	1007		na

Table 116: Mandatory Edition 2 Tissues

Part	Tissue Nr	Description	Implemented Y/na
	1044	PTRC as fault indicator - Update of description required	na
	1077	TapChg in AVCO	na
	1177	Rename DOnames within LTIM	na
	1273	Winding ratio for TCTR and TVTR	na
	1294	Behavior of DOI "Beh" due internal condition	Y
	1330	Description of SIML.GasInsAlm reg. Buchholz	na
	1331	proposal in tissue 830 seems not consistent with 7-3 Ed2	na
	1333	Mod, Beh and Health with q=TEST, client can't receive their states	na
	1456	SPS datapoint for Select is not present in LN ATCC for process bus	na
	1568	Annex A and Mod/Beh/Health	na
		ISAF.AlmReset ->transient	
7-3	697	persistent command / PulseConfig	na
	698	Wrong case is BAC.dB attribute	na
	709	Semantic of tstEna	na
	722	Units for 'h' and 'min' not in UnitKind enumeration.	Y
	814	subQ bit used	na
	819	APC and ASG	na
	832	Data attribute semantic of minVal & maxVal	na
	839	Use of opRcvd also in Blocked	na
	887	Data semantics for q and t	na
	919	Presence Condition for sVC	na
	924	Missing curve characteristics	na
	925	Presence of i or f attribute - Problem with writing	na
	926	Presence Conditions within RangeConfig	na
	929	condition AC_SCAV unclear	na
	953	missing trigger option forCSG units	na
	954	Data attributes with FC=CF should have trgOp=dchg	na
	962	instMag optional?	na
	968	BCR value range	N

Table 116: Mandatory Edition 2 Tissues

Part	Tissue Nr	Description	Implemented Y/na
	1078	CMV.t update if rangeAng changed	na
	1079	q and t semantic syntax errors	na
	1187	ldNs example value shal be 2007A	na
	1253	Can CDC ACT be used for 3-phase indication?	Y
	1387	Default value of SboClasses	na
	1430	opRcvd for controllable object	na
	1481	configRev presence condition	Y
7-2	728	BRCB: could PurgeBuf be set when RptEna=TRUE?	Y
	778	AddCause values	Y
	780	What are unsupported trigger option at a control block?	Y
	783		na
	786	TimOper Resp- ; add Authorization check	Y
	813	AddCause values 26 and 27 are switched	na
	820	TimeAccuracy choices	Y
	850	Mandatory ACSI services (use for PICS template)	Y
	852	Report Value needs a corresponding index when data-FALSE	na
	858	Check condition type - parameter type wrong	Y
	861	Typo in enumeration ServiceType	na
	869	dchg of ConfRev attribute	na
	875	Grammer/spelling error	na
	876	GenLogiclNodeClass and compatible LN Classes	na
	943	GenLogiclNodeClass and SGCB, GoCB, MsvCB, UsvCB	na
	970	control model change to "local" when TimeActivated-Operate	na
	1038		na
	1050	Wrong reference to GSSE	na
	1061	Loss of Info Detection After Resynch	na
	1062	GTS Phycomaddr definition in SCL	na
	1071	EntryTime wronglly appllied	Y
	1091	Entrytime not used in CDC	na
	1092	Length of DO name	na
	1116	The sentence "The initial value of EditSG shall be 0" in 7.2	na

Table 116: Mandatory Edition 2 Tissues

Part	Tissue Nr	Description	Implemented Y/na
	1127	NewEntrTm and OldEntrTm Type in LOG Class	na
	1145	CONTROL service(s) parameter 'orgin' misspelled	na
	1154	Missing owner attribute in BTS and UTS	na
	1202	T – control time-stamp	Y
	1232	Inconistent Definition for Response Parameter	Y
	1242	GI not optional	na
	1252	EntryID needs clarification	na
	1283	NTS definiton	na
	1307	Data-Instance-ID: is 01 allowed?	Y
	1341	pleonasm "qchg-change" (for Ed.2)	Y
	1428	Segemented report with Buffer overflow	na
	1569	Attribute Owner is missing in GetBRCBValues services	na
		MTS and NTS should use svOptFlds	
		How to track Select service in service tracking?	
7-1	828	Data model namespace revision IEC 61850-7-4:2007[A]	Y
	874	Logical Node Class needs to be updated	na
	948	Enumeration (string) values format	na
	1060	Error in encoding in Figure F.9	na
	1072	Statistical Data and Reporting	na
	1129	Rules for extending nameplate information	na
	1151	Simulated GOOSE disappears after 1st appearance	na
	1251	All "L" logical nodes shall be in the same LD - except for gateways	Y
	1268	Assigment of single CDC to DOclass	na
	1312	Presence condition of lnNs and dataNs	Y
	1396	The use and configuration flow of LGOS and LSVS is Unclear	na
	1491	CmdBlk blocks itself?	na
6	658	Tracking related features	na
	660	XML encoding header repeat	na
	663	FCDA element cannot "functionally constrained logical node"	Y
	668	Autotransformer modeling	na

Table 116: Mandatory Edition 2 Tissues

Part	Tissue Nr	Description	Implemented Y/na
	687	SGCB ResvTms	na
	699	DO type description table	na
	719	ConfDataSet - maxAttributes definition is confusing	Y
	721	Log element name	na
	731	quoted SCL inconsistant with annex.	na
	752	Input Section/ Inputs Section	na
	768	bType VisString65 is missing	na
	779	Object references	Y
	787	SICS I45 inconsistency	Y
	788	SICS S56 from optional to mandatory	na
	789	ConfLdName as services applies to both server and client	Y
	804	valKind and IED versus System configuration	na
	806	Max length of log name inconsistent between -6 and -7-2	na
	807		Y
	823	Need a way to indicate if "Owner" present in RCB	Y
	824	ValKind for structured data attributes	na
	825	Short addresses on structured data attributes	na
	845	Floating point value	na
	853	SGCB ResvTms	na
	855	SBO and ProtNs	N
	856	Recursive SubFunction	na
	857	VoltageLevel frequency and phases	Y
	873	Function/SubFunction for ConductingEquipment	na
	886	Examples for "curvPts"	na
	901	Missing 8-1 P-types	na
	936	tServices as AP or as IED element	na
	949	SupSubscription parameter usage is difficult	na
	1118	type of LN inst is ambiguous	na
	1147	Clarification of how tClientLN is used to enable Report Control Blocks	na
	1175	tServices - FileHandling not consistent with -7-2	na
	1185		na

Table 116: Mandatory Edition 2 Tissues

Part	Tissue Nr	Description	Implemented Y/na
	1195	IPv6 address lowercase only na	na
	1208	Valkind value Conf for EX FC data	na
	1284	Typographical Error	Y
	1298	IPv6 Address format	na
	1304	SCSM mapping may require a communication section in an ICD file	na
	1318	How to differentiate preconfigured Report Datasets and generated ones	na
	1328	Error in the SCL object model	Y
	1354	SSD will not validate against XSD	Y
	1365	Limitation on the size of data type templates identifiers	N
	1397	Changes to SICS Template	na
	1398	Need to tighten up the XSD in regards to IEDName usage	N
	1415	Subscription limitation visible in IxD file	na
	1444	originalSclVersion management in SCT	Y
	1445	SICS-S110 IID import mandatory for Edition2	Y
		Need to support fixed and SCT controlled Datasets	
		ConfReportControl and a fixed ReportSettings	
6	1447	Restriction on ENUMtypes in SCL	Y
	1450	originalSclXxx computation rules	N
	1451	Services section-"client" is confusing	na
	1457	Multiple DOI nodes with the same name.	Y

NOTE: Editorial tissues are marked as “na”.

Table 116: Mandatory Edition 2 Tissues

10.5 Protocol Implementation extra Information for Testing (PIXIT)

This document specifies the protocol implementation extra information for testing (PIXIT) of the IEC 61850 interface in RTU500 series IEC 61850 server, version 10.6.

Together with the PICS and the MICS the PIXIT forms the basis for a conformance test according to IEC 61850-10.

Each chapter specifies the PIXIT for each applicable ACSI service model as structured in IEC 61850-10.

10.5.1 PIXIT for Association model

ID	Description	Value / Clarification
As1	Maximum number of clients that can set-up an association simultaneously	8 (The number of clients that are able to enable reports is restricted to 5, these clients must be pre-assigned in the SCD file)
As2	TCP_KEEPALIVE value	5 seconds
As3	Lost connection detection time	TCP_KEEPIDLE = 10 s TCP_KEEPCNT = 3 TCP_KEEPINIT = 10 s TCP_KEEPINTVL = 5s 10s after association start to begin sending keepalive, and 15s (3 * 5s) to detect lost connection.
As4	Is authentication supported	N
As5	What association parameters are necessary for successful association	Transport selector Y Session selector Y Presentation selector Y AP Title N AE Qualifier N
As6	If association parameters are necessary for association, describe the correct values e.g.	Transport selector 0001 (default) Session selector 0001 (default) Presentation selector 00000001 (default) AP Title n/a AE Qualifier n/a
As7	What is the maximum and minimum MMS PDU size	Max MMS PDU size 32000 bytes Min MMS PDU size 1024 bytes
As8	What is the maximum start up time after a power supply interrupt	That depends on the other functionalities that are configured for the device. Typical value are 2..3 minutes.

Table 117: PIXIT for Association model

10.5.2 PIXIT for Server model

ID	Description	Value / Clarification
Sr1	Which analogue value (MX) quality bits are supported (can be set by server)	Validity: Y Good, Y Invalid,

Table 118: PIXIT for Server model

ID	Description	Value / Clarification
		N Reserved, N Questionable Y Overflow Y OutofRange N BadReference N Oscillatory N Failure Y OldData N Inconsistent N Inaccurate Source: Y Process Y Substituted Y Test Y OperatorBlocked
Sr2	Which status value (ST) quality bits are supported (can be set by server)	Validity: Y Good, Y Invalid, N Reserved, N Questionable N BadReference N Oscillatory N Failure Y OldData N Inconsistent N Inaccurate Source: Y Process Y Substituted Y Test Y OperatorBlocked

Table 118: PIXIT for Server model

ID	Description	Value / Clarification
Sr3	What is the maximum number of data values in one GetDataValues request	Limited to a MMS read request (GetDataValues) containing a list of maximum 20 entries.
Sr4	What is the maximum number of data values in one SetDataValues request	Service SetDataValues is not supported by the device.
Sr5	Which Mode / Behaviour values are supported	Mode / Behaviour handling is not supported by the device. Therefore the value is “on” always.

Table 118: PIXIT for Server model

10.5.3 PIXIT for Data set model

ID	Description	Value / Clarification
Ds1	What is the maximum number of data elements in one data set (compare ICD setting)	Maximum FCDAs = 150 Maximum Data Attributes = 450 Note: The data elements can be defined on data object level only.
Ds2	How many persistent data sets can be created by one or more clients	Creating data sets by a client online is not supported by the device.
Ds3	How many non-persistent data sets can be created by one or more clients	Creating data sets by a client online is not supported by the device.

Table 119: PIXIT for Data set model

10.5.4 PIXIT for Substitution model

Substitution of values is not supported by the device.

10.5.5 PIXIT for Setting group control model

Setting groups are not supported by the device.

10.5.6 PIXIT for Reporting model

ID	Description	Value / Clarification
Rp1	The supported trigger conditions are (compare PICS)	Integrity Y* data change Y quality change Y data update N general interrogation Y * It is not possible to configure an integrity report for the device and the possible online change is a not supported operating mode

Table 120: PIXIT for Reporting model

ID	Description	Value / Clarification
Rp2	The supported optional fields are	sequence-number Y report-time-stamp Y reason-for-inclusion Y data-set-name Y data-reference Y buffer-overflow Y entryID Y conf-rev Y segmentation Y
Rp3	Can the server send segmented reports	Y
Rp4	Mechanism on second internal data change notification of the same analogue data value within buffer period (Compare IEC 61850-7-2 $14.2.2.9)	Send report immediately
Rp5	Multi client URCB approach (compare IEC 61850-7-2 $14.2.1)	N
Rp6	What is the format of EntryID	Octet string 8
Rp7	What is the buffer size for each BRCB or how many reports can be buffered	50000 bytes for each used BRCB (max. 48 BRCBs a 5 clients = max. 240 BRCB instances)
Rp8	Pre-configured RCB attributes that cannot be changed online when RptEna = FALSE (see also the ICD report settings)	- DatSet - ConfRev - SqNum - TimeofEntry
Rp9	May the reported data set contain: - structured data objects? - data attributes?	Y N
Rp10	What is the scan cycle for binary events? Is this fixed, configurable	The assured accuracy for capturing binary event is +/- 5 milliseconds Fixed
Rp11	Does the device support to pre-assign a RCB to a specific client in the SCL	N

Table 120: PIXIT for Reporting model

10.5.7 PIXIT for Logging model

Logging is not supported by the device.

10.5.8 PIXIT for Generic substation events model

ID	Description	Value / Clarification
Go1	What elements of a subscribed GOOSE header are checked to decide the message is valid and that all data values are accepted? If yes, describe the conditions. Note: the VLAN tag may be removed by a Ethernet switch and should not be checked	N source MAC address Y destination MAC address Y Ethertype = 0x88B8 Y APPID Y gocbRef N/Y timeAllowedtoLive* Y datSet Y goID N t Y stNum Y sqNum Y test Y confRev Y ndsCom Y numDatSetEntries * An invalid TAL value (e.g. TAL=0) doesn't lead to invalidated data but GOOSE telegrams are supervised according to TAL (see Go4)
Go2	Can the test flag in the published GOOSE be turned on / off	N
Go3	What is the behaviour when the GOOSE publish configuration is incorrect	n/a (It is not possible to setup an incorrect GOOSE publish configuration)
Go4	When is a subscribed GOOSE marked as lost? (TAL = time allowed to live value from the last received GOOSE message)	Message does not arrive prior to 2*TAL, then the message is marked as lost at the receiver. (Time allowed to live = MaxTime as defined in IEC 61850 part 6). Note that erroneous GOOSE telegrams are discarded, and valid telegrams are supervised according to TAL.
Go5	What is the behaviour when one or more subscribed GOOSE messages isn't received or syntactically incorrect (missing GOOSE)	Is ignored. The data value of this data are set to invalid if time allowed to live times out.
Go6	What is the behaviour when a subscribed GOOSE message is out-of-order	Is ignored.
Go7	What is the behaviour when a subscribed GOOSE message is duplicated	Is ignored.

Table 121: PIXIT for Generic substation events model

ID	Description	Value / Clarification
Go8	Does the device subscribe to GOOSE messages with/without the VLAN tag?	Y, with the VLAN tag Y, without the VLAN tag
Go9	May the GOOSE data set contain: - structured data objects (FCD)? - timestamp data attributes? Note: data attributes (FCDA) is mandatory	Subscribed Published N N Y N
Go10	Published FCD supported common data classes are	Structured data objects are not supported in GOOSE data sets.
Go11	Subscribed FCD supported common data classes are	Structured data objects are not supported in GOOSE data sets.
Go12	What is the slow retransmission time? Is it fixed or configurable?	The time (MinTime) is configured by the SCD file. Typical values are 1000 ... 10000 mseconds
Go13	What is the fast retransmission scheme? Is it fixed or configurable?	The time (MaxTime) is configured by the SCD file. A typical value is 4 mseconds. The fast retransmission scheme is fix implemented. For e.g. MinTime = 4 mseconds and MaxTime = 10000 mseconds the scheme works as follows: 1. 0ms (SqNum = 0) GOOSE change, 2. 4ms later (SqNum = 1), 3. 4ms later (SqNum = 2), 4. 8ms later (SqNum = 3), 5. 32ms later (SqNum = 4), 6. 128ms later (SqNum = 5), 7. 512ms later (SqNum = 6), 8. 2048ms later (SqNum = 7), 9. 8192ms later (SqNum = 8), 10. 10000ms later (SqNum = 9) and then after every 10000ms (++SqNum) retransmission happens.
Go14	Can the Goose publish be turned on / off by using SetGoCBValues(GoEna)	N
Go15	What is the initial value of the GOOSE telegram sequence number (sqNum)?	The initial sequence number in a GOOSE telegram is defined as follows: • Initial GOOSE send, sqNum = 1 • After GOOSE change, sqNum = 0

TAL = Time Allowed to Live

Table 121: PIXIT for Generic substation events model

10.5.9 PIXIT for Control model

ID	Description	Value / Clarification
Ct1	What control models are supported (compare PICS)	Y status-only Y direct-with-normal-security* N sbo-with-normal-security N direct-with-enhanced-security Y sbo-with-enhanced-security** * The control model DOns is supported for the common data classes INC and ISC ** The control model SBOes is supported for the common data classes DPC, SPC and BSC.
Ct2	Is the control model fixed, configurable and/or online changeable?	Fixed defined for the supported common data classes.
Ct3	Is TimeActivatedOperate supported	N
Ct4	Is “operate-many” supported	N
Ct5	Will the DUT activate the control output when the test attribute is set in the SelectWithValue and/or Operate request (when N test procedure Ctl2 is applicable)	The test mode is not supported by the device.
Ct6	What are the conditions for the time (T) attribute in the SelectWithValue and/or Operate request?	The device ignores the time value and executes the command as defined.
Ct7	Is pulse configuration supported	N
Ct8	What is the behaviour of the DUT when the check conditions are set? Is this behaviour fixed, configurable, online changeable?	N synchrocheck N interlock-check The device ignores the check value Fixed
Ct9	What additional cause diagnosis are supported	Y Blocked-by-switching-hierarchy Y* Select-failed Y* Invalid-position Y* Position-reached Y* Parameter-change-in-execution Y* Step-limit Y* Blocked-by-Mode Y* Blocked-by-process Y* Blocked-by-interlocking Y* Blocked-by-synchrocheck

Table 122: PIXIT for Control model

ID	Description	Value / Clarification
		Y Command-already-in-execution Y* Blocked-by-health Y* 1-of-n-control Y* Abortion-by-cancel Y* Time-limit-over Y* Abortion-by-trip Y Object-not-selected * supported by user created application program (PLC) only
Ct10	How to force a “test-not-ok” respond with SelectWithValue request?	Send a request for the same command already selected or Acquire control authority with local HMI and send a request
Ct11	How to force a “test-not-ok” respond with Select request?	The Select request (SBOns) is not supported by the device
Ct12	How to force a “test-not-ok” respond with Operate request?	DOns: Acquire control authority with local HMI and send a request SBOns: Not supported DOes: Not supported SBOes: Send Operate request for not selected control object
Ct13	Which origin categories are supported?	The device ignores received origin categories and replies with categorie Remote-Control always.
Ct14	What happens if the orCat value is not supported?	DOns: orCat is ignored SBOns: Not supported DOes: Not supported SBOes: orCat is ignored
Ct15	Does the IED accept a SelectWith-Value/Operate with the same ctlVal as the current status value?	DOns: Y SBOns: Not supported DOes: Not supported SBOes: Y
Ct16	Does the IED accept a select/operate on the same control object from 2 different clients at the same time?	DOns: N SBOns: Not supported

Table 122: PIXIT for Control model

ID	Description	Value / Clarification
		DOes: Not supported SBOes: N
Ct17	Does the IED accept a Select/ SelectWithValue from the same client when the control object is already selected (tissue 334)	SBOns: Not supported SBOes: N
Ct18	Is for SBOes the internal validation performed during the SelectWithValue and/ or Operate step?	SelectWithValue and Operate
Ct19	Can a control operation be blocked by Mod=Off or Blocked	Mode / Behaviour handling is not supported by the device.
Ct20	Does the IED support local / remote operation?	Local / remote operations are supported by the means of control authority. When the local HMI holds the control authority, controlling via the IEC 61850 server is blocked (if configured).
Ct21	Does the IED send an InformationReport with LastApplError as part of the Operate response- for control with normal security?	SBOns: Not supported DOns: N

Table 122: PIXIT for Control model

10.5.10 PIXIT for Time and time synchronisation model

ID	Description	Value / Clarification
Tm1	What quality bits are supported (may be set by the IED)	N LeapSecondsKnown N ClockFailure Y ClockNotSynchronized
Tm2	Describe the behaviour when the time synchronization signal/messages are lost	Request of up to 5 SNTP server in unicast mode with a configurable polling interval between 1 and 1440 minutes (one day). In each interval the SNTP client tries to request every configured server two times. If both accesses fail the server is defined as not available. Are the received time from the available servers is significant different (> 1 minute) no time will be accepted. If more than one server is available the sntp client uses for synchronization the time from the server with the lowest transmission delay. Two successful SNTP requests (two intervals) are required to set the internal clock to synchronized.

Table 123: PIXIT for Time and time synchronisation model

ID	Description	Value / Clarification
		Once synchronized the clock is set to not synchronized when for a configurable time (typical 10 minutes) no new synchronization is received.
Tm3	When is the time quality bit "ClockFailure" set?	The quality bit "ClockFailure" is never set.
Tm4	When is the time quality bit "Clock not synchronised” set?	The time quality bit "Clock not synchronised” is set: - At start-up before synchronization - When after synchronization for a configurable time (typical 10 minutes) no new synchronization is received.
Tm5	Is the timestamp of a binary event adjusted to the configured scan cycle?	N
Tm6	Does the device support time zone and daylight saving?	Y
Tm7	Which attributes of the SNTP response packet are validated?	N Leap indicator not equal to 3? Y Mode is equal to SERVER Y OriginateTimestamp is equal to value sent by the SNTP client as Transmit Timestamp Y RX/TX timestamp fields are checked for reasonableness Y SNTP version > 1 and <= 4

Table 123: PIXIT for Time and time synchronisation model

10.5.11 PIXIT for File transfer model

File transfer is not supported by the device.

10.6 SCL Implementation Conformance Statement (SICS)

This SICS is applicable for:

- Tool name: RTUtil500
- Main role: ICT
- Version: 12.2

The following tables contain mandatory and optional features of System Configuration tools and IED configuration tools. It is up to the tool manufacturer to decide to which extent his tool fulfills one or both roles. At least for one main role all mandatory features shall be supported.

The IED configurator features can also partly be implemented within the IED itself, if it can be configured by an SCD or CID file. In this case the conformance statement refers to the combination of IED and IED configurator tool. If an IED tool supports several IED types with different engineering capabilities, then for each combination of tool and IED type a separate IED configurator conformance statement should be given.

The features are grouped. If a group is mandatory, then at least all mandatory features of this group shall be implemented. If a group is optional, then either all features of this group shall be missing, or at least all mandatory ones shall be implemented.

The result of an export function can be checked in the generated SCL file. The result of an import can be checked by tool behaviour, and at the final configured IED, by browsing through it or by its communication behaviour.

		Mandatory/ optional	Value/ comments
ICD export		**M**	
I11	Fix ICD file (no adaptable export needed)	GC_1 (1)	NO
I12	Export of ICD file or IID file according to IED pre-configuration performed by tool	GC_1 (1)	YES
I13	State the data model name space (61850-7-3 subclause 7.2) within ICD file (LLN0.NamPlt.ldNs value)	M	YES
I14	State the data model version (61850-7-3 sub-clause 7.8.3) and any predefined / fixed configuration values within ICD file ([10] 9.5.4.4)	M	YES
I15	Version 2003 export	GC_1 (2)	YES
I16	Version 2007A export	GC_1 (2)	YES
I17	Predefined data sets	O	YES
I18	Predefined control blocks	O	YES
I19	Substation bay template with IED part	O	NO
I110	Communication section with default address	O	YES
I111	Export correct valKind value ([10] Table 46)	O	YES (RO)
I112	Exports internal addresses as InRef or Input section (subclause 285H 9.3.13)	O	NO
I113	Exports internal addresses in Input section with expected serviceType (subclause [10] 9.3.13)	O	NO
I114	Exports in UTF-8 coding	M	YES
SCD import		**M**	
I21	Identify IED to be configured in SCD file by IED name	M	YES
I22	Configure LD name (at least via ldInst, dependent on the IED capabilities) and IED addresses from SCD	M	YES
I23	Determine communication side addresses of IED inputs from SCD	C1	YES
I24	Determine and use clock communication addresses from SCD	C1	NO
I25	Configure values of (existing) control block from SCD([10] 9.3)	C3	NO

Table 124: IED configurator conformance statement

		Mandatory/ optional	Value/ comments
I26	Prepare (new) control block instances according to SCD file	C3	NO
I27	Prepare / configure data sets according to SCD file	C3	NO
I28	Modify predefined data sets according to SCD	C3	NO
I29	Interpret client references in the control blocks of other IEDs to find the control block instances allocated to this IED, and data sent to this IED.	C1	YES
I210	Set IED configuration values and parameter values as defined in SCD file	O	NO
I211	Support changed (reduced capability) valKind (e.g. from Set to RO or to Conf) ([10] Table 46)	O	NO
I212	Support ldName on other IEDs ([10] 9.3.4)	C3	NO
I213	Interpret input signal references to source control blocks (290H 9.3.13)	O	YES
I214	Imports UTF-8 coding of XML	M	YES
IID export after IED engineering			
I31	IED version and instance information: LPHD.PhyNam: hwRev, swRev, serNum, LLN0.NamPlt.configRev	O	NO
I32	Configuration values (fc=CF)	O	NO
I33	Setting Parameter values (fc=SP, SG)	O	NO
I34	SCL Header management ([10] 9.1)	C3	NO
I35	Modify IED data model (add LN/Data object/LD, or remove unused LD/LN/Data object)	O	NO
Tool functionality			
I41	Support MustUnderstand concept ([10] 8.2)	M	YES
I42	Bind incoming 61850 signals to IED internal (input) signals	C1	YES
I43	Use or create IED Input section for binding incoming (external) signals to internal signals, to document this binding	O	YES
I44	Create CID file for IED	O	NO
I45	Support ldName for LD name specification	C3	YES
I46	Modify LN prefixes or lnInst	O	YES (Both can be set as wanted)

C1 - Mandatory, if the IED can receive data from other IEDs, i.e. be either client or subscriber

C2 - Mandatory, if any of the other features in this table section is supported.

C3 - Mandatory, if the appropriate IED capability is claimed in PIXIT or IED capability section.

GC_1 (n) - At least one of the elements of group n shall be available.

Table 124: IED configurator conformance statement

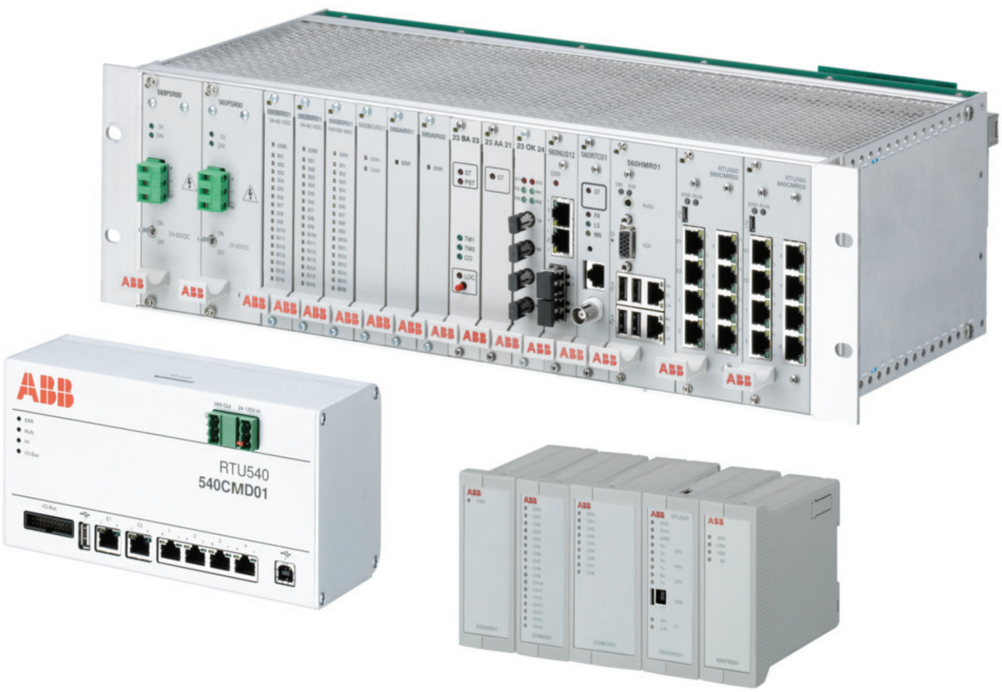
	Mandatory/ optional	Value/ comments
O - Optional; should match the IED capabilities; i.e. if an IED claims that RCBs can be configured by SCL, then the IED tool shall support it. M - Mandatory		

Table 124: IED configurator conformance statement

Power Grids

Remote Terminal Units Subdevice Communication Interface with DNP3

Protocol description



Revision

Document identity:		1KGT 150 484 V021 1
Revision:	**Date:**	**Changes:**
0	03/2001	Initial version
1	11/2001	
2	03/2002	
3	08/2003	Delay Measurement (Fcode 23) included Control relay output is object 12, variation 1
4	10/2003	Chapter 'TEST Link' and Chapter 'Representation of DPI' introduced
5	06/2004	Chapter ‘Dial up’ included
6	07/2004	New parameter for AMI, SCO, DCO and RCO (Available with Release 6.1, Build 0)
7	07/2004	Function command ‘Enable Unsolicited’ introduced (Available with FW Release 6.1, Build 0) (RTUtil560 Release 6.1, Build 202 necessary)
8	03/2005	Conversion of value for DCO changed Conversion of value for RCO changed Note: Conversion of RCO also changed in FW Release 6.3 Build 3
9	01/2006	Qualifier Code ‘Request all Variations’ corrected
10	06/2006	New function: Collision Avoidance
11	07/2007	New function, IP based communication
12	01/2008	Device Profile: Send/Execute Control Operation Small updates in chapter 2
13	05/2009	File transfer added
14	11/2009	System Events added
15	05/2011	DPI object Type 3 and 4 added MFI and FSO Objects added Interoperability List Updated Time Synchronization Updated
16	07/2012	Description for MFI and FSO updated
	09/2012	New layout
17	10/2012	Updated Threshold Supervision for MFI
18	02/2013	Range for Master address and Slave address updated to 0 ... 65 519 Added restriction on length of file name for file transfer
19	02/2014	Removed object group 41 variation 1
20	12/2014	Document corrections in section 2.2 Chapter system commands added

Document identity:		1KGT 150 484 V021 1
Revision:	**Date:**	**Changes:**
		Support NT-Flag New layout Clarification added on AMI, MFI integrated threshold supervision
		Update chapter system events and system commands
	06/2016	Removed parameter transmission format from chapter AMI (PR#29691)
	04/2017	Updated Sends/Execute Control Operations in Interoperability List (PR#17055)
21	09/2017	Updated supported file types in chapter 'File Transfer' (PR#30099)
	11/2017	Updated tables 'Maximum Data Link Retries' and 'Maximum Application Layer Retries' of Interoperability List (PR#31858)
	03/2018	New layout

Contents

1 Introduction 5
- 1.1 Preface 5
- 1.2 References 5
- 1.3 Conventions 6

2 Physical Layer 7
- 2.1 Serial line-based communication 7
  - 2.1.1 Collision avoidance 7
- 2.2 IP based Communication 8
  - 2.2.1 TCP initiating end point 9
  - 2.2.2 TCP dual end point 9
  - 2.2.3 UDP/IP 10

3 Link Layer 11
- 3.1 General 11
- 3.2 Transmission mode 12
- 3.3 Dial-up 12
  - 3.3.1 Dial-up configuration 13
  - 3.3.2 Dial-up parameters at the the serial interfaces of the CMU 13
  - 3.3.3 Dial-up properties: Dial-up parameters for IEDs 14
  - 3.3.4 Dial-up parameters of the RTU 15
  - 3.3.5 Dial-up properties: Telephone number(s) 15

4 Transport Layer 17

5 Application Layer 19
- 5.1 Application Layer 19

6 Addressing 25
- 6.1 Restrictions for the index address 25

7 Data Types - Monitoring Direction 27
- 7.1 SPI – Single Point Information 27
  - 7.1.1 Supported data types 27
  - 7.1.2 Additional information 27
  - 7.1.3 Conversion of values 27
  - 7.1.4 Conversion of quality descriptors 27
  - 7.1.5 Conversion of causes of transmission 28
- 7.2 DPI – Double Point Information 28
  - 7.2.1 DPI – Double Point Information 28
  - 7.2.2 Supported data types 29
  - 7.2.3 Additional information 29
  - 7.2.4 Conversion of values 29
  - 7.2.5 Conversion of quality descriptors 29
  - 7.2.6 Conversion of causes of transmission 30
- 7.3 EPI – Protection Event Information 30

7.4 STI – Step Position Information....30
7.4.1 Supported data types....30
7.4.2 Additional Information....31
7.4.3 Conversion of values....31
7.4.4 Conversion of quality descriptors....31
7.4.5 Conversion of causes of transmission....32
7.5 BSI – Bit String Information....32
7.5.1 Supported data types....32
7.5.2 Additional Information....32
7.5.3 Conversion of values....32
7.5.4 Conversion of quality descriptors....33
7.5.5 Conversion of causes of transmission....33
7.6 ITI – Integrated Totals Information....33
7.6.1 Supported data types....34
7.6.2 Additional Information....34
7.6.3 Conversion of values....34
7.6.4 Conversion of quality descriptors....34
7.6.5 Conversion of causes of transmission....35
7.7 DMI – Digital Measured Information....35
7.7.1 Supported data types....35
7.7.2 Additional Information....36
7.7.3 Conversion of values....36
7.7.4 Conversion of quality descriptors....36
7.7.5 Conversion of causes of transmission....37
7.8 AMI – Analog Measured Information....37
7.8.1 Supported data types....37
7.8.2 Additional configuration parameters....37
7.8.3 Conversion of values....38
7.8.4 Conversion of quality descriptors....38
7.8.5 Conversion of causes of transmission-....38
7.9 MFI – Measured Float Information....39
7.9.1 Supported data types....39
7.9.2 Additional configuration parameters....40
7.9.3 Conversion of values....40
7.9.4 Conversion of quality descriptors....41
7.9.5 Conversion of causes of transmission....42

8 Data Types - Controlling Direction....43
8.1 SCO – Single Command Output....43
8.1.1 Supported data types....43
8.1.2 Command Authority....43
8.1.3 Additional configuration parameters....43
8.1.4 Conversion of values....43
8.1.5 Conversion of quality descriptors....44
8.1.6 Conversion of causes of transmission....44
8.2 DCO – Double Command Output....44
8.2.1 Supported data types....44

8.2.2 Command Authority ... 45
8.2.3 Additional configuration parameters ... 45
8.2.4 Conversion of values ... 45
8.2.5 Conversion of quality descriptors ... 45
8.2.6 Conversion of causes of transmission ... 46
8.3 RCO – Regulation Command Output ... 46
8.3.1 Supported data types ... 46
8.3.2 Command Authority ... 46
8.3.3 Additional configuration parameters ... 46
8.3.4 Conversion of values ... 47
8.3.5 Conversion of quality descriptors ... 47
8.3.6 Conversion of quality descriptors ... 47
8.4 ASO – Analog Setpoint Output ... 48
8.4.1 Supported data types ... 48
8.4.2 Command Authority ... 48
8.4.3 Additional Information ... 48
8.4.4 Conversion of values ... 48
8.4.5 Conversion of quality descriptors ... 48
8.4.6 Conversion of quality descriptors ... 49
8.5 DSO – Digital Setpoint Output ... 49
8.5.1 Supported data types ... 49
8.5.2 Command Authority ... 49
8.5.3 Additional Information ... 49
8.5.4 Conversion of values ... 50
8.5.5 Conversion of quality descriptors ... 50
8.6 BSO – Bit String Output ... 50
8.6.1 Supported data types ... 50
8.6.2 Command Authority ... 51
8.6.3 Additional Information ... 51
8.6.4 Conversion of values ... 51
8.6.5 Conversion of quality descriptors ... 51
8.6.6 Conversion of quality descriptors ... 52
8.7 FSO – Floating Point Setpoint Output ... 52
8.7.1 Supported data types ... 52
8.7.2 Command Authority ... 52
8.7.3 Additional Information ... 52
8.7.4 Conversion of values ... 53
8.7.5 Conversion of quality descriptors ... 53
8.7.6 Conversion of quality descriptors ... 53

9 File transfer ... 55
9.1 Supported variations ... 55
9.2 Command Authority ... 56
9.3 Conversion of causes of transmission ... 56

10 Internal Functions ... 57
10.1 General Interrogation ... 57

10.2 Time synchronization ... 57
10.2.1 Non-LAN-based method ... 57
10.2.2 LAN-based method ... 58
10.3 System events ... 59
10.3.1 Status Change Device OFFLINE to Device ONLINE ... 60
10.3.2 Status Change Device ONLINE to Device OFFLINE ... 60
10.4 System commands ... 60

11 Interoperability List ... 61
11.1 Data object library ... 62

12 Glossary ... 69

1 Introduction

1.1 Preface

This document describes the functions of the subdevice interface in RTU500 series according to DNP3.

Concerning DNP3 objects, function codes and qualifiers, RTU500 series fulfills the requirements of a DNP3 Level 2 implementation plus some extensions necessary for Level 3. For detailed information see DNP3 Device Profile for RTU500 series and Implementation Table for RTU500 series in the chapter Interoperability list (page Chapter 11).

1.2 References

[1] DNP V3.00
Transport Functions

Version 0.01, May 30, 1997

DNP Users Group

[2] DNP V3.00
Data Link Layer Protocol Description

Version 0.02,May 30, 1997

DNP Users Group

[3] DNP V3.00
Application Layer Protocol Description

Version 0.03, May 28, 1997

DNP Users Group

[4] DNP V3.00
Data Object Library

Version 0.02, July 8, 1997

DNP Users Group

[5] DNP V3.00
Intelligent Electronic Device (IED) Certification Procedure Subset Level 1

Version 1.01, December 15, 1999

DNP Users Group

[6] DNP V3.00
Intelligent Electronic Device (IED) Certification Procedure, Subset Level 2

Version 2.4, November 9, 2004

DNP Users Group

[7] DNP V3.00
Technical Bulletin 9804-007

Clarification of Collision Avoidance Procedures

April 22, 1998

DNP Users Group

1.3 Conventions

In this document function codes of data types according to DNP3 are marked with square brackets: <Function code>

Bold fonts with the table heading "Parameter name" are references to configuration parameters in RTUtil500. The parameter is followed by the parameter location where to find this parameter in RTUtil500. The first element of the parameter location defines the node in the hardware tree on the left side (e. g. RTU, CMU, line, IED) and the second element defines selected header control tab in the parameter window on the right side (e. g. general, interfaces, protocol).

Example:

Parameter name	Default	Parameter location
In use	Enabled	data point (e.g. SPI) - line T101/104
If enabled, the data point is transmitted to the host communication interface. This setting refers to data in monitoring and command direction.		

In this document references to elements of the standard and other references will be printed in brackets. Example: [2, 7.4]

The tables in the next chapters include lists of the functions, options and message types supported according to the protocol structure given in IEC 60870-5 (EPA three layer model) for

- the physical layer
- the link layer
- the application layer

This layered model is valid for the protocol DNP3.

2 Physical Layer

2.1 Serial line-based communication

The protocol DNP3 is running on the serial communication interfaces of the CMUs. For more details see RTU500 series Interfaces and Protocols Release 12 (1KGT 150 939).

Set the communication parameters according to the following table:

Parameter name	Default	Parameter location
Interface type	RS232C	CMU - serial interfaces
Type of physical interface. Select from list. Value range: RS232C, RS485 or fix if selection is not supported		
Baud rate	9600 bits/sec	CMU - serial interfaces
Value range: 50, 75, 100, 110, 150, 200, 300, 600, 1200, 1500, 2400, 4800, 9600, 19200, 38400 bits/sec; 50-600 bits/sec only on selected interfaces		
Modem control	Direct link (TxD/RxD only)	CMU - serial interfaces
Value range: • Direct link (TxD/RxD only) • WT link full duplex (no handshake) • WT link half duplex (RTS/CTS handshake) • WT link half duplex (RTS/DCD handshake) • Dial up (external modem DCD handshake) • Loop switch unit (DSTC 3002), RP570/71 Host interface only • Link with collision avoidance (DCD handshake), DNP 3 only Usage of the controls for this interface. Direct Link: No modem controls. Loop Switch Unit: RP570/71 Host Interface only. Collision Avoidance: DNP3.0 Host/Sub-Interface only		
Transmit delay time	disabled	CMU - serial interfaces
If 'Transmit Delay Time' is enabled: Delay time in Milliseconds. Value range: 1 to 10000 ms. Recommended value for WT modems in half-duplex mode: 30 ms		

ADVICE

The possibility to use different transmission speeds in control and in monitor direction is not supported by RTU500 series.

2.1.1 Collision avoidance

If unsolicited messages are sent by several devices sharing a half-duplex, multi-drop link, using the DCD (Data Carrier Detect) signal [6], the serial line interface (in RS232C mode) with DNP3 protocol is able to avoid collisions between these unsolicited messages.

Parameter name	Default	Parameter location
Link with collision avoidance		RTU – Interface parameters

If the link is busy (DCD), the device waits for a backoff_time, and then transmits an identical retry of the unsolicited message.

backoff_time = fixed delay + random (maximum of random delay)

Parameter name	Default	Parameter location
Fixed delay		RTU – Interface parameters

Parameter name	Default	Parameter location
Maximum of random delay		RTU – Interface parameters

The fixed delay can be adjusted to provide priority of access. The backoff_time can be zero for the master to provide a minimum of access time.

2.2 IP based Communication

The protocol DNP3 is running on the Ethernet-Interfaces of the CMU. For more details see RTU500 series Interfaces and Protocols Release 12 (1KGT 150 939).

For each Ethernet interface following parameters can be configured:

Parameter name	Default	Parameter location
Interface mode	Auto-negotiation	CMU - Network Interfaces
Transmisssion rate and duplex modes. Possible values are: - 100BaseTx half duplex - 100BaseTx full duplex - 10BaseT half duplex - 10BaseT full duplex - Auto-negotiation Default value: Auto-negotiation		
Node name	none	CMU - Network Interfaces
Node name of RTU at this ethernet interface		
IP Address	0.0.0.0	CMU - Network Interfaces
IP Address of this RTU interface		
Subnet mask	0.0.0.0	CMU - Network Interfaces
Subnet mask of IP address		
Default gateway IP	0.0.0.0	CMU - Network Interfaces
IP address of default gateway		

The subdevice interface supports up to 32 stations/IEDs per line. The parameters for the connected IEDs are shown in the following table:

Parameter name	Default	Parameter location
IP-Address		IED/RTU - Line TDNP3 LAN/WAN
IP address of the controlled station		
IP-Protocol	TCP/IP Initiating End Point	IED/RTU - Line TDNP3 LAN/WAN
Kind of connection. value range: TCP/IP initiating end point, TCP/IP dual end point, UDP/IP		
Port number	20000	IED/RTU - Line TDNP3 LAN/WAN
Port number of the substation. Value range: 0 to 65535		

Parameter name	Default	Parameter location
Listening/Master Port number	20000	IED/RTU - Line TDNP3 LAN/WAN
TCP/IP dual end point : Port on which the master will listen for a connection from the substation UDP/IP : Port on which the master expect the data from the substation value range: 0... 65 535		

2.2.1 TCP initiating end point

Using this mode the master (subdevice communication interface) tries to connect a slave with a given IP address and Port number. The slave (subdevice) should be prepared to accept a connection on the given port. If a connection is established, the connection will be maintained until an error occurs. If the master recognizes an error, it will close the active connection and try to establish a new connection.

The parameters IP address and Port number which are used for this connection type can be specified for each station on a line.

Parameter name	Default	Parameter location
IP address	0.0.0.0	
0.0.0.0 .. 255.255.255.255 IP address of the substation		
Port number	20 000	
0 .. 65 535 Port number of the substation		

Station parameters for TCP initiating end point

2.2.2 TCP dual end point

Using this mode both parts, the master as well as the slave, can establish a connection. The master will listen on the Listening port number if the slave wants to establish a connection for sending any data. On the other hand, the master will establish a connection on a given IP address and Port number if it wants to send any requests. If a connection is established, the connection will be maintained by the master. If the master wants to send new data and it recognized an error, it will close the active connection and try to establish a new one.

The slave parameter IP address and Port number and the master parameter Listening port number which are used for this connection type can be specified for each station on a line.

Parameter name	Default	Parameter location
IP address	0.0.0.0	
0.0.0.0 .. 255.255.255.255 IP address of the substation		
Port number	20 000	
0 .. 65 535 Port number of the substation		
Listening port number	20 000	
0 .. 65 535 Port on which the master will listen for a connection from the substation		

Station parameters for TCP dual end point

2.2.3 UDP/IP

Using this mode both parts send their DNP telegrams by using the UDP transport protocol of the network. Each part sends its telegrams to the IP address and the Port number of opposite side.

The slave parameter IP address and Port number and the master parameter Master port number which are used for this connection type can be specified for each station on a line.

Parameter name	Default	Parameter location
IP address	0.0.0.0	
0.0.0.0 .. 255.255.255.255 IP address of the substation		
Port number	20 000	
0 .. 65 535 Port number of the substation		
Master port number	20 000	
0 .. 65 535 Port on which the master (the RTU500 series) expect the data from the substation		

Station parameters for UDP

3 Link Layer

3.1 General

A master/slave address model is used for all RTU500 series subdevice communication interfaces. The basic procedures for data transfer, protection against loss and duplication and flow control are described in [3].

This master and slave address is configurable in the IED/RTU500 series tab of RTUtil500 separately for every subordinated device (IED/RTU500 series).

Parameter name	Default	Parameter location
Master ID	1	
0 ... 65 519		
Slave ID	1	
0 ... 65 519		

Master and slave address configuration

Communication primitives like framing of messages, parity checks or retransmissions are handled by the telecontrol protocol. These tasks are executed in the link layer that connects RTUs and control systems or other RTUs.

The selectable parameters have to be calculated regarding the real communication technology.

Parameter name	Default	Parameter location
Parity	no	
Odd, even, no		
Gap supervision time	Disabled	
Enabled / Disabled		
Link frame timeout	2 000	
1 ... 100 000 ms Maximum waiting time for next expected link frame.		
Fill application fragment timeout	3	
1 ... 255 s Maximum waiting time for subsequent link frames for an application fragment for which some link frames have already been received.		
Block of new request timeout	10	
1 ... 255 s Maximum waiting time for possibility of a new request. Blocking may be due to unsolicited data pouring in.		
Communication retries	3	
0 ... 15 times 0 means no retry Number of telegram repetitions until an online marked subordinated device is marked offline		
Cycle time test supervision	Enabled	
Enabled / Disabled		
Cycle time offline supervision	Enabled	
Enabled / Disabled		

Parameter name	Default	Parameter location
Time interval of clock synchronization commands	Disabled	
Enabled / Disabled		

Line parameters – DNP3

Parameter name	Default	Parameter location
Master station address	1	
0 ... 65 519 Master addresses can be different within subordinated devices on one line. Value will be equal for all data points of one subordinated device.		
Slave station address	1	
0 ... 65 519 Value will be equal for all data points of one subordinated device.		
System event address index	1	
1 ... 65 535 Parameter only available, if subordinated device is of type RTU500 series.		

IED parameters – DNP3

3.2 Transmission mode

- Controlling station (RTU500 series) and controlled station act simultaneously as primary and secondary stations.
- The controlling station uses only SEND/NO REPLY services for message exchange, controlled station may also use the SEND/CONFIRM service.
- During link establishment the controlling station uses the RESET service.
- For alive testing the controlling station uses the TEST link service.
- Frame format is FT3.
- The master accepts unsolicited message with event data from the slave.

3.3 Dial-up

In the dial-up mode a communication link can be established via HAYES-compatible modems between a RTU500 series and subordinate devices.

After start-up of the RTU500 series all devices connected to lines configured for dial-up mode are called once. The first call will be made only when the RTU500 series has been synchronized or when at least 5 minutes have passed since start-up. When all devices have been called once, the RTU500 series changes to the cyclic polling mode.

If the RTU500 series receives a telephone call from subordinate devices, which has been configured on the respective communication line, the RTU500 series switches to the data/ protocol mode after the modem connection has been established properly. As a function of configuration either the RTU500 series or the subordinate device will hang up.

When a telephone connection has been established, but communication according to the protocol does not take place, the telephone connection will be terminated after elapse of the time defined with the interface parameter Maximum time period until connection is established.

It is important that the time parameters (Inactivity hang-up time and Inactivity hang-up time after command) are chosen deliberately.

- The DNP subdevice interface must hang up the dial-up connection before the communication partner.
- All time parameters to read class, read binary inputs, read analog inputs or time interval of clock synchronization commands must be shorter as the inactivity hang-up time.

When the attempt to establish the telephone connection has failed, dialing will be repeated several times (interface parameter: Maximum number of dialing attempts). If this value is exceeded, the device will be marked as not operational and the qualifier invalid will be assigned to its data points. The device status is signaled by the system event messages of the device. Then this device will be interrogated in a configurable background cycle (interface parameter: time interval between two series on dial-up attempts).

When connection to a subordinate device is terminated properly, the status of the device and of its data points will remain unchanged. Only if the connection is terminated abnormally at protocol level, the device will be marked as not operational and the qualifier invalid will be set to all data points.

3.3.1 Dial-up configuration

In addition to the protocol-specific settings described in the chapter Link Layer (page "3-1"), some settings shall be made for the dial-up mode, too.

The dial-up mode will be available only if the parameter Carrier signal keying is set to Dial-up (external modem without handshake; without RTS/CTS) on the communication interface used.

All interface settings such as Parity, Baud rate, Number of data bits, etc. depend on the protocol selected and are valid for both the configuration and the data mode.

The dial-up mode parameters are available in a separate dialog box in the corresponding communication interface section.

3.3.2 Dial-up parameters at the the serial interfaces of the CMU

Parameter name	**Default**	**Parameter location**
Escape sequence preceding silent time	1 s	CMU - serial interfaces (dial up parameters)
Range: 1 … 255 s Minimal delay time between data mode and Hayes command mode		
Configuration string for modem	ATE0X3S0=1	CMU - serial interfaces (dial up parameters)
String Configuration string initializing the modem used. Note:The configuration string depends on the type of modem, the modem manufacturer and the modem function used.		
Dial string for modem	ATDT	CMU - serial interfaces (dial up parameters)
String Command Hayes to establish a modem connection		
Escape string for modem	+++	CMU - serial interfaces (dial up parameters)
String Command Hayes to switch from data mode to command mode		

Parameter name	Default	Parameter location
Answer string for modem	Disable <no defaults>	CMU - serial interfaces (dial up parameters)
String Enable/Disable If enabled: An incoming call is answered with this string. Note: For standard HAYES modems the value S0=0 shall be set in the configuration string, if this feature is enabled (see modem description).		
Hang up string for modem	ATH	CMU - serial interfaces (dial up parameters)
String String requesting the modem to terminate the telephone connection.		
Connect string of modem	CONNECT	CMU - serial interfaces (dial up parameters)
String String sent by the modem if a telephone connection has been established.		
OK string of modem	OK	CMU - serial interfaces (dial up parameters)
String String sent by the modem to acknowledge a command		
Disconnect string of modem	NO CARRIER	CMU - serial interfaces (dial up parameters)
String String sent by the modem if the connection is aborted		
Ring string of modem	RING	CMU - serial interfaces (dial up parameters)
String String sent by the modem signaling an incoming call.		
Busy string of modem	BUSY	CMU - serial interfaces (dial up parameters)
String With this string the modem signals that the remote terminal called is busy.		
PIN configuration string for GSM modem	Disable	CMU - serial interfaces (dial up parameters)
String Enable/Disable		
Service configuration string for GSM modem	Disable	CMU - serial interfaces (dial up parameters)
String Enable/Disable		

3.3.3 Dial-up properties: Dial-up parameters for IEDs

Parameter name	Default	Parameter location
Cyclic calls of dial-up master	Disable	Dial-up parameter
Enable/Disable		
Start time of cyclic calls	<no defaults>	Dial-up parameter
If enabled: 0 … 23 hours 0 … 59 minutes		
Time interval between two calls	<no defaults>	Dial-up parameter
If enabled: 0 … 30 days 0 … 23 hours 0 … 59 minutes		

Dial-up parameters for IEDs

3.3.4 Dial-up parameters of the RTU

The configuration of the dial-up timeout parameters can be found only in the network tree at the RTU node (left window) and on the specific line (right window) at the tab dial up parameters.

Parameter name	Default	Parameter location
Maximum time till link is established	60 s	Network tree only: RTU - line
Value range: 1 ... 255 s		
Maximum time interval until the connection to a higher-level system must be established. When this time has elapsed the modem connection will be terminated.		
Maximum number of dial attempts	2	Network tree only: RTU - line
Value range: 1 ... 255 attempts		
Maximum number of times a telephone number is called. If the higher-level system supports a modem-pool function the next telephone number will then be called.		
Time between dial attempts	60 s	Network tree only: RTU - line
Value range: 1 ... 15 300 s		
When an attempt has failed the number will be called again after elapse of this time.		
Time between two series of dial attempts	7 800 s	Network tree only: RTU - line
Value range: 60 … 15 300 s		
Waiting time between dial series with different telephone numbers (modem pool)		
Inactivity hang up delay	15 s	Network tree only: RTU - line
Value range: disabled, 1 ... 15 300 s		
Inactivity hang up delay after commands	30 s	Network tree only: RTU - line
Value range: disabled, 1 ... 15 300 s		
Maximum period for one telephone connection	600 s	Network tree only: RTU - line
Value range: disabled, 10 ... 15 300 s		

3.3.5 Dial-up properties: Telephone number(s)

Parameter name	Default	Parameter location
Telephone number 1	<no defaults>	Telephone number(s)
String (length max. 27 characters)		

Parameters for telephone number(s)

4 Transport Layer

If necessary, the Transport Layer divides data blocks received from the Application Layer into smaller packages (transport protocol data units) and inserts additional header information. Every one of these smaller packages (multi-fragments) is sent to the Link Layer and fits completely to the FT3 telegram format.

If the Transport Layer receives multi-fragmented packages from the Link Layer, the packages are combined by the Transport Layer to one complete package. If the package is complete, the complete package is sent to the Application Layer.

Every telegram which is sent from the Transport Layer to the Data Link Layer receives an additional octet header byte.

The maximum size of the telegram which is sent from the Transport Layer to the Link Layer is 250 bytes. The structure of these telegrams is shown in [1].

The header byte contains a so-called sequence number (5 bit). The value range of this sequence number is from 0 to 63. This sequence number is incremented by every telegram which is sent from the Transport Layer to the Data Link Layer. The increment of 63 is 0. The telegrams which belong together are identified by the FIR-bit and FIN-bit in this header.

5 Application Layer

5.1 Application Layer

Overview on type identifications for data elements of the application layer defined in [3].

Several basic parameters need to be defined for a connection.

Parameter name	Default	Parameter location
Read static counters	Disabled	Line parameters
Enabled/Disabled		
Cycle time	60	Line parameters
1 ... 86 400 s Counters are only fetched from subordinated devices which have counters.		
Offset to midnight	0	Line parameters
0 ... 86 400 s Offset from midnight to first periodical reading of counters.		

Line parameters – DNP3: Read static counters

Parameter name	Default	Parameter location
Freeze and fetch counters	Disabled	Line parameters
Enabled/Disabled		
Cycle time	9 000	Line parameters
1 ... 86 400 s Counters will be frozen by command broadcast at configured time and read afterwards. Counters are only fetched from subordinated devices which have counters.		
Offset to midnight	0	Line parameters
0 ... 86 400 s Offset from midnight to first periodical freeze and fetch of counters.		
Freeze and clear	Disabled	Line parameters
Enabled/Disabled If enabled, counters will be cleared with every freeze request.		

Line parameters – DNP3: Freeze and fetch counters

Parameter name	Default	Parameter location
Enable delay measurement	Disabled	IED parameter
Enabled/Disabled		

IED parameters – DNP3: Enable delay measurement

Parameter name	Default	Parameter location
Read class 0 periodically	Disabled	IED parameter
Enabled/Disabled		
Cycle time	60	IED parameter
1 ... 3 600 s		

IED parameters – DNP3: Read class 0 periodically

Parameter name	Default	Parameter location
Poll class event cyclically	Disabled	IED parameter
Enabled/Disabled		
Max. number of events per polling	10	IED parameter
1... 255 The maximum number is applied to each of the classes in every request.		

IED parameters – DNP3: Poll class events

Parameter name	Default	Parameter location
Read binary input periodically	Disabled	IED parameter
Enabled/Disabled		
Cycle time	60	IED parameter
1 ... 3 600 s		
Binary input change variations	Disabled All	IED parameter
Enabled/Disabled After an initial reading of static data only binary input changes will be requested. If Binary input change varia-tions enabled: All, without time, with time, with relative time Variation of binary input change is requested.		
Number of objects to read at once	Enabled 1	IED parameter
Enabled/Disabled If Number of objects to read at once enabled: 1 ... 255 Specifies maximum number of objects, either changes or in index range.		

IED parameters – DNP3: Read binary input periodically

Parameter name	Default	Parameter location
Read double bit binary input periodically	Disabled	IED parameter
Enabled/Disabled		
Cycle time	60	IED parameter
1 ... 3 600 s		
Double bit binary input change variations	Disabled All	IED parameter
Enabled/Disabled After an initial reading of static data only double bit binary input changes will be requested. If Double bit binary input change variations enabled: All, without time, with time, with relative time Variation of double bit binary input change is requested.		

Parameter name	Default	Parameter location
Number of objects to read at once	Enabled 16	IED parameter
Enabled/Disabled If Number of objects to read at once enabled: 1 ... 255 Specifies maximum number of objects, either changes or in index range.		

IED parameters – DNP3: Read double bit binary input periodically

Parameter name	Default	Parameter location
Read analog input periodically	Disabled	IED parameter
Enabled/Disabled		
Cycle time	60	IED parameter
1 ... 3 600 s		
Read analog change events	Disabled	IED parameter
Enabled/Disabled After an initial reading of static data only analog change events will be requested.		
Number of objects to read at once	Enabled 20	IED parameter
Enabled/Disabled If Number of objects to read at once enabled: 1 ... 255 Specifies maximum number of objects, either changes or in index range.		

IED parameters – DNP3: Read analog input periodically

The column RTU Data type shows the type of data which must be configured in RTUtil500.

DNP3			RTU
Data object group	**Variation**	**Description**	**Data type**
1	1	Binary input	SPI, DPI
	2	Binary input with status	
2	1	Binary input change without time	SPI, DPI
	2	Binary input change with time	
	3	Binary input relative change with time	
3	1	Double bit binary input	DPI
	2	Double bit binary input with status	
4	1	Double bit binary input change without time	DPI
	2	Double bit binary input change with time	
	3	Double bit binary input relative change with time	

Table 1: Data objects in monitoring direction (Response)

DNP3			RTU
Data object group	Variation	Description	Data type
20	1	32-bit binary counter	ITI
	2	16-bit binary counter	
	3	32-bit delta counter	
	4	16-bit delta counter	
	5	32-bit binary counter without flag	
	6	16-bit binary counter without flag	
	7	32-bit delta counter without flag	
	8	16-bit delta counter without flag	
21	1	32-bit frozen counter	ITI
	2	16-bit frozen counter	
	9	32-bit frozen counter without flag	
	10	16-bit frozen counter without flag	
22	1	32-bit counter change event without time	ITI
	2	16-bit counter change event without time	
30	1	32-bit analog input	STI, AMI, DMI, BSI, MFI
	2	16-bit analog input	
	3	32-bit analog input without flag	
	4	16-bit analog input without flag	
	5	Analog Input – Single-prec flt-pt with flag	MFI
32	1	32-bit analog change event without time	STI, AMI, DMI, BSI, MFI
	2	16-bit analog change event without time	
	3	32-bit analog change event with time	
	4	16-bit analog change event with time	
	5	Analog Input – Single-prec flt-pt with flag	MFI
	7	Analog Input Event – Single-prec flt-pt with time	
70	4	File command status	FDR, FTR
	5	File transport	
	6	File transport status	
	7	File descriptor	

Table 1: Data objects in monitoring direction (Response)

DNP3			RTU
Data object group	**Variation**	**Description**	**Data type**
12	1	Control relay output block	SCO, DCO, RCO
41	2	16-bit analog output	ASO, DSO, BSO
	3	Analog Output – Single-prec flt-pt	FSO
70	3	File command	FDR, FTR
	4	File command status	
	5	File transport	
	6	File transport status	
	7	File descriptor	

Table 2: Data objects in control direction (Send)

6 Addressing

The sizes of the addressing fields cannot be configured. The size of the master station address is always 16 bit. The size of the slave station address is also always 16 bit.

The length of the index address is variable and could change on every telegram. Valid sizes are 8, 16 or maximum 32 bit. Three bits in the control field of every telegram define the length of the index address.

DNP3 supports separate address spaces for different data types. The following data types with their own address space are:

- binary inputs
- binary outputs
- counter
- analog inputs
- analog outputs

Parameter name	Default	Parameter location
Master ID	1	Data object – Protocol address and parameters
2 octetsRange: 0 ... 65 519		
Values ≥ 65 520 is used as broadcast addresses in DNP3		
Slave ID	1	Data object – Protocol address and parameters
2 octetsRange: 0 ... 65 519		
Values ≥ 65 520 is used as broadcast addresses in DNP3		
Index address	0	Data object – Protocol address and parameters
Size: max. 1, 2 or 4 octets		
Not configurableQualifier selection in dependency of the size of the index address		

Address elements

6.1 Restrictions for the index address

All addresses must be unique within one station and data object.

7 Data Types - Monitoring Direction

7.1 SPI – Single Point Information

Binary process information is indicated by one bit.

7.1.1 Supported data types

DNP3			RTU				
Group	Variation	Default variation	Data type	Parameter name	Parameter location	Parameter range / Explanation	Default
1	1, 2	1	SPI	Index address	SPI – Protocol address and parameters	see chapter Addressing (page "6-1"6-1)	0
2	1, 2, 3	2	SPI	Index address	SPI – Protocol address and parameters	see chapter Addressing (page "6-1"6-1)	0

Table 3: SPI – Supported data types

7.1.2 Additional information

None

7.1.3 Conversion of values

RTU internal value	DNP3
off	0
on	1

Table 4: SPI - Conversion of values

7.1.4 Conversion of quality descriptors

RTU		DNP3
Internal communication (short)	Internal communication (long)	Communication
BL	Blocked	-
SB	Substituted	Flag: Forced data (local and remote)

Table 5: SPI – Conversion of quality descriptors

RTU		DNP3
Internal communication (short)	**Internal communication (long)**	**Communication**
NT	Not Topical	-
IV	Invalid	Device state offline / Flag: not On-Line / Flag: Communication lost
TQ	Time quality	> 0, if no timestamp in received data object included. Value depend on communication settings
TIV	Time invalid	-

Table 5: SPI – Conversion of quality descriptors

7.1.5 Conversion of causes of transmission

RTU		DNP3
Internal communication (short)	**Internal communication (long)**	**Communication**
T	Test	Test
P/N	Positive/negative confir-mation	- Irrelevant -
Cause	Spontaneous	Received data object
	Interrogated	-

Table 6: SPI – Conversion of causes of transmission

7.2 DPI – Double Point Information

Binary process information is indicated by two bits.

7.2.1 DPI – Double Point Information

Binary process information is indicated by two bits.

DPIs are supported based on the double bit binary objects (object type 3 and 4) and by emulating DPIs using object type 1 and 2.

DPIs are emulated by use of two consecutive bits on DNP3 protocol.

The DNP3 index of the DPI is the lowest index of the two DNP3 objects. It is the lowest index which carries the state ON.

7.2.2 Supported data types

DNP3			RTU				
Group	Variation	Default variation	Data type	Parameter name	Parameter location	Parameter range / Explanation	Default
1	1, 2	1	DPI	Index address	DPI – Protocol address and parameters	see chapter Addressing (page "6-1"6-1)	0
2	1, 2, 3	2	DPI	Index address	DPI – Protocol address and parameters	see chapter Addressing (page "6-1"6-1)	0
3	1, 2	1	DPI	Index address	DPI – Protocol address and parameters	see chapter Addressing (page "6-1"6-1)	0
4	1, 2, 3	2	DPI	Index address	DPI – Protocol address and parameters	see chapter Addressing (page "6-1"6-1)	0

Table 7: DPI – Supported data types

7.2.3 Additional information

None

7.2.4 Conversion of values

RTU internal value	DNP3
intermediate	00
off	10
on	01
indeterminate	11

Table 8: DPI – Conversion of values

7.2.5 Conversion of quality descriptors

RTU		DNP3
Internal communication (short)	Internal communication (long)	Communication
BL	Blocked	-

Table 9: DPI – Conversion of quality descriptors

RTU		DNP3
Internal communication (short)	**Internal communication (long)**	**Communication**
SB	Substituted	Flag: Forced data (local and remote)
NT	Not Topical	-
IV	Invalid	Device state offline / Flag: not On-Line / Flag: Communication lost
TQ	Time quality	> 0, if no timestamp in received data object included. Value depend on communication settings
TIV	Time invalid	-

Table 9: DPI – Conversion of quality descriptors

7.2.6 Conversion of causes of transmission

RTU		DNP3
Internal communication (short)	**Internal communication (long)**	**Communication**
T	Test	-
P/N	Positive/negative confir-mation	- Irrelevant -
Cause	Spontaneous	Received data object
	Interrogated	-

Table 10: DPI – Conversion of causes of transmission

7.3 EPI – Protection Event Information

Binary process information is indicated by two bits and relative timetag (used by protection relays).

7.4 STI – Step Position Information

Binary process information is indicated by 8 bits.

7.4.1 Supported data types

DNP3			RTU				
Group	**Variation**	**Default variation**	**Data type**	**Parame-ter name**	**Parameter location**	**Parameter range / Explanation**	**Default**
30	1, 2, 3, 4	2	STI	Index address	STI – Protocol address	see chapter Addressing (page "6-1")	0

Table 11: STI – Supported data types

DNP3			RTU				
Group	Variation	Default variation	Data type	Parame-ter name	Parameter location	Parameter range / Explanation	Default
					and para-meters		
32	1, 2, 3, 4	4	STI	Index address	STI – Protocol address and para-meters	see chapter Addressing (page "6-1")	0

Table 11: STI – Supported data types

7.4.2 Additional Information

None

7.4.3 Conversion of values

Range	RTU internal value	DNP3 value
Range min.	-63	-63
...	...	
Range max.	+63	+63

Table 12: STI - Conversion of values

7.4.4 Conversion of quality descriptors

RTU		DNP3
Internal communication (short)	Internal communication (long)	Communication
OV	Overflow	Value outside of range / Flag: Over-range
BL	Blocked	-
SB	Substituted	Flag: Forced data (local and remote)
NT	Not Topical	-
IV	Invalid	Device state offline / Flag: not On-Line / Flag: Communication lost
T	Transient Bit	-
TQ	Time quality	> 0, if no timestamp in received data object included. Value depends on communication settings
TIV	Time invalid	-

Table 13: STI – Conversion of quality descriptors

7.4.5 Conversion of causes of transmission

RTU		DNP3
Internal communication (short)	**Internal communication (long)**	**Communication**
T	Test	-
P/N	Positive/negative confirmation	- Irrelevant -
Cause	Spontaneous	Received data object
	Interrogated	-

Table 14: STI – Conversion of causes of transmission

7.5 BSI – Bit String Information

Binary process information is indicated by 8, 16 or 32 bit.

7.5.1 Supported data types

DNP3			RTU				
Group	**Variation**	**Default variation**	**Data type**	**Parameter name**	**Parameter location**	**Parameter range / Explanation**	**Default**
30	1, 2, 3, 4	2	BSI	Index address	BSI – Protocol address and parameters	see chapter Addressing (page "6-1")	0
32	1, 2, 3, 4	4	BSI	Index address	BSI – Protocol address and parameters	see chapter Addressing (page "6-1")	0

Table 15: BSI – Supported data types

7.5.2 Additional Information

None

7.5.3 Conversion of values

Range	RTU internal value	DNP3
Range min.	0	0
...	...	
Range max.	BSI8: Bit mask of 8 bit; range ... 255	255

Table 16: BSI - Conversion of values

Range	RTU internal value	DNP3
	BSI16: Bit mask of 16 bit; range ... 65 535	65 535
	BSI32: Bit mask of 32 bit; range ... 4 294 967 295	4 294 967 295

Table 16: BSI - Conversion of values

7.5.4 Conversion of quality descriptors

RTU		DNP3
Internal communication (short)	**Internal communication (long)**	**Communication**
OV	Overflow	Value outside of range / Flag: Over-range
BL	Blocked	-
SB	Substituted	Flag: Forced data (local and remote)
NT	Not Topical	-
IV	Invalid	Device state offline / Flag: not On-Line / Flag: Communication lost
TQ	Time quality	> 0, if no timestamp in received data object included. Value depends on communication settings
TIV	Time invalid	-

Table 17: BSI – Conversion of quality descriptors

7.5.5 Conversion of causes of transmission

RTU		DNP3
Internal communication (short)	**Internal communication (long)**	**Communication**
T	Test	-
P/N	Positive/negative confir-mation	- Irrelevant -
Cause	Spontaneous	Received data object
	Interrogated	-

Table 18: BSI – Conversion of causes of transmission

7.6 ITI – Integrated Totals Information

Binary process information is indicated by 32 bits as a count value.

7.6.1 Supported data types

DNP3			RTU				
Group	Variation	Default variation	Data type	Parameter name	Parameter location	Parameter range / Explanation	Default
20	1, 2, 3, 4, 5, 6, 7, 8	1	ITI	Index address	ITI – Protocol address and parameters	see chapter Addressing (page "6-1")	0
21	1, 2, 9, 10	1	ITI	Index address	ITI – Protocol address and parameters	see chapter Addressing (page "6-1")	0
22	1, 2	1	ITI	Index address	ITI – Protocol address and parameters	see chapter Addressing (page "6-1")	0

Table 19: ITI – Supported data types

7.6.2 Additional Information

None

7.6.3 Conversion of values

Range	RTU internal value	DNP3 value
Range min.	0	0
...	...	
Range max.	65 535	65 535 Max. value for 20 (2, 4, 6, 8) 21 (2, 10) 22 (2)
	4 294 967 295	4 294 967 295

Table 20: ITI – Conversion of values

7.6.4 Conversion of quality descriptors

RTU		DNP3
Internal communication (short)	Internal communication (long)	Communication
SEQ	Sequence number	-

Table 21: ITI – Conversion of quality descriptors

RTU		DNP3
Internal communication (short)	**Internal communication (long)**	**Communication**
CY	Carry	Flag octet: rollover
CA	Adjusted	-
IV	Invalid	Device state offline Flag octet: not online Flag octet: communication lost
TQ	Time quality	> 0, if no timestamp in received data object included. Value depends on communication settings
TIV	Time invalid	-

Table 21: ITI – Conversion of quality descriptors

7.6.5 Conversion of causes of transmission

RTU		DNP3
Internal communication (short)	**Internal communication (long)**	**Communication**
T	Test	-
P/N	Positive/negative confir-mation	- Irrelevant -
Cause	Spontaneous	Received data object
	Requested	Received frozen counter object
	Interrogated	-

Table 22: ITI – Conversion of causes of transmission

7.7 DMI – Digital Measured Information

Binary process information indicated by 8 or 16 bit is used as a measured value from digital inputs in normalized format.

7.7.1 Supported data types

DNP3			RTU				
Group	**Variation**	**Default variation**	**Data type**	**Parame-ter name**	**Parameter location**	**Parameter range / Explanation**	**Default**
30	1, 2, 3, 4	2	DMI	Index address	DMI – Protocol address and para-meters	see chapter Addressing (page "6-1")	0

Table 23: DMI – Supported data types

DNP3			RTU				
Group	Variation	Default variation	Data type	Parame-ter name	Parameter location	Parameter range / Explanation	Default
32	1, 2, 3, 4	2	DMI	Index address	DMI – Protocol address and para-meters	see chapter Addressing (page "6-1")	0

Table 23: DMI – Supported data types

7.7.2 Additional Information

None

7.7.3 Conversion of values

Range	RTU internal value	DNP3 value
Range min.	-100 %	16-bit: -32 768 32-bit: -2 147 483 648
...	...	
Range max.	+100 %	16-bit: +32 767 32-bit: +2 147 483 648

Table 24: DMI – Conversion of values

7.7.4 Conversion of quality descriptors

RTU		DNP3
Internal communication (short)	Internal communication (long)	Communication
OV	Overflow	Value outside of range / Flag: Over-range
BL	Blocked	-
SB	Substituted	Flag: Forced data (local and remote)
NT	Not Topical	-
IV	Invalid	Device state offline / Flag: not On-Line / Flag: Communication lost
TQ	Time quality	> 0, if no timestamp in received data object included. Value depends on communication settings
TIV	Time invalid	-

Table 25: DMI – Conversion of quality descriptors

7.7.5 Conversion of causes of transmission

RTU		DNP3
Internal communication (short)	**Internal communication (long)**	**Communication**
T	Test	-
P/N	Positive/negative confir-mation	- Irrelevant -
Cause	Spontaneous	Received data object
	Interrogated	-

Table 26: DMI – Conversion of causes of transmission

7.8 AMI – Analog Measured Information

Analog process information indicated by 16 bit used as a measured value from analog inputs in normalized or scaled format.

7.8.1 Supported data types

DNP3			RTU				
Group	**Variation**	**Default variation**	**Data type**	**Parame-ter name**	**Parameter location**	**Parameter range / Explanation**	**Default**
30	1, 2, 3, 4	2	AMI	Index address	AMI – Protocol address and para-meters	see chapter Addressing (page "6-1")	0
32	1, 2, 3, 4	2	AMI	Index address	AMI – Protocol address and para-meters	see chapter Addressing (page "6-1")	0

Table 27: AMI – Supported data types

7.8.2 Additional configuration parameters

Parameter name	Default	Parameter location
Threshold supervision	Enabled	AMI – Protocol address and parameters
Enabled /Disabled If enabled, the object is supervised by threshold supervision. Note: Disabled means that every change will be transmitted.		
Type	Integrated	AMI – Protocol address and parameters
Absolute / Integrated Note: The integration algorithm is applied only when there is data to be reported. The integration algorithm is NOT applied periodically		
Threshold	5 %	AMI – Protocol address and parameters
Value range: 0 ... 100% Dead-band value for threshold supervision.		

	Parameter name	Default	Parameter location
	Maximum value (100 %)	32 767	AMI – Protocol address and parameters
	See figure in chapter Conversion of causes of transmission (page 7-15).		
	Minimum value (-100 %)	-32 768	AMI – Protocol address and parameters
	See figure in chapter Conversion of causes of transmission (page 7-15).		

AMI – Additional configuration parameters

7.8.3 Conversion of values

Range	RTU internal value	DNP3 value
Range min.	-100 %	16-bit: -32 768 32-bit: -2 147 483 648
...	...	
Range max.	+100 %	16-bit: +32 768 32-bit: +2 147 483 648

Table 28: AMI – Conversion of values

7.8.4 Conversion of quality descriptors

RTU		DNP3
Internal communication (short)	**Internal communication (long)**	**Communication**
OV	Overflow	Value outside of range / Flag: Over-range
BL	Blocked	-
SB	Substituted	Flag: Forced data (local and remote)
NT	Not Topical	-
IV	Invalid	Device state offline / Flag: not On-Line / Flag: Communication lost
TQ	Time quality	> 0, if no timestamp in received data object included. Value depends on communication settings
TIV	Time invalid	-

Table 29: AMI – Conversion of quality descriptors

7.8.5 Conversion of causes of transmission-

RTU		DNP3
Internal communication (short)	**Internal communication (long)**	**Communication**
T	Test	-

Table 30: AMI – Conversion of causes of transmission

RTU		DNP3
Internal communication (short)	**Internal communication (long)**	**Communication**
P/N	Positive/negative confirmation	- Irrelevant -
Cause	Periodic / Cyclic	-
	Spontaneous	Received data object
	Interrogated	-

Table 30: AMI – Conversion of causes of transmission

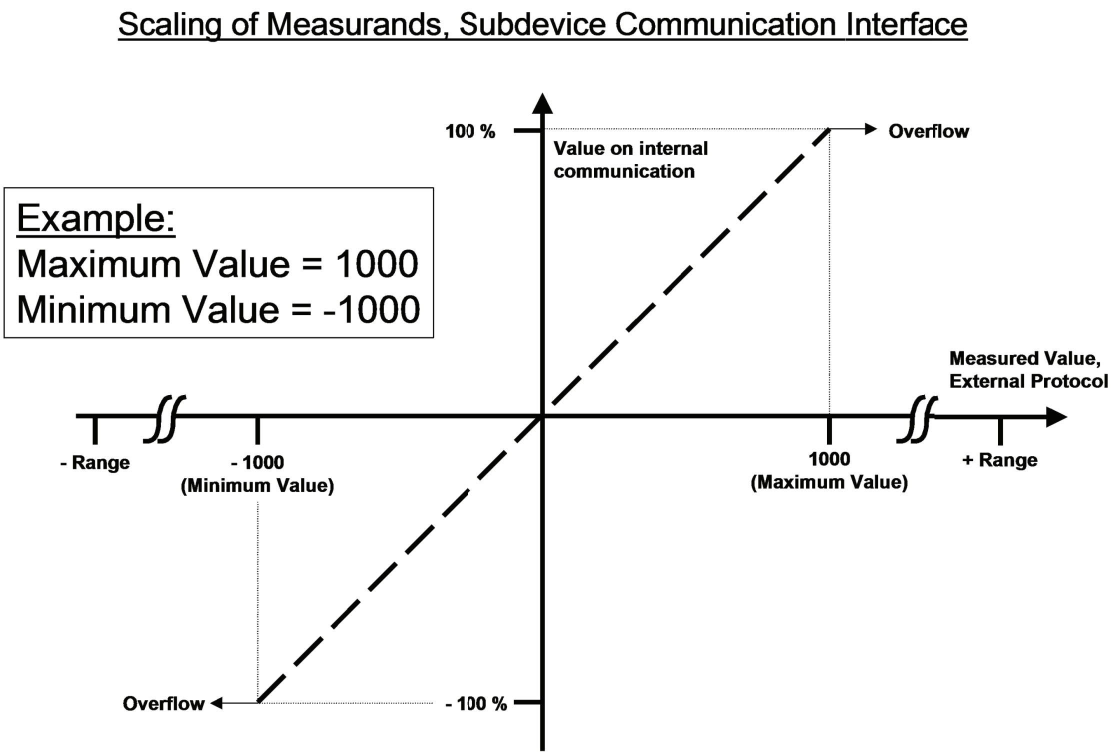


Figure 1: Scaling of measurands, subdevice communication interface

7.9 MFI – Measured Float Information

32 bit analog process information is used as a measured value in float format.

7.9.1 Supported data types

DNP3			RTU				
Group	**Variation**	**Default variation**	**Data type**	**Parameter name**	**Parameter location**	**Parameter range / Explanation**	**Default**
30	1, 2, 3, 4, 5	1	MFI	Index address	MFI – Protocol address	see chapter Addressing (page "6-1")	0

Table 31: MFI – Supported data types

DNP3			RTU				
Group	Variation	Default variation	Data type	Parame-ter name	Parameter location	Parameter range / Explanation	Default
					and para-meters		
32	1, 2, 3, 4, 5, 7	1	MFI	Index address	MFI – Protocol address and para-meters	see chapter Addressing (page "6-1")	0

Table 31: MFI – Supported data types

7.9.2 Additional configuration parameters

Parameter name	Default	Parameter location
Threshold supervision	Enabled	MFI – Protocol address and parameters
Enabled /Disabled If the parameter is enabled, the object is supervised by threshold supervision. Note: Disabled means that every change will be transmitted.		
Type	Integrated	MFI – Protocol address and parameters
Absolute / Integrated Note: The integration algorithm is applied only when there is data to be reported. The integration algorithm is NOT applied periodically		
Threshold	0.5	MFI – Protocol address and parameters
0 ... +3.4 x 10e38 Deadband value for threshold supervision. Note: 0 means that every change is transmitted.		
Min. float value	0	MFI – Protocol address and parameters
When the MFI value is received in 16-bit or 32-bit variations, the parameter Min. float value specifies the float value corresponding to the minimum received value. When the MFI value is received in a single precision float format, the parameter Min. float value is ignored.		
Max. float value	65 535	MFI – Protocol address and parameters
When the MFI value is received in 16-bit or 32-bit variations, the parameter Max. float value specifies the float value corresponding to the maximum received value. When the MFI value is received in a single precision float format, the parameter Max. float value is ignored.		

MFI – Additional configuration parameters

ADVICE

If the Data Object (Variations) : 30 (5) or 32 (5, 7) is received from the subdevice, the received value is used as it is for the floating point value. In this case, the parameters Min. float value and Max. float value are not used.If the Data Object (Variations) : 30 (1,2,3,4) or 32 (1,2,3,4), is received from the subdevice, the received value is scaled based on the scaling factor specified in Min. float value and Max. float value.

7.9.3 Conversion of values

Data Object (Variations) : 30 (5) and 32 (5, 7)

Range	RTU internal value	DNP3 value
Range min.	-3.4 x 10e38	Single precision floating point: -3.4 x 10e38
...	...	
Range max.	+3.4 x 10e38	Single precision floating point: +3.4 x 10e38

Table 32: MFI – Conversion of values

Data Object (Variations) : 30 (1,3) and 32 (1,3)

Range	RTU internal value	DNP3 value
Range min.	-3.4 x 10e38	32-bit: -2 147 483 648
...	...	
Range max.	+3.4 x 10e38	32-bit: +2 147 483 647

Table 33: MFI – Conversion of values

Data Object (Variations) : 30 (2,4) and 32 (2,4)

Range	RTU internal value	DNP3 value
Range min.	-3.4 x 10e38	16-bit: -32 768
...	...	
Range max.	+3.4 x 10e38	16-bit: +32 767

Table 34: MFI – Conversion of values

7.9.4 Conversion of quality descriptors

RTU		DNP3
Internal communication (short)	Internal communication (long)	Communication
OV	Overflow	Value outside of range / Flag: Over-range
BL	Blocked	-
SB	Substituted	Flag: Forced data (local and remote)
NT	Not Topical	-
IV	Invalid	Device state offline / Flag: not On-Line / Flag: Communication lost
TQ	Time quality	> 0, if no timestamp in received data object included. Value depends on communication settings
TIV	Time invalid	-

Table 35: MFI – Conversion of quality descriptors

7.9.5 Conversion of causes of transmission

RTU		DNP3
Internal communication (short)	**Internal communication (long)**	**Communication**
T	Test	-
P/N	Positive/negative confir-mation	- Irrelevant -
Cause	Periodic / Cyclic	-
	Spontaneous	Received data object
	Interrogated	-

Table 36: MFI – Conversion of causes of transmission

8 Data Types - Controlling Direction

8.1 SCO – Single Command Output

Binary process command (one bit).

8.1.1 Supported data types

DNP3			RTU				
Group	Variation	Default variation	Data type	Parameter name	Parameter location	Parameter range / Explanation	Default
12	1	1	SCO	Index address	SCO – Protocol address and parameters	see chapter Addressing (page "6-1")	0

Table 37: SCO – Supported data types

8.1.2 Command Authority

None

8.1.3 Additional configuration parameters

Parameter name	Default	Parameter location
Control code	Pulse output	SCO – Protocol address and parameters
Persistent, Pulse Output, Trip/CloseCount: Always 1		
Length of command ON	0	SCO – Protocol address and parameters
0 … 65 635 ms (Persistent = 0)		
Length of command OFF	0	SCO – Protocol address and parameters
0 … 65 535 ms (Pulse Output only)Status: Always 0		

SCO – Additional configuration parameters

8.1.4 Conversion of values

RTU internal value	DNP3 value
off (0)	Persistent: 0x04 (latchOFF) Pulse Output: 0x02 (pulseOFF) Trip/Close: 0x81 (TRIP)
on (1)	Persistent: 0x03 (latchON) Pulse Output: 0x01 (pulseON)

Table 38: SCO – Conversion of values

RTU internal value	DNP3 value
	Trip/Close: 0x41 (CLOSE)

Table 38: SCO – Conversion of values

8.1.5 Conversion of quality descriptors

RTU		DNP3
Internal communication (short)	**Internal communication (long)**	**Communication**
SE	Select	Select
	Execute	Execute / Direct operate

Table 39: SCO – Conversion of quality descriptors

8.1.6 Conversion of causes of transmission

RTU		DNP3
Internal communication (short)	**Internal communication (long)**	**Communication**
T	Test	-
Cause	Activation	-
	Positive activation confir- mation	Status field: 0 – OK
	Negative activation confir- mation	Status field: 5 – Busy
	- No response from any activity -	Status field: 6 – HW Problem
	Deactivation	-
	Deactivation Confirmation	-
	Activation Termination	-

Table 40: SCO – Conversion of causes of transmission

8.2 DCO – Double Command Output

Binary process command (two bits).

8.2.1 Supported data types

DNP3			RTU				
Group	**Variation**	**Default variation**	**Data type**	**Parame- ter name**	**Parameter location**	**Parameter range / Explanation**	**Default**
12	1	1	DCO	Index address	DCO – Protocol address	see chapter Addressing (page "6-1")	0

Table 41: DCO – Supported data types

DNP3			RTU				
Group	Variation	Default variation	Data type	Parameter name	Parameter location	Parameter range / Explanation	Default
					and parameters		

Table 41: DCO – Supported data types

8.2.2 Command Authority

None

8.2.3 Additional configuration parameters

Parameter name	Default	Parameter location
Control code	Pulse output	DCO – Protocol address and parameters
Persistent, Pulse Output, Trip/CloseCount: Always 1		
Length of command ON	0	DCO – Protocol address and parameters
0 … 65 635 ms		
Length of command OFF	0	DCO – Protocol address and parameters
0 … 65 535 ms (Pulse Output only)Status: Always 0		

DCO – Additional configuration parameters

8.2.4 Conversion of values

RTU internal value	DNP3 value
off (01)	Pulse Output: 0x02 (pulseOFF) Trip/Close: 0x81 (TRIP)
on (10)	Pulse Output: 0x01 (pulseON) Trip/Close: 0x41 (CLOSE)

Table 42: DCO – Conversion of values

8.2.5 Conversion of quality descriptors

RTU		DNP3
Internal communication (short)	Internal communication (long)	Communication
SE	Select Execute	Select Execute / Direct operate

Table 43: DCO – Conversion of quality descriptors

8.2.6 Conversion of causes of transmission

RTU		DNP3
Internal communication (short)	**Internal communication (long)**	**Communication**
T	Test	-
Cause	Activation	-
	Positive activation confirmation	Status field: 0 – OK
	Negative activation confirmation	Status field: 5 – Busy
	- No response from any activity -	Status field: 6 – HW Problem
	Deactivation	-
	Deactivation Confirmation	-
	Activation Termination	-

Table 44: DCO – Conversion of causes of transmission

8.3 RCO – Regulation Command Output

Regulation step command (two bits).

8.3.1 Supported data types

DNP3			RTU				
Group	**Variation**	**Default variation**	**Data type**	**Parameter name**	**Parameter location**	**Parameter range / Explanation**	**Default**
12	1	1	RCO	Index address	RCO – Protocol address and parameters	see chapter Addressing (page "6-1")	0

Table 45: RCO – Supported data types

8.3.2 Command Authority

None

8.3.3 Additional configuration parameters

Parameter name	Default	Parameter location
Control code	Trip close	RCO – Protocol address and parameters
Trip/CloseCount: Always 1		
Length of command ON	0	RCO – Protocol address and parameters
0 … 65 635 ms		

Parameter name	Default	Parameter location
Length of command OFF	0	RCO – Protocol address and parameters
0 … 65 535 ms (Pulse Output only)Status: Always 0		

RCO – Additional configuration parameters

8.3.4 Conversion of values

RTU internal value	DNP3 value
Lower (01)	Pulse Output: 0x02 (pulseOFF) Trip/Close: 0x81 (TRIP)
Raise (10)	Pulse Output: 0x01 (pulseON) Trip/Close: 0x41 (CLOSE)

Table 46: RCO – Conversion of values

8.3.5 Conversion of quality descriptors

RTU		DNP3
Internal communication (short)	**Internal communication (long)**	**Communication**
SE	Select Execute	Select Execute / Direct operate

Table 47: RCO – Conversion of quality descriptors

8.3.6 Conversion of quality descriptors

RTU		DNP3
Internal communication (short)	**Internal communication (long)**	**Communication**
T	Test	-
Cause	Activation	-
	Positive activation confir-mation	Status field: 0 – OK
	Negative activation confir-mation	Status field: 5 – Busy
	- No response from any activity -	Status field: 6 – HW Problem
	Deactivation	-
	Deactivation Confirmation	-
	Activation Termination	-

Table 48: RCO – Conversion of causes of transmission

8.4 ASO – Analog Setpoint Output

Analog process command (16 bit signed number).

8.4.1 Supported data types

DNP3			RTU				
Group	Variation	Default variation	Data type	Parameter name	Parameter location	Parameter range / Explanation	Default
41	2	2	ASO	Index address	ASO – Protocol address and parameters	see chapter Addressing (page "6-1")	0

Table 49: ASO – Supported data types

8.4.2 Command Authority

None

8.4.3 Additional Information

None

8.4.4 Conversion of values

Range	RTU internal value	DNP3 value
Range min.	-100 %	-32 768
...	...	
Range max.	+100 %	+32 767

Table 50: ASO – Conversion of values

8.4.5 Conversion of quality descriptors

RTU		DNP3
Internal communication (short)	Internal communication (long)	Communication
SE	Select	Select
	Execute	Execute / Direct operate

Table 51: ASO – Conversion of quality descriptors

8.4.6 Conversion of quality descriptors

RTU		DNP3
Internal communication (short)	**Internal communication (long)**	**Communication**
T	Test	-
Cause	Activation	-
	Positive activation confirmation	Status field: 0 – OK
	Negative activation confirmation	Status field: 5 – Busy
	- No response from any activity -	Status field: 6 – HW Problem
	Deactivation	-
	Deactivation Confirmation	-
	Activation Termination	-

Table 52: ASO – Conversion of causes of transmission

8.5 DSO – Digital Setpoint Output

Binary process command (8 or 16 bit signed number).

8.5.1 Supported data types

DNP3			RTU				
Group	**Variation**	**Default variation**	**Data type**	**Parameter name**	**Parameter location**	**Parameter range / Explanation**	**Default**
41	2	2	DSO	Index address	DSO – Protocol address and parameters	see chapter Addressing (page "6-1")	0

Table 53: DSO – Supported data types

8.5.2 Command Authority

None

8.5.3 Additional Information

None

8.5.4 Conversion of values

Range	RTU internal value	DNP3 value
Range min.	-100 %	8-bit: -128 16-bit: -32 768
...	...	
Range max.	+100 %	8-bit: +127 16-bit: +32 768

Table 54: DSO – Conversion of values

8.5.5 Conversion of quality descriptors

RTU		DNP3
Internal communication (short)	**Internal communication (long)**	**Communication**
T	Test	-
Cause	Activation	-
	Positive activation confirmation	Status field: 0 – OK
	Negative activation confirmation	Status field: 5 – Busy
	- No response from any activity -	Status field: 6 – HW Problem
	Deactivation	-
	Deactivation Confirmation	-
	Activation Termination	-

Table 55: DSO – Conversion of causes of transmission

8.6 BSO – Bit String Output

Binary process command (1, 2, 8, 16, 32 bit unsigned number).

8.6.1 Supported data types

DNP3			RTU				
Group	**Variation**	**Default variation**	**Data type**	**Parameter name**	**Parameter location**	**Parameter range / Explanation**	**Default**
41	2	2	BSO	Index address	BSO – Protocol address and parameters	see chapter Addressing (page "6-1")	0

Table 56: BSO – Supported data types

8.6.2 Command Authority

None

8.6.3 Additional Information

None

8.6.4 Conversion of values

Range	RTU internal value	DNP3 value
Range min.	0	0
...	...	
Range max.	BSO01: Bit mask of 1 bit range ... 1	1
	BSO02: Bit mask of 2 bit range ... 4	4
	BSO08: Bit mask of 8 bit range ... 255	255
	BSO16: Bit mask of 16 bit range ... 65 535	65 535

Table 57: BSO – Conversion of values

8.6.5 Conversion of quality descriptors

RTU		DNP3
Internal communication (short)	Internal communication (long)	Communication
SE	Select Execute	Select Execute / Direct operate

Table 58: BSO – Conversion of quality descriptors

8.6.6 Conversion of quality descriptors

RTU		DNP3
Internal communication (short)	**Internal communication (long)**	**Communication**
T	Test	-
Cause	Activation	-
	Positive activation confirmation	Status field: 0 – OK
	Negative activation confirmation	Status field: 5 – Busy
	- No response from any activity -	Status field: 6 – HW Problem
	Deactivation	-
	Deactivation Confirmation	-
	Activation Termination	-

Table 59: BSO – Conversion of causes of transmission

8.7 FSO – Floating Point Setpoint Output

Floating point process command (32 bit short floating point number)

8.7.1 Supported data types

DNP3			RTU				
Group	**Variation**	**Default variation**	**Data type**	**Parameter name**	**Parameter location**	**Parameter range / Explanation**	**Default**
41	3	3	FSO	Index address	FSO – Protocol address and parameters	see chapter Addressing (page "6-1")	0

Table 60: FSO – Supported data types

8.7.2 Command Authority

None

8.7.3 Additional Information

None

8.7.4 Conversion of values

Range	RTU internal value	DNP3 value
Range min.	-3.4 x 10e38	Single precision floating point: -3.4 x 10e38
...	...	
Range max.	+3.4 x 10e38	Single precision floating point: +3.4 x 10e38

Table 61: FSO – Conversion of values

8.7.5 Conversion of quality descriptors

RTU		DNP3
Internal communication (short)	**Internal communication (long)**	**Communication**
SE	Select	Select
	Execute	Execute / Direct operate

Table 62: FSO – Conversion of quality descriptors

8.7.6 Conversion of quality descriptors

RTU		DNP3
Internal communication (short)	**Internal communication (long)**	**Communication**
T	Test	-
Cause	Activation	-
	Positive activation confirmation	Status field: 0 – OK
	Negative activation confirmation	Status field: 5 – Busy
	- No response from any activity -	Status field: 6 – HW Problem
	Deactivation	-
	Deactivation Confirmation	-
	Activation Termination	-

Table 63: FSO – Conversion of causes of transmission

9 File transfer

The file transfer is used for exchanging files between a control center and a RTU500 series or a subordinated device.

The following file types can be transferred via the DNP3 protocol and can be configured by RTUtil500.

Supported file type	Explanation
PRO - PLC file	PLC file generated by MULTIPROG wt / MULTIPROG 5
RCD - RTU configuration data	RTU configuration file generated by RTUtil500
UNDEF	not specified in greater detail

Table 64: Supported file types

Files which belong to a subordinated device are routed through the RTU500 series.

The DNP3 protocol identifies its files only via a file name assignable by RTUtil500. This can be any user defined ASCII string. The file name contains the full path name and should correspond to the file name which is expected by the slave. The file name string is limited to 200 characters.

If a file archive is configured, the RTU500 series generates a FC_get_file_info request cyclically every 90 seconds for each file configured on the DNP3 line. If a change of creation time will be detected, the DNP3 master will read the file again and will update the file archive.

The master will use the listed function codes for the file exchange.

Supported function code	Function code	Description
FC_readfnc_file	<1>	Read
FC_writefnc_file	<2>	Write
FC_open_file	<25>	File open
FC_close_file	<26>	File close
FC_get_file_info	<28>	Get file info
FC_file_abort	<30>	Abort file transaction
FC_response_file	<129>	Response to request

Table 65: Supported function codes

Not supported function code	Function code	Description
FC_delete_file	<27>	File delete
FC_file_authenticate	<29>	File authentication

Table 66: Not supported function codes

9.1 Supported variations

File control objects	Variation
VAR_FILE_COMMAND	3
VAR_FILE_COMMAND_STATUS	4
VAR_FILE_TRANSPORT	5

Table 67: Supported variations

File control objects	Variation
VAR_FILE_TRANSPORT_STATUS	6
VAR_FILE_DESCRIPTOR	7

Table 67: Supported variations

9.2 Command Authority

None

9.3 Conversion of causes of transmission

RTU		DNP3
Internal communication (short)	**Internal communication (long)**	**Communication**
T	Test	Ignored
P/N	Positive/negative confirmation	negative confirmation converted to abort file transaction
Cause	Spontaneous	Ignored
	Requested	Ignored
	File transfer	Ignored

Table 68: File transfer – Conversion of causes of transmission

10 Internal Functions

10.1 General Interrogation

In case of a status change from OFFLINE to ONLINE of a subordinated device, that means after a link is established, a general interrogation is started.

The handling of the general interrogation depends on the configuration.

- If class event polling is configured, the master is sending a Class 0 request.
- If no class event reading is configured, all data will be read as static data.
- If Unsolicited messages class x are enabled (see tables IED parameters – DNP3 in chapter Application Layer (page "5-1")), the subdevice communication interface will generate the Function Command 0x14 for the concerned devices.

10.2 Time synchronization

The RTU500 series will not send any time synchronization command to a subdevice until the RTU500 series internal time-base is synchronized, either by real-time-clock or by host protocol.

Time synchronization messages can be sent periodically according to the configuration. If no subdevice of a line performs a delay measurement and there is more than one subdevice on the line, the periodical time setting is done during the broadcast. In all other cases, time setting is done by selective requests.

The time synchronization is also performed if the flag time synchronization requested by master in the internal indication byte (Bit 4) is set.

Optionally the delay to an individual subdevice can be measured by means of function 23. The delay measurement is performed immediately before a time setting, but not necessarily before every time setting. The rule is that if time setting is performed less frequent than every 5 minutes, every time setting is preceded by a delay measurement. If time setting is more frequent than every 10 minutes, it is ensured that the delay is measured at least every 10 minutes and at least before every 5th time setting. If the delay is not measured, it is set to 5 milliseconds. If a new delay has been measured, the new delay is set to (old_delay * 3 + measured_delay + 1) / 4 to suppress fluctuations.

There are two time synchronization methods used in DNP3, the non-LAN-based method and the LAN-based method.

10.2.1 Non-LAN-based method

In the non-LAN-based method, the RTU sends the DELAY_MEASURE request, function code 23, to the subdevice. If the request DELAY_MEASURE is acknowledged, a write request with an absolute time object (data object 50 variation 1) is sent to the subdevice.

10.2.1.1 Supported data types

Data object	Variation
50	1

Table 69: Time synchronization – Supported data types

10.2.1.2 Values

Complete time and date information in CP56Time2a format

10.2.1.3 Command Authority

None

10.2.1.4 Additional Information

None

10.2.2 LAN-based method

With the LAN-based method the mode of communication can be either TCP or Serial over TCP. If there are several IEDs connected to a TCP line via Serial Interface (like a switch or serial converters), the configuration will require a Serial over TCP. The different IEDs will be mapped with a single IP for the LAN switch and will have different slave IDs for identification.

The Serial over LAN method will use the same procedure of time synchronization as described in the non-LAN-based method above, see chapter Non-LAN-based method (page "10-1"). In the LAN-based method, two separate request messages are transmitted from the RTU500 series, RECORD_CURRENT_TIME, function code 24 and write, Data Object 50 variation 3.

10.2.2.1 Supported data types

Data object	Variation
50	3

Table 70: Time synchronization – Supported data types

10.2.2.2 Values

Complete time and date information in CP56Time2a format

10.2.2.3 Command Authority

None

10.2.2.4 Additional Information

None

10.3 System events

The subdevice communication interface manages internal status messages for every device connected to this line. These status messages are created from the subdevice communication interface itself for every connected device.

Parameter name	Default	Parameter location
Fix SEV address schema	enabled	SDI - line
Value range: enabled/ disabled if enabled: a base address for the whole block of system events is defined at the SDI node if disabled: individual addresses per SEV can be defined In order to avoid collisions, the addresses of the system events may not be used for other process objects.		
In use	enabled	SDI - line
Value range: enabled/ disabled if disabled: no SEVs will be transmitted on this line		

The subdevice communication interface generates the following system events:

IED SEVs influenced by the SCI	Description of system event	Address offset
X	Device is active While initialization the value of SEV#024 is set to ON. On a running system this system event does not change anymore.	#024
X	At least one DCE (data communication equipment) faulty	#044
	Device connected (controled by SSC#003)	#045
X	Device inoperable The SEV#048 is set in dependency of the state of the subordinated device.	#048
	Device out of service (controled by SSC#001)	#049
	Device reachable on redundant line 1 / 2	#180, #181
	Device reachable on redundant line 3 / 4	#182, #183
	Device active on redundant line 1 / 2	#184, #185
	Device active on redundant line 3 / 4	#186, #187
	Device preferred on redundant line 1 / 2	#188, #189
	Device preferred on redundant line 3 / 4	#190, #191
X[1)]	Process command collision with host x, 1 ≤ x ≤ 16	#242 ... #257
X[1)]	Process command collision with Integrated HMI	#258
X[1)]	Process command collision with webserver	#259
X[1)]	Process command collision with PLC	#260

Table 71: Description of system events

1) The process command collision will be signalized as 1ms impulse in two following system events.

10.3.1 Status Change Device OFFLINE to Device ONLINE

If the state of a subordinated device or line changes from OFFLINE to ONLINE, a general interrogation command is send to the concerning device(s).

The system event "device inoperable" (SEV#048) with value 0 is sent as SPI to the internal communication for every device that changed its state to ONLINE.

If Unsolicited messages class x are enabled (see tables IED parameters – DNP3 in chapter Application Layer), the subdevice communication interface will generate the Function Command 0x14 for the concerned devices.

10.3.2 Status Change Device ONLINE to Device OFFLINE

If the state of a subordinated device or line changes from ONLINE to OFFLINE all configured data points connected to these devices are sent to the internal communication with the actual state, marked as INVALID (IV) or NOT TOPICAL (NT) and with the timestamp of the own RTU. INVALID or NOT TOPICAL is set depending on the configuration parameter Information object qualifier.

Parameter name	Default	Parameter location
Information object qualifier (usage for disconnected subordinated devices)	Mark as invalid (IV)	RTU - Parameter
Value range: Mark as invalid (IV) / Mark as not topical (NT)		

ADVICE

Also in not topical (NT) configuration are data points which have not been updated since RTU startup marked as invalid (IV).

The system event DEVICE_INOPERABLE (48) with value 1 is sent as SPI to the internal communication for every device that changed its state to OFFLINE.

10.4 System commands

System Single Commands (SSC) are not supported by Sub interface DNP.

11 Interoperability List

The following interoperability definitions are copied from DNP3 Subset Definitions, the original numbering and layout is maintained.

DNP V3.00

DEVICE PROFILE DOCUMENT

Vendor Name:	ABB AG Power Technologies Division Power Technology Systems
Device Name:	RTU500 series

Highest DNP Level Supported:			**Device Function:**	
For Requests	Level 2, parts of Level 3	X	Master	Slave
For Responses	Level 2, parts of Level 3			

Notable objects, functions, and/or qualifiers supported in addition to the Highest DNP Levels Supported (The complete list is described in the attached table in chapter Data object library (page "14-3".)):

Maximum Data Link Frame Size (octets):		**Maximum Application Fragment Size (octets):**	
Transmitted	46	Transmitted (if >2048, must be configurable)	31
Received	292 (must be 292)	Received	2048 (must be >= 249)

Maximum Data Link Retries:			**Maximum Application Layer Retries:**
	None	X	None
	Fixed at ____________________		Configurable, range _ to ___ (Fixed is not permitted)
X	Configurable, range 0 to 15		

Requires Data Link Layer Confirmation:			
X	Never		
	Always		
	Sometimes	If 'Sometimes', when?	____________________________
	Configurable	If 'Configurable', how?	____________________________

Requires Application Layer Confirmation:	
	Never

Requires Application Layer Confirmation:			
	Always (not recommended)		
	When reporting Event Data (Slave devices only)		
	When sending multi-fragment responses (Slave devices only)		
X	Sometimes	If 'Sometimes', when?	When reading class 0 data
	Configurable	If 'Configurable', how?	______________________________

Timeouts while waiting for:							
Data Link Confirm	X	None	Fixed at ____		Variable		Configurable
Complete Appl. Fragment		None	Fixed at ____	X	Variable		Configurable
Application Confirm		None	Fixed at ____	X	Variable		Configurable
Complete Appl. Response		None	Fixed at ____	X	Variable		Configurable
Others	____						

Attach explanation if 'Variable' or 'Configurable' was checked for any timeout see table Line parameters – DNP3 in chapter General (page "3-1").

Sends / Execute Control Operations								
WRITE Binary Outputs	X	Never		Always		Sometimes		Configurable
Select / Operate		Never	X	Always		Sometimes		Configurable
Direct Operate		Never		Always		Sometimes	X	Configurable
Direct Operate, no ACK		Never		Always		Sometimes		Configurable
Count > 1	X	Never		Always		Sometimes		Configurable
Pulse ON		Never	X	Always		Sometimes		Configurable
Pulse OFF		Never	X	Always		Sometimes		Configurable
Latch ON		Never		Always	X	Sometimes		Configurable
Latch OFF		Never		Always	X	Sometimes		Configurable
Queue	X	Never		Always		Sometimes		Configurable
Clear Queue	X	Never		Always		Sometimes		Configurable

Attach explanation if 'Sometimes' or 'Configurable' was checked for any operation.

Select/operate and direct operate is decided by command received from host.

FILL OUT THE FOLLOWING ITEM FOR MASTER DEVICES ONLY:	
Expects Binary Input Change Events:	
X	Either time-tagged or non-time-tagged for a single event
	Both time-tagged and non-time-tagged for a single event
	Configurable (attach explanation)

11.1 Data object library

The following implementation table includes all object variations, function codes and qualifiers which must be supported for DNP3-L2.

Object			REQUEST		RESPONSE	
			(slave must parse)		(master must parse)	
Obj.	**Var.**	**Description**	**Func. codes (dec)**	**Qual. codes (hex)**	**Func. codes**	**Qual. codes (hex)**
1	0	Binary Input – All Variations	1	00, 01, 06		
	1	Binary Input			129, 130	00, 01
	2	Binary Input with Status			129, 130	00, 01
2	0	Binary Input Change – All Variations	1	06, 07, 08		
	1	Binary Input Change without Time	1	06, 07, 08	129, 130	17, 28
	2	Binary Input Change with Time	1	06, 07, 08	129, 130	17, 28
	3	Binary Input Change with Relative Time	1	06, 07, 08	129, 130	17, 28
3	0	Double-bit Binary Input – All Variations	1	06, 07, 08	129, 130	17, 28
	1	Double-bit Binary Input – Packed format	1	06, 07, 08	129, 130	17, 28
	2	Double-bit Binary Input – With flags	1	06, 07, 08	129, 130	17, 28
4	0	Double-bit Binary Input Event – All Variations	1	06, 07, 08	129, 130	17, 28
	1	Double-bit Binary Input Event – Without time	1	06, 07, 08	129, 130	17, 28
	2	Double-bit Binary Input Event – With absolute time	1	06, 07, 08	129, 130	17, 28
	3	Double-bit Binary Input Event – With relative time	1	06, 07, 08	129, 130	17, 28
10	0	Binary Output – All Variations	1	06		
	1	Binary Output				
	2	Binary Output Status			129, 130	00, 01
12	0	Control Block – All Variations				
	1	Control Relay Output Block	3, 4, 5, 6	17, 28	129	echo of request
	2	Pattern Control Block				
	3	Pattern Mask				
20	0	Binary Counter – All Variations	1, 7, 8, 9, 10	06		
	1	32-bit Binary Counter			129, 130	00, 01
	2	16-bit Binary Counter			129, 130	00, 01

Object			REQUEST		RESPONSE	
			(slave must parse)		(master must parse)	
Obj.	**Var.**	**Description**	**Func. codes (dec)**	**Qual. codes (hex)**	**Func. codes**	**Qual. codes (hex)**
	3	32-bit Delta Counter			129, 130	00, 01
	4	16-bit Delta Counter			129, 130	00, 01
	5	32-bit Binary Counter without Flag			129, 130	00, 01
	6	16-bit Binary Counter without Flag			129, 130	00, 01
	7	32-bit Delta Counter without Flag			129, 130	00, 01
	8	16-bit Delta Counter without Flag			129, 130	00, 01
21	0	Frozen Counter – All Variations	1	06		
	1	32-bit Frozen Counter			129, 130	00, 01
	2	16-bit Frozen Counter			129, 130	00, 01
	3	32-bit Frozen Delta Counter				
	4	16-bit Frozen Delta Counter				
	5	32-bit Frozen Counter with Time of Freeze				
	6	16-bit Frozen Counter with Time of Freeze				
	7	32-bit Frozen Delta Counter with Time of Freeze				
	8	16-bit Frozen Delta Counter with Time of Freeze				
	9	32-bit Frozen Counter without Flag			129, 130	00, 01
	10	16-bit Frozen Counter without Flag			129, 130	00, 01
	11	32-bit Frozen Delta Counter without Flag				
	12	16-bit Frozen Delta Counter without Flag				
22	0	Counter Change Event – All Variations	1	06, 07, 08		
	1	32-bit Counter Change Event without Time			129, 130	17, 28
	2	16-bit Counter Change Event without Time			129, 130	17, 28
	3	32-bit Delta Counter Change Event without Time				

Object			REQUEST		RESPONSE	
			(slave must parse)		(master must parse)	
Obj.	Var.	Description	Func. codes (dec)	Qual. codes (hex)	Func. codes	Qual. codes (hex)
	4	16-bit Delta Counter Change Event without Time				
	5	32-bit Counter Change Event with Time				
	6	16-bit Counter Change Event with Time				
	7	32-bit Delta Counter Change Event with Time				
	8	16-bit Delta Counter Change Event with Time				
23	0	Frozen Counter Event – All Variations				
	1	32-bit Frozen Counter Event without Time				
	2	16-bit Frozen Counter Event without Time				
	3	32-bit Frozen Delta Counter Event without Time				
	4	16-bit Frozen Delta Counter Event without Time				
	5	32-bit Frozen Counter Event with Time				
	6	16-bit Frozen Counter Event with Time				
	7	32-bit Frozen Delta Counter Event with Time				
	8	16-bit Frozen Delta Counter Event with Time				
30	0	Analog Input – All Variations	1	00, 01, 06		
	1	32-bit Analog Input			129, 130	00, 01
	2	16-bit Analog Input			129, 130	00, 01
	3	32-bit Analog Input without Flag			129, 130	00, 01
	4	16-bit Analog Input without Flag			129, 130	00, 01
	5	Analog Input – Single-prec flt-pt with flag	1		129, 130	00, 01

Object			REQUEST (slave must parse)		RESPONSE (master must parse)	
Obj.	**Var.**	**Description**	**Func. codes (dec)**	**Qual. codes (hex)**	**Func. codes**	**Qual. codes (hex)**
31	0	Frozen Analog Input – All Variations				
	1	32-bit Frozen Analog Input				
	2	16-bit Frozen Analog Input				
	3	32-bit Frozen Analog Input with Time of Freeze				
	4	16-bit Frozen Analog Input with Time of Freeze				
	5	32-bit Frozen Analog Input without Flag				
	6	16-bit Frozen Analog Input without Flag				
32	0	Analog Change Event – All Variations	1	06, 07, 08		
	1	32-bit Analog Change Event without Time			129, 130	17, 28
	2	16-bit Analog Change Event without Time			129, 130	17, 28
	3	32-bit Analog Change Event with Time			129, 130	17, 28
	4	16-bit Analog Change Event with Time			129, 130	17, 28
	5	Analog Input Event – Single-prec flt-pt with-out time	1		129, 130	17, 28
	7	Analog Input Event – Single-prec flt-pt with time	1		129, 130	17, 28
33	0	Frozen Analog Event – All Variations				
	1	32-bit Frozen Analog Event without Time				
	2	16-bit Frozen Analog Event without Time				
	3	32-bit Frozen Analog Event with Time				
	4	16-bit Frozen Analog Event with Time				
40	0	Analog Output Status – All Variations	1	06		
	1	32-bit Analog Output Status				

Object			REQUEST		RESPONSE	
			(slave must parse)		(master must parse)	
Obj.	**Var.**	**Description**	**Func. codes (dec)**	**Qual. codes (hex)**	**Func. codes**	**Qual. codes (hex)**
	2	16-bit Analog Output Status			129, 130	00, 01
41	0	Analog Output Block – All Variations				
	2	16-Bit Analog Output Block	3, 4, 5, 6	17, 28	129	echo of request
	3	Analog Output – Single-prec flt-pt	3, 4, 5, 6	17, 28	129	echo of request
50	0	Time and Date – All Variations				
	1	Time and Date	2 (see Application layer (page 5 - 1))	07 where quantity = 1		
	2	Time and Date with Interval				
51	0	Time and Date CTO – All Variations				
	1	Time and Date CTO			129, 130	07, quantity=1
	2	Unsynchronized Time and Date CTO			129, 130	07, quantity=1
52	0					
	1	Time Delay Coarse			129, 130	07, quantity=1
	2	Time Delay Fine			129, 130	07, quantity=1
60	0					
	1	Class 0 Data	1	06		
	2	Class 1 Data	1	06, 07, 08		
	3	Class 2 Data	1	06, 07, 08		
	4	Class 3 Data	1	06, 07, 08		
70	3	File Command	25	11		
	4	File Command Status	26, 30, 1	11	129	11
	5	File Transport	1, 2	11	129	
	6	File Transport Status			129	11
	7	File Descriptor	28	11	129	11
80	1	Internal Indications	2	00 index=7		
81	1	Storage Object				
82	1	Device Profile				
83	1	Private Registration Object				

Object			REQUEST		RESPONSE	
			(slave must parse)		(master must parse)	
Obj.	Var.	Description	Func. codes (dec)	Qual. codes (hex)	Func. codes	Qual. codes (hex)
	2	Private Registration Object Descriptor				
90	1	Application Identifier				
100	1	Short Floating Point				
	2	Long Floating Point				
	3	Extended Floating Point				
101	1	Small Packed Binary-Coded Decimal				
	2	Medium Packed Binary-Coded Decimal				
	3	Large Packed Binary-Coded Decimal				
112	1 - 255	Virtual Terminal Output Block				
113	1 - 255	Virtual Terminal Event Data				
		No Object	13			
		No Object	23 (see Time-sync.)			

12 Glossary

AMI	Analog Measured value Input
ASO	Analog Setpoint command Output
BSI	Bit String Input
BSO	Bit String Output
CMU	Communication and Data Processing Unit
CTO	Common Time Object
DCE	Data Communication Equipment
DCO	**D**ouble **C**ommand **O**utput
DMI	Digital Measured value Input (8, 16 bit)
DPI	Double Point Input
DSO	Digital Setpoint command Output (8, 16 bit)
EPI	Event of Protection equipment Input (1 bit)
FDR	File transfer directory
FSO	Floating Setpoint Command Output
FTR	File transfer file
IED	Intelligent Electronic Device
ITI	Integrated Totals Input
MFI	Analog Measured value Floating Input
MS	Microsoft
PLC	Programmable Logic Control
RCD	RTU Configuration Data
RCO	Regulation step Command Output
RTU	Remote Terminal Unit
SCI	Sub-Device Communication Interface
SCO	Single Command Output
SEV	System Event
SPI	Single Point Input or Single point information
SSC	System Single Command
STI	Step position Input
UDP	User Datagram Protocol

Note:

Visit us

ABB AG
Power Grids
P.O. Box 10 03 51
68128 Mannheim, Germany

www.abb.com/remote-terminal-units

1KGT 150 484 V021 1

RTU500 series

RTU500 series Remote Terminal Unit
Protocol description
Subdevice Communication Interface with SPAbus

1 Revision

Document identity:		1KGT 150 483 V013 1
Revision:	Date:	Changes:
0	04/2001	Base version
1	03/2002	
2	07/2002	Chapter 1.1 modified Chapter 4.5 “Data process keys” extended Chapter 4.7 DMI not supported
3	12/2002	New function: Transparent Data (Available with RTU560 FW Release 6)
4	04/2003	Chapter 12 ‘Transparent Data’ modified(Available with RTU560 FW Release 6)
5	06/2003	Chapter 7 ‘File Transfer’ extended (Available with RTU560 FW Release 6) New Data Process Key introduced
6	06/2009	New Protection Devices supported Procedure for Rex5xx included Chapter ‘Physical Layer’ corrected
7	02/2011	Bit String Information corrected
8	07/2011	Extended to support multiple data of multiple channels (Added to the Line parameter Table 2.1)
9	04/2012	Event processing through individual channels for SPI and DPI objects.
10	09/2012	New layout
11	12/2012	Chapter 9: Correction file transfer: REF541/3/5 not supported
12	02/2013	Updated description for Timeout acknowledgement
13	12/2017	Updated Pulse weight parameter details for ITI Updated data process key values for SPIs (PR#24740/#36234)

Contents

1 Revision 1-1

2 Introduction 2-1
2.1 Preface 2-1
2.2 References 2-1
2.3 Conventions 2-1

3 Physical Layer 3-1
3.1 Communication interfaces 3-1
3.2 Communication settings 3-1

4 Link Layer 4-1
4.1 General 4-1
4.2 Monitoring direction 4-2
4.2.1 Data requests 4-2
4.2.2 Event messages 4-2
4.2.3 Command directions 4-2
4.2.4 Response times 4-2

5 Application Layer 5-1
5.1 Data category 5-1

6 Addressing 6-1
6.1 Slave address 6-1
6.1.1 Restrictions for Slave address 6-1
6.2 Data point parameters 6-1
6.2.1 Restrictions for Channel number 6-1
6.2.2 Restrictions for Data number 6-2
6.3 Event messages 6-2
6.3.1 Restrictions for Channel number of event 6-3
6.3.2 Restrictions for Event number state on 6-3
6.3.3 Restrictions for Event number state off 6-4
6.3.4 Restrictions for Event number state intermediate 6-4
6.3.5 Restrictions for Event number state indeterminate 6-4
6.4 Command parameters 6-4
6.4.1 Restrictions for Channel number first/second SPA command 6-4
6.4.2 Restrictions for Data category first/second SPA command 6-4
6.4.3 Restrictions for Data number second SPA command 6-5
6.4.4 Restrictions for Output value first/second SPA command 6-5
6.5 Data process keys (Excel import) 6-5

7 Data types – monitoring direction 7-1
7.1 AMI – Analog Measured Information 7-1
7.1.1 Additional configuration parameters 7-1

7.1.2 Conversion of values....7-1
7.1.3 Conversion of quality descriptors....7-2
7.1.4 Conversion of causes of transmission....7-2
7.2 BSI – Bit String Information....7-3
7.2.1 Additional Information....7-3
7.2.2 Conversion of values....7-3
7.2.3 Conversion of quality descriptors....7-3
7.2.4 Conversion of causes of transmission....7-3
7.3 DMI – Digital Measured Information....7-4
7.4 DPI – Double Point Information....7-4
7.4.1 Additional configuration parameters....7-4
7.4.2 Conversion of values....7-5
7.4.3 Conversion of quality descriptors....7-5
7.4.4 Conversion of causes of transmission....7-5
7.5 EPI – Protection Event Information....7-5
7.6 ITI – Integrated Totals Information....7-5
7.6.1 Additional information....7-6
7.6.2 Conversion of values....7-6
7.6.3 Conversion of quality descriptors....7-6
7.6.4 Conversion of causes of transmission....7-6
7.7 MFI – Measured Float Information....7-7
7.7.1 Additional configuration parameters....7-7
7.7.2 Values....7-7
7.7.3 Conversion of values....7-7
7.7.4 Conversion of quality descriptors....7-7
7.7.5 Conversion of causes of transmission....7-8
7.8 SPI – Single Point Information....7-8
7.8.1 Additional configuration parameters....7-9
7.8.2 Conversion of values....7-9
7.8.3 Conversion of quality descriptors....7-9
7.8.4 Conversion of causes of transmission....7-10
7.9 STI – Step Position Information....7-10
7.9.1 Additional Information....7-10
7.9.2 Conversion of values....7-10
7.9.3 Conversion of quality descriptors....7-10
7.9.4 Conversion of causes of transmission....7-11

8 Data types – controlling direction....8-1
8.1 ASO – Analog Setpoint....8-1
8.1.1 Command Authority....8-1
8.1.2 Additional configuration parameters....8-1
8.1.3 Conversion of values....8-1
8.1.4 Conversion of quality descriptors....8-1
8.1.5 Conversion of causes of transmission....8-2

8.2 BSO – Bit String Output....8-2
8.2.1 Command Authority....8-2
8.2.2 Additional Information....8-2
8.2.3 Conversion of values....8-2
8.2.4 Conversion of quality descriptors....8-2
8.2.5 Conversion of causes of transmission....8-3
8.3 DCO – Double Command Output....8-3
8.3.1 Command Authority....8-3
8.3.2 Additional configuration parameters....8-3
8.3.3 Conversion of values....8-4
8.3.4 Conversion of quality descriptors....8-4
8.3.5 Conversion of causes of transmission....8-4
8.4 DSO – Digital Setpoint Output....8-4
8.4.1 Command Authority....8-4
8.4.2 Additional configuration parameters....8-5
8.4.3 Conversion of values....8-5
8.4.4 Conversion of quality descriptors....8-5
8.4.5 Conversion of causes of transmission....8-5
8.5 RCO – Regulation Command Output....8-6
8.5.1 Command Authority....8-6
8.5.2 Additional Information....8-6
8.5.3 Conversion of values....8-6
8.5.4 Conversion of quality descriptors....8-6
8.5.5 Conversion of causes of transmission....8-6
8.6 SCO – Single Command Output....8-6
8.6.1 Command Authority....8-7
8.6.2 Additional configuration parameters....8-7
8.6.3 Conversion of values....8-7
8.6.4 Conversion of quality descriptors....8-7
8.6.5 Conversion of causes of transmission....8-8

9 Transparent Data Messages....9-1
9.1 Command direction....9-1
9.2 Monitoring direction....9-2

10 File transfer....10-1
10.1 Transfer of disturbance data files....10-1
10.2 Configuration....10-1
10.3 Transmission procedure for REF542(plus), REx316*4....10-2
10.4 Transmission procedure for REx5xx (e.g. REL531/561)....10-2

11 Internal functions....11-1
11.1 General Interrogation....11-1
11.2 Time Synchronization....11-1
11.2.1 Supported data types....11-1

11.2.2 Command Authority........ 11-2
11.2.3 Additional Information........ 11-2
11.2.4 Conversion of causes of transmission........ 11-2
11.3 System events........ 11-3
11.3.1 Status Change Device OFFLINE to Device ONLINE........ 11-3
11.3.2 Status Change Device ONLINE to Device OFFLINE........ 11-3

12 Interoperability list........ 12-1
12.1 Supported and selectable parameters........ 12-1
12.2 Network configuration........ 12-1
12.3 Physical Layer........ 12-1
12.3.1 Electrical interface........ 12-1
12.3.2 Optical Interface........ 12-1
12.3.3 Transmission speed and settings........ 12-1
12.3.4 Link Layer........ 12-2
12.3.5 Application Layer........ 12-2
12.3.6 Transmission mode for application data........ 12-2
12.3.7 Address values........ 12-2
12.3.8 Application data in monitoring direction........ 12-2
12.3.9 Application data in command direction........ 12-3
12.3.10 File transfer........ 12-4

13 Glossary........ 13-1

2 Introduction

2.1 Preface

This document describes the functions of the subdevice interface in the RTU500 series according to SPAbus communication protocol version 2.5.

2.2 References

[1] SPAbus
Communication Protocol V 2.5
1MRS 750076-MTD EN Version A
1996-01-23
[2] Interfaces and Protocols
1KGT 150 714
[3] Utility Programs for File and Process Archive
1KGT 150 644

2.3 Conventions

In this document the message types and data categories of data types according to SPAbus protocol are marked with angle brackets:

<Function code>

Italic fonts with the heading Parameter name are references to configuration parameter in RTUtil500. The parameter is followed by definitions where to find this parameter in RTUtil500.

Example:

	Parameter name	Default	Parameter location
Link address		1	RTU – Line parameter

In this document references to elements of the standard will be printed bold and in brackets: [1]

The tables in the next chapters include lists of functions, options and message types supported according to the protocol structure given in SPAbus (EPA three layer models) for

- the physical layer
- the link layer
- the application layer

This layered model does not exactly apply to the protocol [1], but is adapted because of the structure of the host communication interface of RTU500 series.

3 Physical Layer

3.1 Communication interfaces

The protocol SPAbus is a serial protocol, running on a serial communication line of a CMU. For more details see [2].

3.2 Communication settings

The default data transfer rate of the SPAbus is 9 600 bit/s and is defined in [1]. In some cases other transfer rates may be required. Additional parameters see the following table.

The transmission settings of the SPAbus are 1 start bit, 7 bits, even parity, 1 stop bit. They are defined in [1].

Communication settings according to the following table.

Parameter name	Default	Parameter location
Interface type	RS232C	CMU - serial interfaces
Type of physical interface. Select from list. Value range: RS232C, RS485 or fix if selection is not supported		
Baud rate	9600 bits/sec	CMU - serial interfaces
Value range: 50, 75, 100, 110, 150, 200, 300, 600, 1200, 1500, 2400, 4800, 9600, 19200, 38400 bits/sec; 50-600 bits/sec only on selected interfaces		
Modem control	Direct link (TxD/RxD only)	CMU - serial interfaces
Value range: – Direct link (TxD/RxD only) – WT link full duplex (no handshake) – WT link half duplex (RTS/CTS handshake) – WT link half duplex (RTS/DCD handshake) – Dial up (external modem DCD handshake) – Loop switch unit (DSTC 3002), RP570/71 Host interface only – Link with collision avoidance (DCD handshake), DNP 3 only Usage of the controls for this interface. Direct Link: No modem controls. Loop Switch Unit: RP570/71 Host Interface only. Collision Avoidance: DNP3.0 Host/Sub-Interface only		
Transmit delay time	disabled	CMU - serial interfaces
If 'Transmit Delay Time' is enabled: Delay time in Milliseconds. Value range: 1 to 10000 ms. Recommended value for WT modems in half-duplex mode: 30 ms		

Communication settings

4 Link Layer

4.1 General

The SPAbus protocol defines no special link layer Therefore only global parameters have to be configured for the communication lines.

These parameters can be configured on the line folder of RTUtil500 separately for every line.

Parameter name	Default	Parameter location
General parameter		RTU – Line parameter

Communication primitives like the framing of messages and parity checks are handled by the telecontrol protocol. Data polling and retransmissions are handled by the subdevice interface of RTU500 series. These tasks are executed in the link layer that connects RTUs and SPAbus relays.

The selectable parameters have to be calculated regarding the communication technology really used.

Parameter name	Default	Parameter location
Timeout acknowledgement	1 000 ms	Line TSPABUS - SPA-bus
1 ... 600 s in steps of 100 ms		
Time interval of clock synchronization commands	60 s	Line TSPABUS - SPA-bus
0 ... 65 535 s Interval for synchronization with date and time		
Communication retry	7	Line TSPABUS - SPA-bus
0 ... 255		
Maximum number of requests per read message	6	Line TSPABUS - SPA-bus
0 ... 20 Maximum number of requests packed in one telegram.		
Allow master requesting for multiple data of multiple channels	Disable	Line TSPABUS - SPA-bus
Enable / Disable		
Gap supervision time	Enable	Line TSPABUS - SPA-bus
Enable / Disable		
Disturbance recorder request	90 s	Line TSPABUS - SPA-bus
10 ... 65535		

Line parameters – Line T104

4.2 Monitoring direction

4.2.1 Data requests

All application data in monitoring direction is polled by the RTU500 series subdevice communication interface using the SPAbus read message type <R>. Received messages have the SPAbus message type <D> or <N>.

4.2.2 Event messages

If event messages are configured, a combination of event polling using message type <R> and data category <L> and data polling is used.

In cases where both mechanisms are used for one data point, data is only polled by data requests at initialization and afterwards polling for event messages is used.

4.2.3 Command directions

Data in command direction is sent by the RTU500 series subdevice communication interface to the slave device with the write message type <W>. Received answers have the message type positive acknowledge <A> or negative acknowledge <N>. Message type <N> is followed by a number which specifies the cause.

4.2.4 Response times

Because of the fact that all data of SPAbus devices is polled, the response time of the data changes in a slave device depends on the following facts:

- Transmission rate
- Type of data polling in monitoring direction
- Number of slave devices on the physical link
- Number of configured data to be polled per physical link

Therefore you must be aware of these factors, if defined response times are required.

5 Application Layer

5.1 Data category

Overview of the data category for the data elements of the application layer defined in [1].

The column RTU data type shows the type of data which must be configured in RTUtil500.

SPAbus		RTU
Data category	**Description**	**Data type**
I	Input data	SPI, DPI, BSI8/16, AMI, MFI, ITI
O	Output data	SPI, DPI, BSI8/16, AMI, MFI, ITI
S	Setting values	SPI, DPI, BSI8/16, AMI, MFI, ITI
M	Memory data	SPI, DPI, BSI8/16, AMI, MFI, ITI, Disturbance Data
V	Variables (internal)	SPI, DPI, STI, BSI8/16, AMI, MFI, ITI, Disturbance Data
E	Events	SPI, DPI

Table 1: Message types in monitoring direction

SPAbus		RTU
Data category	**Description**	**Data type**
I	Input data	SCO, DCO, ASO, RCO, DSO8/16, BSO1/2/8/16
O	Output data	SCO, DCO, ASO, RCO, DSO8/16, BSO1/2/8/16
S	Setting values	SCO, DCO, ASO, RCO, DSO8/16, BSO1/2/8/16
M	Memory data	SCO, DCO, ASO, RCO, DSO8/16, BSO1/2/8/16, Distur-bance Data
V	Variables (internal)	SCO, DCO, ASO, RCO, DSO8/16, BSO1/2/8/16, Distur-bance Data

Table 2: Message types in control direction

6 Addressing

Selection according to [1]. The size of the addressing fields cannot be configured. Data process keys are necessary to handle data conversion from the SPAbus to the RTU500 series internal protocol.

6.1 Slave address

The SPAbus parameter Slave address must be the same for the "System Event Block" and for all data points of this IED.

Parameter name	Default	Parameter location
Slave address	1	Line parameter – SPAbus
Integer Range: 1 ... 999		

Data points of the IED

6.1.1 Restrictions for Slave address

Slave address 900 is reserved for broadcast messages.

6.2 Data point parameters

Parameter name	Default	Parameter location
Channel number	1	Data point parameters – SPAbus
Integer Range: -1, 0 ... 999 -1: Not included in scan		
Data category	< Output (O) >	Data point parameters – SPAbus
< Input (I) > < Output (O) > < Settings (S) > < Variable (V) > < Memory (M) >		
Data number	1	Data point parameters – SPAbus
Integer Range: 0 ... 65 535		

General parameters

6.2.1 Restrictions for Channel number

None.

6.2.2 Restrictions for Data number

Data numbers are only supported up to value 65 535. Higher values up to 999 999 as defined in [1] are not supported.

6.3 Event messages

The data category of event messages is <E>, [1]. Event messages are polled by using SPAbus message type <R> and data category <L>.

If event message parameters are configured, event polling is used. The events are processed through the individual channel number. If data request parameters are configured too, data polling will be used only in general interrogation to initialize data points in the RTU500 series subdevice communication interface. If the event number 50 and 51 are processed, then RTU acknowledges and sends a clear command to the IED.

Parameter name	Default	Parameter location
Channel number state on	200	Data point parameters – SPAbus
Integer Range: 0 ... 999 Individual channel number per event message		
Channel number state off	200	Data point parameters – SPAbus
Integer Range: 0 ... 999 Individual channel number per event message		
Channel number intermediate	200	Data point parameters – SPAbus
Integer Range: 0 ... 999 Individual channel number per event message		
Channel number indeterminate	200	Data point parameters – SPAbus
Integer Range: 0 ... 999 Individual channel number per event message		
Event number state on	1	Data point parameters – SPAbus
Integer Range: 0 ... 255		
Event number state off	SPI: 0, DPI 2	Data point parameters – SPAbus
Integer Range: 0 ... 255		
Event number state intermediate	0	Data point parameters – SPAbus
Integer Range: 0 ... 255		
Event number state indeterminate	3	Data point parameters – SPAbus
Integer Range: 0 ... 255		

Address elements of event messages

6.3.1 Restrictions for Channel number of event

Channel number 0 does not process the events.

6.3.2 Restrictions for Event number state on

None.

6.3.3 Restrictions for Event number state off

None.

6.3.4 Restrictions for Event number state intermediate

This parameter can be used only with data type DPI.

6.3.5 Restrictions for Event number state indeterminate

This parameter can be used only with data type DPI.

6.4 Command parameters

Data points configured for command direction are send by using SPAbus message type <W>.

Parameter name	Default	Parameter location
Channel number first/second SPA command	1/100	Data point parameters – SPAbus
Integer Range: 0 ... 999		
Data category first/second SPA command	< Output (O) >	Data point parameters – SPAbus
< Input (I) > < Output (O) > < Settings (S) > < Variable (V) > < Memory (M) >		
Data number first/second SPA command	1	Data point parameters – SPAbus
Integer Range: 0 ... 65 535		
Output value first/second SPA command	0	Data point parameters – SPAbus
Integer Range: 0 ... 65 535		

Address elements of the dataset

6.4.1 Restrictions for Channel number first/second SPA command

None.

6.4.2 Restrictions for Data category first/second SPA command

None.

6.4.3 Restrictions for Data number second SPA command

Data numbers are only supported up to value 65 535. Higher values up to 999 999 as defined in [1] are not supported.

6.4.4 Restrictions for Output value first/second SPA command

None.

6.5 Data process keys (Excel import)

Data process keys are in some cases necessary to convert information from SPAbus into the RTU500 series internal protocol.

	Parameter name	Default	Parameter location
Data process key		Usage like data type definition	Excel sheet
Value 0: No event processing Value 1 (only SPI): Only comming indication, going indication is send automatically Value 4 (only SCO, DCO): Initialization value Value 5 (only SCO, DCO): Output value used as SPABus 'On' command Value 6 (only SCO, DCO): Output value used as SPABus 'Off' command Value 7, 9 (only DPI): Conversion of SPAbus register values in internal protocol: 0 = state intermediate 1 = state on 2 = state off 3 = state indeterminate Value 8 (only DPI): Conversion of SPAbus register values in internal protocol: 0 = state intermediate 2 = state off 3 = state on 4 = state indeterminate Value 10 (only SPI): Activate event messages Value 11 (only DPI with event processing): Conversion of SPAbus register values in internal protocol: 0 = state intermediate 1 = state off 2 = state on 3 = state indeterminate			

Data process keys

7 Data types – monitoring direction

7.1 AMI – Analog Measured Information

Analog process information indicated by 16 bit is used as a measured value from analog inputs in normalized format.

7.1.1 Additional configuration parameters

Parameter name	Default	Parameter location
Activate event messages	No	Protocol address and parameters
Yes / No		
Channel number	0	Protocol address and parameters
0 … 999		
Event number	0	Protocol address and parameters
0 … 63		
Threshold supervision	Enabled	Protocol address and parameters
Enabled / Disabled		
Type	Integrated	Protocol address and parameters
Integrated / Absolute		
Threshold	20 %	Protocol address and parameters
Range: 0 ... 100 %		
Measurand value	Bipolar	Protocol address and parameters
Unipolar / Bipolar		
Range maximum	100	Protocol address and parameters
Range: –3.4 x $10e^{38}$...+ 3.4 x $10e^{38}$		
Range minimum	0	Protocol address and parameters
Range: –3.4x $10e^{38}$...+ 3.4 x $10e^{38}$		

AMI – Additional configuration parameters

7.1.2 Conversion of values

Range	RTU internal value	SPAbus value
Range min.	-100 %	<Range min.>
...	...	
Range max.	+100 %	<Range max.>

Table 3: AMI – Conversion of values

7.1.3 Conversion of quality descriptors

RTU		SPAbus
Internal communication (short)	**Internal communication (long)**	**Communication**
OV	Overflow	Value > ± 3.4 x 10e38
BL	Blocked	-
SB	Substituted	-
NT	Not Topical	-
IV	Invalid	In case of communication failure

Table 4: AMI – Conversion of quality descriptors

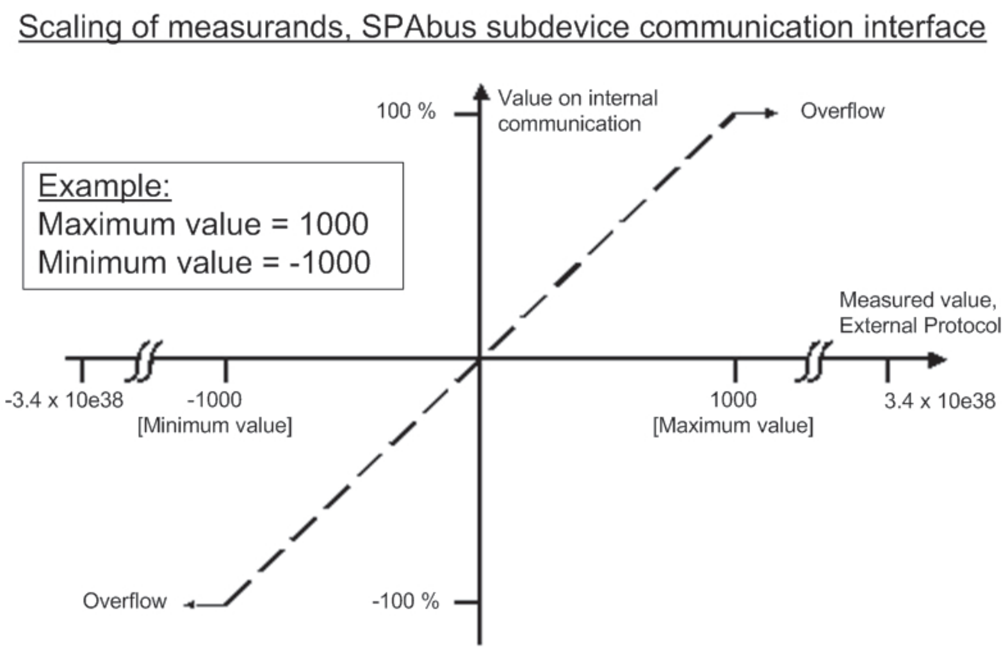


Figure 1: Scaling of measurands, subdevice communication interface

7.1.4 Conversion of causes of transmission

RTU		SPAbus
Internal communication (short)	**Internal communication (long)**	**Communication**
T	Test	-
P/N	Positive/negative confirmation	- Irrelevant -
Cause	Periodic / Cyclic	-
	Spontaneous	Received message type: <D>
	Requested	-
	Interrogated	-

Table 5: AMI – Conversion of causes of transmission

7.2 BSI – Bit String Information

Binary process information is indicated by 8, 16 or 32 bits.

7.2.1 Additional Information

None

7.2.2 Conversion of values

Range	RTU internal value	SPAbus value
Range min.	0	0
...	...	
Range max.	BSI8: Bit mask of 8 bit; range 0 ... 255	255
	BSI16: Bit mask of 16 bit; range 0 ... 65 535	65 535
	BSI32: Bit mask of 32 bit; range 0 ... 4 294 967 295	4 294 967 295

Table 6: BSI – Conversion of values

7.2.3 Conversion of quality descriptors

RTU		SPAbus
Internal communication (short)	**Internal communication (long)**	**Communication**
OV	Overflow	If BSI08 > 255
BL	Blocked	-
SB	Substituted	-
NT	Not Topical	-
IV	Invalid	In case of communication failure

Table 7: BSI – Conversion of quality descriptors

7.2.4 Conversion of causes of transmission

RTU		SPAbus
Internal communication (short)	**Internal communication (long)**	**Communication**
T	Test	-
P/N	Positive/negative confirmation	- Irrelevant -
Cause	Spontaneous	Received message type: <D>
	Requested	-
	Interrogated	-

Table 8: BSI – Conversion of causes of transmission

7.3 DMI – Digital Measured Information

DMI is not supported.

7.4 DPI – Double Point Information

Binary process information is indicated by two bits.

7.4.1 Additional configuration parameters

Parameter name	Default	Parameter location
Data process key	Default – only register scan	Protocol address and parameters
<Default – only register scan> <Conversion SPA-bus to RTU values: 0->0 (intermediate), 1->1 (off), 2->2 (on), 3->3 (indeterminate)> <Conversion SPA-bus to RTU values: 0->0 (intermediate), 2->1 (off), 1->2 (on), 3->3 (indeterminate)>		
Activate event messages	Yes	Protocol address and parameters
Yes / No		
Channel number state on	200	Protocol address and parameters
0 … 999		
Channel number state off	200	Protocol address and parameters
0 … 999		
Channel number intermediate	200	Protocol address and parameters
0 … 999		
Channel number indeterminate	200	Protocol address and parameters
0 … 999		
Event number state on	0	Protocol address and parameters
0 ... 255		
Event number state off	0	Protocol address and parameters
0 ... 255		
Event number state intermediate	0	Protocol address and parameters
0 ... 255		
Event number state indeterminate	0	Protocol address and parameters
0 ... 255		

DPI – Additional configuration parameters

7.4.2 Conversion of values

RTU internal value	SPAbus value		
	Data process key		
	0, 11	8	7, 9
intermediate	0	0	0
off	1	2	2
on	2	3	1
indeterminate	3	4	3

Table 9: DPI – Conversion of values

7.4.3 Conversion of quality descriptors

RTU		SPAbus
Internal communication (short)	Internal communication (long)	Communication
BL	Blocked	-
SB	Substituted	-
NT	Not Topical	-
IV	Invalid	-

Table 10: DPI – Conversion of quality descriptors

7.4.4 Conversion of causes of transmission

RTU		SPAbus
Internal communication (short)	Internal communication (long)	Communication
T	Test	-
P/N	Positive/negative confirmation	- Irrelevant -
Cause	Spontaneous	Received message type: <D>
	Interrogated	-

Table 11: DPI – Conversion of causes of transmission

7.5 EPI – Protection Event Information

EPI is not supported in the SPAbus sub interface.

7.6 ITI – Integrated Totals Information

Binary process information is indicated by 32 bits as a count value.

7.6.1 Additional information

	Parameter name	Default	Parameter location
Pulse weight		0.001	ITI – Protocol address and parameters
0…3.4 x 10e38			

ADVICE

This parameter was not configurable in versions before Release 11. In all older versions this parameter was set to 0.001

7.6.2 Conversion of values

Range	RTU internal value	SPAbus value
Range min.	0	0
...	...	
Range max.	4 294 967 295	3.4 x 10e38

Table 12: ITI – Conversion of values

7.6.3 Conversion of quality descriptors

RTU		SPAbus
Internal communication (short)	**Internal communication (long)**	**Communication**
SEQ	Sequence number	-
CY	Carry	-
CA	Adjusted	-
IV	Invalid	In case of communication failure

Table 13: ITI – Conversion of quality descriptors

7.6.4 Conversion of causes of transmission

RTU		SPAbus
Internal communication (short)	**Internal communication (long)**	**Communication**
T	Test	-
P/N	Positive/negative confirmation	- Irrelevant -
Cause	Spontaneous	Received message type: <D>
	Requested	-
	Interrogated	-

Table 14: ITI – Conversion of causes of transmission

7.7 MFI – Measured Float Information

32 bit analog process information is used as a measured value in float format.

7.7.1 Additional configuration parameters

	Parameter name	Default	Parameter location
Activate event messages		No	Protocol address and parameters
Yes / No			
Channel number		0	Protocol address and parameters
0 … 999			
Event number		0	Protocol address and parameters
0 … 63			
Threshold supervision		Disabled	Protocol address and parameters
Enabled / Disabled			
Type		Integrated	Protocol address and parameters
Integrated / Absolute			
Threshold		1	Protocol address and parameters
Range: 0...+ 3.4 x 10e38			

MFI – Additional configuration parameters

7.7.2 Values

R32-IEEE STD 754

7.7.3 Conversion of values

Range	RTU internal value	SPAbus value
Range min.	-3.4 x 10e38	-3.4 x 10e38
...	...	
Range max.	+3.4 x 10e38	+3.4 x 10e38

Table 15: MFI – Conversion of values

7.7.4 Conversion of quality descriptors

RTU		SPAbus
Internal communication (short)	Internal communication (long)	Communication
OV	Overflow	-
BL	Blocked	-
SB	Substituted	-

Table 16: MFI – Conversion of quality descriptors

RTU		SPAbus
Internal communication (short)	**Internal communication (long)**	**Communication**
NT	Not Topical	-
IV	Invalid	In case of communication failure

Table 16: MFI – Conversion of quality descriptors

7.7.5 Conversion of causes of transmission

RTU		SPAbus
Internal communication (short)	**Internal communication (long)**	**Communication**
T	Test	-
P/N	Positive/negative confirmation	- Irrelevant -
Cause	Periodic / Cyclic	-
	Spontaneous	Received message type: <D>
	Requested	-
	Interrogated	-

Table 17: MFI – Conversion of causes of transmission

7.8 SPI – Single Point Information

Binary process information is indicated by one bit.

7.8.1 Additional configuration parameters

Parameter name	Default	Parameter location
Data process key	Default – usage like data type definition	Protocol address and parameters
<Default – usage like data type definition> <Only coming indication, going indication is sent automatically> <Single indication processing>		
Activate event messages	Yes	Protocol address and parameters
Yes / No		
Channel number state on	200	Protocol address and parameters
0 … 999		
Channel number state off	200	Protocol address and parameters
0 … 999		
Event number state on	0	Protocol address and parameters
0 ... 255		
Event number state off	0	Protocol address and parameters
0 ... 255		

SPI – Additional configuration parameters

7.8.2 Conversion of values

RTU internal value	SPAbus value
off	0
on	1

Table 18: SPI – Conversion of values

7.8.3 Conversion of quality descriptors

RTU		SPAbus
Internal communication (short)	**Internal communication (long)**	**Communication**
BL	Blocked	-
SB	Substituted	-
NT	Not Topical	-
IV	Invalid	-

Table 19: SPI – Conversion of quality descriptors

7.8.4 Conversion of causes of transmission

RTU		SPAbus
Internal communication (short)	**Internal communication (long)**	**Communication**
T	Test	-
P/N	Positive/negative confirmation	- Irrelevant -
Cause	Spontaneous	Received message type: <D>
	Interrogated	-

Table 20: SPI – Conversion of causes of transmission

7.9 STI – Step Position Information

Binary process information is indicated by 8 bits.

7.9.1 Additional Information

None

7.9.2 Conversion of values

Range	RTU internal value	SPAbus value
Range min.	-64	-63
...	...	
Range max.	+63	+63

Table 21: STI – Conversion of values

7.9.3 Conversion of quality descriptors

RTU		SPAbus
Internal communication (short)	**Internal communication (long)**	**Communication**
OV	Overflow	Value > ± 63
BL	Blocked	-
SB	Substituted	-
NT	Not Topical	-
IV	Invalid	In case of communication failure
T	Transient Bit	-

Table 22: STI – Conversion of quality descriptors

7.9.4 Conversion of causes of transmission

RTU		SPAbus
Internal communication (short)	**Internal communication (long)**	**Communication**
T	Test	-
P/N	Positive/negative confirmation	- Irrelevant -
Cause	Spontaneous	Received message type: <D>
	Requested	-
	Interrogated	-

Table 23: STI – Conversion of causes of transmission

8 Data types – controlling direction

8.1 ASO – Analog Setpoint

Binary process command (16 bit signed number)

8.1.1 Command Authority

None

8.1.2 Additional configuration parameters

Parameter name	Default	Parameter location
Maximum value	3 2767	Protocol address and parameters
-2 147 483 648 … 2 147 483 647		
Minimum value	-32 768	Protocol address and parameters
-2 147 483 648 … 2 147 483 647		
Decimal factor	0	Protocol address and parameters
0 … 10		

ASO – Additional configuration parameters

8.1.3 Conversion of values

Range	RTU internal value	SPAbus value
Range min.	-100 %	-32 768
…	…	
Range max.	+100 %	+32 767

Table 24: ASO – Conversion of values

8.1.4 Conversion of quality descriptors

RTU		SPAbus
Internal communication (short)	Internal communication (long)	Communication
SE	Select / Execute	Ignored

Table 25: ASO – Conversion of quality descriptors

8.1.5 Conversion of causes of transmission

RTU		SPAbus
Internal communication (short)	**Internal communication (long)**	**Communication**
T	Test	Ignored
P/N	Positive/negative confirmation	Relevant in monitoring direction only
Cause	Activation	-
	Activation Confirmation	-
	Deactivation	-
	Deactivation Confirmation	-
	Activation Termination	-

Table 26: ASO – Conversion of causes of transmission

8.2 BSO – Bit String Output

Digital process command (1, 2, 8 or 16 bit unsigned number)

8.2.1 Command Authority

None

8.2.2 Additional Information

None

8.2.3 Conversion of values

Range	RTU internal value	SPAbus value
Range min.	0	0
...	...	
Range max.	65 535	65 535

Table 27: BSO – Conversion of values

8.2.4 Conversion of quality descriptors

RTU		SPAbus
Internal communication (short)	**Internal communication (long)**	**Communication**
SE	Select / Execute	Ignored

Table 28: BSO – Conversion of quality descriptors

8.2.5 Conversion of causes of transmission

RTU		SPAbus
Internal communication (short)	**Internal communication (long)**	**Communication**
T	Test	Ignored
P/N	Positive/negative confirmation	Relevant in monitoring direction only
Cause	Activation	-
	Activation Confirmation	-
	Deactivation	-
	Deactivation Confirmation	-
	Activation Termination	-

Table 29: BSO – Conversion of causes of transmission

8.3 DCO – Double Command Output

Binary process command (two bits)

8.3.1 Command Authority

None

8.3.2 Additional configuration parameters

Parameter name	Default	Parameter location
Data process key	Default – usage like data type definition	Protocol address and parameters
<Default – usage like data type definition> <Initialization value> <Output value used as SPA-bus 'on' command> <Output value used as SPA-bus 'off' command>		
Output value	0	Protocol address and parameters
0 … 65 535 (first command)		
Output value	0	Protocol address and parameters
0 … 65 535 (second command)		

DCO – Additional configuration parameters

8.3.3 Conversion of values

RTU internal value	SPAbus value	
	Data process key	
	0	4, 5, 6
off	0	Output value first SPAbus command
on	1	Output value second SPAbus command

Table 30: DCO – Conversion of values

8.3.4 Conversion of quality descriptors

RTU		SPAbus
Internal communication (short)	Internal communication (long)	Communication
SE	Select / Execute	Ignored

Table 31: DCO – Conversion of quality descriptors

8.3.5 Conversion of causes of transmission

RTU		SPAbus
Internal communication (short)	Internal communication (long)	Communication
T	Test	Ignored
P/N	Positive/negative confirmation	Relevant in monitoring direction only
Cause	Activation	-
	Activation Confirmation	-
	Deactivation	-
	Deactivation Confirmation	-
	Activation Termination	-

Table 32: DCO – Conversion of causes of transmission

8.4 DSO – Digital Setpoint Output

Digital process command (8 or 16 bit signed number)

8.4.1 Command Authority

None

8.4.2 Additional configuration parameters

Parameter name	Default	Parameter location
Maximum value	3 2767	Protocol address and parameters
-2 147 483 648 … 2 147 483 647		
Minimum value	-32 768	Protocol address and parameters
-2 147 483 648 … 2 147 483 647		
Decimal factor	0	Protocol address and parameters
0 … 10		

DSO – Additional configuration parameters

8.4.3 Conversion of values

Range	RTU internal value	SPAbus value
Range min.	-100 %	DSO08: -128, DSO16: -32 768
…	…	
Range max.	+100 %	DSO08: 127, DSO16: +32 767

Table 33: DSO – Conversion of values

8.4.4 Conversion of quality descriptors

RTU		SPAbus
Internal communication (short)	**Internal communication (long)**	**Communication**
SE	Select / Execute	Ignored

Table 34: DSO – Conversion of quality descriptors

8.4.5 Conversion of causes of transmission

RTU		SPAbus
Internal communication (short)	**Internal communication (long)**	**Communication**
T	Test	Ignored
P/N	Positive/negative confirmation	Relevant in monitoring direction only
Cause	Activation	-
	Activation Confirmation	-
	Deactivation	-
	Deactivation Confirmation	-
	Activation Termination	-

Table 35: DSO – Conversion of causes of transmission

8.5 RCO – Regulation Command Output

Binary process command (two bits)

8.5.1 Command Authority

None

8.5.2 Additional Information

None

8.5.3 Conversion of values

RTU internal value	SPAbus value
Lower	0
Higher	1

Table 36: RCO – Conversion of values

8.5.4 Conversion of quality descriptors

RTU		SPAbus
Internal communication (short)	**Internal communication (long)**	**Communication**
SE	Select / Execute	Ignored

Table 37: RCO – Conversion of quality descriptors

8.5.5 Conversion of causes of transmission

RTU		SPAbus
Internal communication (short)	**Internal communication (long)**	**Communication**
T	Test	Ignored
P/N	Positive/negative confirmation	Relevant in monitoring direction only
Cause	Activation	-
	Activation Confirmation	-
	Deactivation	-
	Deactivation Confirmation	-
	Activation Termination	-

Table 38: RCO – Conversion of causes of transmission

8.6 SCO – Single Command Output

Binary process command (one bit)

8.6.1 Command Authority

None

8.6.2 Additional configuration parameters

 Parameter name	Default	Parameter location
Data process key	Default – usage like data type definition	Protocol address and parameters
<Default – usage like data type definition> <Initialization value> <Output value used as SPA-bus 'on' command> <Output value used as SPA-bus 'off' command>		
Output value	0	Protocol address and parameters
0 … 65 535 (first command)		
Output value	0	Protocol address and parameters
0 … 65 535 (second command)		

SCO – Additional configuration parameters

8.6.3 Conversion of values

RTU internal value	SPAbus value	
	Data process key	
	0	**4, 5, 6**
off	0	Output value first SPAbus command
on	1	Output value second SPAbus command

Table 39: SCO – Conversion of values

8.6.4 Conversion of quality descriptors

RTU		SPAbus
Internal communication (short)	**Internal communication (long)**	**Communication**
SE	Select / Execute	Not supported

Table 40: SCO – Conversion of quality descriptors

8.6.5 Conversion of causes of transmission

RTU		SPAbus
Internal communication (short)	Internal communication (long)	Communication
T	Test	Ignored
P/N	Positive/negative confirmation	Relevant in monitoring direction only
Cause	Activation	-
	Activation Confirmation	-
	Deactivation	-
	Deactivation Confirmation	-
	Activation Termination	-

Table 41: SCO – Conversion of causes of transmission

9 Transparent Data Messages

With the Transparent Data Messages, the RTU500 series is able to transmit any data of a foreign protocol from/to the Controlling Station. The RTU500 series supports the passing of SPAbus messages in a transparent data channel.

The SPAbus message is encapsulated with SPAbus frame and the checksum characters. This message passes the RTU without any conversion. There is no translation of the message in the RTU.

9.1 Command direction

The user data of transparent data channel must have the following general format of a SPAbus telegram. It has to start with > and to end with the delimiter cr.

>nTe/eXm/m:yyy/yyy:CCcr

where

Character	Explanation
n	slave number of SPAbus device
T	message Type code
e	channel number
e/e	first/ last channel
X	data category code (data type)
m	data number
m/m	first/last data
yyy	data-part (optional)
CC	Checksum

Table 42: Command direction – Telegram format

All user data bytes are ASCII-coded.

Examples:

>16RF:CCcr

Read slave identification of slave number 16

>57R1/2I50:CCcr

Read of input data of channel 1 to 2, data number 50 of slave number 57

>23W7O2:1:CCcr

Write value 1 to output data of channel number 7, data number 2

9.2 Monitoring direction

The received SPAbus reply will be passed as transparent data channel in the following format. It hast to start with < and to end with delimiter cr lf.

<nT:xxxx/xxxx:CCcrlf

where

Character	Explanation
n	slave number of SPAbus device
T	message Type code
xxxx	data part
CC	Checksum

Table 43: Monitoring direction – Telegram format

All user data bytes are ASCII-coded.

If a SPAbus subdevice does not respond to a command which is sent as transparent data, the transparent data will be acknowledged with activation confirmation negative.

10 File transfer

10.1 Transfer of disturbance data files

The subdevice communication interface with protocol SPAbus is capable to read disturbance data files from a protection device, and to store them on the CompactFlash memory file system of the RTU500 series. The user is able to access them via the internal web server. The web server is also used to transfer these files to a workspace PC.

10.2 Configuration

The file archive is running on any CMU in the system. In configurations with redundant CMUs the file archive must be configured on a non-redundant CMU (Group C), see the following figure. It is also possible to have several file archives in a system.

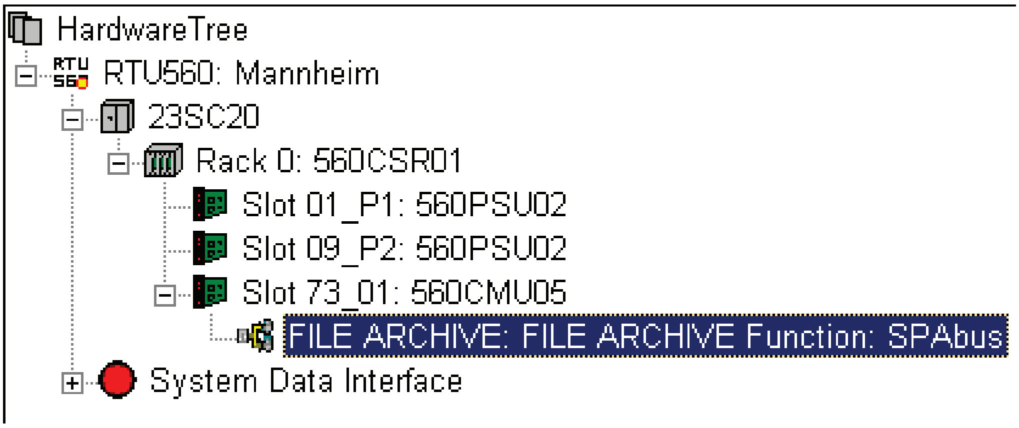


Figure 2: Configuration of file archives function

The file transfer function is configured on a SPAbus subdevice communication line. At least two elements are necessary for this function, see the following figure:

- The File transfer directory (FDR) with the name of the directory on the CompactFlash card
- At least one File transfer file (FTR)

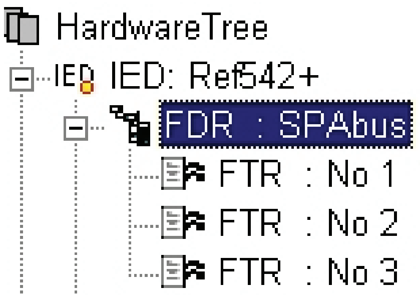


Figure 3: Configuration of file directory

1. Set the parameter for the File Archive according to the following table.

	Parameter name	Default	Parameter location
File type		-	
Disturbance recorder – SPAbus – REF542 plus, REx316, REx5xx			
Max. size of directory storage		Enabled	
Enable / Disable			
Max. number of days for directory storage		Enabled	
Enable / Disable			

Parameters for the file archive directory

10.3 Transmission procedure for REF542(plus), REx316*4

The transmission of disturbance data files is according to [1], the used variables are described in the following table.

Variable REF542 REG316	Explanation	Read	Write
V20	Reset block and line identifier	X	X
M28	Description of the oldest record	X	X
M29	Identifier of recording block	X	
M31	Identifier of recording line	X	X
M31	Contents of recording line	X	
n.u.[1]	Status of recorder	X	X

Table 44: Used SPAbus variables

[1]n.u. = not used

The SPAbus protocol is limited to ASCII character with 7 data bits. That is why each data byte of a disturbance record will be converted into two ASCII characters, see the following table. After reception the subdevice communication interface converts two ASCII characters back to one byte, before it stores the result in a file of the CompactFlash card.

Byte to be transmitted			SPAbus Transmission		
Format	Higher nibble	Lower nibble	Format	Byte x	Byte x+1
HEX	5	D	ASCII	'5'	'D'
	0101	1101		0110101	1000100

Table 45: Transmission in ASCII Format

10.4 Transmission procedure for REx5xx (e.g. REL531/561)

Disturbance files of protection devices of type REx5xx can be uploaded to RTU560. Within this ABB product family only devices of type REx500 of version 2.x are supported.

The disturbance data files are provided by the protection device in REVAL format. One disturbance record in REVAL format is presented in two files – a header file and a data file. The subdevice communication interface SPAbus packs these two files for transfer within RTU500 series. To unpack the REVAL header and REVAL data file again, the utility program REX5XXConvert.exe has to be used, see also [3].

11 Internal functions

11.1 General Interrogation

The general interrogation is sent to the subordinated devices directly after the initialization of the RTU and on every change of the subordinated link from OFFLINE to ONLINE.

A general interrogation is done by polling all configured data with a data request (see chapter Data requests (page "3-2")) for one subordinated device. If this polling cycle is finished, the general interrogation is considered to be terminated.

11.2 Time Synchronization

If the RTU shall synchronize subordinated devices, it must be configured. The configuration parameters are described in chapter General (page "3-1").

ADVICE

The command date and time synchronization is sent periodically to the subordinated devices which are in the ONLINE state and only if the time tag of the own RTU is valid (synchronized). The cycle time can be configured.

11.2.1 Supported data types

SPAbus			RTU				
Data category	**Message type**	**Code letter**	**Data type**	**Parameter name**	**Parameter location**	**Parameter range / Explanation**	**Default**
Time	<W>	T		Time interval of clock synchronization commands	Line parameter	The command is sent as broadcast after link state changes from off- to online and it is sent periodically with configured cycle time when the device is online. format ‘ss.mmm’ (ss = seconds, mmm = milliseconds)	

Table 46: Time Synchronization – Supported data types

SPAbus			RTU				
Data category	Message type	Code letter	Data type	Parameter name	Parameter location	Parameter range / Explanation	Default
Date and Time	<W>	D		Time interval of clock synchronization commands	Line parameter	The command is sent as broadcast after link state changes from off- to online and it is sent periodically with configured cycle time when the device is online. format 'yy-nn-dd hh.ii;ss.mmm' (yy =year, nn=month, dd=day, hh=hours, ii=minutes, ss=seconds, mmm =milliseconds)	

Table 46: Time Synchronization – Supported data types

11.2.2 Command Authority

None

11.2.3 Additional Information

None

11.2.4 Conversion of causes of transmission

RTU		SPAbus
Internal communication (short)	Internal communication (long)	Communication
T	Test	-
P/N	Positive/negative confirmation	Relevant in monitoring direction only
Cause	Activation	-
	Activation Confirmation	-

Table 47: Time Synchronization – Conversion of causes of transmission

11.3 System events

The subdevice interface manages internal status messages for every device connected to these lines. These status messages are created from the subdevice interface itself for every connected device.

The subdevice communication interface supports two system events:

Description of system event	Address offset
Device is active	24
Device inoperable	48

Table 48: Description of system events

While initialization the system event RTU_IS_ACTIVE (24) is sent as SPI with value 1 to the internal communication. On a running system this system event will not change anymore.

The system event RTU_INOPERABLE (48) is sent as SPI to the internal communication in dependency of the state of the subordinated device:

State of subordinated device	Value of system event 48
OFFLINE	1
ONLINE	0

Table 49: State of subordinated device

11.3.1 Status Change Device OFFLINE to Device ONLINE

If the state of a subordinated device or line changes from OFFLINE to ONLINE, a general interrogation command is send to the concerning device(s).

The system event "device inoperable" (SEV#048) with value 0 is sent as SPI to the internal communication for every device that changed its state to ONLINE.

11.3.2 Status Change Device ONLINE to Device OFFLINE

If the state of a subordinated device or line changes from ONLINE to OFFLINE all configured data points connected to these devices are sent to the internal communication with the actual state, marked as INVALID (IV) or NOT TOPICAL (NT) and with the timestamp of the own RTU. INVALID or NOT TOPICAL is set depending on the configuration parameter Information object qualifier.

Parameter name	Default	Parameter location
Information object qualifier (usage for disconnected subordinated devices)	Mark as invalid (IV)	RTU - Parameter
Value range: Mark as invalid (IV) / Mark as not topical (NT)		

ADVICE
Also in not topical (NT) configuration are data points which have not been updated since RTU startup marked as invalid (IV).

The system event DEVICE_INOPERABLE (48) with value 1 is sent as SPI to the internal communication for every device that changed its state to OFFLINE.

12 Interoperability list

12.1 Supported and selectable parameters

In this document parameter settings and selections from the standard SPAbus that are supported by RTU500 series are marked by squares with an x.

Functions and parameters with filled (black) squares ■ are not supported by RTU500 series!

12.2 Network configuration

(network-specific parameter)

- [X] Point-to-point
- [X] Multipoint loop
- [X] Multipoint star

12.3 Physical Layer

12.3.1 Electrical interface

- [X] EIA RS-485

Number of unit loads: 32 per line

ADVICE
EIA RS-485 standard defines unit loads so that 32 of them can be operated on one line. For detailed information, refer to clause 3 of EIA RS-485 standard.

12.3.2 Optical Interface

X	Glass fiber (23OK24)	
X	Plastic fiber	
X	F-SMA type connector	(for plastic fiber interface)
X	BFOC/2,5 type connector	(for glass fiber interface) (23OK24)

12.3.3 Transmission speed and settings

Transmission settings are defined as follows: 1 start bit, 7 data bits, even parity and 1 stop bit.

- [X] 300 bit/s
- [X] 1 200 bit/s

- [X] 2 400 bit/s
- [X] 4 800 bit/s
- [X] 9 600 bit/s
- [X] 19 200 bit/s

12.3.4 Link Layer

Messages only include 7-bit ASCII characters.

Special characters

- [X] continuation character '&'

Message length

≤ 255 Maximum length L (number of characters)

12.3.5 Application Layer

12.3.6 Transmission mode for application data

- [X] Data polling
- [X] Event polling
- [X] Combined Data and Event polling

12.3.7 Address values

(system-specific parameter)

- [X] Slave address range 1 .. 999 (900 reserved for broadcast address)
- [X] Channel number 0
- [X] Channel number range 1 .. 999
- [X] Data number range 1 .. 999 999, (only range 1 .. 65 535 is supported by RTU500 series)

12.3.8 Application data in monitoring direction

Message type of data request

- [X] Read < R >

Message type of data request answer

- [X] Data < D >

☒ No acknowledgement < N >, values 1 .. 9

☒ (Binary) events < E > (supported only for SPI and DPI data)

■ Analogue events < Q >

Data category of data request

☒ Input data < I >

☒ Output data < O >

☒ Setting values < S >

☒ Variables (internal) < V >

☒ Memory data < M >

☒ Slave status < C > (as event)

■ Slave identification < F >

■ Time < T >

■ Date and time < D >

☒ Last events < L >

☒ Last events from backup buffer (repeated requesting) < B >

■ Alarms valid < A >

12.3.9 Application data in command direction

Message type of write data

☒ Write < W >

Message type of write data acknowledgement

☒ Acknowledge < A >

☒ No acknowledgement < N >, values 1 .. 9

Data category of data write

☒ Input data < I >

☒ Output data < O >

☒ Setting values < S >

☒ Variables (internal) < V >

☒ Memory data < M >

☒ Slave status < C >

■ Slave identification < F >

☒ Time < T >

- [X] Date and time < D >
- ■ Last events < L >
- ■ Last events from backup buffer (repeated requesting) < B >
- ■ Alarms valid < A >

12.3.10 File transfer

Disturbance recorder

- [X] File upload from slave to master

File transfer for configuration files (SPAFTR)

- ■ write configuration to slave (command direction)
- ■ read configuration from slave (monitoring direction)

Basic application functions

Clock synchronization

(link-specific parameter)

- [X] Clock synchronization

Command transmission

(object-specific parameter)

- [X] Direct command transmission
- [X] Direct set point command transmission
- [X] Select and execute command
- [X] Select and execute set point command

13 Glossary

AMI	Analog Measured value Input
ASO	Analog Setpoint command Output
BSI	Bit String Input
BSO	Bit String Output
CMU	Communication and Data Processing Unit
DCO	**D**ouble **C**ommand **O**utput
DMI	Digital Measured value Input (8, 16 bit)
DPI	Double Point Input
DSO	Digital Setpoint command Output (8, 16 bit)
EPI	Event of Protection equipment Input (1 bit)
IED	Intelligent Electronic Device
ITI	Integrated Totals Input
MFI	Analog Measured value Floating Input
MS	Microsoft
RCO	Regulation step Command Output
RTU	Remote Terminal Unit
SCO	Single Command Output
SEV	System Event
SPI	Single Point Input or Single point information
STI	Step position Input

Note:

KEMA

ATTESTATION OF CONFORMITY

No. 30107031-Consulting 10-0847

issued to:
ABB AS
Ole Deviks vei 10
0666 Oslo
Norway

for the product:
RTU560
Release 9.8, build 1
Controlling station implementation

With the implemented communication protocol:

IEC 60870-5-104 ed.2 (IS 2006)

Network Access for IEC 60870-5-101 using standard transport profiles and the Statkraft Norway PID requirements, version 1.0, in Standard direction[1]

The product has not been shown to be non-conforming to the specified protocol standard, including the interface requirements.

End-to-End data element tests for the information and control points as described in manufacturer Protocol Implementation Conformance Statement (PICS) have been performed on the product's protocol implementation. Functional tests in controlled mode are performed for the following compatible Basic Application Functions:

☐ *Station initialization*[1] ☐ *Acquisition of events*[1]	☐ *General Interrogation*[1] ☐ *Command transmission*[1]

The test campaign did not reveal any errors in the product's protocol implementation.

This Attestation is granted on account of tests made at location of ABB AS Oslo, Norway and performed with UnIECim 60870-5-104 version 1.20.02 (October 2009) running CS104 Test Suite version CS104 V1.34. The results, including remarks and limitations, are laid down in our report no. 30107031-Consulting 10-0846.

The tests have been carried out on one single specimen of the product, submitted by ABB. The Attestation does **not** include an assessment of the manufacturer's production. Conformity of his production with the specimen tested by KEMA is not the responsibility of KEMA.

Arnhem, 12 April 2010

Заличено по чл. 36а, ал.3 от ЗОП

W. Strabbing
Manager Intelligent Networks and Communication

P. Cioci
Test Consultant

[1] IMPORTANT: Remarks apply to the implementation of this function. See the resulting report (chapter 4) for full details

KEMA Nederland B.V.
Utrechtseweg 310, 6812 AR Arnhem; P.O. Box 9035, 6800 ET Arnhem, The Netherlands.
Telephone + 31 26 356 91 11, Telefax + 31 26 443 38 43

ATTESTATION OF CONFORMITY

No. 30107031-Consulting 10-0849

issued to:
ABB AS
Ole Deviks vei 10
0666 Oslo
Norway

for the product:
RTU560
Release 9.8, build 1
Controlled station implementation

With the implemented communication protocol:

IEC 60870-5-104 ed.2 (IS 2006)

Network Access for IEC 60870-5-101 using standard transport profiles and the Statkraft Norway PID requirements, version 1.0, in Standard direction[1]

The product has not been shown to be non-conforming to the specified protocol standard, including the interface requirements.

End-to-End data element tests for the information and control points as described in manufacturer Protocol Implementation Conformance Statement (PICS) have been performed on the product's protocol implementation. Functional tests in controlled mode are performed for the following compatible Basic Application Functions:

☐ *Station initialization*[1] ☐ *Acquisition of events*[1] ☐ *General Interrogation*[1]	☐ *Command transmission*[1] ☐ *Redundancy requirements*[1]

The test campaign did not reveal any errors in the product's protocol implementation.

This Attestation is granted on account of tests made at location of ABB AS Oslo, Norway and performed with UnIECim 60870-5-104 version 1.20.02 (October 2009) running CS104 Test Suite version CS104 V1.34. The results, including remarks and limitations, are laid down in our report no. 30107031-Consulting 10-0848.

The tests have been carried out on one single specimen of the product, submitted by ABB. The Attestation does **not** include an assessment of the manufacturer's production. Conformity of his production with the specimen tested by KEMA is not the responsibility of KEMA.

Arnhem, 12 April 2010

Заличено по чл. 36а, ал.3 от ЗОП

W. Strabbing
Manager Intelligent Networks and Communication

P. Cioci
Test Consultant

[1] IMPORTANT: Remarks apply to the implementation of this function. See the resulting report (chapter 4) for full details

KEMA Nederland B.V.
Utrechtseweg 310, 6812 AR Arnhem; P.O. Box 9035, 6800 ET Arnhem, The Netherlands.
Telephone + 31 26 356 91 11, Telefax + 31 26 443 38 43

UCA International Usersgroup

IEC 61850 Certificate Level A[1]

No. 74101960-MOC/INC 12-02107

Issued to:
ABB AG
Kallstadter Str 1
68309, Mannheim
Germany

For the client system:
RTU560
Hardware: RTU560
Software: Release 10.6

Issued by: KEMA

The client system has not shown to be non-conforming to:

IEC 61850-6, 7-1, 7-2, 7-3, 7-4 and 8-1

Communication networks and systems in substations

The conformance test has been performed according to IEC 61850-10 and UCA IUG Conformance Test Procedures for Client System with IEC 61850-8-1 interface, revision 1.1 with TPCL[2] version 1.2 with client system's protocol, model and technical issue implementation conformance statements and product's extra information for testing: "IEC 61850 Client, reference; 1KGT 150 590 V003 1".

The following IEC 61850 conformance blocks have been tested with a positive result (number of relevant and executed test cases / total number of test cases):

1 Basic Exchange (19/22)	12a Direct Control (6/7)
2 Data Sets (3/9)	12b SBO Control (8/9)
5 Unbuffered Reporting (16/18)	12c Enhanced Direct Control (6/7)
6 Buffered Reporting (20/22)	12d Enhanced SBO Control (8/9)
	13 Time Synchronization (4/4)
	14 File Transfer (5/8)

This certificate includes a summary of the test results as carried out at KEMA in the Netherlands with UniCA Multi IED Simulator 3.26.00 and UniCA 61850 Analyzer 4.25.00. This document has been issued for information purposes only, and the original paper copy of the KEMA report: No. 74101960-MOC/INC 12-02106 will prevail.

The test has been carried out on one single specimen of the client system as referred above and submitted to KEMA by ABB AG. The manufacturer's production process has not been assessed. This attestation does not imply that KEMA has approved any product other than the specimen tested.

Arnhem, November 2, 2012

Заличено по чл. 36а, ал.3 от ЗОП

M. Adriaensen
Director Intelligent Networks & Communication

Заличено по чл. 36а, ал.3 от ЗОП

R. Schimmel
Certification Manager

[1] Level A - Independent test lab with certified ISO 9000 or ISO 17025 Quality System
[2] TPCL - Test Procedure Change List

KEMA Nederland B.V.
Utrechtseweg 310, 6812 AR Arnhem, P.O.Box 9035, 6800 ET Arnhem, The Netherlands
T +31 26 356 20 25 F +31 26 351 36 83 sales@kema.com www.kema.com

Applicable Test Procedures from the UCA IUG Conformance Test Procedures for Client System with IEC 61850-8-1 interface, revision 1.1 with TPCL version 1.2

Conformance Block	Mandatory	Conditional
1: Basic Exchange	cAss1, cAss2, cAss3, cAss4, cAssN1, cAssN4, cAssN5, cAssN6	cAssN7 cSrv1, cSrv2, cSrv3, cSrv4, cSrv5, cSrv6, cSrvN3, cSrvN4, cSrvN5, cSrvN6
2: Data Sets		cDs1, cDs2, cDs5
5: Unbuffered Reporting	cRp3, cRp4, cRp5, cRp8, cRp9, cRp10, cRpN2, cRpN3, cRpN7, cRpN8	cRp1, cRp2, cRp6, cRp7, cRpN1, cRpN4
6: Buffered Reporting	cBr3, cBr4, cBr5, cBr8, cBr9, cBr10, cBr11, cBr12, cBrN2, cBrN3, cBrN7, cBrN8, cBrN9	cBr1, cBr2, cBr6, cBr7 cBr13, cBrN1c, BrN4
12a: Direct control	cCtl4, cCtlN1 cDOns1, cDOns2	cCtl1, cCtl2
12b: SBO control	cCtl4, cCtlN1 cSBOns1, cSBOns2, cSBOns3	cCtl1, cCtl2 cSBOns4
12c: Enhanced Direct Control	cCtl4, cCtlN1 cDOes1, cDOes2	cCtl1, cCtl2
12d: Enhanced SBO control	cCtl4, cCtlN1, cSBOes1, cSBOes2, cSBOes3	cCtl1, cCtl2 cSBOes4
13: Time sync	cTm1	cTm2, cTmN1, cTmN2
14: File transfer	cFt1, cFt2, cFt3, cFtN1, cFtN2	

KEMA

ATTESTATION OF CONFORMITY

No. E-12-I-035-EH

Issued to:

ABB(Asea Brown Boveri), S.A.
Quinta da Fonte, Edifício Q36,
Plaza I
Rua da Quinta da Quintã, nº 3
2774-002 PAÇO DE ARCOS
Portugal.

for the product:

RTU560
Firmware version: 10.4.2.0
Type: Controlled station

With the implemented communication protocol:

IEC 60870-5-104 ed.2 (IS 2006)

Network Access for IEC 60870-5-101 using standard transport profiles in Standard direction[1] and the EDP IEC60870-5-104 interoperability profile (07-1532 LIGHT PID 104 v1.1)

The product has not been shown to be non-conforming to the specified protocol standard, including the interface requirements.

End-to-End data element tests for the information and control points as described in manufacturer Protocol Implementation Conformance Statement (PICS) have been performed on the product's protocol implementation. Functional tests in controlled mode are performed for the following levels:

• *Station initialization* [1] • *Acquisition of events* • *General Interrogation*[1] • *Command transmission* [1] • *Time synchronisation*	• *Parameter loading* • *Transmission of integrated totals* • *Test procedure* • *PIXIT related*[1]

The test campaign did not reveal any errors in the product's protocol implementation.

This Attestation is granted on account of tests made at location of ABB AG in Mannheim (Germany), and performed with UnIECim 60870-5-104 version 1.23.01 (March 2011) running CS104 Test Suite version CS104 V1.36. The results, including remarks and limitations, are laid down in our report no. E-12-I-034-EH.

The tests have been carried out on one single specimen of the product, submitted by ABB. The Attestation does **not** include an assessment of the manufacturer's production. Conformity of his production with the specimen tested by KEMA is not the responsibility of KEMA.

Arnhem, March 26, 2012

Заличено по чл. 36а, ал.3 от ЗОП

M. Adriaensen
Director Management & Operations Consulting NMEA

Заличено по чл. 36а, ал.3 от ЗОП

E. Henríquez
Test Consultant

[1] IMPORTANT: Remarks apply to the implementation of this function. See the resulting report (Chapter 4) for full details

KEMA Nederland B.V.
Utrechtseweg 310, 6812 AR Arnhem; P.O. Box 9035, 6800 ET Arnhem, The Netherlands.
Telephone + 31 26 356 91 11, Telefax + 31 26 443 38 43

UCA International Users Group

IEC 61850 Certificate
Level A[1]

TÜV SÜD Product Service

No. ZE 18 07 05559 001 B

Issued to:

ABB AG
Kallstadterstrasse 1
68309 Mannheim
Germany

For the client product:

RTU 560

Version: 12.3

Communication Unit (Client)

Issued by:

TÜV SÜD Product Service GmbH
Communication Protocols
Barthstrasse 16
D-80339 Munich
Germany

Certification Mark:

TÜV SÜD IEC 61850 Conformance

This certification mark can only be used for the product defined above.

The client product has not been shown to be non-conforming to:

IEC 61850 Edition 2 Parts 6, 7-1, 7-2, 7-3, 7-4 and 8-1

Communication networks and systems for power utility automation.

The conformance test has been performed according to IEC 61850-10 Edition 2, the UCA International Users Group Edition 2 Client Test Procedures version 1.0 with TPCL[2] version 1.0_rev3 with the product's protocol, model and technical issue implementation conformance statements: "Remote Terminal Units, IEC 61850 Client (Chapter PICS)", "Remote Terminal Units, IEC 61850 Client (Chapter MICS)", "Remote Terminal Units, IEC 61850 Client (Chapter TICS)" and product's extra information for testing: "Remote Terminal Units, IEC 61850 Client (Chapter PIXIT)".

The following IEC 61850 conformance blocks have been tested with a positive result (number of relevant and executed test cases / total number of test cases):

1 Basic Exchange (15/24)	12a Direct Control (6/9)
2 Data Sets(4/10)	12b SBO Control (8/11)
5 Unbuffered Reporting (17/23)	12c Enhanced Direct Control (6/9)
6 Buffered Reporting (21/28)	12d Enhanced SBO Control (8/11)
	13 Time Synchronization (4/4)
	14 File Transfer (5/8)

This certificate includes a summary of the test results as carried out at Munich in Germany with Anvil 3.6.0.0 and Wireshark 2.4.1. This document has been issued for information purposes only, and the original paper copy of the TÜV SÜD Product Service GmbH test report: No. **713130580-TR01**, version **1.0** will prevail.

The test has been carried out on one single specimen of the product as referred above and submitted to TÜV SÜD Product Service GmbH by ABB AG. The manufacturer's production process has not been assessed. This certificate does not imply that TÜV SÜD Product Service GmbH has certified or approved any product other than the specimen tested.

Munich, 10.07.2018

Заличено по чл. 36а, ал.3 от ЗОП

Peter Pfisterer
Technical Certifier

Заличено по чл. 36а, ал.3 от ЗОП

Albi Kospiri
Test Engineer

[1] Level A - Independent Test lab with certified ISO 17025 Quality System
[2] Test Procedure Change List

According to the "TÜV SÜD Group Certification Rules" please see reverse side.

ZERTIFIKAT ◆ CERTIFICATE ◆ 認証証書 ◆ СЕРТИФИКАТ ◆ CERTIFICADO ◆ CERTIFICAT

UCA International Users Group

TÜV SÜD Product Service

No. ZE 18 07 05559 001 B

Applicable Test Procedures from the UCA International Users Group Edition 2 Client Test Procedures version 1.0 with TPCL version 1.0_rev3:

Conformance Block	Mandatory	Conditional
1: Basic Exchange	cAss1, cAss2, cAss3, cAssN1, cAssN4, cAssN5, cAssN6	cAssN7, cSrv4, cSrv5, cSrv6, cSrv7, cSrvN4, cSrvN5, cSrvN6
2: Data Sets		cDs2, cDs5, cDs6, cDsN1b
5: Unbuffered Reporting	cRp3, cRp4, cRp5, cRp8, cRp9, cRp10, cRp11, cRp13a, cRp14, cRp15, cRpN2, cRpN5, cRpN6	cRp2, cRp6, cRp7, cRp16
6: Buffered Reporting	cBr3, cBr4, cBr5, cBr8, cBr9, cBr10, cBr11, cBr13a, cBr14, cBr15, cBr30, cBr31, cBrN2, cBrN5, cBrN6, cBrN20	cBr2, cBr6, cBr7, cBr16, cBr32
12a: Direct control	cCtl4, cCtl5, cDOns1, cDOns2	cCtl1, cCtl2
12b: SBO control	cCtl4, cCtl5, cSBOns1, cSBOns2, cSBOns3	cCtl1, cCtl2, cSBOns4,
12c: Enhanced Direct Control	cCtl4, cCtl5, cDOes1, cDOes2	cCtl1, cCtl2
12d: Enhanced SBO control	cCtl4, cCtl5, cSBOes1, cSBOes2, cSBOes3	cCtl1, cCtl2, cSBOes4,
13: Time sync	cTm1, cTmN1	cTm2, cTmN2
14: File transfer	cFt1, cFt3, cFtN1	cFt2, cFtN2

According to the “TÜV SÜD Group Certification Rules” please see reverse side.

Zertifiziervertrag

Grundlage für die Zertifikatserteilung ist die Prüf- und Zertifizierordnung von TÜV SÜD Product Service.

Mit Erhalt des Zertifikates erkennt der Zertifikatsinhaber die jeweils gültige Fassung der Prüf- und Zertifizierordnung an (www.tuev-sued.de/ps_regulations) und wird somit Partner im Zertifiziersystem von TÜV SÜD Product Service.

Prinzipielle Voraussetzung für die Gültigkeit des Zertifikates:

- Gültigkeit der zitierten normativen Prüfgrundlage(n) ist gegeben

und zusätzlich bei Zertifikaten mit Berechtigung zur Verwendung eines Prüfzeichens bzw. bei Zertifikaten für QM-Systeme:

- Voraussetzungen für vorschriftsmäßige Fertigung werden eingehalten.
- Die Fertigungs- bzw. Betriebsstätten werden regelmäßig überwacht.

Certification contract

Certification is based on the TÜV SÜD Product Service Testing and Certification Regulations.

On receipt of the certificate the certificate holder agrees to the current version of the Testing and Certification Regulations (www.tuev-sued.de/ps_regulations) and thus becomes partner in the TÜV SÜD Product Service Certification System.

Requirements for the validity of the certificate in principle:

- Validity of the quoted test standard(s)

In addition for certificates with the right to use a certification mark and for QM certificates:

- Conditions for an adequate manufacturing are maintained
- Regular surveillance of the facility is performed

Akkreditierungen / Benennungen (Status 14.10.2013) /
Accreditations / notifications (as of 2013-10-14)

Deutschland / Germany

Produktsicherheitsgesetz (ProdSG) /
Product Safety Act (ProdSG)

Europa / Europe

- Niederspannungsrichtlinie 2006/95/EG
- Spielzeugrichtlinie 2009/48/EG
- Richtlinie für aktive medizinische Implantate 90/385/EWG
- Richtlinie für Medizinprodukte 93/42/EWG
- Richtlinie für In-vitro-Diagnostika 98/79/EG
- Richtlinie für Gasverbrauchseinrichtungen 2009/142/EG
- Richtlinie für persönliche Schutzausrüstungen 89/686/EWG
- EMV-Richtlinie 2004/108/EG
- Richtlinie für Sportboote 94/25/EG + 2003/44/EG
- Richtlinie für Maschinen 2006/42/EG
- Richtlinie für Ex-Schutz Geräte 94/9/EG

- Low Voltage Directive 2006/95/EC
- Toys Directive 2009/48/EC
- Directive for Active Implantable Medical Devices 90/385/EEC
- Directive for Medical Devices 93/42/EEC
- Directive on In Vitro Diagnostic Medical Devices 98/79/EC
- Directive for Gas Appliances 2009/142/EC
- Directive for Personal Protective Equipment 89/686/EEC
- EMC Directive 2004/108/EC
- Directive for Recreational Craft 94/25/EC + 2003/44/EC
- Directive for Machinery 2006/42/EC
- Directive for Ex Safe Equipment 94/9/EC

- ENEC Agreement for luminaires, household and IT equipment

USA

- Nationally Recognized Testing Laboratory (NRTL) to 29 CFR 1910.7 by OSHA
- Accredited for FDA 510(k) Third Party Review
- Conformity Assessment Body to the MRA for Medical Devices; FDA QSReg Inspections, FDA 510(k) Third Party Review

Asien-Pazifik Region / Asia Pacific

- Recognized Certification Body to Electrical Products (Safety) Regulation; Hong Kong
- Konformitätsbewertungsstelle / Conformity Assessment Body to the MRA for Medical Devices; Australien / Australia
- Konformitätsbewertungsstelle / Conformity Assessment Body to the MRA for Medical Devices; Neuseeland / New Zealand

Weltweit / Worldwide

- NCB im CB-Scheme des IECEE /
  NCB in the CB Scheme of IECEE
- ExCB im IECEx-Scheme des IECEE /
  ExCB in the IECEx Scheme of IECEE
- Zertifizierstellen durch DAkkS akkreditiert
  DE-ZE-11321-01, DE-ZM-11321-09 und DE-ZM-11321-01.
  Certification Bodies accredited by DAkkS
  DE-ZE-11321-01, DE-ZM-11321-09 and DE-ZM-11321-01.

Zertifizierstelle für Produkte / Certification Body for Products • e-mail ps-zert@tuev-sued.de
Zertifizierstelle für Medizinprodukte / Certification Body for Medical Devices • e-mail medical_devices@tuev-sued.de
Kundenservice / Clients Services • Phone +49/89/50 08-42 61 • Fax +49/89/50 08-42 30 • e-mail ps-zert@tuev-sued.de

560AIR01
RTU560 product line

Application, characteristics and technical data have to be taken from the hardware data sheet:

560AIR01 Data sheet 1KGT 150 929

Operation

The 560AIR01 module records up to 8 analog measured values.

ADVICE
This module requires RTU500 series Release 9 firmware or higher.

Processing functions

The micro controller EAP (Ein-/ Ausgabe -Prozessor / Input- output processor) controls the A/D converter and reads the digitized analog measured value. The configuration parameters are loaded by the CMU (communication unit). The used processing functions of the 560AIR01 are defined by the RTU560.

In general the 560AIR01 board can process the following functions per input channel:

- Zero value supervision
- Switching detection
- Smoothing
- Cyclic transmission to the CMU independent from threshold supervision
- Threshold supervision

Input signal conversion

The A/D converter operates by the sigma-delta method. The sigma-delta method allows a high suppression of line-frequency and line-harmonics interference voltages. This is still specified by a deviation from the nominal line-frequency of up to ±10 %. On this occasion the suppression is still > 45 dB.

The 560AIR01 transmits the measured value with 12 bit plus sign to the CMU. The scaling to the telecontrol transmission protocol presentation is done by the CMU.

With a ninth internal measuring channel the 560AIR01 does an automatic zero calibration at each cycle. The A/D converter uses the result as a rating factor.

Settings

Input signal range

A measuring range can be differently configured for each of the eight channels. Therefore the configuration has to be done for all eight channels.

For each channel:

- the switch registers S1 to S3 **AND**
- the jumper X5x1

should be configured to the same measuring range. Only if jumper and switch register setting corresponds the 560AIR01 scans and converts the measuring value correct.

The configuration of jumper X5x1 is shown in Table 1. Hereby is x the channel to be configured. Table 2 shows the corresponding settings for switch register S1 to S3 and the corresponding position of jumper X5x1.For channel 5 = 20 mA as an example it should be set:

- X5x1 jumper 5 = position 1-2
- S3-5 = OFF
- S2-5 = ON
- S1-5 = ON

The firmware of the 560AIR01 uses the position of switch register S1 to S3 for the scaling and calculation to the nominal measuring range. In addition it identifies by the position which rating value it should use.

Pos.	X5x1	Measuring range
1	1 2 3	10 mA 20 mA 40 mA
2	1 2 3	2 mA 5 mA
3	1 2 3	2 V 20 V
x = 1 to 8 for the respective channel		

Figure 1: Configuration jumper X5x1

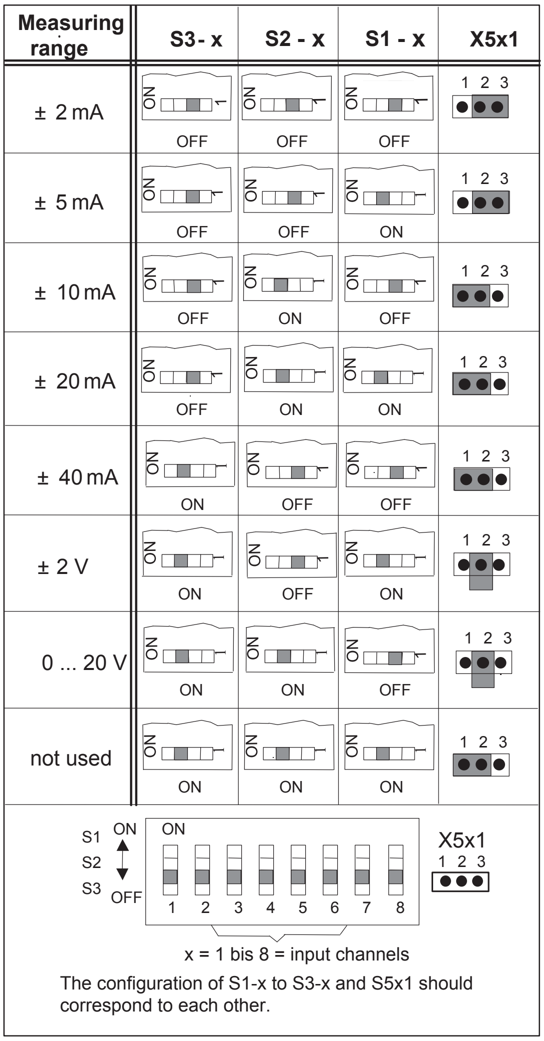


Figure 2: **Configuration S1 to S3 and X5x1**

Configuration of line-frequency

Beside the information about the configured measuring range the information about the line-frequency is requested for the A/D-conversion. The configured line-frequency is valid for all eight channels. Therefore jumper X401 has to be configured.

Frequency	Conversion time per channel	Scan cycle time (same for all channels)
60 Hz	54 ms	486 ms
50 Hz	54 ms	486 ms
16.7 Hz	155 ms	1395 ms

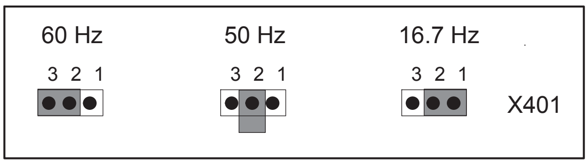


Figure 3: Configuration of line-frequency

Factory calibration

An on-site calibration of the A/D converter is not necessary.

The 560AIR01 will be calibrated for all channels and measuring ranges at the factory. During the calibration the firmware calculates a rating value per measuring range and channel and stores this rating value in an EEPROM. The rating values are protected by a checksum.

The 560AIR01 checks the checksum of all rating values during initialization of the board. The 560AIR01 does not start operation if one or more of these checksum are wrong. The 560AIR01 stays passive, that means the CMU does not detect the board and indicates it with "board out of operation". The LED ERR flashes in addition with approx. 3 Hz.

Signaling

The board monitors and checks its functionality as well as the dialog via the peripheral bus.

Detected errors are indicated and/or transmitted by the board:

- by the red LED ERR on the front plate
- by diagnostic messages
- in the process signal messages (signal status)

The LED ERR indicates board errors, peripheral bus errors and/or A/D converter failures.

The LED ERR indicates:

- board runs initialization procedure
- board has detected a memory error (RAM or EPROM)
- micro controller faulty
- no dialog via the peripheral bus for at least two minutes. The board is not polled by the PBP (Peripheral Bus Processor) of CMU.
- A/D converter faulty
- flashing with 3 Hz: rating values in the EEPROM faulty

Each configured measuring value will be indicated faulty by the CMU for the listed errors.

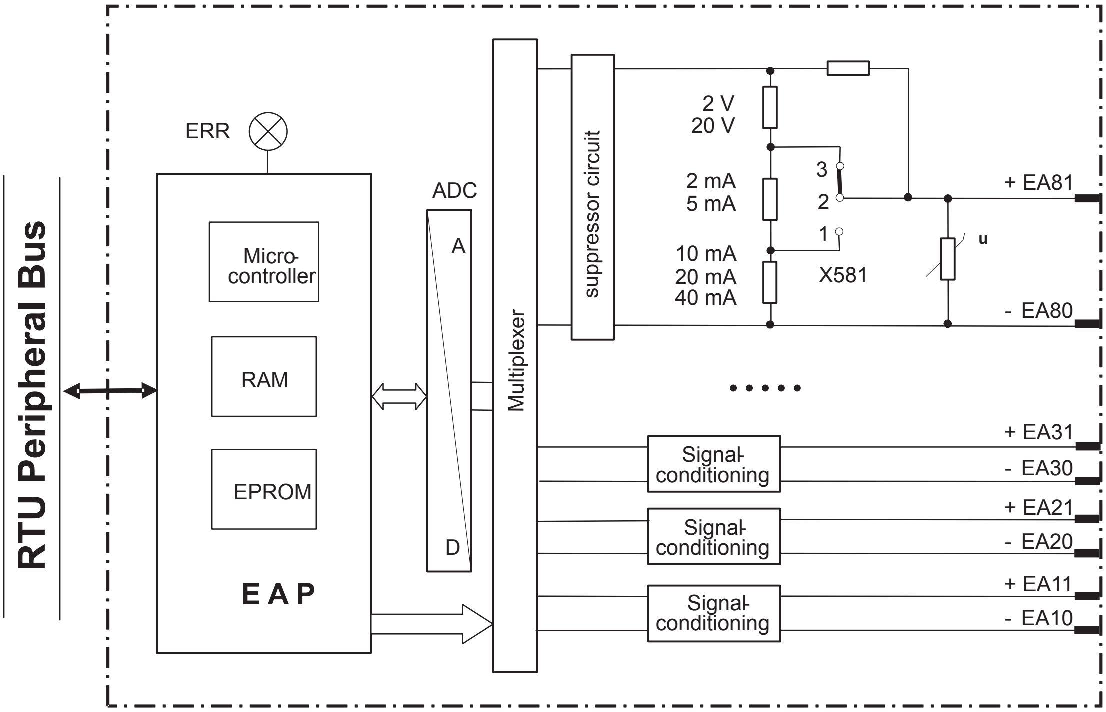


Figure 4: Logic block diagram

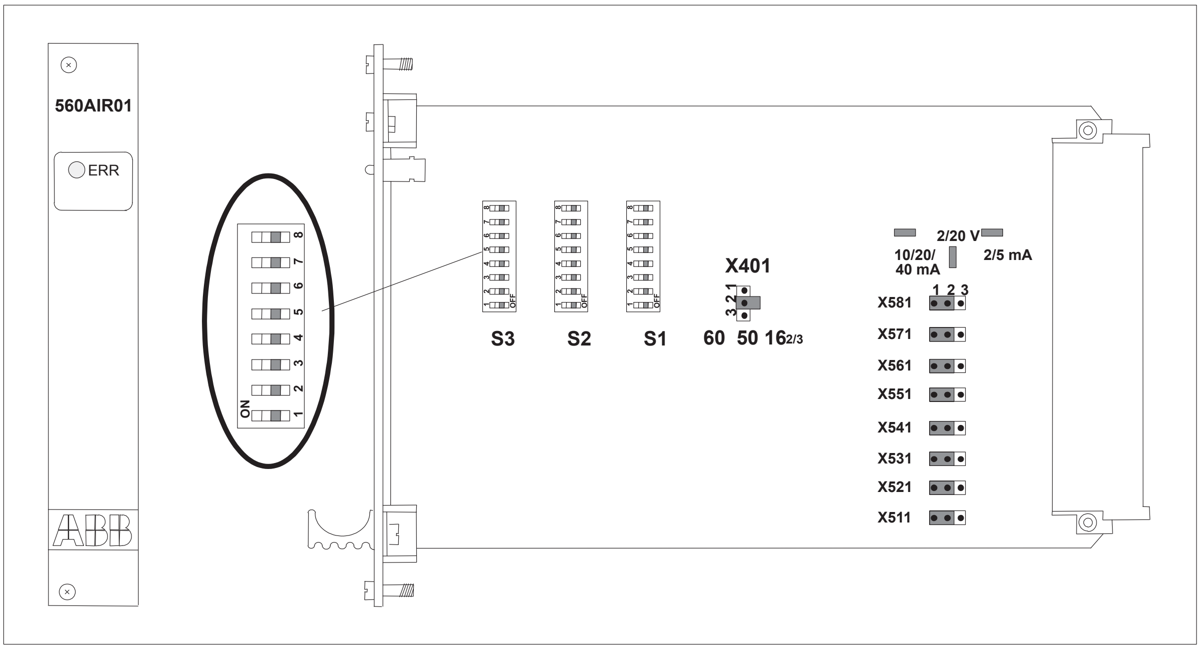


Figure 5: Board layout with setting positions

560MPR03	560SFR02	Signal Identification	
	Sub connector	Identification	Meaning
1	z32	AI10 -	Analog input 1-
2	b32	AI11+	Analog input 1+
3	d32	AI20-	Analog input 2-
4	z30	AI21+	Analog input 2+
5	b30	AI30-	Analog input 3-
6	d30	AI31+	Analog input 3+
7	z28	AI40-	Analog input 4-
8	b28	AI41+	Analog input 4+
9	d28	AI50-	Analog input 5-
10	z26	AI51+	Analog input 5+
11	b26	AI60-	Analog input 6-
12	d26	AI61+	Analog input 6+
13	z24	AI70-	Analog input 7-
14	b24	AI71+	Analog input 7+
15	d24	AI80-	Analog input 8-
16	z22	AI81+	Analog input 8+
17			Not used
18	b22		Not used
19	d22		Not used

Table 1: Subrack terminal connection

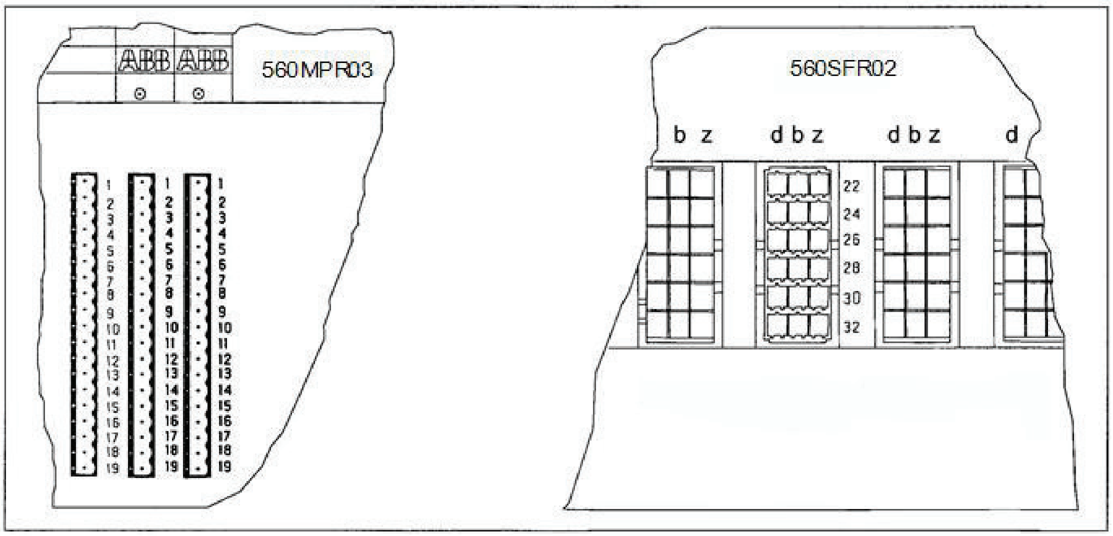


Figure 6: Placement of signal terminal connectors on subracks

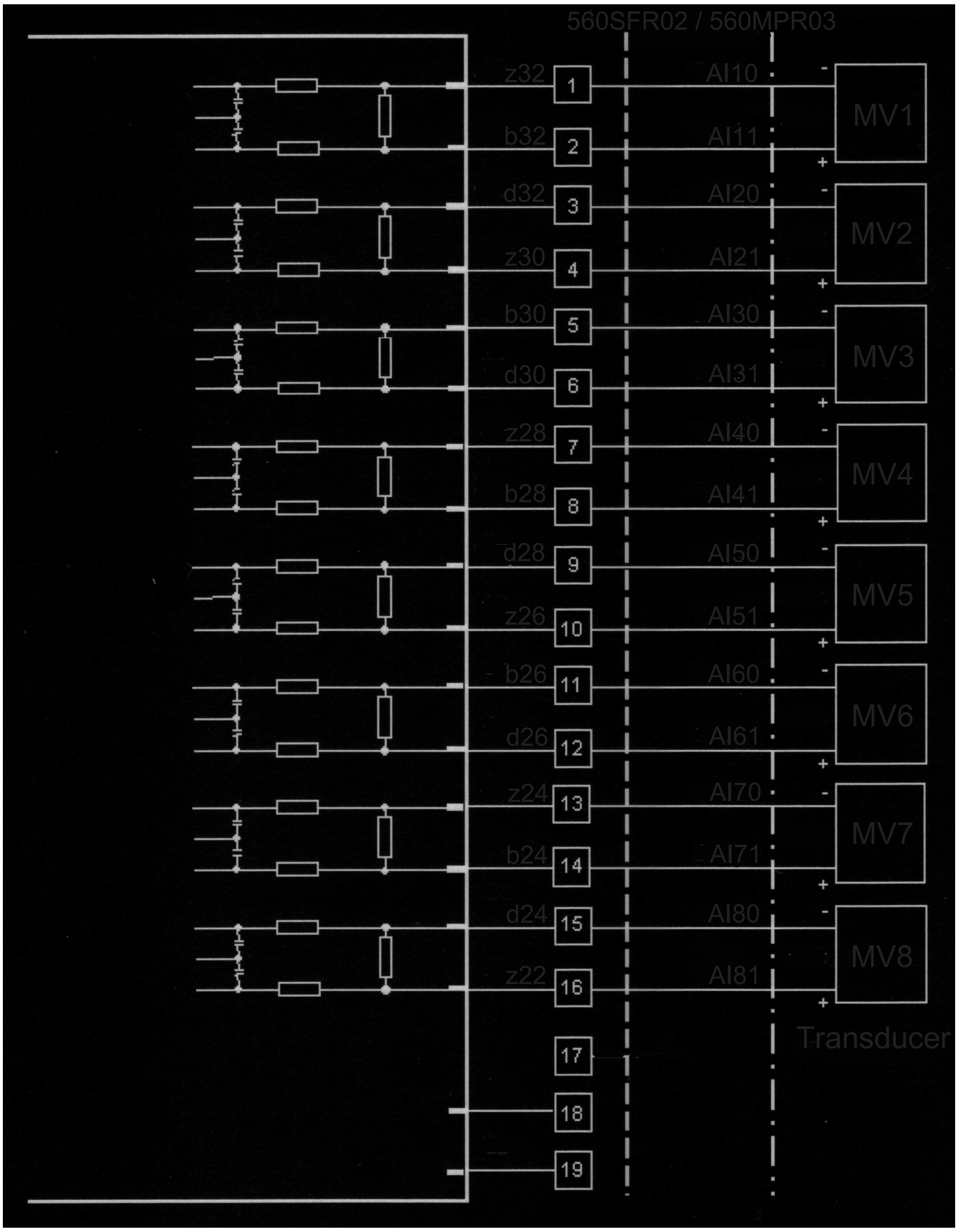


Figure 7: **Connection diagram 560SFR02/560MPR03 subrack**

ABB AG
Power Grids
P.O. Box 10 03 51
68128 Mannheim, Germany
Tel. +49 621 381-3000

www.abb.com/remote-terminal-units

1KGT 150 930 V003 1

Binary input 560BIR01
RTU560 product line

Application, characteristics and technical data have to be taken from the hardware data sheet:

560BIR01 Data sheet 1KGT 150 901

Operation

The binary input module 560BIR01 provides 16 galvanic isolated inputs for up to 16 binary process signals. Scanning and processing of the inputs are executed with the high time resolution of 1 ms. The allocation of an input signal to the processing functions can be done according to the rules of configuration.

The module is available in two versions (rubrics):
- 560BIR01 R0001: process voltage 24 to 60 V DC. LED signaling for each input, common return per 8 inputs.
- 560BIR01 R0002: process voltage 110 to 125 V DC. LED signaling for each input, common return per 8 inputs.

ADVICE

This module requires RTU500 series Release 9 firmware or higher.

Processing functions

The module 560BIR01 is able to process the following types of signals or a combination of them:
- 16 single point information with time stamp (SPI)
- 8 double point information with time stamp (DPI)
- 2 digital measured values each with 8 bit (DMI8)
- 1 digital measured value with 16 bit (DMI16)
- 16 integrated totals (max. 120 Hz) (ITI)
- 2 step position information each with 8 bit (STI)
- 2 bitstring input each with 8 bit (BSI8)
- 1 bitstring input with 16 bit (BSI16)
- or combinations of this signal types

The micro-controller on the module processes all time critical tasks of the parameterized processing functions. Moreover it carries out the interactive communication with the RTU I/O bus. All configuration data and processing parameters are loaded by the communication unit via the RTU I/O bus.

The binary input unit can execute the following processing functions for the different types of signals:
- Digital filtering to suppress contact bounce
- Suppression of oscillating signals caused by the process
- Validity check and suppression of intermediate input states for double indications
- Consistancy check for all channels allocated to digital measured values or step position information
- Summation of increment pulses to form integrated totals in registers of 31 bit resolution
- Copying of integrated totals values into freezing registers for data conservation

Parameter name	Default	Parameter location
Digital filter	10 ms	SPI, DPI, DMI, STI, ITI, BSI – PDP parameters

value range: 2... 255 ms or disabled
Digital filter specifies the time during which an input has to be stable before it is accepted as a new signal state.

Parameter name	Default	Parameter location
Maximum chatter frequency	deactivated	SPI, DPI – PDP parameters

value range: 1... 100 Hz (typical 2 Hz)
Oscillation suppression prevents permanent transmissions. A threshold value for the number of events per time period can be set. If this value is exceeded, the system automatically blocks the corresponding indication.

Parameter name	Default	Parameter location
Supervision time for intermediate position	30 sec	DPI – PDP parameters

value range: 1... 255 sec or deactivated
Use the supervision time to specify when an intermediate DPI message is transmitted as an event.

Parameter name	Default	Parameter location
Consistency check time	1 sec	DMI, STI, BSI – PDP parameters

value range: 0.1... 25.5 sec or deactivated
The digital value is only consistant and valid if all binary channels of the value are valid and stable for at least the consistency check time.

For additional information on these configuration parameters in RTUtil500 refer to RTU500 series function description - part 5: SCADA functions (1KGT 150 797).

Settings

The device has no switches or jumpers.

Signaling

LED 1... 16

The 560BIR01 has 16 yellow LED’s on the front plate indicating the state of the inputs.

The LED’s indicate the signal after the conversion by the optocouplers. So the LED's follow the signal directly.

LED ERR

The module monitors and checks the own functionality as well as the dialog via the I/O bus. Detected errors are indicated by the red LED ERR on the front plate and transmitted via the I/O bus to the communication unit (CMU). Additional diagnostic messages are available using the Web-Server on the CMU.

The LED ERR indicates module errors or I/O bus errors:

- module runs initialization procedure
- module is performing a cold or warm start
- module has detected a memory error (RAM or Flash)
- micro-controller is faulty
- no dialog via the I/O bus for at least 2 minutes. The module is not polled by the CMU.

Connections

Connection to RTU560 racks

The module is intended to be used in an RTU560 rack. The connection to the power supply, the RTU560 I/O bus and the process terminals is done via the backplane connector in the RTU560 rack.

The module can be used in all RTU560 racks if the process voltage (I/O voltage) is not higher than 60 V DC. For process voltages higher than 60 V DC (e. g. 110 V DC) only the racks 560SFR02 and 560MPR03 can be used.

⚠ WARNING

For process voltages > 60 V DC only the racks 560SFR02 and 560MPR03 can be used.

For other RTU560 racks the insulation between process voltage (I/O voltage) and internal electronics is not ensured.

In case of insulation failure the rack and other modules could be damaged and dangerous situations for operating personal could occur.

Compatibility

The 560BIR01 module is plug and functional compatible to the module 23BE23 or 23BE21 used in RTU560. It can replace this modules.

Safety instructions

Dangerous process voltages

⚠ DANGER

Hazardous voltage.

Contact with live circuits will cause electric shock or burn.

Verify that all terminals feeding dangerous contact voltages (supply voltage, input or output channels) is in secure OFF state before connecting or withdrawing the terminals.

Cover all free slots

⚠ DANGER

Cover all free slots within racks with process voltages > 60 V DC with front plates to ensure that live circuits can't be touched.

Group devices in rack

ADVICE

Group devices with same process voltages within a rack.

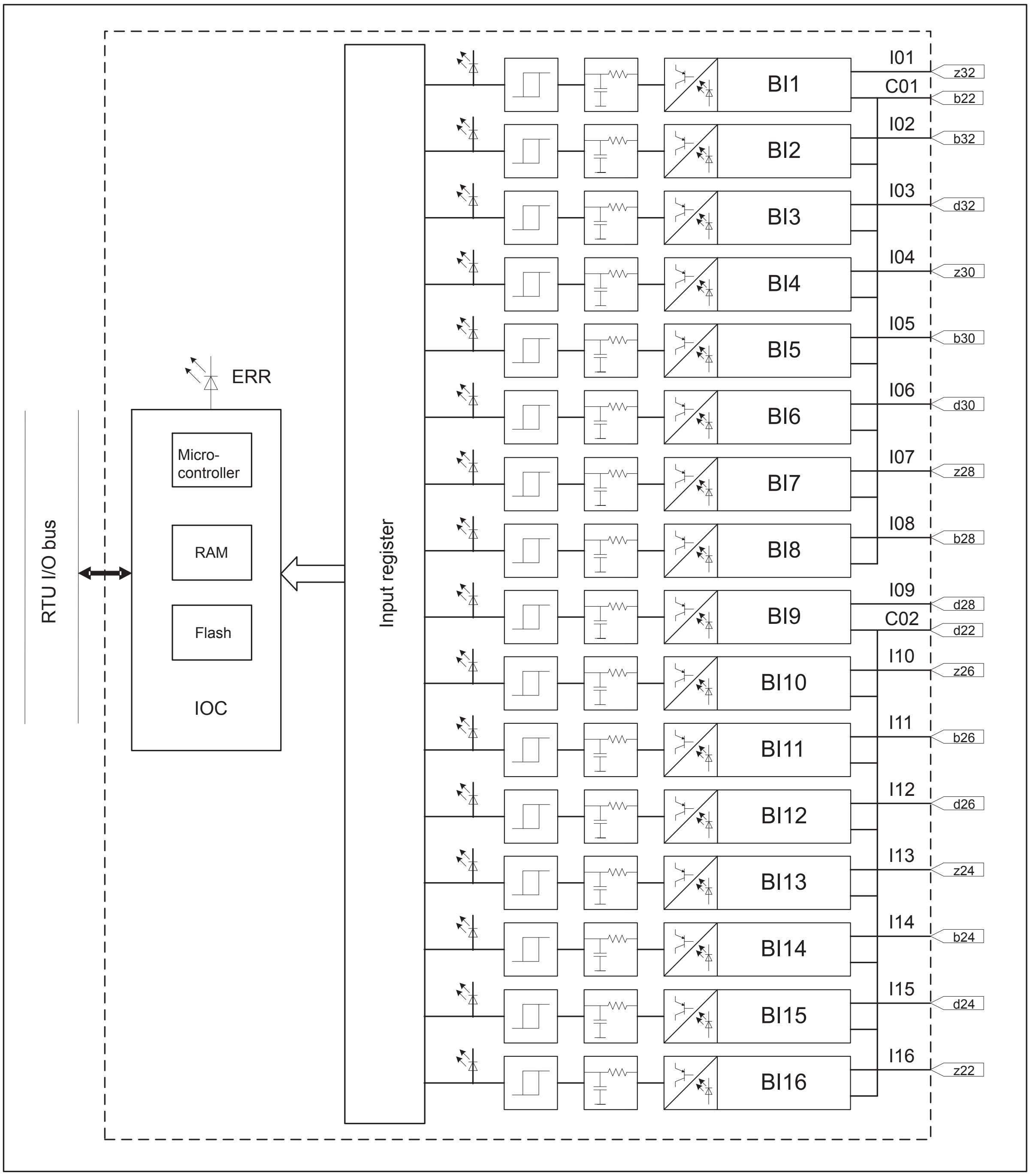


Figure 1: Logic block diagram with input circuit

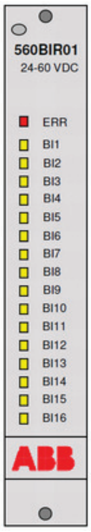


Figure 2: 560BIR01 R0001 Front plate

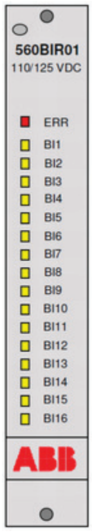


Figure 3: 560BIR01 R0002 Front plate

560MPR01 **560MPR03**	**560SFR02**			**Signal Identification**	
		Sub-connector		**Identification**	**Meaning**
1			z32	I01	Binary input 1 (+)
2		b32		I02	Binary input 2 (+)
3	d32			I03	Binary input 3 (+)
4			z30	I04	Binary input 4 (+)
5		b30		I05	Binary input 5 (+)
6	d30			I06	Binary input 6 (+)
7			z28	I07	Binary input 7 (+)
8		b28		I08	Binary input 8 (+)
9	d28			I09	Binary input 9 (+)
10			z26	I10	Binary input 10 (+)
11		b26		I11	Binary input 11 (+)
12	d26			I12	Binary input 12 (+)
13			z24	I13	Binary input 13 (+)
14		b24		I14	Binary input 14 (+)
15	d24			I15	Binary input 15 (+)
16			z22	I16	Binary input 16 (+)
17				A	not used
18		b22		C01	Connection return input channel 1 to 8 (-)
19	d22			C02	Connection return input channel 9 to 16 (-)
The pin configuration of 560SFR02 subrack corresponds to the pin configuration of the board connector					

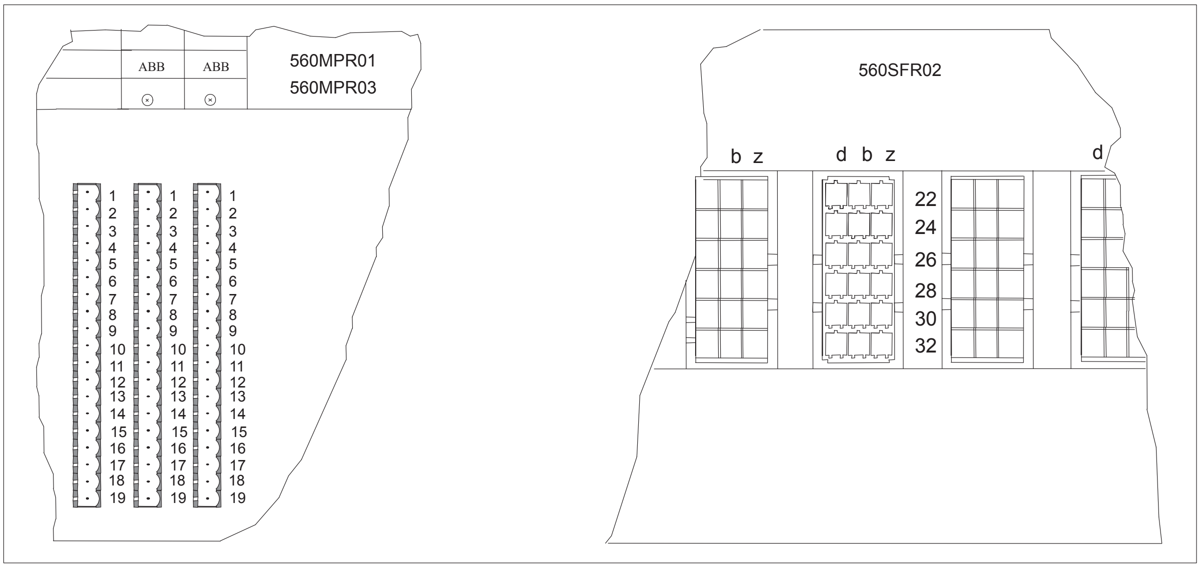


Figure 4: Placement of signal terminal connectors on subracks

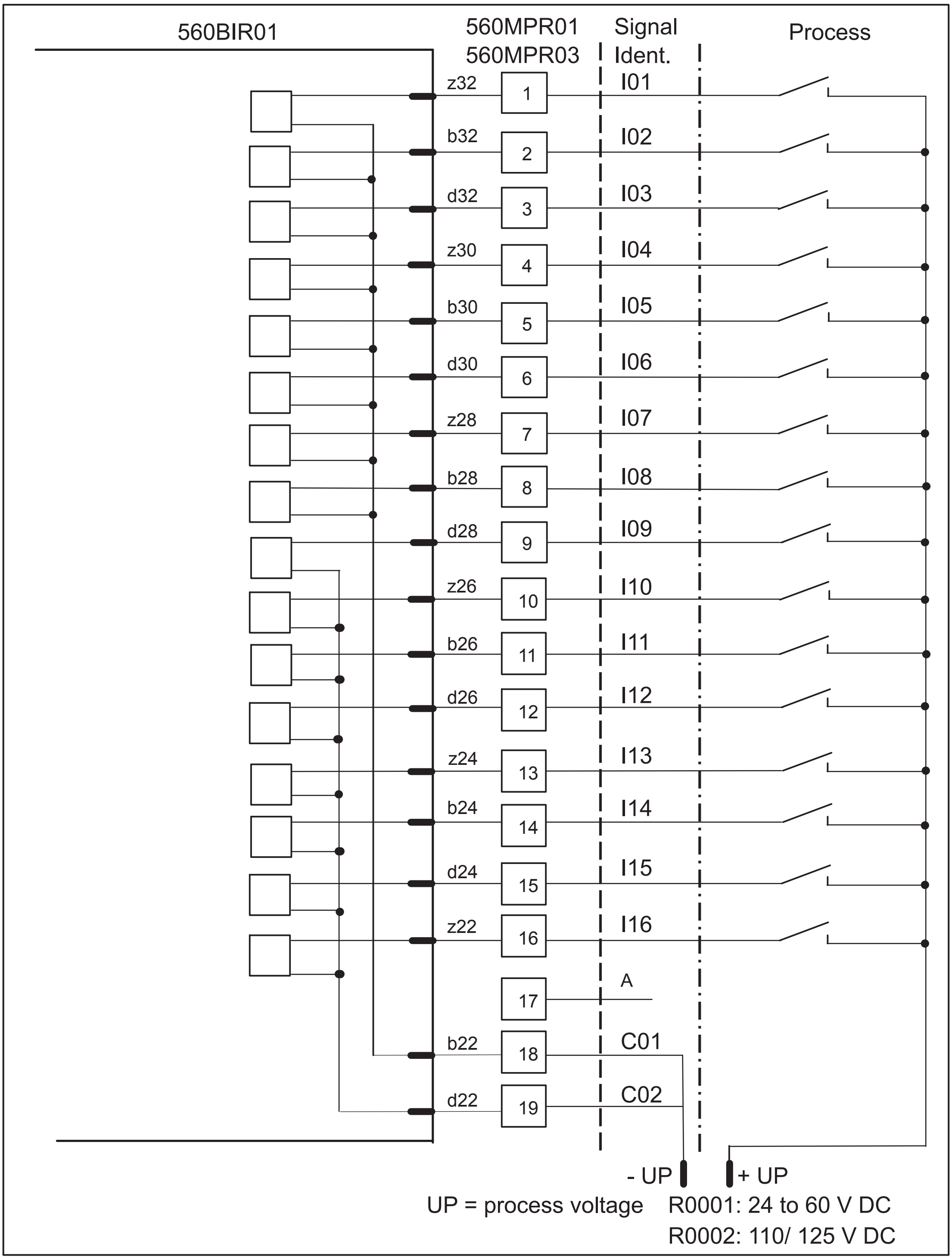


Figure 5: Process connection 560BIR01

—
ABB AG
Power Grids
P.O. Box 10 03 51
68128 Mannheim, Germany
Tel. +49 621 381-3000

www.abb.com/remote-terminal-units

1KGT 150 902 V003 1

Binary output 560BOR01
RTU560 product line

Application, characteristics and technical data have to be taken from the hardware data sheet:

560BOR01 Data sheet 1KGT 150 956

Operation

The 560BOR01 board has sixteen output relays. Two groups of eight contacts have the same common return. This allows to split the output channels only to two different process voltage sources.

ADVICE
This module requires RTU500 series Release 9 firmware or higher.

Processing function

The I/O micro controller (IOP Input- output processor) activates any output forced by the VAP of communication unit (CMU) by a command output request. The IOP controls the time duration of a pulse output by the loaded pulse length time value.

Output monitoring and supervision

Any output is checked and monitored by the IOP by different tests and supervision functions:
- The output pattern is read back before the output is activated.
- The 24 V DC from backplane bus to switch the output relays is supervised during an active output.
- The pulse duration is controlled by the IOP.
- Any detected error is indicated by LEDs.

One or two pole outputs

The figures "Fig. 2: Placement of signal terminal connectors on subracks" to Fig. 5: show the different principle wirings for one or two pole output channels.

See the 23BA23 Connections and settings for wiring if (1 out of n) check is requested.

⚠ WARNING
23BA23: The maximum process voltage is 60 V DC!

Settings

There are no settings required and possible on the 560BOR01 board.

Signalling

The board monitors and checks its functionality as well as the dialog via the peripheral bus. Detected errors are indicated and/or transmitted by the board:
- by the red LED ERR on the front plate
- by diagnostic messages

LED ERR

The LED ERR indicates board errors or peripheral bus errors.

The LED ERR indicates:
- board runs initialization procedure
- board is doing a cold- or warm start
- board has detected a memory error (RAM or EPROM)
- micro controller faulty
- no dialog via the peripheral bus for at least 2 minutes. The board is not polled by the PBP of CMU.

LED CMD

At least one output relay is switched on. The LED CMD is direct connected to the 24 V DC. The LED CMD is ON for the time an output is active (pulse or persistent).

Safety instructions

Cover all free slots

⚠ DANGER
Cover all free slots within racks with process voltages > 60 V DC with front plates to ensure that live circuits can't be touched.

Group devices in rack

ADVICE
Group devices with same process voltages within a rack.

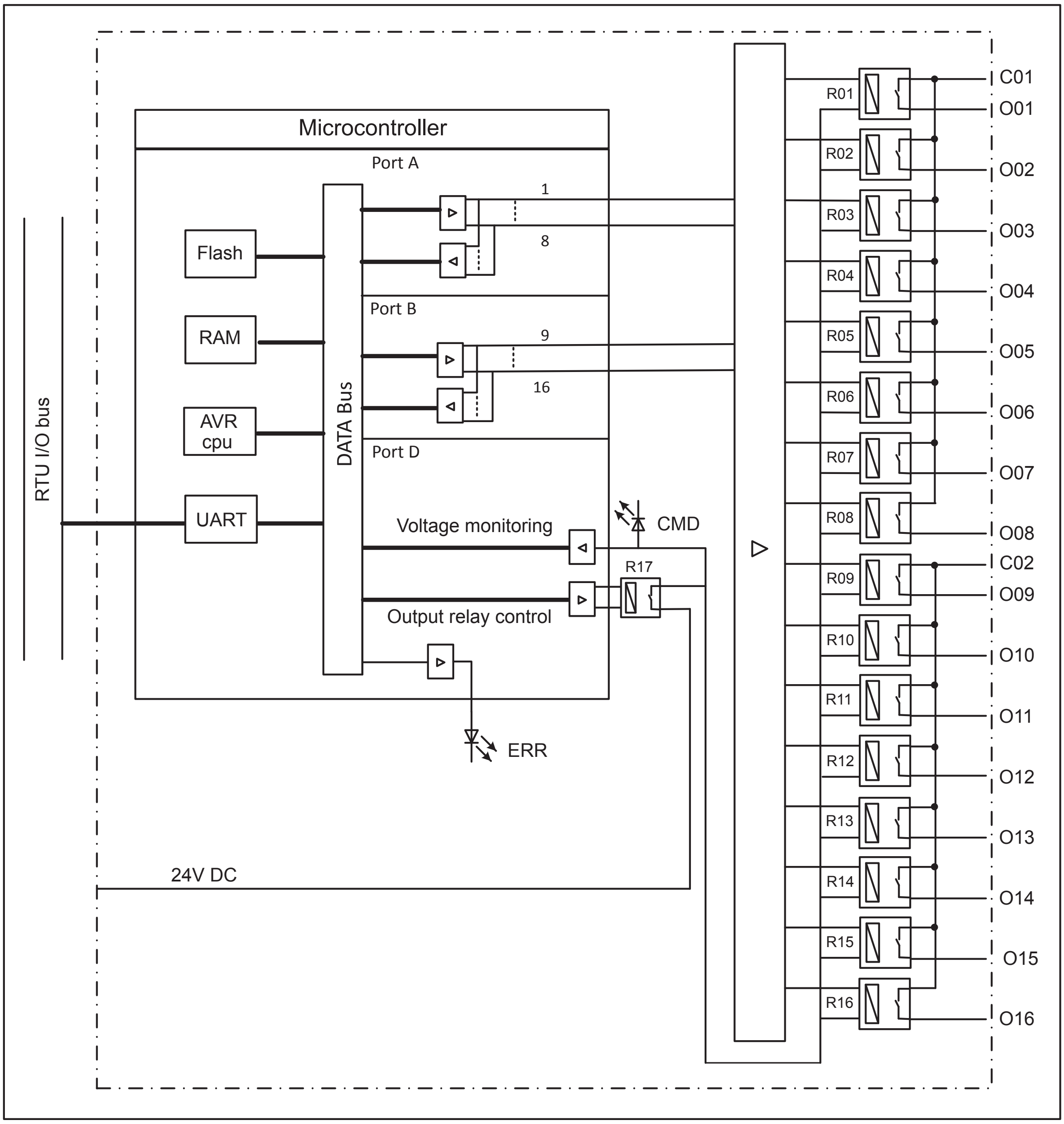


Figure 1: Logic block diagram

560MPR03	560SFR02	Signal Identification	
	Sub-connector	Identification	Meaning
1	z32	O01	Binary output 1 (+)
2	b32	O02	Binary output 2 (+)
3	d32	O03	Binary output 3 (+)
4	z30	O04	Binary output 4 (+)
5	b30	O05	Binary output 5 (+)
6	d30	O06	Binary output 6 (+)
7	z28	O07	Binary output 7 (+)
8	b28	O08	Binary output 8 (+)
9	d28	O09	Binary output 9 (+)
10	z26	O10	Binary output 10 (+)
11	b26	O11	Binary output 11 (+)
12	d26	O12	Binary output 12 (+)
13	z24	O13	Binary output 13 (+)
14	b24	O14	Binary output 14 (+)
15	d24	O15	Binary output 15 (+)
16	z22	O16	Binary output 16 (+)
17		O17	not used
18	b22	C01	Connection return input channel 1 to 8 (-)
19	d22	C02	Connection return input channel 9 to 16 (-)
The pin configuration of 560SFR02 subrack corresponds to the pin configuration of the board connector			

Table 1: Subrack terminal connection: 560BOR01

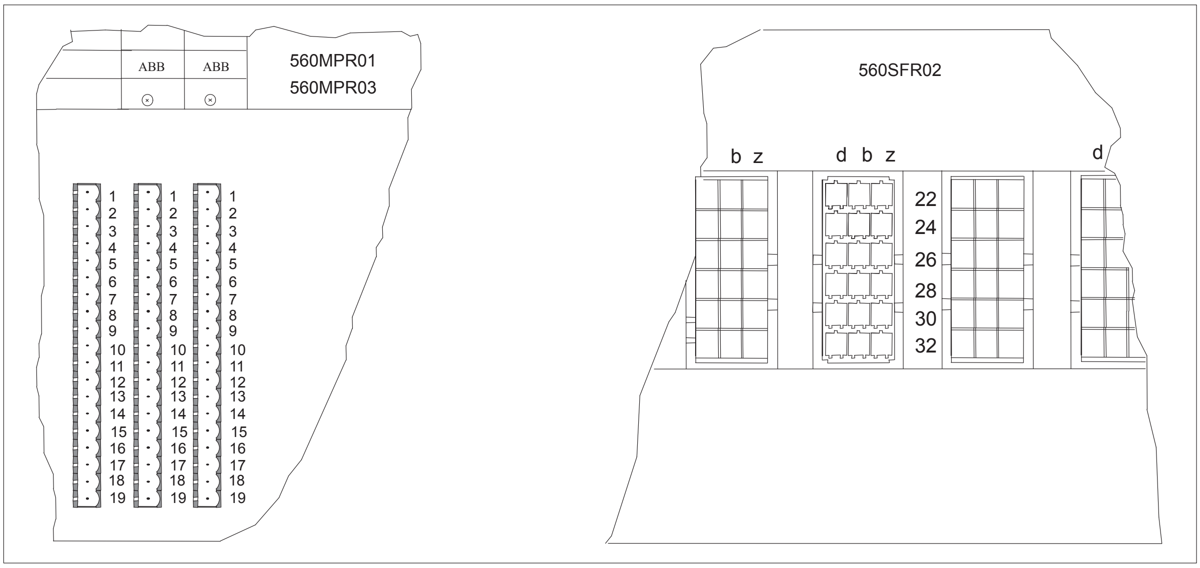


Figure 2: Placement of signal terminal connectors on subracks

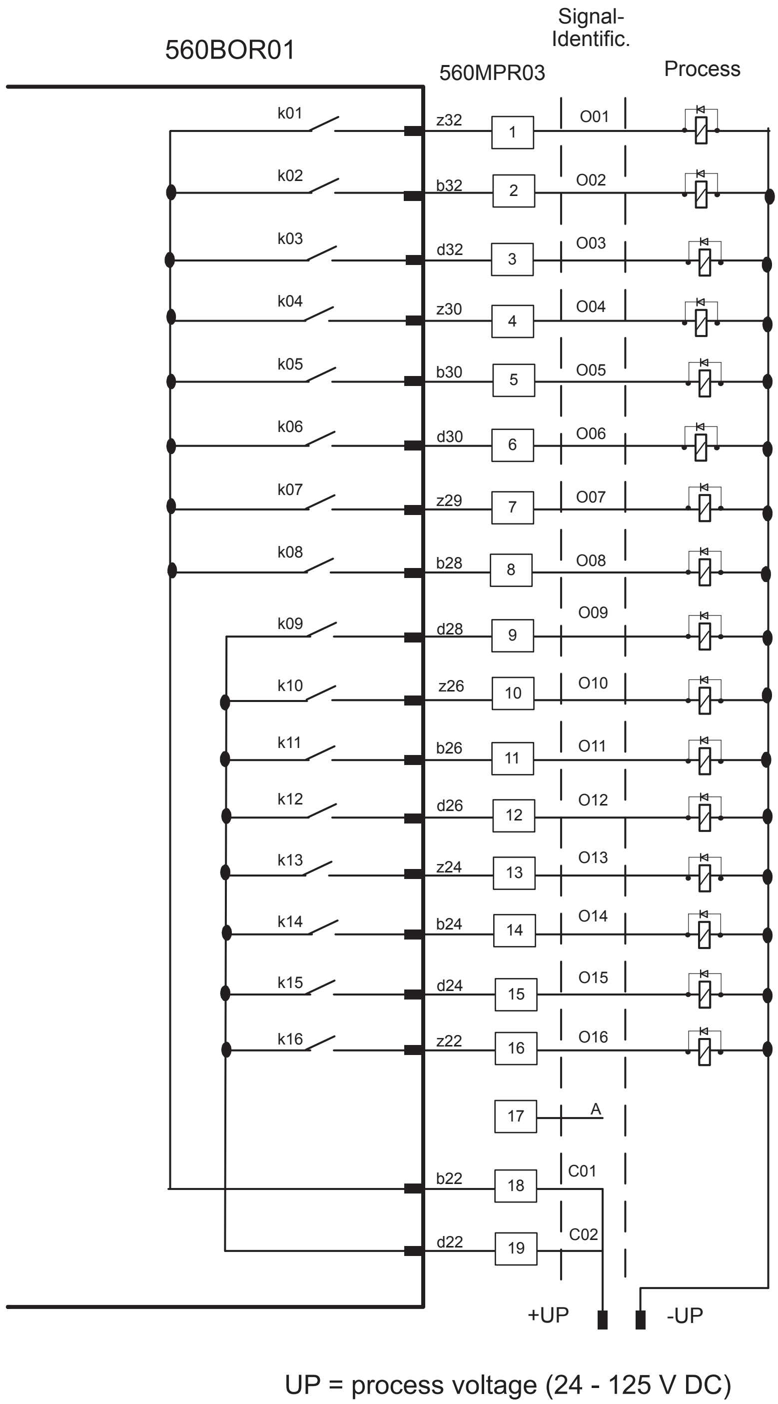


Figure 3: Binary output 1 pole - same process voltage circuit on both output groups

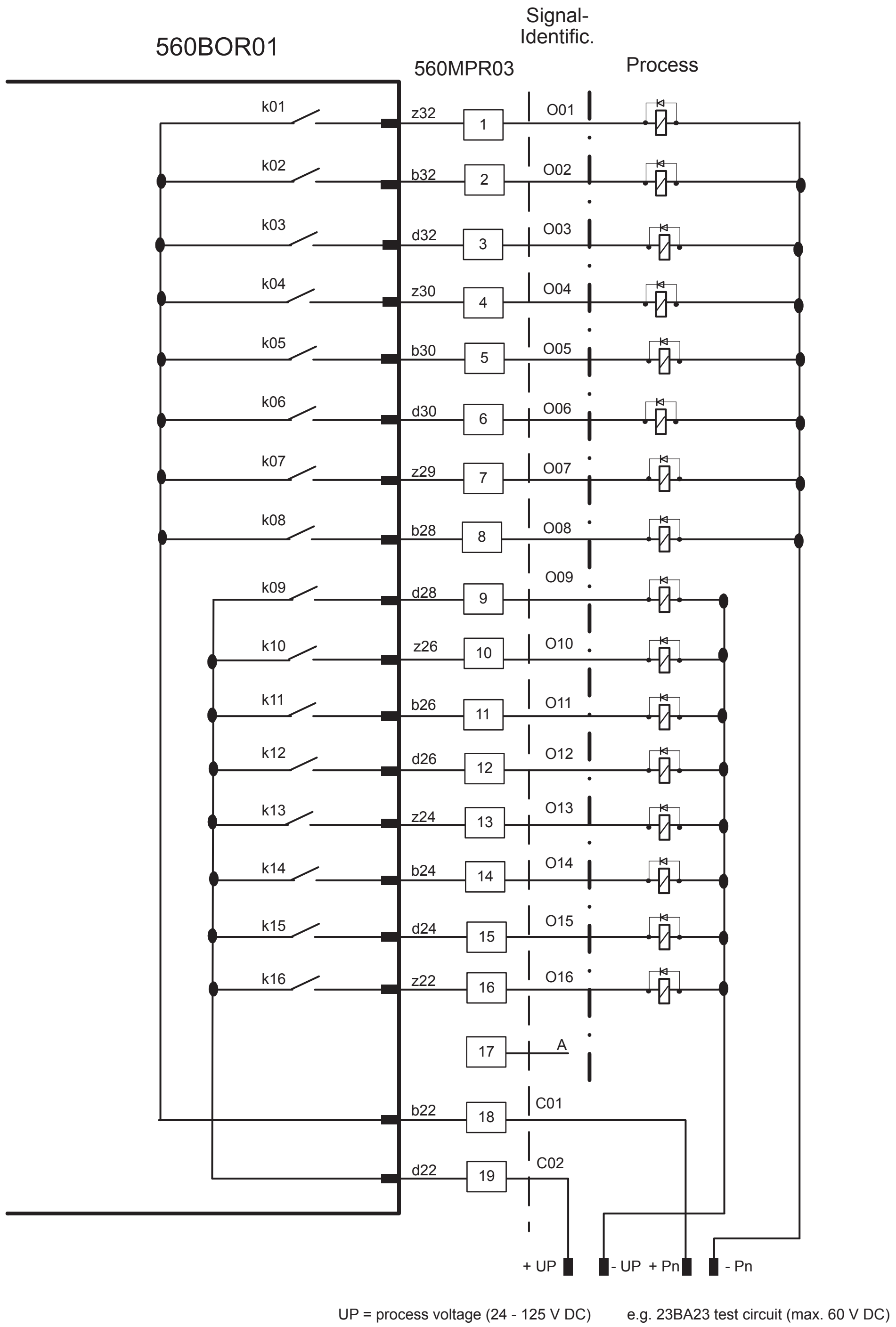


Figure 4: Binary output 1 pole - different process voltage sources on k 01 - k 08 and k 09 - k 16

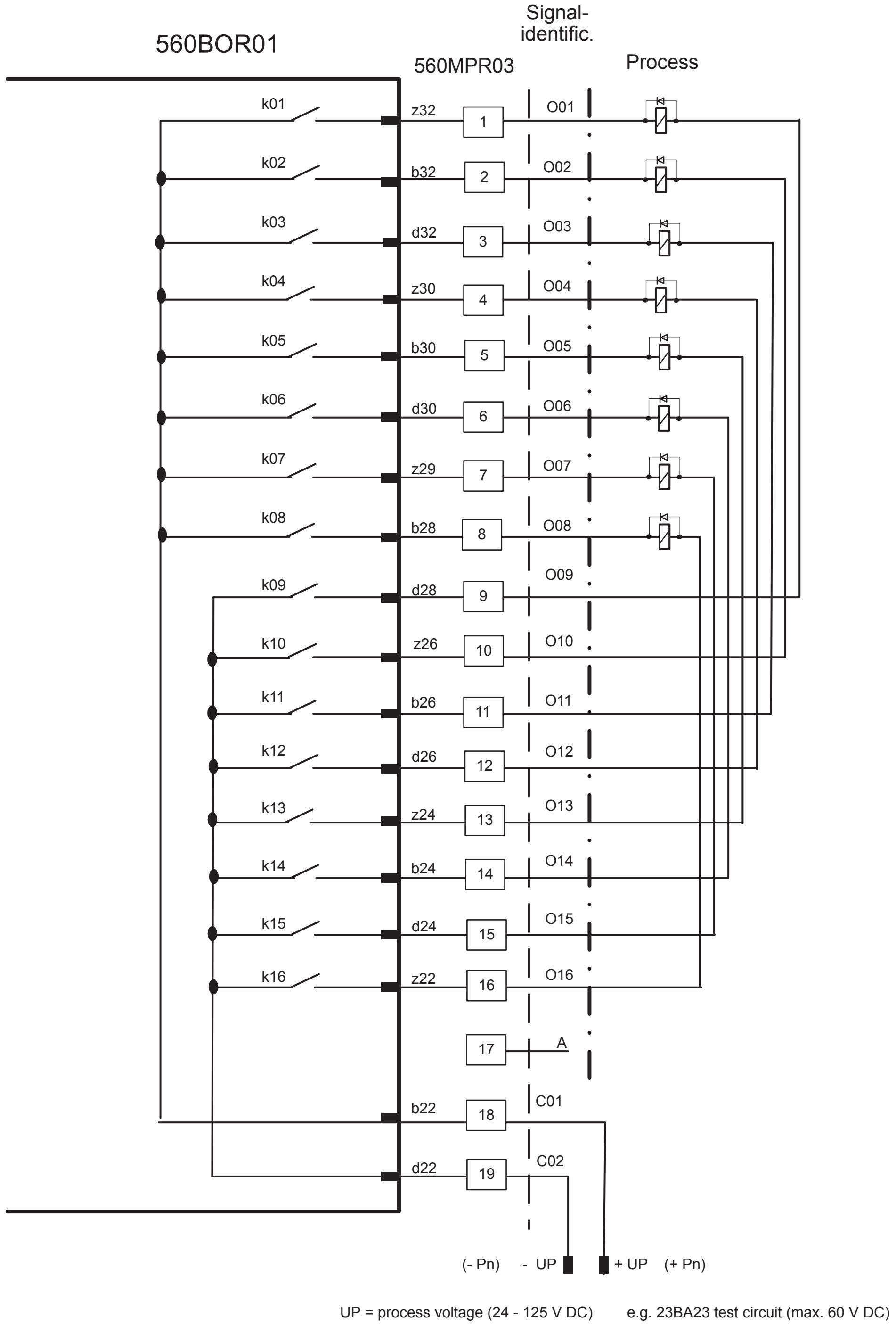


Figure 5: Binary output 2 pole - either direct or by 1 out of n check

ABB AG
Power Grids
P.O. Box 10 03 51
68128 Mannheim, Germany
Tel. +49 621 381-3000

www.abb.com/remote-terminal-units

1KGT 150 957 V004 1

RTU560

Remote Terminal Unit

Connections and Settings
Analog Output 23AA21

Application, characteristics and technical data have to be taken from the hardware data sheet:

23AA21 R0001 1 KGT 150 673

Operation

The 23AA21 board has two galvanic isolated analog output channels. Each of them can be configured individually to one of the following output currents:

- -2.5 mA...0...+2.5 mA
- -5 mA..... 0...+5 mA
- -10 mA... 0...+10 mA
- -20 mA... 0...+20 mA
- 4 mA ....+ 20 mA

Unipolar or Live-Zero value output definitions have to be specified by an RTU560 function parameter.

Processing function

The I/O microcontroller (EAP = Ein- Ausgabe-Prozessor/Input- output processor) controls the two digital to analog converters. It converts the received output value from the CMU (CMU = communication unit) into the D/A format and forces an output conversion. The output value keeps stable until a new value is received.

The output value is zero after a power up, cold start or warm start of the 23AA21.

The last output value keeps set if the ST-LED is ON after normal operation.

Live-Zero/Unipolar output

Defined by the output type parameter of the setpoint message or general output message.

The EAP calculates the output value to the Live-Zero definition:

- 0 % = 4 mA
- 100 % = 20 mA

The output channel becomes a Live-Zero channel after it is parameterized by the CMU. Until that time the output is bipolar by default.

Power supply requirements

The 23AA21 board consumes up to 650 mA on +5 V DC (Vcc) of the rack power supply unit. The total load in the rack has to be regarded.

Settings

The jumper settings for channel 1 and channel 2 are described in table 1 and table 2.

Signalling

The board monitors and checks its functionality as well as the dialog via the peripheral bus (PBP). Detected errors are indicated and/or transmitted by the board:

- by the red LED ”ST” on the front plate
- by diagnostic messages

The ”ST” LED indicates board errors or peripheral bus errors.

The ”ST” -LED indicates:

- board runs initialization procedure
- board is doing a cold- or warm start
- board has detected a memory error (RAM or EPROM)
- micro controller faulty
- no dialog via the peripheral bus for at least 2 minutes. The board is not polled by the PBP of the CMU..

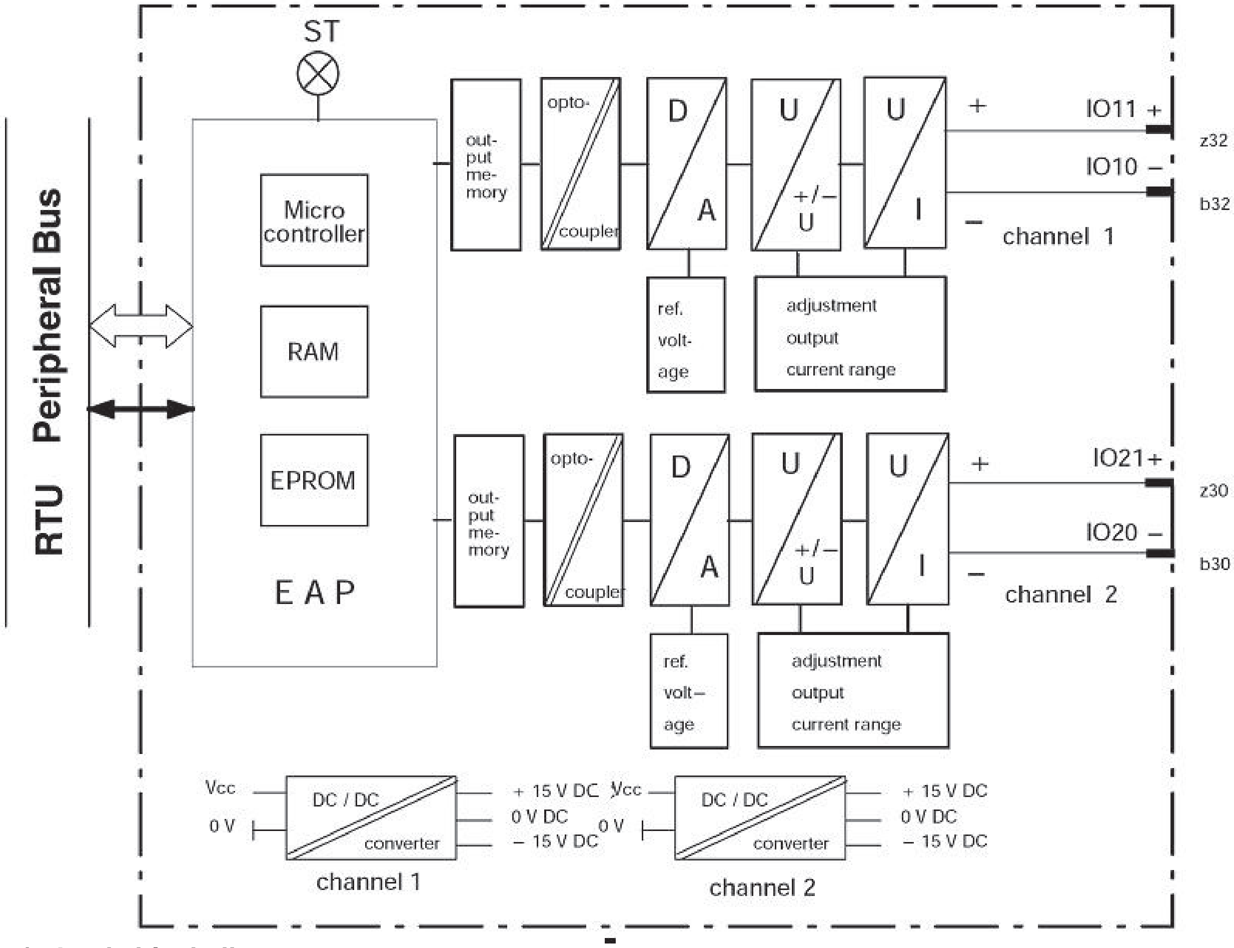


Fig. 1: Logic block diagram

Channel 1 jumper Configuration

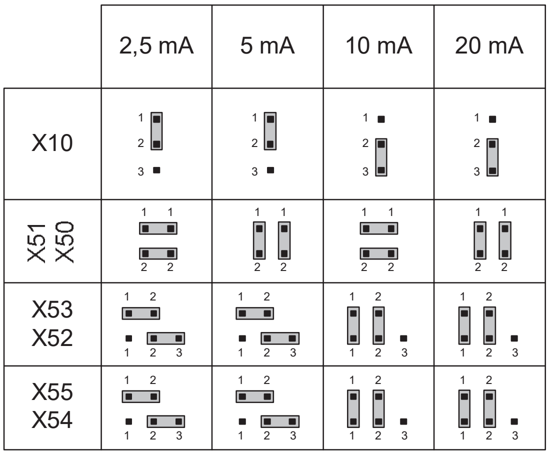


Table 1: Channel 1 jumpers

Channel 2 jumper Configuration

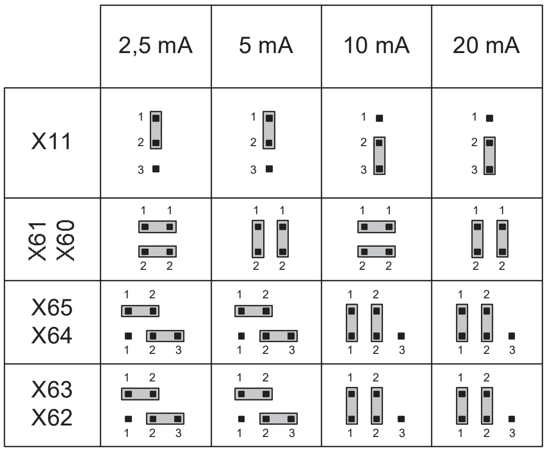


Table 2: Channel 2 jumpers

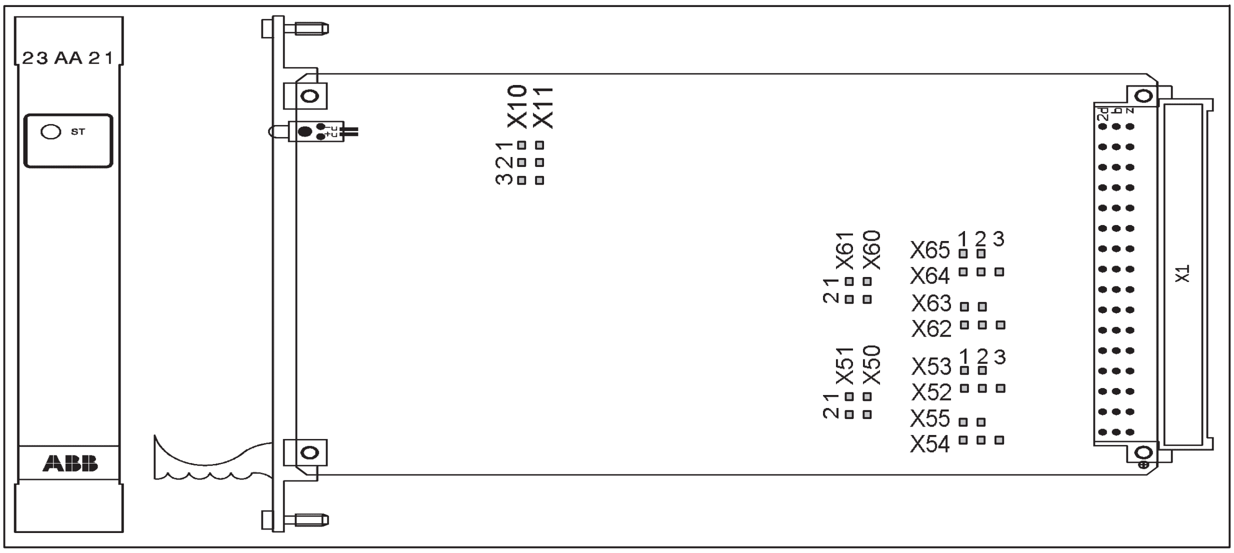


Fig. 2: Board layout with setting positions

23TP22 560MPR01 560MPR03	23ET24, 560SFR02 Sub Connector			Signal		Remark
				Identification	Meaning	
1			z32	IO11+	Output channel 1 +	
2		b32		IO10-	Output channel 1 -	
3	d32					
4			z30	IO21+	Output channel 2 +	
5		b30		IO20-	Output channel 2 -	
6	d30					
7			z28			
8		b28				
9	d28					
10			z26			
11		b26				
12	d26					
13			z24			
14		b24				
15	d24					
16			z22			
17	<Not used>					
18		b22				
19	d22					
The pin configuration of the racks 23ET24/560SFR02 corresponds to the pins of the onboard connector						

Fig. 3: Rack terminal connection: 23AA21

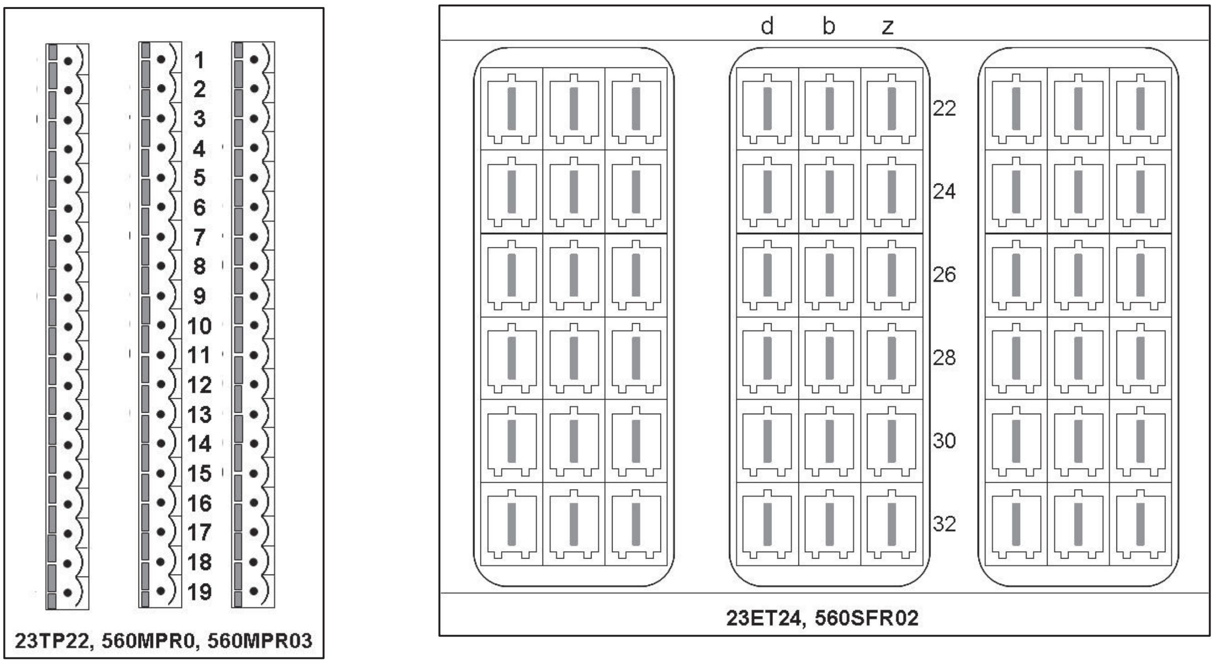


Fig. 4: Placement of signal terminal connectors on racks

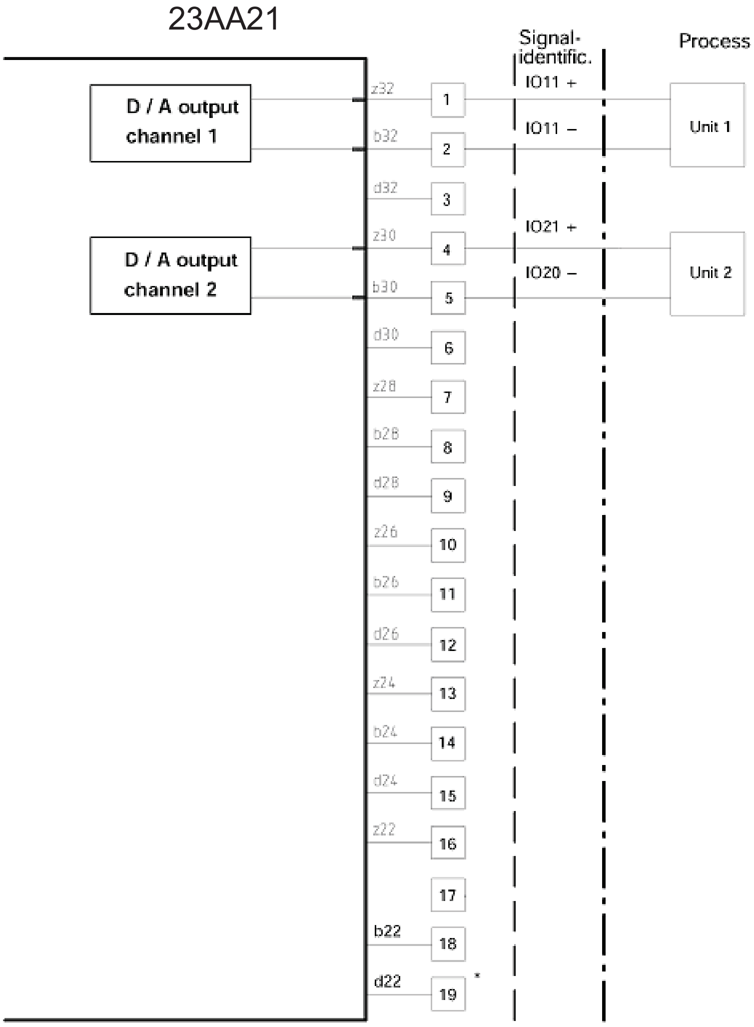


Fig. 5: Connection diagram 23TP22/560MPR01/560MPR03 rack

ABB AG
Power Grids Division
P.O. Box 10 03 51
68128 Mannheim, Germany
Telefon: +49 (0) 621 381-3000
Fax: +49 (0) 621 381-7602
E-Mail: rtu-sales-support@de.abb.com

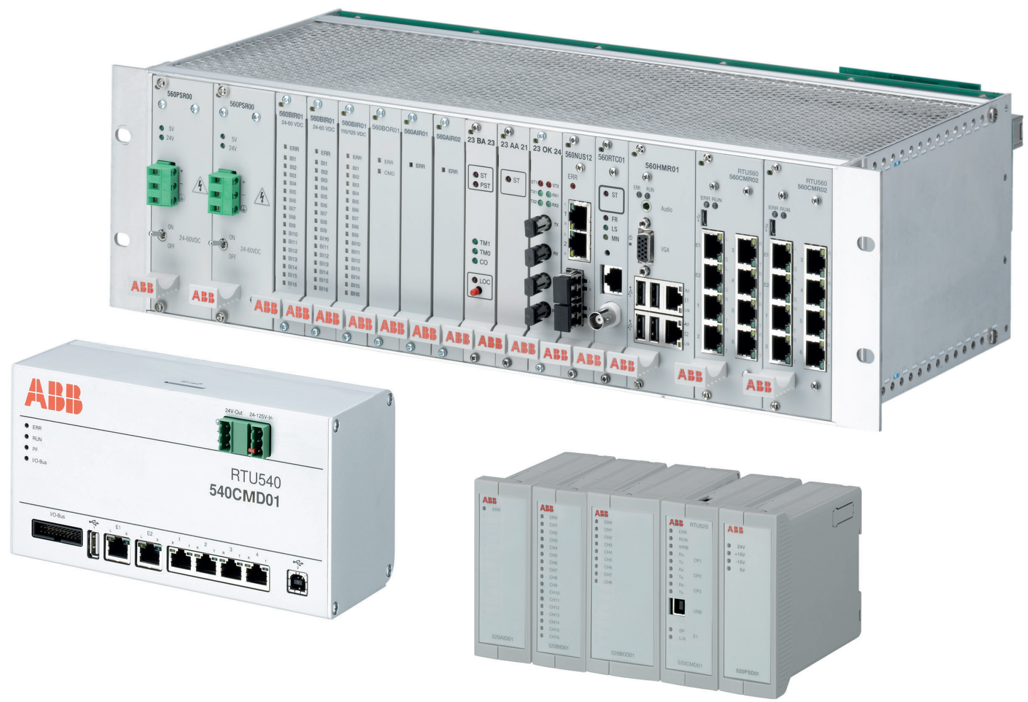
abb.com/remote-terminal-units

DEABB174612 EN printed in Germany

PRODUCT CATALOG

Remote Terminal Units

RTU500 Series



Note:
We reserve the right to make technical changes or modify the contents of this document without prior notice. With regard to purchase orders, the agreed particulars shall prevail. ABB AG does not accept any responsibility whatsoever for potential errors or possible lack of information in this document.

Table of contents

002 Introduction

003–005 RTU500 series – Intellligence distributed across your power grid

006–029 Product line RTU560

030–033 Product line RTU540

034–042 Product line RTU520

044–057 Product line RTU500

058–063 RTU500 series functions and software

Remote Terminal Units
Introduction

Dear Madam and Sir,

this catalog will give you an overview of our Remote Terminal Units (RTU) product portfolio - the RTU500 series. The products are divided into the product lines RTU560 (rack), RTU540 (DIN rail), RTU520 (DIN rail) and RTU500 series modules. Complementing the RTU500 series functions and software are adjustable to the respective product lines and requirements.The catalog will inform you about each single module and its additional material.

With more than 100,000 installed RTUs at around 2,000 customers in more than 100 countries, ABB is among the world market leader for RTU applications.

ABB has been working successfully in the area of remote control applications for more than 40 years and offers the security of a strong and experienced partner. Worldwide presence with local partners in almost all regions allows quick access to service and support.

For more information please ask your local sales and service contact or visit us at **www.abb.com/remote-terminal-units**.

Yours sincerely,

Helmut Weber	**Sigbert Reimann**	**Thorsten Platz**
Global product line manager RTU	Global product manager RTU	Global sales manager RTU

Заличено по чл. 36а, ал.3 от ЗОП

Remote Terminal Units
RTU500 series – Intellligence distributed across your power grid

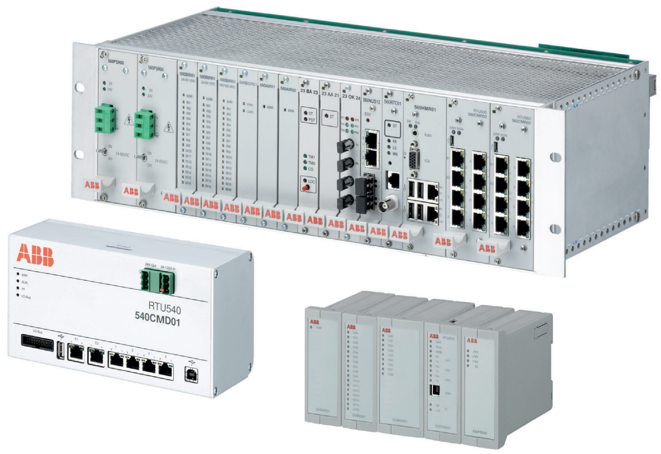
Your benefits at a glance

4 **Intellligence distributed across your power grid**

5 **RTU service and support**

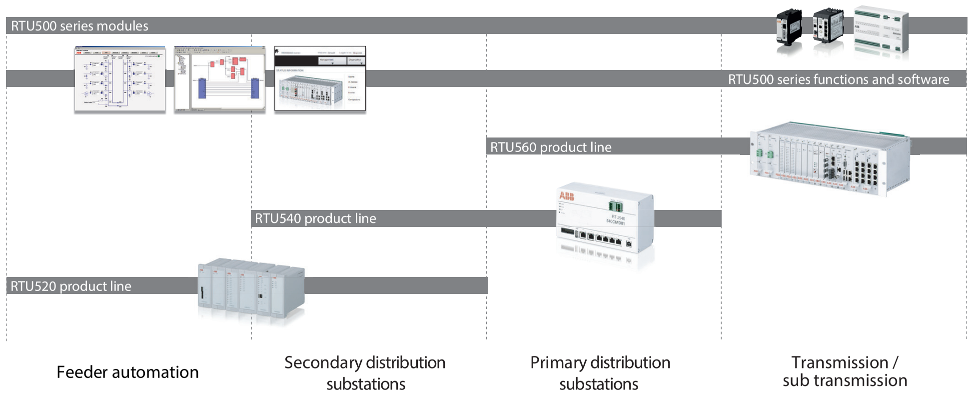
5 **Product life cycle management**

Remote Terminal Units
Your benefits at a glance



Intelligence distributed across your power grid
The RTU500 series is suitable for the future requirements of the automation market. It offers a future proofed and reliable series of products.
Our RTU500 series brings the information from the physical power grid to your SCADA system. The modular Remote Terminal Units (RTU) are designed to meet your needs in transmission and distribution automation, enabling you to have the most efficient solution for your requirements. As with many of ABB's products - our RTUs have been designed from the ground up with strong and resilient cyber security enabling you to communicate securely via all forms of networks - offering peace-of-mind and confidence in your network. Functional and hardware extensions can be realized easily and the complete series can be quickly engineered to your needs using our proven software tool enabling greater flexibility and cost savings in training.

Remote Terminal Units
Intelligence distributed across your power grid

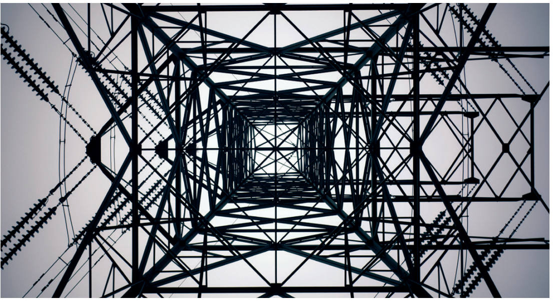


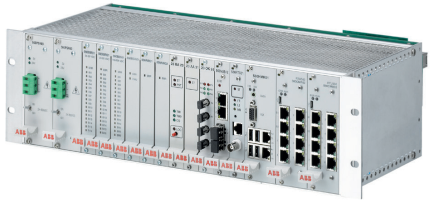
RTU Service and support
Professional service and support over the complete product lifecycle have always been of great interest within ABB. The high quality of technical support also adds to the track record of RTUs, ensuring optimized and reliable system operations. Product support of RTU specialists worldwide and support with engineering and programming provide you effective and reliable solutions.

Product life cycle management
Through the extensive product lifecycle policy ABB has a long standing commitment to protect its customers' investments in ABB products and technologies.
To protect your investments over a long time, existing installations can be ugraded to modern RTUs with only little effort. The available migration kits and ABB's extensive knowledge makes it very easy to exchange your installed base in just a few steps.

Remote Terminal Units

RTU560 product line – Superior scalability for grid automation and control





Substation automation product for transmission and sub-transmission. RTU560 represents high-end network interfacing - offering maximum flexibility with the highest number of supported protocols for sub and host communications.
Designed to handle the highly complex systems in grid automation and control interfacing. RTU560 connects to all kinds of IEDs, parallel I/Os, serial connected and communication via IEC 68150. All this real time data can then be transmitted to your central SCADA systems for critical actions - protecting your primary equipment from overloading of the grid. Optimize your investments with our long life cycle policy and benefit from our agile migration concepts.

Your benefits
- Adaptability to changing conditions in your network
- Secure flexibility with our modular platform that allows hot swap depending on your requirements
- Precise data handling gives you peace-of-mind
- Superior performance with up to 16 CMUs enables mass data handling
- IT security according to the latest standard, including usability and critical infrastructure, BDEW conformance and support of the certificate process
- Experience of more than 40 years in substation automation make RTU560 a secure investment for you
- Our agile migration concept saves your money and time

Application examples
In complex network environments you are challenged by a large amount of data. Our RTU560 is the perfect solution for various applications for automation and control.
- The migration solution allows you to retrofit your secondary equipment with reduced investment.
- The combination of parallel wired I/Os, serial links and IEC 61850 is efficiently feasable with our RTU560 allowing you to work with infrastructures from different generations
- Our flexible redundancy concepts provide high availability where you need it

Application Areas
Transmission network substations
- Automation of transmission substation
- Digital substation
- Migration
- Electrical distribution network, primary substation
- Automation of primary substation
- Transformer automation and control

Remote Terminal Units

RTU560 product line – Superior scalability for grid automation and control

RTU560 Communication units

560CMR01 P. 9	**560CMR02** P. 10	**560HMR01** P. 10

RTU560 Power supply units

560PSR00 P. 11	**560PSU01** P. 11	**560PSU02** P. 12

RTU560 Input/output modules

560BIR01 P. 13	**560BOR01** P. 14	**23BA23** P. 15	**560AIR01** P. 15	**560AIR02** P. 16	**23AA21** P. 16	**23BE50** P. 17	**23BA40** P. 17	**23BE40** p. 18

RTU560 Racks

560MPR01 P. 19	**560MPR03** P. 20	**560SFR02** P. 21

RTU560 Serial Communication

23OK24 P. 23	**23WT23** P. 23	**23WT24** P. 24	**23WT25** P. 25

RTU560 Ethernet communication

560NUS04 P. 26	**560NUS12** P. 26	**560NMS24** P. 27	**560NMS34** P. 27

Remote Terminal Units
RTU560 product line – Superior scalability for grid automation and control

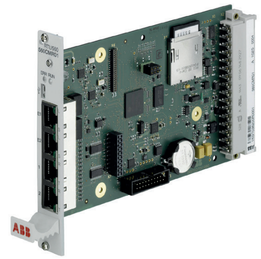
RTU560 Real time clocks

560RCR01
P. 28

560RTC02
P. 28

Remote Terminal Units
RTU560 product line – Communication units

—
560CMR01
1KGT036200R0001



Description
Communication module of the RTU560 with 32 bit CPU
- 2x serial communication interface (RS-232 or RS-485) for remote communication
- 2x Ethernet interface (10/100BaseT)
- 1x USB port
- 1x serial peripheral bus
- battery buffered real time clock

Licences for protocol, functions and SD card are not included.

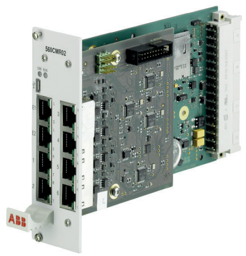
560CMR01 - Communication unit (CMU) for RTU560, 2 serial ports, 2 Ethernet ports

Application
The 560CMR01 communication unit is one of the CMU modules of the RTU560 product line.
The essential tasks are:
- Managing and controlling of the I/O modules via the interface to the serial I/O bus.
- Reading Process events from the input modules.
- Send commands to the output modules.
- Communicating with control systems and local HMI systems via the serial interfaces (RS232) and the Ethernet 10/100BaseT interfaces.
- Communication with Sub-RTU's, IED's or multimeter devices via the interfaces (RS485) and the Ethernet interfaces.
- Managing the time base for the RTU560 product line station and synchronizing the I/O modules.
- Handling the dialog between RTU560 product line and Web-Browser via the LAN interfaces.

Within the RTU560 racks the board occupies .
The communication unit is able to handle Ethernet- and UART-character based communication protocols.
The unit has a battery buffered real time clock (RTC).

Remote Terminal Units
RTU560 product line – Ethernet communication

—
560CMR02
1KGT036300R0001



Description
Communication module of the RTU560 with 32 bit CPU
- 6x serial communication interface (RS-232 or RS-485) for remote communication
- 2x Ethernet interface (10/100BaseT)
- 1x USB port
- 1x serial peripheral bus
- battery buffered real time clock

Licences for protocol, functions and SD card are not included.

560CMR02 - Communication unit (CMU) for RTU560, 6 serial ports, 2 Ethernet ports

Application
The 560CMR02 communication unit is one of the CMU modules of the RTU560 product line.
The essential tasks are:
- Managing and controlling of the I/O modules via the interface to the serial I/O bus.
- Reading Process events from the input modules.
- Send commands to the output modules.
- Communicating with control systems and local HMI systems via the serial interfaces (RS232) and the Ethernet 10/100BaseT interfaces.
- Communication with Sub-RTU's, IED's or multimeter devices via the interfaces (RS485) and the Ethernet interfaces.
- Managing the time base for the RTU560 product line station and synchronizing the I/O modules.
- Handling the dialog between RTU560 product line and Web-Browser via the LAN interfaces.

Within the RTU560 racks the board occupies two slots. The communication unit is able to handle Ethernet- and UART-character based communication protocols. The unit has a battery buffered real time clock (RTC).

—
560HMR01
1KGT030100R0001

Description
Interface board to RTU500 integrated web HMI
- Windows Embedded Standard 7 (english, 32 bit)
- 2x Ethernet interface (10/100BaseT)
- 4x USB port (for keyboard and mouse)
- 1x VGA port (for monitor)
- 1x stereo audio-out
- Windows 7 recovery DVD

560HMR01 - Human machine interface (HMI) for RTU560, 2 Ethernet ports, 4 USB ports, VGA, audio

Application
The 560HMR01 is a rack based human machine interface module of the RTU560 system.
The essential tasks of the 560HMR01 are:
- Interface to RTUs that are running Web server and RTU500 series Integrated HMI. It communicates via Ethernet LAN interfaces and provides interfaces to connect a local monitor, mouse and keyboard
- Runs Windows based operating system for RTU500 series Integrated HMI

The 560HMR01 takes two slots of the module rack. The connection from the 560HMR01 to the 19" rack is done via a DIN 41612 F-connector.
The unit is available in 2 versions:
- R0001: Interface module to RTU500 integrated web HMI
- R0002: Interface module to RTU500 bundled with SDM600 Software

Remote Terminal Units
RTU560 product line – Power supply units

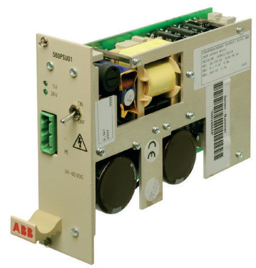
—
560PSR00
1KGT026500R0001

Description
Power supply unit for RTU560 racks
- Input voltage 24...60 V DC
- Output voltage: 5 and 24 V DC
- Suitable for redundant power supply in 560MPR03/560SFR02

560PSR00 - Power supply unit for RTU560, 24 ... 60 V DC, 44.3 W

Application
The power supply unit 560PSR00 generates the two supply voltages (5 V DC and 24 V DC) for the RTU560 subracks 560MPR03 and 560SFR02. The output power is sufficient to supply a subrack with up to 4 communication units (CMU).
It is possible to configure redundant power supplies for project configurations with higher requirements to availability. In this configuration two power supply units 560PSR00 are operating in parallel mode. They are able to take over the full load, if one power supply fails. Only power supplies of the same type and rubric should be used for redundant operation.
The power supply unit 560PSR00 is available in the following version (rubric):
- R0001 Input range 24 ... 60 V DC (-20%... +15%)

—
560PSU01
1KGT006600R0002



Description
Power supply unit for RTU560 racks
- Input voltage 110...220 V DC
- Output voltage: 5 and 24 V DC
- Suitable for redundant power supply in 560MPR03/560SFR02

560PSU01 - Power supply unit for RTU560, 110 ... 220 V DC, 44.3 W

Application
The power supply unit 560PSU01 generates the two supply voltages (5 V DC and 24 V DC) for the RTU560 subracks 560MPR03 and 560SFR02. The output power is sufficient to supply a subrack with up to 4 communication units (CMU).
It is possible to configure redundant power supplies for project configurations with higher requirements to availability. In this configuration two power supply units 560PSU01 are operating in parallel mode. They are able to take over the full load, if one power supply fails.
The power supply unit 560PSU01 is available in the following version (rubric):
- R0002 Input range 110 ... 220 V DC (-20%... +15%)

Remote Terminal Units
RTU560 product line – Power supply units

—
560PSU02
1KGT011900R0001

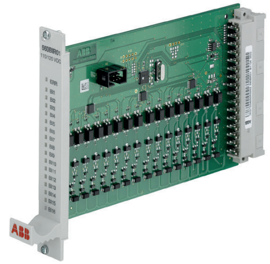
Description
Power supply unit for RTU560 racks
- Input voltage: 48...220 V DC
- Output voltage: 5 and 24 V DC
- Suitable for redundant power supply in 560MPR03/560SFR02

560PSU02 - Power supply unit for RTU560, 48 … 220 V DC, 85 W

Application
The power supply unit 560PSU02 generates the two supply voltages (5 V DC and 24 V DC) for the RTU560 communication units (CMU) within the rack. The output power is sufficient to supply a subrack with up to 8 communication units (CMU).
It is possible to configure redundant power supplies for project configurations with higher requirements to availability. In this configuration two power supply units 560PSU02 are operating in parallel mode. They are able to take over the full load, if one power supply fails.
The power supply unit 560PSU02 is available in the following version (rubric):
- R0001 Input range 48 … 220 V DC (-20%... +15%)

Remote Terminal Units
RTU560 product line – Input/output modules

—
560BIR01
1KGT034000R0001
1KGT034000R0002



Description
To be used for single indications, double indications, digital measurands and pulse counters.
- Resolution: 1 ms
- Process voltage: 24...60 V DC and 110...125 V DC
- LED signal for each input

560BIR01 - Binary input, 16 channels, LED‘s

Application
The module 560BIR01 provides 16 galvanic isolated inputs for up to 16 binary process signals. Scanning and processing of the inputs are executed with the high time resolution of 1 ms. The allocation of an input signal to the processing functions can be done according to the rules of configuration.
The module 560BIR01 is able to process the following types of signals or a combination of them:
- 16 single point information with time stamp (SPI)
- 8 double point information with time stamp (DPI)
- 2 digital measured values each with 8 bit (DMI8)
- 1 digital measured value with 16 bit (DMI16)
- 16 integrated totals (max. 120 Hz) (ITI)
- 2 step position information each with 8 bit (STI)
- 2 bitstring input each with 8 bit (BSI8)
- 1 bitstring input with 16 bit (BSI16)
- or combinations of this signal types
- LED signaling for each input, common return per 8 inputs.

The module is available in two versions (rubrics):
- 560BIR01 R0001: process voltage 24 to 60 V DC.
- 560BIR01 R0002: process voltage 110 to 125 V DC.

Remote Terminal Units
RTU560 product line – Input/output modules

—
560BOR01
1KGT036800R0002

Description
- 16 output contacts configured as
- 1-pole command
- 2-pole command
- 1.5-pole command in configuration with 23BA23
- Operating voltage 24...125 V DC, 60 W
- Imax: 2 A <= 30 V DC (ohmic load)

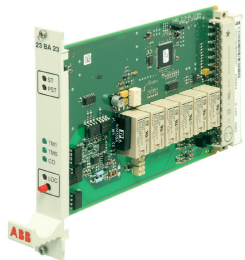
560BOR01 - Binary output, 16 channels, LED's

Application
The module 560BOR01 can be used for the control of 16 binary process signals using relay contacts. The allocation of an output signal to the processing functions can be done according to the rules of configuration.
The module 560BOR01 is able to process the following types of signals:
- Single or double commands (SCO or DCO) with 1 or 2 pole output without (1 out of n) check
- Single or double commands (SCO or DCO) with 1.5 or 2 pole output with (1 out of n) check
- Regulation step command (RCO), 1 or 2 pole
- Digital setpoints commands, 8 or 16 Bit without strobe (DSO8 or DSO16)
- Digital setpoint commands, 8 or 16 Bit with strobe (DSO8 or DSO16)
- Bitstring output, 1, 2, 8 or 16 Bit (BSO1, BSO2, BSO8 or BSO16)

The module allows switching voltages up to 150 V DC or max. 2 A continious current.

Remote Terminal Units
RTU560 product line – Input/output modules

—
23BA23
1KGT020800R001



Description
- Two test and switching circuits
- Auxiliary test voltage 24...60 V DC

23BA23 - Command output monitoring (1 out of n) check

Application
The 23BA23 board is intended for use in the RTU560 product line. The 23BA23 board should be installed if the output circuit of an object command has to be checked before the actual command is given. The 23BA23 board executes a (1 out of n) check. It checks if only one interposing relay will be activated in the output circuit. This is only possible if all interposing relays connected to one check circuit have the same resistance value.
The 23BA23 board allows to check 2 different interposing relay types by using two separated check circuits. The permissible tolerance range is defined by means of parameters. Up to 16 23BA23 boards can be used in one RTU560.
- Galvanic isolation of the check circuit
- Suppression of line frequency during measuring

—
560AIR01
1KGT036500R0001

Description
- AD converter resolution: 16 bit
- Measuring ranges: +/-2 mA; +/-5 mA; +/-10 mA; +/-20 mA; +/-40 mA; +/-2 V DC; 0...20 V DC

560AIR01 - Analog input, 8 channels

Application
The 560AIR01 module records up to 8 analog measured values.
The module 560AIR01 is able to process the following types of signals:
- Analog measured values (AMI)
- Measured floating point information (MFI)

Following measurement ranges can be configured:
- ± 2 mA
- ± 5 mA
- ± 10 mA
- ± 20 mA
- ± 40 mA
- ± 2 V DC
- 0... 20 V DC

Other effective ranges and live zero signals become generated out of these ranges through conversion of the communication unit (CMU).

Remote Terminal Units
RTU560 product line – Input/output modules

—
560AIR02
1KGT037500R0001

560AIR02 - Analog input, 8 channels

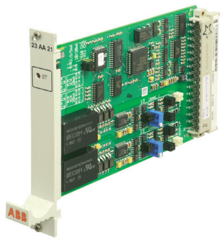
Application
The 560AIR02 module records up to 8 analog measured values.
The module 560AIR02 is able to process the following types of signals:
- Analog measured values (AMI)
- Measured floating point information (MFI)

Following measurement ranges can be configured:
- ± 2 mA
- ± 5 mA
- ± 10 mA
- ± 20 mA
- ± 40 mA

Other effective ranges and live zero signals become generated out of these ranges through conversion of the communication unit (CMU).

Description
- AD converter resolution: 16 bit
- Measuring ranges: +/-2 mA; +/-5 mA; +/-10 mA; +/-20 mA; +/-40 mA

—
23AA21
1KGT020700R0001



23AA21 - Analog output, 2 channels with potential isolation

Application

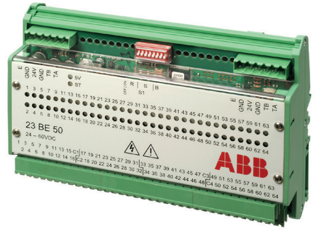
Via the analog output board 23AA21, analog control outputs for sequential or closed loop control, display instruments, measurand recorders etc. can be connected to the RTU560. The 23AA21 board has 2 isolated output channels which can be configured to different output current ranges. The output format, unipolar or bipolar resp. Live-Zero (4...20 mA), can be set by software parameters.
The following output current ranges can be configured independently per channel via plug-in jumpers:
- ± 2,5mA
- ± 5 mA
- ± 10 mA
- ± 20 mA (4...20 mA)

Description

- Analog signal represented digitally by 11 bit + sign
- Selectable current outputs: +/-2.5 mA; +/-5 mA; +/-10 mA; +/-20 mA; +4...20 mA

Remote Terminal Units
RTU560 product line – Input/output modules

—
23BE50
1KGT020900R001

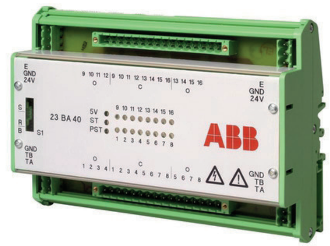


23BE50 - Binary input, 64 channels, LED's

Application
The binary input board 23BE50 is used for the isolated input of 64 process signals in 4 groups with up to 16 binary signals each. Scanning and processing of the inputs are executed with the high time resolution of 1 ms.
The Allocation of an input signal to the processing functions can be done according to the rules of configuration. The board 23BE50 can process the following types of signals:
- 64 single indications with time stamp
- 32 double indications with time stamp
- 8 step position information each with 8 bit
- 8/16 bit digital measured value(s)
- 8/16 bit string Information
- 64 pulse counters (max. 120Hz)

Description
To be used for single indications, double indications, digital measurands and pulse counters.
- Resolution: 1 ms
- Process voltage: 24...60 V DC
- LED signal for each input

—
23BA40
1KGT011200R0011



23BA40 - Command output module 110 ... 220 VDC

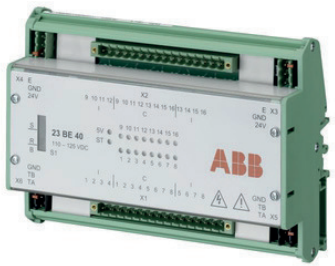
Application
The module 23BA40 can be used for the control of 16 binary process signals using relay contacts.
The allocation of an output signal to the processing functions can be done according to the rules of configuration.
The module 23BA40 is able to process the following types of signals:
- Single or double commands (SCO or DCO) with 1 or 2 pole output without (1 out of n) check
- Regulation step command (RCO), 1 or 2 pole
- Digital setpoints commands, 8 or 16 Bit without strobe (DSO8 or DSO16)
- Bitstring output, 1, 2, 8 or 16 Bit (BSO1, BSO2, BSO8 or BSO16)

The module allows switching voltages up to 250 V DC or max. 8 A continious current.

Description
- 16 output contacts configured as 16 single contact outputs or 8 double contact outputs
- Switching voltage: 24...220 V DC / 250 V AC
- Max. switching capacity: 120 W (DC)
- Max. switching current: 300 mA at 110 V DC, 200 mA at 220 V DC (L/R = 40 ms)
- Isolated relay output contacts NO, 2-pole connection

Remote Terminal Units
RTU560 product line – Input/output modules

—
23BE40
1KGT011100R0011
1KGT011100R0012



Description
- 16 channel potential isolated inputs, without common return
- Process voltage: 110...125 V DC and 220...250 V DC

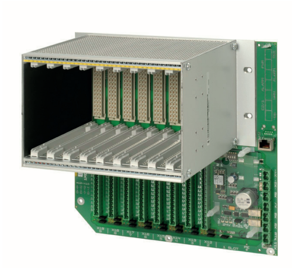
23BE40 - Binary input, 16 channels 110...125 V DC (R0011) and 220...250 V DC (R0012)

Application
The module 23BE40 provides 16 galvanic isolated inputs for up to 16 binary process signals. Scanning and processing of the inputs are executed with the high time resolution of 1 ms. The allocation of an input signal to the processing functions can be done according to the rules of configuration.
The module 23BE40 is able to process the following types of signals or a combination of them:
- 16 single point information with time stamp (SPI)
- 8 double point information with time stamp (DPI)
- 2 digital measured values each with 8 bit (DMI8)
- 1 digital measured value with 16 bit (DMI16)
- 16 integrated totals (max. 25 Hz) (ITI)
- 2 step position information each with 8 bit (STI)
- 2 bitstring input each with 8 bit (BSI8)
- 1 bitstring input with 16 bit (BSI16)
- or combinations of this signal types

The module is available in two versions (rubrics):
- 23BE40 R0011: process voltage 110 to 125 V DC.
- 23BE40 R0012: process voltage 220 to 250 V DC.

Remote Terminal Units
RTU560 product line – Racks

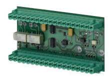
—
560MPR01
1KGT012500R001



560MPR01 - Rack with 9 slots, wall mounted

Application
The mounting plate rack 560MPR01 accommodates up to 2 communication units (CMU) 560CMR01 or 560CMR02 and up to 8 peripheral modules in a RTU560 substation. One additional (extension) mounting plate rack can be connected to the 560MPR01 via the RTU560 serial peripheral bus (SPS).

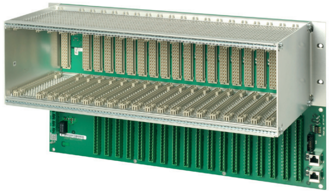
Description
- Mounting panel for RTU with plug for serial peripheral bus for extension
- Max. 8 slots for I/O modules
- Max. 2 CMUs (560CMR01/02)



Additional material		
Bus connection unit for 560MPR01	1KGT007900R0001	560BCU02 R0001 • Alarm and warning contacts • Minute pulse in- and output
Process connector 2-/ 17-/ 19-pole for 560MPR01/03	1KGN000556R2002 1KGN000556R2017 1KGN000556R2019	23XS20 R2019 • 19-pole connector with screw-terminals AWG12 for process connections to the I/O modules on 560MPR01/03 (one connector per module); 100 pcs per package 23XS20 R2017 • 17-pole connector with screw-terminals AWG12 for process connections to the I/O modules on 560MPR01/03 (one connector per module); 100 pcs per package 23XS20 R2002 • 2-pole connector with screw-terminals AWG12 for process connections to the I/O modules on 560MPR01/03; 100 pcs per package
Blanking front plate	1KGT007700R1002	560FPR01 R1002 • Blanking front plate to cover free slots within a module sub rack (1 slot) • light beige, plastic, with ABB logo grip • Incl. screws • 100 pcs per package

Remote Terminal Units
RTU560 product line – Racks

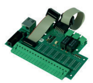
—
560MPR03
1KGT022100R001



Description
With flexible configuration for I/O, CMU and power supply (23XS20 not included).

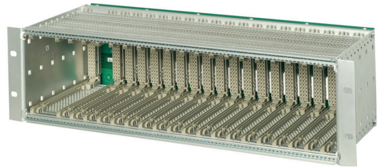
560MPR03 - Mounting panel rack for optional redundant power supply

Application
The 560MPR03 rack is designed to be used with or without redundant power supply. Therefore, it has 2 slots for redundant power supply units (PSU). Up to 18 slots can be used for I/O boards, communication units (CMU) or a mixture of both. It is interfaced to other racks via the RTU560 serial peripheral bus. Up to 7 560MPR03 racks can be connected to an I/O bus segment. By using the bus connection unit 560BCU04, the 560MPR03 becomes a rack with up to 8 communication units (560CMR01/ 560CMR02).
Also for some functions the usage of 560BCU04 is required, even if only one communication unit is inserted The rack 560MPR03 is mounted on a mounting plate in a cubicle. Only in slot 19 the second PSU can be inserted and will be operated. It is not allowed to put in other modules. Slot 18 is available when the option of the second PSU is not used.

	Additional material		
	**Bus connection unit for 560MPR03 (Basic, Extension and CAN bus termination)**	1KGT022300R0001 1KGT022300R1002 1KGT022300R0003	560BCU04 R0001 (Basiseinheit) • Alarm and warning contacts • Minute pulse input and output • Supervision of redundant power supply • For 2 units 560CMU0x (one basic unit. one extension unit) 560BCU04 R1002 (Erweiterungseinheit) • Extension kit for 10 additional 560CMU0x, 10 pcs per package 560BCU04 R0003 (CAN-Bus-Terminierung) • Single CMU CAN bus termination only (no alarm and warning contacts, no minute pulse in- and output, no supervision of redundant power supply)
	**Process connector 2-/ 17-/ 19-pole for 560MPR01/03**	1KGN000556R2002 1KGN000556R2017 1KGN000556R2019	23XS20 R2019 • 19-pole connector with screw-terminals AWG12 for process connections to the I/O modules on 560MPR01/03 (one connector per module); 100 pcs per package 23XS20 R2017 • 17-pole connector with screw-terminals AWG12 for process connections to the I/O modules on 560MPR01/03 (one connector per module); 100 pcs per package 23XS20 R2002 • 2-pole connector with screw-terminals AWG12 for process connections to the I/O modules on 560MPR01/03; 100 pcs per package
	**Blanking front plate**	1KGT007700R1002	560FPR01 R1002 • Blanking front plate to cover free slots within a module sub rack (1 slot) • light beige, plastic, with ABB logo grip • Incl. screws • 100 pcs per package

Remote Terminal Units
RTU560 product line – Racks

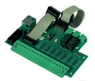
—
560SFR02
1KGT022200R001



Description
With flexible configuration for I/O, CMU and power supply

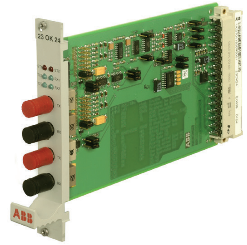
560SFR02 - 19" Swing frame rack for optional redundant power supply

Application
The 560SFR02 rack is designed to be used with or without redundant power supply. Therefore, it has 2 slots for redundant power supply units (PSU). Up to 18 slots can be used for I/O boards, communication units (CMU) or a mixture of both. It is interfaced to other racks via the RTU560 serial peripheral bus. Up to 7 560SFR02 racks can be connected to an I/O bus segment. By using the bus connection unit 560BCU05, the 560SFR02 becomes a rack with up to 8 communication units (560CMR01/ 560CMR02). Also for some functions the usage of 560BCU05 is required, even if only one CMU is inserted it is installed in a swing frame cabinet or in a frame.
Only in slot 19 the second PSU can be inserted and will be operated. It is not allowed to put in other modules. Slot 18 is available, when the option of the second PSU is not used.

	Additional material		
	**Bus connection unit for 560MPR03 (Basic, Extension and CAN bus termination)**	1KGT022400R0001 1KGT022400R1002 1KGT022400R0003	560BCU04 R0001 (Basiseinheit) • Alarm and warning contacts • Minute pulse input and output • Supervision of redundant power supply • For 2 units 560CMU0x (one basic unit. one extension unit) 560BCU04 R1002 (Erweiterungseinheit) • Extension kit for 10 additional 560CMU0x, 10 pcs per package 560BCU04 R0003 (CAN-Bus-Terminierung) • Single CMU CAN bus termination only (no alarm and warning contacts, no minute pulse in- and output, no supervision of redundant power supply)
	**Process-connector-housing 560SFR02**	1KGN000758R3001	23XS40 R3001 • 18-pole plug for connectors of 560SFR02 (housing only. without snap-in-contacts) • 100 pcs per package
	**Snap-in contacts for 23XS40 R3001**	1KGN000758R4001	23XS40 R4001 • Snap-in contacts for 23XS40 R3001 (18 contacts per plug required) • Suitable for AWG20 - AWG26 • 500 pcs per package
	**Crimp tool for 23XS40 R4001**	1KGN000797R0001	23XS41R0001 • Tool to connect wires to snap-in-contacts (23XS40 R4001)
	**Removal tool for snap-in contacts**	1KGN000798R0001	23XS42 R0001 • Tool to extract snap-in contacts (23XS40 R4001)
	**Removal tool for process connector 23XS40 R3001**	1KGN000799R0001	23XS43 R0001 • Tool to remove connector housing 23XS40 R3001 from subrack 560SFR02
	**Blanking front plate**	1KGT007700R1002	560FPR01 R1002 • Blanking front plate to cover free slots within a module sub rack (1 slot) • light beige, plastic, with ABB logo grip • Incl. screws • 100 pcs per package

Remote Terminal Units
RTU560 product line – Serial communication

—
23OK24
1KGT011800R5001



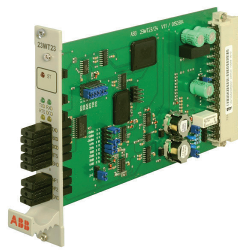
23OK24 - Fibre optic coupler (BFOC/2.5) for 2 glass-fibre optical lines

Description
- Fibre optic coupler for glass-fibre optic cable with emission wave length of 820 nm
- Fiber optic connection with bayonet socket BFOC/2.5 (IEC-SC86B)
- Optical isolation of RTU560 I/O bus
- Suitable as star coupler for RS485 and RS232
- Interfacing of IEC 60870-5-103 devices
- Connector for 2 optical lines on frontplate

Application
The fiber optic coupler 23OK24 is intended for use in the RTU560. The module is used to transmit data via 2 independent optical links (receive and transmit).
Optical fiber cables are not sensitive to inductive and capacitive interferences, as well for potential differences between the 2 data communication equipments. Fiber optic cables will be used to bridge over distances in critical environments, or if a potential isolation is required. The maximum distance can be up to 2600 m via fiber optic cable type 200 µm.
The module can be used for signal conversion to fiber optic signals of the received and transmitted data for the following electrical interface standards:
- RTU560 SPB I/O bus
- RS-485 bus
- RS-232 C

The fiber optic coupler 23OK24 can be connected to the RTU500 series coupler 560FOC40.

—
23WT23
1KGT008200R001
1KGT008200R002



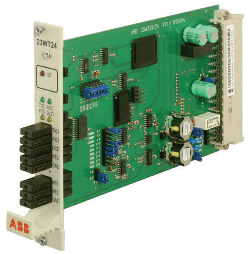
23WT23 - Modem V.23, power supply 5...24 V DC

Description
– Voice frequency telegraphy device (VFT) according CCITT V.23 standard with max. 1200 baud

Application
The 23WT23 board is a modem which converts the serial data according to CCITT V.23 standard. Therefore it can be used for the transmission via leased PTT-lines, private networks or for radio transmission.
Two- or four-wire operation mode is selectable by jumper. The voice frequency (VF) output has a high impedance which enables the connection of up to 10 remote stations to a multi drop line.
The modem 23WT23 is available in two versions (rubrics):
- R0001: 5 V DC power supply
- R0002: 24 V DC power supply

Remote Terminal Units
RTU560 product line – Serial communication

—
23WT24
1KGT010500R001



23WT24 - Modem 9.6 kBaud. power supply 5 VDC

Application
The 23WT24 board is a modem with 9600 baud transmission speed. Therefore it can be used for the transmission via private networks over pilot cable.
The board operates on the frequency shift keying principle (FSK). Two- or four-wire operation mode is selectable by jumper. The voice frequency (VF) output has high impedance enabling connection of up to 10 remote stations to a multi drop line.

Description
- FSK device with 9600 baud transmission speed
- Connector for RS-232 testing and disconnecting on frontplate
- Communication over pilot cables
- Auxilliary voltage: 5 V DC

Remote Terminal Units
RTU560 product line – Serial communication

—
23WT25
1KGT012400R001
1KGT012400R002

23WT25 - Modem 50-2400 Baud, power supply 5 VDC (R0001) and 24 VDC (R0002)

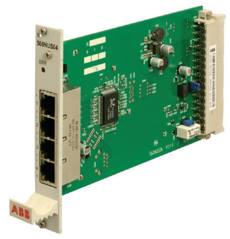
Application
The 23WT25 modem is designed for the operation on telecontrol lines together with the RTU560. However it can also be connected to other data terminal equipments because it operates at the interfaces like a universal FSK-modem in the voice-band range (300-3400 Hz) according to CCITT.
The 23WT25 modem allows the assignment of a two- or four-wire line with communication channels for 50 baud up to 2400 baud (24 channels 50 baud, 12 channels 100 baud, 6 channels 200 baud, 2 channels 600 baud, 1 channel 1200 baud).
The modem 23WT25 is available in two versions (rubrics):
- R0001: 5 V DC power supply
- R0002: 24 V DC power supply

Description
- Voice frequency telegraphy device (VFT)
- Channel-frequencies and -bandwidth are selectable according to CCITT standards (R35... R38) and V.23/ 1200 baud
- Additional 600 baud and 2400 baud channels

Additional material		
Programming cable 23WT25	1KGT013200R0001	23PK31 • For download of project specific firmware version to 23WT25

Remote Terminal Units
RTU560 product line – Ethernet communication

—
560NUS04
1KHW001891R001



Description
- Unmanaged switch
- 4x 10/100 BaseT port (electrical)
- Linear network structure supported

560NUS04 - Integrated unmanaged switch with 4 Ethernet ports

Application
The RTU component 560NUS04 is an unmanaged plug and play 10/100 Mbps Ethernet switch providing 4 fast Ethernet autonegotiating RJ45-ports with auto MDI/X (automatic crossover detection and correction). The switch is intended for distributing Ethernet within a station and supplying a local area network (LAN) with additional ports and can be used with rack types 560MPR01, 560MPR03, 560SFR02.

—
560NUS12
1KHW001892R001

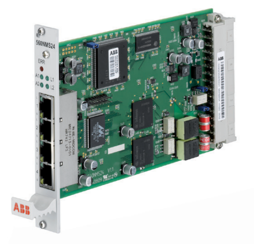
Description
- Unmanaged switch
- 2x SFP slot, without optical transmitter/receiver
- Additional SFP modules are required (see 560NFOxx)
- 2x 10/100 BaseT port (electrical)
- Linear network structure supported

560NUS12 - Integrated unmanaged switch with 2 SFP slot

Application
The RTU component 560NUS12 is an unmanaged plug and play 10/100 Mbps Ethernet switch providing 2 fast Ethernet autonegotiating RJ45-ports with auto MDI/X (automatic crossover detection and correction) and 2 fiber optic 100 Mbps slots for use with SFP (small form-factor pluggable) modules.
The switch is intended for distributing Ethernet within a station through the RJ45-ports. The fiber optic ports can be used for interconnecting stations with a maximum distance of 40 km.

Remote Terminal Units
RTU560 product line – Ethernet communication

—
560NMS24
1KHW002108R001

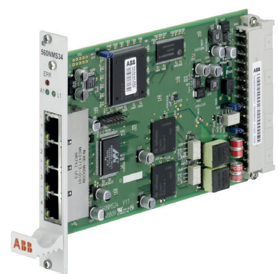


Description
- Integrated managed layer-2-switch
- 4x 10/100 BaseT port (RJ45, electrical, autonegotiating)
- 2x SDSL-port for copper wire
- Provides redundant topologies by the (Rapid) Spanning Tree Protocol (RSTP)
- 1x RS-232 port suitable for serial protocols

560NMS24 - Integrated managed switch with 2 SDSL-ports and 4 Ethernet ports

Application
The RTU component 560NMS24 is a managed plug and play Layer-2-switch providing 4 fast Ethernet auto-negotiating RJ45- ports with auto MDI/X (Automatic Crossover Detection and Correction) and two 2-wire SDSL-ports for use with private copper cables. It can be used with rack types 560MPR01, 560MPR03 and 560SFR02.
The switch is intended for distributing Ethernet within a station through the RJ45-ports. The SDSL-ports can be used for interconnecting stations with a maximum distance of 20 km (copper cable with diameter of 0.8 mm). Longer distances can be achieved by cascading multiple 560NMS24.
The switch is able to provide redundant topologies by the (Rapid) Spanning Tree Protocol. The switch supports VLAN frames and tunneling of serial data.

—
560NUS34
1KHW023538R001



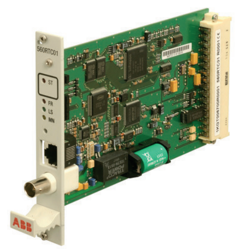
Description
- Integrated managed layer-2-switch
- 4x 10/100 BaseT port (RJ45, electrical, autonegotiating)
- 1x SDSL-port for copper wire
- Provides redundant topologies by the (Rapid) Spanning Tree Protocol (RSTP)
- 1x RS-232 port suitable for serial protocols

560NMS34 - Integrated managed switch with 1 SDSL-port and 4 Ethernet ports

Application
The RTU component 560NMS34 is a managed plug and play Layer-2-switch providing 4 fast Ethernet auto-negotiating RJ45-ports with auto MDI/X (automatic crossover detection and correction) and one 2-wire SDSL-port for use with private copper cables. It can be used with rack types 560MPR01, 560MPR03 and 560SFR02.
The switch is intended for distributing Ethernet within a station through the RJ45-ports. The SDSL-port can be used for interconnecting stations with a maximum distance of 20 km (copper cable with diameter of 0.8 mm). The switch is able to provide redundant topologies by the (Rapid) Spanning Tree Protocol. The switch supports VLAN frames and tunneling of serial data.

Remote Terminal Units
RTU560 product line – Real time clocks

—
560RCR01
1KGT006700R0001



560RCR01 - Real time clock GPS for RTU560

Application
A remote terminal unit RTU560 can be synchronized with the time information received from the global positioning system (GPS) satellites using the module 560RCR01. The RTU560 reads the time and date from the module 560RCR01 and synchronizes its internal time to the standard time by the means of a minute pulse. The use of the module 560RCR01 ensures that process information from several terminal units are synchronized, when they include time information.

Description
Real time clock for synchronization of the RTU560 with the standard time of the GPS satellite including configuration tool.
- Antenna and cable have to be ordered separately

—
560RTC02
1KGT007800R0001

560RTC02 - Real time clock DCF77 for RTU560

Application
A RTU560 product line unit can be synchronized with the standard time of the long-wave transmitter DCF77 using the module 560RTC02. The RTU560 reads the time and date from the module 560RTC02 and synchronizes its internal clock to the standard time by means of a minute pulse. The use of the module 560RTC02 ensures that indications from several terminal units are synchronized, when they include time information.

Description
For synchronization of the RTU560 with the standard time of the long-wave transmitter DCF77.
- Antenna and cable have to be ordered separately

Remote Terminal Units
RTU560 product line – Real time clocks

Additional material		
Connection cable 20 m for real time clock	1KGT006900R0020 1KGT006900R0050	23AC02 R0020 • Cable to connect real time clock module 560RCR01 with 23AN02 or 560RTC02 with 25AN01 • Length 20 meters 23AC02 R0050 • Cable to connect real time clock module 560RCR01 with 23AN02 or 560RTC02 with 25AN01 • Length 50 meters
Ferrite antenna for outside installation	GSNP812601R0003	25AN01 R0003 • Ferrite antenna for real time clock module 560RTC02 • Incl. wall mounting kit, 360° rotatable
GPS Antenna	1KGT006800R0001	23AN02 R0001 • Active antenna for real time clock module 560RCR01

Remote Terminal Units
Technology translator for past and future system integration: RTU540 product line

Gateway product for distribution and subtransmission. Bridges old and new technology and combines existingdevices and new standards protocols (such as IEC 61850) in one substation automation system. RTU540 incorporates advanced features like programmable logic control and a human machine interface allowing for instant insight into the status of the grid. The high-quality, compactmetal housing includes input and output modules whichlead to space savings in the control cabinet.

Your benefits
- Powerful protocol gateway to bridge old and new technologies in one system
- Intelligent device for automated load and voltage control
- Robust and compact housing for fan-less operation enables you to handle a complex network due to distributed intelligence
- Agile functionality allows easy adaption of automation based on changing system requirements
- Selective interpretation allow fast decision making in the network control center and safes primary equipment
- Communication redundancy for peace of mind and confidence in your network

Application examples
Being responsible for a whole network puts you in the situation where some devices might be brand new while others are working since a very long time. RTU540 is the perfect product for you to bring them together in one system. As a gateway between IEDs and network control system (communication protocols and station bus) it is able to interprete information from all standard protocols. Additionally our gateway is perfect if you want to integrate serial I/Os into your digital station bus.
We offer full protocol support and are able to digitize your data. The changing topology of modern electric networks requires a constant voltage control. This can be automated with the integration of RTU540 in the transformer. The device can independent from the network control center control the voltage levels and send signals to adjust them. This gives you the time to focus on more important topics in the control center and peace of mind that the RTU540 is the reliable solution for automation.

Application Areas
Automation of primary distribution substation
- Gateway between IEDs and Network control system
- Interfacing of station level I/Os into station bus
- Integration of serial IEDs into station bus
- Transformer monitoring and control
- Voltage control

Remote Terminal Units
Technology translator for past and future system integration: RTU540 product line

RTU540 Communication units

540CMD01
P. 32

540CID01
P. 33

Remote Terminal Units
RTU540 product line - Communication units

—
540CID01
1KGT037300R0001
1KGT037300R0002

Description
DIN rail mounted base module RTU540
- Metal housing
- 4x serial port (RS-232 or RS-485)
- 2x Ethernet interface (10/100BaseT)
- USB configuration interface
- Power supply 24… 125 V DC
- Integrated I/O (16 binary inputs, 8 binary outputs, 8 analog inputs)
- (1 out of n) check
- With connection interface to RTU500 I/O-extension modules
- Battery buffered real time clock
- Process voltage R0001: 24…60 V DC
- Process voltage R0002: 110…125 V DC

540CID01 - RTU540 base module with 2 Ethernet ports

Application
The 540CID01 is a module of the RTU540 product line consisting of a communication unit (CMU), a multi-I/O module (IOM) and a galvanic isolated wide range power supply (PSM) in a metal DIN rail housing.
The essential tasks are:
- Managing and controlling of the RTU520 I/O modules via the serial I/O bus
- Reading Process events from the input modules.
- Send commands to the output modules.
- Communicating with control systems and local HMI systems via the serial interfaces (RS232) and the Ethernet 10/100BaseT interfaces.
- Communication with Sub-RTU's, IED's or multimeter devices via the interfaces (RS485) and the Ethernet interfaces.
- Managing the time base for the RTU540 product line station and synchronizing the I/O modules.
- Handling the dialog between RTU540 product line and Web-Browser via the LAN interfaces.
- Capturing of 8 analog input signals (mA or V signals), fast scan cycle of 100 ms for 2 inputs
- Capturing of 16 digital input signals, 1 high speed counter input (max. 16 kHz)
- 8 output contacts (normal open), 1 or 2 pole output
- (1 out of n) check

The unit is suitable for Ethernet and UART based communication protocols, as well as for the serial I/O bus (WRB).
The unit has a battery buffered real time clock (RTC).
The unit is available in 2 versions:
- R0001: 24 … 60 V DC process voltage for binary I/Os
- R0002: 110 / 125 V DC process voltage for binary I/Os

Remote Terminal Units
RTU540 product line - Communication units

—
540CMD01
1KGT037400R0001

Description
DIN rail mounted base module RTU540
- Metal housing
- 4x serial port (RS-232, RS-485)
- 2x Ethernet interface (10/100BaseT)
- USB configuration interface
- Power supply 24… 125 V DC
- With connection interface to RTU500 I/O-extension modules
- Battery buffered real time clock

540CMD01 - RTU540 base module with 2 Ethernet ports

Application
The 540CMD01 is a module of the RTU540 product line consisting of a communication unit (CMU) and a galvanic isolated wide range power supply (PSM) in a metal DIN rail housing.
The essential tasks are:
- Managing and controlling of the RTU520 I/O modules via the serial I/O bus
- Reading Process events from the input modules.
- Send commands to the output modules.
- Communicating with control systems and local HMI systems via the serial interfaces (RS232) and the Ethernet 10/100BaseT interfaces.
- Communication with Sub-RTU's, IED's or multimeter devices via the interfaces (RS485) and the Ethernet interfaces.
- Managing the time base for the RTU540 product line station and synchronizing the I/O modules.
- Handling the dialog between RTU540 product line and Web-Browser via the LAN interfaces.

The unit is suitable for Ethernet and UART based communication protocols, as well as for the serial I/O bus (WRB).
The unit has a battery buffered real time clock (RTC).

Remote Terminal Units
RTU520 product line – Intuitive insight for distribution systems

Distribution automation product for power grids. Interface with your SCADA to obtain a complete understanding of the status of your grid on a distribution level with RTU520. Allowing for the simple integration of renewables into your excising networks. Low power consumption saves costs for uninterruptible power supply and makes your installation greener. Highly customizable design enables the adaptation of input and output modules based on your application requirements.

Your benefits
- Efficient footprint allows to fit the RTU520 into small control cabinets
- Intuitive handling allows faster project execution
- User friendly design enables your employees to work fast and efficient with the products
- Secure communication in public networks saves time and money and fulfills highest cyber security standards
- Customizable product solution adapts fast and simple to changing requirements

Application examples
As your distribution network develops towards an intelligent network you will need more and more independent monitoring and control devices to handle all different tasks. With our RTU520 you will keep your costs down while ensuring a stable supply for your customers.
- RTU520 takes over the function of monitoring and control of switching devices for pole-top switch monitoring and control applications. The advantage for you is that you save costs for maintenance staff and that you will reduce the average outage duration for each customer (SAIDI).
- Recent developments bring distributed energy resources into the distribution grid and they need to be controlled in order to protect primary equipment and ensure power quality. With the RTU520 you can monitor and control the distributed energy resources (DER). This enables you to focus on the critical tasks of network management while the RTU locally controls DER.
- In the automation of secondary substation and ring main units the RTU520 monitors and controls your transformer and intelligently handles loads.

Application areas
Electrical distribution network
- Pole-top switch monitoring and control
- Capacitor bank automation
- Demand response management
- Automation of DER
- Energy storage
- Automation of secondary substation / ring main unit
- Transformer automation and control

Oil and gas application
- Wellhead automation
- Pipeline supervision
- Monitoring and control of pumping stations

Water distribution network
- Monitoring and control of water reservoirs
- Monitoring and control of pumping stations

Remote Terminal Units
RTU520 product line – Intuitive insight for distribution systems

Produktlinie 520 – Communication units

520CMD01
P. 36

Produktlinie 520 – Power supply units

520PSD01
P. 37

Produktlinie 520 – Input/Output modules

520AID01 P. 38
520AOD01 P. 38
520BID01 P. 39
520BOD01 P. 39
520CSD01 P. 40
520PTD01 P. 40

Produktlinie 520 – Input/Output adapters

520ADD01 P. 41
520ADD02 P. 41
520ADD03 P. 42

Remote Terminal Units
RTU520 product line - Communication units

—
520CMD01
1KGT031900R0001
1KGT031900R0002

Description
DIN rail mounted base module RTU520
- 3x serial port (2x RS-232, 1x RS-485)
- 1x Ethernet interface (10/100BaseT)
- 1x USB port
- With connection interface to RTU520 I/O-extension modules
- Battery buffered real time clock (R0002)

520CMD01- Base module

Application
The 520CMD01 communication unit is the CMU module of the RTU520 product line.
The essential tasks are:
- Managing and controlling of the RTU520 I/O modules via the serial I/O bus
- Reading Process events from the input modules.
- Send commands to the output modules.
- Communicating with control systems via the serial interfaces (RS232) and the Ethernet 10/100BaseT interface.
- Communication with Sub-RTU's, IED's or multimeter devices via the interfaces (RS485) and the Ethernet interface.
- Managing the time base for the RTU520 product line station and synchronizing the I/O modules.
- Handling the dialog between RTU520 product line and Web-Browser via the LAN interfaces.

The communication unit will be mounted on a DIN-rail, together with the power supply module and the I/O modules. The communication unit is able to handle Ethernet- and UART character based communication protocols.
The unit is available in 2 versions:
- R0001: without battery buffered real time clock (RTC)
- R0002: with battery buffered real time clock (RTC)

Remote Terminal Units
RTU520 product line – Power supply unit

—
520PSD01
1KGT031500R0001

Description
- Power supply unit in combination with 520CMD01
- Input voltage: 24 V DC
- Output power: 20 W

520PSD01 - Power supply unit

Application
The power supply unit 520PSD01 generates or switches the voltages 24 VDC, ±15 VDC and 5 VDC for the RTU520 system. The output power is sufficient to supply a RTU520 with up to 16 I/O modules.

Remote Terminal Units
RTU520 product line – Input/Output modules

—
520AID01
1KGT033100R0001
1KGT033100R0002

Description
R0001:
- Resolution 11 bit + sign; accuracy class 0.25
- Measuring range: +/- 5 mA; +/- 10 mA; +/- 20 mA; 4…20 mA
- Resolution 10 bit + sign; accuracy class 0.5
- Measuring range: +/- 2,5 mA

R0002:
- Resolution 11 bit + sign; accuracy class 0.25
- Measuring range: +/- 1 V DC; +/- 10 VDC

520AID01 - 6 analog inputs, mA signals / V signals

Application
The 520AID01 module records up to 6 analog measured values.
The module 520AID01 is able to process the following types of signals:
- Analog measured values (AMI)
- Measured floating point information (MFI)

Following measurement ranges can be configured:
- ± 2.5 mA
- ± 5 mA
- ± 10 mA
- ± 20 mA

Other effective ranges and live zero signals become generated out of these ranges through conversion of the communication unit (CMU).

—
520AOD01
1KGT024500R0001

Description
- Resolution 12 bit + sign; accuracy class 0.25
- Measuring range: +/- 2,5 mA; +/- 5 mA; +/- 10 mA; +/- 20 mA; 4…20 mA; +/- 1 V DC; +/- 10 V DC

520AOD01 - 2 analogoutputs

Application
Analog control outputs for sequential or closed-loop control, display instruments, measurement recorders etc. can be connected by the analog output board 520AOD01. The board 520AOD01 has 2 output channels, which can be configured to different output current ranges.
The module 520AOD01 is able to process the following types of signals:
- analog setpoint commands (ASO)
- floating point setpoint commands (FSO)

The output format unipolar, bipolar or live zero (4 … 20 mA) can be configured by software parameters.

Remote Terminal Units
RTU520 product line – Input/Output modules

—
520BID01
1KGT033200R0001
1KGT033200R0002

Description
- To be used for single indications, double indications, digital measurands and pulse counters
- Resolution: 1ms
- Process voltage: 24…60 V DC / 110...125 V DC
- LED signal for each input
- Common return per 8 inputs

520BID01 - 16 binary inputs, 24 … 60 / 110 ... 125 V DC

Application
The module 520BID01 provides 16 galvanic isolated inputs for up to 16 binary process signals. Scanning and processing of the inputs are executed with the high time resolution of 1 ms. The allocation of an input signal to the processing functions can be done according to the rules of configuration.
The module 520BID01 is able to process the following types of signals or a combination of them:
- 16 single point information with time stamp (SPI)
- 8 double point information with time stamp (DPI)
- 2 digital measured values each with 8 bit (DMI8)
- 1 digital measured value with 16 bit (DMI16)
- 16 integrated totals (max. 25 Hz) (ITI)
- 2 step position information each with 8 bit (STI)
- 2 bitstring input each with 8 bit (BSI8)
- 1 bitstring input with 16 bit (BSI16)
- or combinations of this signal types

The module is available in two versions (rubrics):
- 520BID01 R0001: process voltage 24 to 60 V DC.
- 520BID01 R0002: process voltage 110 to 125 V DC.

—
520BOD01
1KGT033300R1002

Description
- 8 single commands 1-pole NO contact (high capacity relays)
- Max. switching voltage: 150 V DC
- Max. load: 110 V DC / 3 A

520BOD01 - 8 binary outputs, relays

Application
The module 520BOD01 can be used for the control of 8 binary process signals using relay contacts. The allocation of an output signal to the processing functions can be done according to the rules of configuration.
The module 520BOD01 is able to process the following types of signals:
- Single or double commands (SCO or DCO) with 1 or 2 pole output without (1 out of n) check
- Single or double commands (SCO or DCO) with 1.5 or 2 pole output with (1 out of n) check
- Regulation step command (RCO), 1 or 2 pole
- Digital setpoints commands, 8 Bit without strobe (DSO8)
- Bitstring output, 1 or 8 Bit (BSO1 or BSO8)

The module allows switching voltages up to 150 V DC or max. 8 A continious current.

Remote Terminal Units
RTU520 product line – Input/Output modules

—
520CSD01
1KGT034800R0001

Description
- 1 out of n check function
- Input voltage range of measuring circuit: 0.1 … 10 V
- Max. switching voltage (UP): 150 VDC
- Max. switching capacity (resistive/inductive): 120 W / 50 VA (L/R = 40 ms)
- 4 single commands 1-pole NO contact
- Max. switching voltage of switching relay: 72 VDC
- Max. breaking current (resistive/inductive): 5 A <= 55 VDC / 50 VA (L/R = 40 ms)

520CSD01 - I/O adapter Command output monitoring (1 out of n check) and 4 binary outputs

Application
The command output and supervision module 520CSD01 can be used for the control of 4 binary process commands using relay contacts. In addition it can be used if the output circuit of an object command has to be checked before the actual command is given. The 520CSD01 board executes a (1 out of n) check. It checks if only one interposing relay will be activated in the output circuit. Therefore all interposing relays connected to the check circuit must have the same resistance value.
The module 520CSD01 is able to process the following types of signals:
- Single or double commands (SCO or DCO) with 1 pole output without (1 out of n) check
- Single or double commands (SCO or DCO) with 1.5 pole output with (1 out of n) check
- Regulation step command (RCO), 1 pole
- Bitstring output, 1Bit (BSO1)

The command outputs of the 520CSD01 allows switching voltages up to 72 V DC or max. 5 A continuous current. The (1 out of n) test circuit can be used for voltage up to 150 V DC in combination with the command output relays of the 520BOD01.

—
520PTD01
1KGT024700R0001

Description
- 6 PT100 inputs
- 2…4 wires per channel
- Resolution: 11 bit + sign
- Accuracy class: +/-1 °C (-25 °C...125 °C)
- Measuring range: -25 °C…150 °C
- Overrange: -200 °C…200 °C
- Measuring current: 6 mA

520PTD01 - Temperatur module for 6 PT100 inputs

Application
The 520PTD01 board is used to connect PT100 temperature transmitter directly. Up to six transmitters can be connected to the board. The measurement range is ± 200 °C.

Remote Terminal Units
RTU520 product line – Input/Output adapters

—
520ADD01
1KGT033000R0001

Description
- Standard adapter module for up to 8 I/O modules
- 520BID01, 520BOD01, 520AID01, 520AOD01, 520PTD01
- Incl. 20 pole ribbon cable, cable length 300 mm

520ADD01 - I/O adapter

Application
The I/O adapter 520ADD01 is used to connect RTU520 I/O modules to a RTU520 or RTU540 communication module.

—
520ADD02
1KGT024300R0001
1KGT024300R0002

Description
- Standard adapter module for up to 8 I/O modules
- 520BID01, 520BOD01, 520AID01, 520AOD01, 520PTD01 and interface to further I/O extension
- RS-485: 19,2 kbaud, 200 m
- Incl. 20 pole ribbon cable, cable length 300 mm

520ADD02 - I/O adapter, RS-485, optionally with fiber optical interface

Application
The I/O adapter 520ADD02 is used to connect more than 16 RTU520 I/O modules to an I/O bus with RS485 or fiber optic connection in RTU520 or RTU540.
The adapter is also used to extend the WRB I/O bus for decentralized I/O applications up to 2 km distance and if distances of more than 30 cm between the I/O adapters are required.
In addition the I/O adapter 520ADD02 is used as a stand-alone module to connect RTU560 I/O modules (e. g. 23BE40, 23BE50, 23BA40) to an RTU540.
The module is available in two versions (rubrics):
- R0001: RS485
- R0002: RS485 and glass fiber optical, 840 nm

Remote Terminal Units
RTU520 product line – Input/Output adapters

—
520ADD03
520ADD03R0001
520ADD03R0002

Description
Adapter to connect more than 16 RTU520 I/O modules to an I/O bus with connection in RTU520 or RTU540

- Also used to extend the WRB I/O bus for decentralized I/O applications up to 2 km distance and if distances of more than 30 cm between the I/O adapters are required
- In addition used to connect RTU520 I/O modules to an RTU560
- Is always used together with the power supply unit 520PSD01

520ADD03 - I/O adapter, remote I/O

Application
The I/O adapter 520ADD03 is used to connect more than 16 RTU520 I/O modules to an I/O bus with RS485 or fiber optic connection in RTU520 or RTU540.
The adapter is also used to extend the WRB I/O bus for decentralized I/O applications up to 2 km distance and if distances of more than 30 cm between the I/O adapters are required.
In addition the I/O adapter 520ADD03 is used to connect RTU520 I/O modules to an RTU560.
The I/O adapter is always used together with the power supply unit 520PSD01.
The module is available in two versions (rubrics):

- R0001: RS485
- R0002: glass fiber optical, 840 nm

Remote Terminal Units

Flexible extension modules for the whole RTU500 series: RTU500 series modules

The RTU500 series modules can be used with all product lines to provide additional and extended functionality. The modules offer special functions to complete a RTU for your specific application. RTU500 series modules include:

- RTU500 series power supply units
- RTU500 series I/Os
- RTU500 series I/O adapter
- RTU500 series multimeters
- RTU500 series serial communication
- RTU500 series ethernet communication

Multimeters
RTU's multimeter devices enable direct measurement of voltage, current and power. The configuration of the devices is completely integrated into the easy-to-use RTUtil500 and the DIN rail wizard. Multimeters provide for a detailed monitoring of the network. To locate a fault, multimeters offer fault current detection with directional information. Additionally, the increased and reliable information about the network protect your investments and allow for precise new investments, if need be.

Communication
Flexibility of communication is a precondition for modern RTU systems. To guarantee an error-free and comprehensive communication to a variety of devices, the RTU500 series offers modules for Ethernet and serial communication.
Serial communication:

- Modems are used for serial communcation. The RTU500 series modules offer modems with speed rates up to 9.600 Baud for distances up to 20 km. The modems operate in wide or voice band range to meet your requirements. What is more, the modems are available for CCITT V.23 standard.

Ethernet communication:

- unmanaged switches
- 4 port Ethernet switches distribute Ethernet with support of redundant topologies. Copper as well as fiber optical media are supported.
- managed switches with DSL

Available copper lines in combination with new fiber optical lines can be re-used for TCP/IP communication, allowing for an independent network for private communication.
Additionally, tunneling of serial data via RS 232 interface allows for an easy migration from serial to Ethernet communication.

Remote Terminal Units

Flexible extension modules for the whole RTU500 series: RTU500 series modules

RTU500 Power supply units


CP-E 24/2.5
P. 46


560PSU40
P. 46


560PSU41
P. 47


23VG23
P. 47


23VG24
P. 48

RTU500 Mulitmeters


560CVD03
P. 49


560CVD11
P. 51


500CVD21
P. 52

RTU500 Serial communication


500FSD10
P. 53


500FSD11
P. 53


500LTD01
P. 54


500LTD02
P. 54

RTU500 Ethernet communication


500NMD01
P. 55


500NMD02
P. 55


500NMD11
P. 56


500NMD20
P. 57


500LTD03
P. 58

Remote Terminal Units
RTU500 series modules – Power supply units

—
CP-E 24/2.5
1SVR427032R0000

CP-E 24/2.5 - DIN rail power supply unit for 100 … 240 V AC (85 … 264 VAC, 90 … 375 V DC), 60 W

Application
The primary switch mode power supply offers two voltage input ranges. This enables the supply with AC or DC. Furthermore it is equipped with two generous capacitors, which ensure mains buffering of at least 30 ms (at 230 V AC). That is why the devices can be used worldwide also in high fluctuating net-works and battery powered plants.

Description
Power supply module for DIN rail mounting
- Input voltage: 85…264 V AC, 90…375 V DC
- Output voltage: 24 V DC, max. 2.5 A, 60 W
- Typical efficiency of 89 %
- Ambient temperature range during operation -40…+70° C
- Power failure buffering time: min. 20 ms at 115 V AC, min. 30 ms at 230 V AC

—
560PSU40
1KGT011600R0001

560PSU40 - DIN rail power supply unit for 110 … 220 V DC, 230 V AC

Application
The power supply unit 560PSU40 is a galvanic iso-lated DIN rail power supply. It is designed to sup-ply the DIN rail I/O-modules the 560MPR01 and the communication modules of RTU500 series.
In order to increase the availability 2 power sup-plies can be operated in parallel. External diodes are not necessary.

Description
Power supply module for DIN rail mounting
- Input voltage: 85...264 V AC or 85...375 V DC
- Output voltage: 24 V DC, max. 2.5 A, 60 W
- Suitable for supply of up to 8 interposing modules 23BEx0 / 23BA40 / 560FSMxx / 560MPR01 / 560CVDxx / RTU540 / RTU520

Remote Terminal Units
RTU500 series modules – Power supply units

—
560PSU41
1KGT017700R0001

560PSU41 - DIN rail power supply unit for 24 … 60 V DC

Application
The power supply unit 560PSU41 is a galvanic iso-lated DIN rail power supply. It is designed to sup-ply the RTU560 DIN rail I/O-modules the 560MPR01 and the communication modules of RTU500 series.

Description
Power supply module for DIN rail mounting
- Input voltage: 24...60 V DC
- Output voltage: 24 V DC, max. 2.5 A, 60 W
- Suitable for supply of up to 8 interposing modules 23BEx0 / 23BA40 / 560FSMxx / 560MPR01/ 560CVDxx / RTU540 / RTU520

—
23VG23
1KGT005500R0001

23VG23 - Mains adapter 115 … 230 V AC to 24 V DC, 48 W

Application
The mains adapter 23VG23 is an AC/DC converter in combination with an external back up battery for the use as an uninterruptible power system (UPS). It contains a switch-mode power supply of 92 V AC to 265 V AC without switch over the input voltage. The mains adapter supplies an output voltage of 24 V DC with an output current of min. 0,2 A and max. 2 A.
- Charge current: max. 0.35 A

Description
Mains adapter AC/DC converter for 115...230 V AC input, output 24 V DC, 2 A max.
- Designed for use with back-up battery 24 V DC nominal for maximum 1.5 hours full operation

Remote Terminal Units
RTU500 series modules – Power supply units

—
23VG24
1KGT005600R0001

23VG24 - Mains adapter 115 ... 230 V AC to 24 V DC, 240 W

Application
The mains adapter 23VG24 is an AC/DC converter for an input voltage of 115 or 230 V AC. It supplies an output voltage of 24 V DC with an output current of max. 10 A.
It can supply the module racks, the mounting panels and the I/O modules of a RTU560 station with a power output of approx. 240 W.

Description
Mains adapter AC/DC converter for 230 or 115 V AC input, output 24 V DC, 10 A max.

Remote Terminal Units
RTU500 series modules – Multimeters

—
560CVD03
1KGT028000R0021
1KGT028000R0025
1KGT028000R0041
1KGT028000R0045

Version	Type	Display	LO	HI	1A	5A
560CVD03 R0031	3U3I		x		x	
560CVD03 R0035	3U3I		x			x
560CVD03 R0051	3U3I			x	x	
560CVD03 R0055	3U3I			x		x

560CVD03 - Multimeter 1A/5A , 3U3I

Application
The Multimeter 560CVD03 is used for measuring analog AC input signals from three independent phases. For each phase voltage and current are measured directly and a number of calculated values are generated by the module. The module supports configurations with 2 or 3 voltage transformers.
There are several versions available.

Description
- CT/VT interface with 3 voltage and 3 current inputs for direct monitoring of 3 wire 85…400 V AC
- 1A / 5A inputs from AC transformers
- Serial interface to RTU500 (RS-485)
- LO power supply: 20...48 V DC
- HI power supply: 80...260 V AC, 80...330 V DC

Remote Terminal Units
RTU500 series modules – Multimeters

—
560CVD03
1KGT028000R0031
1KGT028000R0035
1KGT028000R0051
1KGT028000R0055

Version	Type	Display	LO	HI	1A	5A
560CVD03 R0031	3U3I	x	x		x	
560CVD03 R0035	3U3I	x	x			x
560CVD03 R0051	3U3I	x		x	x	
560CVD03 R0055	3U3I	x		x		x

560CVD03 - Multimeter with display, 1A / 5A , 3U3I

Application
The Multimeter 560CVD03 is used for measuring analog AC input signals from three independent phases. For each phase voltage and current are measured directly and a number of calculated values are generated by the module. The module supports configurations with 2 or 3 voltage transformers.
There are several versions available.

Description
- CT/VT interface with 3 voltage and 3 current inputs for direct monitoring of 3 wire 85…400 V AC
- 1 A/ 5 A inputs from AC transformers
- Serial interface to RTU500 (RS-485)
- With display on front
- LO power supply: 20...48 V DC
- HI power supply: 80...260 V AC, 80...330 V DC

Remote Terminal Units
RTU500 series modules - Multimeters

—
560CVD11
1KGT030000R0021
1KGT030000R0025
1KGT030000R0041
1KGT030000R0045

Version	Type	LO	HI	1A	5A
560CVD11 R0021	4U4I	x		x	
560CVD11 R0025	4U4I	x			x
560CVD11 R0041	4U4I		x	x	
560CVD11 R0045	4U4I		x		x

560CVD11 - Multimeter with FCD, 1A / 5A, 4U4I

Application
The Multimeter 560CVD11 is used for measuring analog AC input signals from three independent phases with addition input for neutral current and voltage. For each phase voltage and current are measured directly and a number of calculated values are generated by the module. In addition the module detects the fault current and the over current direction. The module supports configurations with 3 or 4 voltage transformers.
There are several versions available.

Description
- CT/VT interface with 4 voltage and 4 current inputs for direct monitoring of 3/4 wire 10…300 V AC
- 1 A/ 5 A signals
- Serial interface to RTU560 (RS-485)
- Fault current detection (FCD), directional information, 20x In

Remote Terminal Units
RTU500 series modules – Multimeters

—
500CVD21
1KGT030300R0121
1KGT030300R0125
1KGT030300R0141
1KGT030300R0145

Version	Type	LO	HI	1A	5A
500CVD21 R0121	4U24I	x		x	
500CVD21 R0125	4U24I	x			x
500CVD21 R0141	4U24I		x	x	
500CVD21 R0145	4U24I		x		x

500CVD21 - Multimeter with FCD, 1A / 5A, 4U24I

Application
The Multimeter 500CVD21 is used for measuring analog AC input signals from three independent phases with optional inputs for neutral current and voltage. The module can measure currents from 6 or 8 feeders (3 phase systems) depending on the current input configuration. For each phase voltage and current are measured directly and a number of calculated values are generated by the module. In addition the module detects the fault current and the over current direction. The module supports configurations with 2, 3 or 4 voltage transformers.
There are several versions available.

Description
- CT/VT interface with 4 voltage and 24 current inputs for direct monitoring of 3/4 wire 0…300 V AC (line to earth), 0...500 V AC (phase to phase)
- 1A / 5A from AC transformers
- Serial interface to RTU500 (RS-485)
- Fault current detection (FCD), directional information, 20x In
- LO power supply: 24...60 V DC
- HI power supply: 80...330 V AC, 80...260 V DC

Configuration kit for 560CVDxx	560KCA01 • Configuration kit for RTU500 series - multimeters • Set containing one cable mini-USB to DB-9 for RS-232 configuration port and CD with configuration tool for RTU500 series - multimeters

Remote Terminal Units
RTU500 series modules – Serial communication

—
500FSD10
1KGT019200R0001

500FSD10 - Modem V.23

Application
The 500FSD10 is a modem which converts the serial data according to CCITT V.23 standard with 1200 baud. It operates on the frequency shift keying principle (FSK).
Two- or four-wire operation mode is selectable by DIP-switch. The line output is capable to drive up to 10 remote stations connected in a multi-drop line. It can be connected to the 23WT23 modem for rack mounting and can be used as a self-contained counterpart of it.

Description
- Voice frequency telegraphy device (VFT)
- According CCITT V.23 standard with max. 1200 baud
- Can be connected to 23WT23
- DIN rail mounted
- Auxilliary voltage: 24...60 V DC

—
500FSD11
1KGT019300R0001

500FSD11 - Modem 9600 baud

Application
The 500FSD11 is a modem for transmitting serial data at rates up to 9600 baud. It operates on the frequency shift keying principle (FSK). Two- or four wire operation mode is selectable by DIP-switch.
The line output is capable to drive up to 10 remote stations connected in a multi-drop line. It can be connected to the 23WT24 modem for rack mounting and can be used as a self-contained counterpart of it.

Description
FSK device with 9600 baud transmission speed
- Communication over pilot cable
- Can be connected to 23WT24
- DIN rail mounted
- Isolation test voltage 3 kV
- Auxilliary voltage: 24...60 V DC

Remote Terminal Units
RTU500 series modules – Serial communication

—
500LTD01
1KGT026200R0001

Description
Isolated line transformer for galvanic isolation of transmission line
- Operates at a frequency range from 300 Hz to 3.4 kHz (23WT23, 23WT25 and 500FSD10)
- Isolation test voltage 10 kV/50 Hz/10 s
- Optimized for line impedances of 600 Ω
- Ratio 1:1
- Snap locked
- Screw terminals
- Insulation resistance: 10000 MΩ at 500 V between windings and the case

500LTD01 - Line Transformer 10 kV, 300 Hz…3.4 kHz

Application
The line transformer 500LTD01 is designed for FSK channels in the range of 50 Bd to 2400 Bd and to isolate and protect the RTU500 series Modems 23WT23, 23WT25 and 500FSD10 from the telecontrol line. Moreover it can also be connected to other data terminal equipments.
It is optimized for pilot wire communication with a frequency range from 300 Hz to 3400 Hz and for line impedances of 600 Ohms which applies to above mentioned modems.
A high-resistance staggering is possible with all three types of modems on e.g. party lines and multi-drop lines. This is because of the line transformer has no additional load at the line.
In configurations using full duplex communication channels two line transformers are required, one for transmitting direction and one for receiving direction.

—
500LTD02
1KGT026600R0002

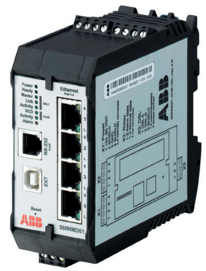
Description
Isolated line transformer for galvanic isolation of transmission line
- Operates at a frequency range from 2 kHz to 50 kHz (23WT24 and 500FSD11)
- Isolation test voltage 7.5 kV
- Optimized for line impedances of 150 Ω
- Ratio 1:1
- Insulation resistance: 10000 MΩ at 500 V between windings and the case

500LTD02 - Line Transformer 7.5 kV, 2-50 kHz

Application
The line transformer 500LTD02 is designed for FSK channels with 9600 baud to isolate and protect the RTU560 Modems 23WT24 and 500FSD11 from the telecontrol line. Moreover it can also be connected to other data terminal equipments. It operates at a frequency range from 2 kHz to 50 kHz and is optimized for line impedances of 150 Ohms which applies to above mentioned modems.
A high resistance staggering is possible with both types of modems on e.g. party lines and multi-drop lines. This is because the line transformer has no additional load at the line. In configurations using full duplex communication channels two line transformers are required, one for transmitting direction and one for receiving direction.

Remote Terminal Units
RTU500 series modules – Ethernet communication

—
500NMD01
1KHW025096R0001



Description
- Integrated managed layer-2-switch
- 4x 10/100 BaseT port (RJ45, electrical, autonegotiating)
- 1x SDSL-port for copper wire (pilot cable)
- Provides redundant topologies by the (Rapid) Spanning Tree Protocol (RSTP)
- 1x RS-232 port suitable for tunneling of serial protocols

500NMD01 - DIN rail integrated managed switch with 1 SDSL-port, 4 Ethernet ports and 1 serial RS-232 port

Application
The DIN rail mountable 500NMD01 is a managed plug and play layer-2-switch providing 4 fast Ethernet auto-negotiating RJ45- ports with auto MDI/X (Automatic Crossover Detection and Correction) and one 2-wire SDSL-port for use with private copper cables. The switch is intended for distributing Ethernet within a station through the RJ45-ports.
The SDSL-port can be used for interconnecting stations with a maximum distance of 20 km (copper cable with diameter of 0.8 mm). The switch is able to provide redundant topologies by the (Rapid) Spanning Tree Protocol. The modem can be connected to 560NMS24 and 560NMS34.

—
500NMD02
1KHW025097R0001

Description
- Integrated managed layer-2-switch
- 4x 10/100 BaseT port (RJ45, electrical, autonegotiating)
- 2x SDSL-port for copper wire
- Provides redundant topologies by the (Rapid) Spanning Tree Protocol (RSTP)
- 2x RS-232 port suitable for tunneling of serial protocols

500NMD02 - DIN rail integrated managed switch with 2 SDSL-ports, 4 Ethernet ports and 2 serial RS-232 ports

Application
The DIN rail mountable 560NMD02 is a managed plug and play layer-2-switch providing 4 fast Ethernet auto-negotiating RJ45- ports with auto MDI/X (Automatic Crossover Detection and Correction) and two 2-wire SDSL-ports for use with private copper cables. The switch is intended for distributing Ethernet within a station through the RJ45-ports.
The SDSL-ports can be used for interconnecting stations with a maximum distance of 20 km (copper cable with diameter of 0.8 mm). The switch is able to provide redundant topologies by the (Rapid) Spanning Tree Protocol in one device. The modem can be connected to 560NMS24 and 560NMS34.

Remote Terminal Units
RTU500 series modules – Ethernet communication

—
500NMD11
1KHW027869R0001

500NMD11 - DIN rail integrated managed switch with 1 SDSL-port. 1 FX-port and 4 Ethernet ports

Application
The DIN rail mountable 500NMD11 is a managed plug and play layer-2 switch providing 4 auto-negotiating fast Ethernet RJ45-ports with auto MDI/X (Automatic Crossover Detection and Cor-rection), one 2-wire SDSL-port for use with private copper cables and one SFP (small form-factor pluggable) module slot for use with fiber optic transceivers. Ethernet may be distributed within a station through the 4 RJ45-ports of the switch.
The SDSL-port can be used for interconnecting stations with a maximum distance of 20 km (diameter of 0.8 mm) copper cable. Depending on the SFP-module equipped, the unit is able to span distances by fiber optic cable up to 40 km. The switch is able to provide redundant topologies by the (Rapid) Spanning Tree Protocol in one device.

Description
- Integrated managed layer-2-switch
- 4x 10/100 BaseT port (RJ45, electrical, autonegotiating)
- 1x SFP slot (without optical transmitter/receiver)
- Additional SFP modules are required (see 560NFOxx)
- 1x SDSL-port for copper wire
- Provides redundant topologies by the (Rapid) Spanning Tree Protocol (RSTP)
- 2x RS-232 port suitable for tunneling of serial protocols

Additional material:		
SFP (small form-factor pluggable) for optical switch	1KHW001893R0001 1KHW001894R0001 1KHW001895R0001	500SMM15 • for 560NUS12 and 500NMD11 mono mode. Distance of typically 15km 500SSM40 • for 560NUS12 and 500NMD11 mono mode. Distance of typically 40km 500SMM02 • for 560NUS12 and 500NMD11 mono mode. Distance of typically 2km
Configuration adapter for 560NMDxx	1KHW027870R0001	560NMA01 • Saves configuration for one DIN rail integrated switch • Enable PC free replacement of modules

Remote Terminal Units
RTU500 series modules – Ethernet communication

—
500NMD20
1KHW025098R0001

500NMD20 - DIN rail integrated managed switch with 2 FX-ports and 4 Ethernet ports

Application
The DIN rail mountable 500NMD20 is a managed plug and play layer-2 switch providing four Fast Ethernet auto-negotiating RJ45-ports with auto MDI/X (Automatic Crossover Detection and Correction) and two SFP (small form-factor pluggable) module slots for use with fibre optic transceivers.
Depending on the SFP module equipped, the unit is able to span distances by fibre optic cable up to 40 km (or even more with special SFP modules). The switch is able to provide redundant topologies by the (Rapid) Spanning Tree Protocol.

Description
- Integrated managed layer-2-switch
- 4x 10/100 BaseT port (RJ45, electrical, autonegotiating)
- 2x SFP-slot (without optical transmitter/receiver)
- Additional SFP module is required (see 560NFOxx)
- Provides redundant topologies by the (Rapid) Spanning Tree Protocol (RSTP)
- 2x RS-232 port suitable for tunneling of serial protocols

—
500LTD03
1KGT026600R0003

500LTD03 - DIN rail line transformer 7.5 kV. 1-1000 kHz

Application
The line transformer 500LTD03 is designed for DSL channels with up to 7168 kbps and to isolate and protect the RTU500 DSL Modems 500NMD01, 500NMD02, 500NMD11, 560NMS24 and 560NMS34 from the telecontrol line. Moreover it can also be connected to other data terminal equipments.
It operates at a frequency range from 1 kHz to 1 MHz and is optimized for line impedances of 100 Ohms.
In DSL modem configurations one line transformer is required at both ends of the line.

Description
Isolated line transformer for galvanic isolation of transmission line
- Designed for DSL channels with up to 7168 kbps
- Isolates and protects the RTU500 SDSL modems 560NMDxx, 500NMDxx, 560NMSxx from the telecontrol line
- Operates at a frequency range from 1 kHz to 1000 kHz
- Isolation test voltage > 10 kV
- Optimized for line impedances of 100 Ohms
- Ratio 1:1
- Insulation resistance: 10.000 M Ohm at 500 V between windings and the case

Remote Terminal Units
One software for all product lines of RTU500 series – RTU500 series functions and software

Licences Release 11	
Release 11 for RTU560 and RTU540 series	
Basic Licence	
PLC/Archive Licence	60-61
HMI (human machine interface) Licence	60-61
	60-61
Release 11 for RTU520 series	
Basic Licence	
PLC/Archive Licence	62
	62

Licences Release 12	
Release 12 for RTU560 and RTU540 series	
Basic Licence	
SPS/Archive Licence	60-61
HMI (human machine interface) Licence	60-61
RTU Licences (Extentsion)	60-61
	60-61
Release 12 for RTU520 series	
Basic Licence	
PLC/Archive Licence	62
RTU Licences (Extentsion)	62
	62

Configuration software	
COMPROTware Tool	63
ITT600 SA Explorer	63
RTUtil500	63
IET600	63
MULTIPROGwt	63

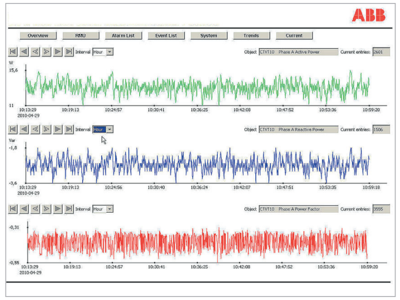
Remote Terminal Units
One software for all product lines of RTU500 series – RTU500 series functions and software

— 01 Presentation of analogue trends.

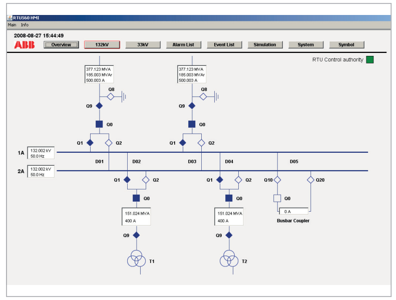
— 02 Human machine interface with example for station monitoring.

— 03 Settings of I / O adapters.

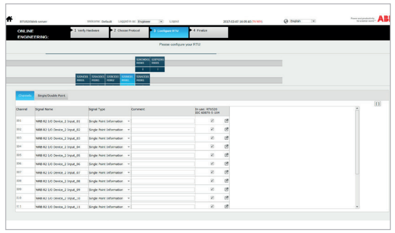
— 04 Web interface for RTU500 series.



— 01



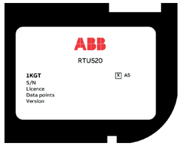
— 02



— 03

— 04

Remote Terminal Units
RTU500 series functions and software



Licences Release 11 for RTU560 and RTU540 series SD card für 560CMR01, 560CMR02, 540CMD01, 540CID01	
Basic Licence 1KGT201651R0011 (50 DP) 1KGT201648R0011 (250 DP) 1KGT201645R0011 (750 DP) 1KGT201437R0001 (5000 DP)	• 50 DP/ 250 DP/ 750 DP/ 5000 DP • Incl. IEC 61850 Server and Client • All protocols • SD card
PLC/Archive Licence 1KGT201652R0011 (50 DP) 1KGT201649R0011 (250 DP) 1KGT201646R0011 (750 DP) 1KGT201643R0011 (5000 DP)	• 50 DP/ 250 DP/ 750 DP/ 5000 DP • Incl. basic licence • SD card
HMI Licence 1KGT201653R0011 (50 DP) 1KGT201650R0011 (250 DP) 1KGT201647R0011 (750 DP) 1KGT201644R0011 (5000 DP)	• 50 DP/ 250 DP/ 750 DP/ 5000 DP • Incl. basic and PLC/Archive licence • SD card

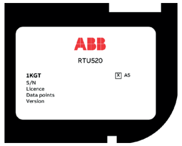
Licences Release 12 for RTU560 and RTU540 series SD card für 560CMR01, 560CMR02, 540CMD01, 540CID01	
Basic Licence 1KGT201651R0012 (50 DP) 1KGT201648R0012 (250 DP) 1KGT201645R0012 (750 DP) 1KGT201642R0012 (5000 DP)	• 50 DP/ 250 DP/ 750 DP/ 5000 DP • Incl. IEC 61850 Server and Client • All protocols
SPS/Archive Licence 1KGT201652R0012 (50 DP) 1KGT201649R0012 (250 DP) 1KGT201646R0012 (750 DP) 1KGT201643R0012 (5000 DP)	• 50 DP/ 250 DP/ 750 DP/ 5000 DP • Incl. basic licence
HMI Licence 1KGT201653R0012 (50 DP) 1KGT201650R0012 (250 DP) 1KGT201647R0012 (750 DP) 1KGT201644R0012 (5000 DP)	• 50 DP/ 250 DP/ 750 DP/ 5000 DP • Incl. basic licence and SPS/Archive Licence
RTU Licences Release 12 (Extension) 1KGT036600R0001	• Advanced security features: VPN, IEC104 secure and IEEE 802.1X • License extension for Release 12 Firmware • Adds the following features to the license: - VPN - IEC104 secure - IEEE 802.1X authentication

Remote Terminal Units
RTU500 series functions and software

Licences Release 11 for RTU560 and RTU540 series CF card for 560CMU02, 560CMU05, 560CMG10, 560CIG10, 560CMD11, 560CID11	
Basic Licence 1KGT201446R0011 (50 DP) 1KGT201443R0011 (250 DP) 1KGT201440R0011 (750 DP) 1KGT201437R0011 (5000 DP)	• 50 DP/ 250 DP/ 750 DP/ 5000 DP • Incl. IEC 61850 Server and Client • All protocols • Compact flash card 128 MB
PLC/Archive Licence 1KGT201447R0011 (50 DP) 1KGT201444R0011 (250 DP) 1KGT201441R0011 (750 DP) 1KGT201438R0011 (5000 DP)	• 50 DP/ 250 DP/ 750 DP/ 5000 DP • Incl. basic licence • Compact flash card 128 MB
HMI Licence 1KGT201448R0011 (50 DP) 1KGT201445R0011 (250 DP) 1KGT201442R0011 (750 DP) 1KGT201439R0011 (5000 DP)	• 50 DP/ 250 DP/ 750 DP/ 5000 DP • Incl. basic and PLC/Archive licence • Compact flash card 128 MB

Licences Release 12 for RTU560 and RTU540 series CF card for 560CMU02, 560CMU05, 560CID11, 560CIG10, 560CMD11, 560CMG10	
Basic Licence 1KGT201446R0012 (50 DP) 1KGT201443R0012 (250 DP) 1KGT201440R0012 (750 DP) 1KGT201437R0012 (5000 DP)	• 50 DP/ 250 DP/ 750 DP/ 5000 DP • Incl. IEC 61850 Server and Client
SPS/Archive Licence 1KGT201447R0012 (50 DP) 1KGT201444R0012 (250 DP) 1KGT201441R0012 (750 DP) 1KGT201438R0012 (5000 DP)	• 50 DP/ 250 DP/ 750 DP/ 5000 DP • Incl. basic licence
HMI Licence 1KGT201448R0012 (50 DP) 1KGT201445R0012 (250 DP) 1KGT201442R0012 (750 DP) 1KGT201439R0012 (5000 DP)	• Incl. basic licence and SPS/Archive licence
RTU Licences Release 12 (Extension) 1KGT036600R0001	• Advanced security features: VPN, IEC104 secure and IEEE 802.1X • License extension for Release 12 Firmware • Adds the following features to the license: - VPN - IEC104 secure - IEEE 802.1X authentication

Remote Terminal Units
RTU500 series functions and software



Licences Release 11 for RTU520 series SD card	
Basic Licence 1KGT201599R0011 (50 DP) 1KGT201596R0011 (250 DP) 1KGT201593R0011 (750 DP)	• 50 DP/ 250 DP/ 750 DP • For all protocols • SD card
PLC/Archive Licence 1KGT201600R0011 (50 DP) 1KGT201597R0011 (250 DP) 1KGT201594R0011 (750 DP)	• 50 DP/ 250 DP/ 750 DP • Incl. basic licence • SD card

Licences Release 12 for RTU520 series SD card für 520CMD01	
Basic Licence 1KGT201599R0012 (50 DP) 1KGT201596R0012 (250 DP) 1KGT201593R0012 (750 DP)	• 50 DP/ 250 DP/ 750 DP • For all protocols • SD card
SPS/Archive Licence 1KGT201600R0012 (50 DP) 1KGT201597R0012 (250 DP) 1KGT201594R0012 (750 DP)	• 50 DP/ 250 DP/ 750 DP • Incl. basic licence • SD card
RTU Licences Release 12 (Extension) 1KGT036600R0001	• Advanced security features: VPN, IEC104 secure and IEEE 802.1X • License extension for Release 12 Firmware • Adds the following features to the license: - VPN - IEC104 secure - IEEE 802.1X authentication

Remote Terminal Units
RTU500 series functions and software







Configuration software		
COMPROTware Tool	1KGT0000000R0003	Integrated test tool for telecontrol protocols • The following protocols are available: IEC 870-5-101, IEC 870-5-102, IEC 870-5-103, IEC 870-5-104, MODBUS, SPABUS, RP570, DNP 3.0 (serial, DNP 3.0 on LAN/WAN • Scope of supply: Dongle (hardlock USB)
ITT600 SA Explorer	1KGT210239R0001	IEC 61850 testing tool (single license) with following functions: • Explore IED's • Explore data models • Explore Ethernet • Explore GOOSE • Scope of supply: dongle (hardlock USB), CD
RTUtil500	1KGT210278R0001	Utility software for industrial standard PC containing the program modules running under Windows XP/Windows 7 (single license): • Configuration of RTU500 (signal tree, network tree, hardware tree) • Creation of download files for RTU500 • EXCEL-Import/Export function • Scope of supply: one CD • For firmware release 11
RTUtil500 Rel 12	1KGT210278R0012	Utility software for industrial standard PC containing the program modules running under Windows 7 (single license): • Configuration of RTU500 (signal tree, network tree, hardware tree) • Creation of download files for RTU500 • EXCEL-Import/Export function • Scope of supply: one CD-ROM • For firmware release 12
IET600	1KGT030900R0001	Integrated Engineering tool IET600 IET600 acts as a system tool which is used to define and share the system-wide 61850 parameters, such as communication addresses, horizontal communication data and its priorities and client/server (system level/IED) connections. The actual configuration of the IED and the downloading of configuration changes is done with PCM600.
Multiprog 5 (PRO)	1KGT038500R0001	Utility software for industrial standard PC containing the program modules running under Windows 7/Windows 10 (single license) • PLC programming according to IEC61131-3, function-block-diagram (FBD), instruction list (IL), structured text (ST), sequential function chart (SFC), ladder diagram (LD) • Import/export with external programming and simulation systems (PLCopen) • Matlab Simulink XML Code Import • Source Code Conversion (FBS/KOP/AWL) • Project comparison and multi-user mode • Scope of supply: license key for one workplace (single license) • for RTUtil500 release 12.2 and newer • Tool is part of the RTUtil500 CD-ROM (needs to be ordered separately)
MULTIPROGwt	1KGT210204R0001	Software package utilities RTU500 for PLC Utility software for industrial standard-PC containing the program modules running under Windows XP (single license): • PLC programming according to IEC61131-3. function-block-diagram (FBD), instruction list (IL), structured text (ST), sequential function chart (SFC), ladder diagram (LD) • Scope of supply: dongle (hardlock USB), software is part of RTUtil560 and RTUtil500 CD • For RTUtil500 Version 11 and 12

Сертификат BG98/13513

Системата за управление на

АББ България ЕООД
АББ България ЕООД – клон Севлиево
АББ България ЕООД – клон Петрич
АББ България ЕООД – клон Раковски

бул. „Витоша“ № 89Б, „ОББ Милениум“ център, сграда А, етаж 17,
1408 София, България

е оценена и сертифицирана съгласно изискванията на

ISO 9001:2015

За следните дейности

Маркетинг и продажби на системи, компоненти и продукти за ниско, средно и високо напрежение, трансформатори, преобразуватели, системи за производство и съхраняване на електроенергия. Проектиране и управление на проекти, свързани с мрежи и системи ниско, средно и високо напрежение, системи за автоматизация и автоматизирано управление, интелигентни системи и мрежи. Управление на процесите на обслужване и поддръжка на електрически централи с възобновяем източник. Сервиз на турбокомпресори за двигатели с вътрешно горене, с мощност над 500 kW и продажба на резервни части за тях. Развойна дейност и тестване. Производство и сглобяване на среднотокови, слаботокови и силнотокови електротехнически и електронни продукти. Конструиране и сглобяване на продукти, модули и компоненти за високо напрежение. Сглобяване на сухи трансформатори. Производство на електромеханични монтажни възли, в това число заваряване, навиване, пресоване, сглобяване на компоненти за продукти ниско напрежение и монтаж на DIN шини.

Този сертификат е валиден от 28 Септември 2018 до 27 Септември 2021
и остава валиден при задоволителни резултати от контролни проверки.
Ресертификационен одит следва да бъде проведен до: 28 Август 2021
Издание 2. Сертификацията е от 30 Юни 1998

Това е многообектова сертификация
Информация за допълнителните обекти е описана на следващия лист.

ИА "БСА"
Рег. № 2 ОСС
ОРГАН ПО СЕРТИФИКАЦИЯ НА СИСТЕМИ

Подписи

Заличено по чл. 36а, ал.3 от ЗОП

Заличено по чл. 36а, ал.3 от ЗОП

Д. Марикин, Управител

А. Амзина, Ръководител ОСС

СЖС България ЕООД
БЦ МЕГАПАРК,Офис „С“, ет. 6
бул. Цариградско шосе № 115Г, 1784 София, България
тел. 02 / 9 10 15, факс 02 / 981 81 43, www.sgs.bg

АББ България ЕООД
АББ България ЕООД – клон Севлиево
АББ България ЕООД – клон Петрич
АББ България ЕООД – клон Раковски

ISO 9001:2015

Издание 2

Допълнителни обекти:

АББ България ЕООД – Централен офис – София

бул. „Витоша" № 89Б, „ОББ Милениум" център, сграда А, етаж 17, 1408 София, България

Маркетинг и продажби на системи, компоненти и продукти за ниско, средно и високо напрежение, трансформатори, преобразуватели, системи за производство и съхраняване на електроенергия. Проектиране и управление на проекти, свързани с мрежи и системи ниско, средно и високо напрежение, системи за автоматизация и автоматизирано управление, интелигентни системи и мрежи. Управление на процесите на обслужване и поддръжка на електрически централи с възобновяем източник.

АББ България ЕООД – Център за развойна дейност - София

Бизнес център „Сердика", бул. „Иван Евстатиев Гешов" № 2Е, Сграда 2, ет. 2, офис 201, 1330 София, България

Развойна дейност и тестване.

АББ България ЕООД – Сервизна станция за турбокомпресори (ССТ) – Варна

КРЗ Одесос, Островна зона, 9009 Варна, България

Сервиз на турбокомпресори за двигатели с вътрешно горене, с мощност над 500 kW и продажба на резервни части за тях.

АББ България ЕООД – клон Севлиево

ул. „Никола Петков" № 32, 5400 Севлиево, България

Конструиране и сглобяване на продукти, модули и компоненти за високо напрежение. Сглобяване на сухи трансформатори.

АББ България ЕООД – клон Петрич

ул. „Варна" № 1, 2850 Петрич, България

Производство на електромеханични монтажни възли, в това число заваряване, навиване, пресоване, сглобяване на компоненти за продукти ниско напрежение и монтаж на DIN шини.

АББ България ЕООД – клон Раковски

ул. „Индустриален път 1" № 14 и № 18, Индустриална зона Раковски, 4142 с. Стряма, България

Производство и сглобяване на средноточкови, слаботокови и силнотокови електротехнически и електронни продукти.

ИА "БСА"
Рег. № 2 ОСС
ОРГАН ПО СЕРТИФИКАЦИЯ НА СИСТЕМИ

Certificate BG98/13513

The management system of

ABB Bulgaria EOOD
ABB Bulgaria EOOD – Sevlievo Branch
ABB Bulgaria EOOD – Petrich Branch
ABB Bulgaria EOOD – Rakovski Branch

89B, Vitosha Blvd., UBB Millenium Center, Building A, floor 17, 1408 Sofia, Bulgaria

has been assessed and certified as meeting the requirements of

ISO 9001:2015

For the following activities

Marketing and sale of low, medium and high voltage products, systems and components, transformers, converters and energy generation storage. Design and management of projects for low, medium and high voltage grids and systems, automation systems and automated management, smart grids and systems. Managing the processes of operation and maintenance of power plants with renewable energy source. Service of turbochargers for internal combustion engines, with output power higher than 500 kW and sale of spare parts. Research, development and testing. Manufacturing and assembly of medium, low and high voltage electro-technical and electronic products. Design and assembling of high voltage products, modules and components. Assembling of dry transformers. Production of electromechanical assemblies, including welding, winding, pressing, assembly of components for low voltage products and DIN rail mounting.

This certificate is valid from 28 September 2018 until 27 September 2021 and remains valid subject to satisfactory surveillance audits.
Re certification audit due before: 28 August 2021
Issue 2. Certified since 30 June 1998

This is a multi-site certification
Additional site details are listed on the subsequent page

Authorised by

Заличено по чл. 36а, ал.3 от ЗОП

D. Marikin, Managing Director

Заличено по чл. 36а, ал.3 от ЗОП

A. Amzina, Head of Management Systems Certification Body

ИА "БСА"
Рег. № 2 ОСС
ОРГАН ПО СЕРТИФИКАЦИЯ НА СИСТЕМИ

SGS Bulgaria Ltd.
BC MEGAPARK, Office C, floor 6
115G, Tsarigradsko shosse Blvd., 1784 Sofia, Bulgaria
t +359 2 9 10 15, f +359 2 981 81 43, www.sgs.bg

ABB Bulgaria EOOD
ABB Bulgaria EOOD – Sevlievo Branch
ABB Bulgaria EOOD – Petrich Branch
ABB Bulgaria EOOD – Rakovski Branch

ISO 9001:2015

Issue 2

Additional facilities:

ABB Bulgaria EOOD – Main office - Sofia

89B, Vitosha Blvd., UBB Millenium Center, Building A, floor 17, 1408 Sofia, Bulgaria

Marketing and sale of low, medium and high voltage products, systems and components, transformers, converters and energy generation storage. Design and management of projects for low, medium and high voltage grids and systems, automation systems and automated management, smart grids and systems. Managing the processes of operation and maintenance of power plants with renewable energy source.

ABB Bulgaria EOOD – R&D office - Sofia

Business Center Serdika, 2E, Ivan Evstatiev Geshov Blvd., Building 2, floor 2, office 201, 1330 Sofia, Bulgaria

Research, development and testing.

ABB Bulgaria EOOD – Turbocharger Service Station (TSS) - Varna

Odessos Shiprepair Yard, Island Zone, 9009 Varna, Bulgaria

Service of turbochargers for internal combustion engines, with output power higher than 500 kW and sale of spare parts.

ABB Bulgaria EOOD – Sevlievo Branch

32, Nikola Petkov str., 5400 Sevlievo, Bulgaria

Design and assembling of high voltage products, modules and components. Assembling of dry transformers.

ABB Bulgaria EOOD – Petrich Branch

1, Varna str., 2850 Petrich, Bulgaria

Production of electromechanical assemblies, including welding, winding, pressing, assembly of components for low voltage products and DIN rail mounting.

ABB Bulgaria EOOD – Rakovski Branch

14 and 18, Industrial Road 1, Industrial Zone Rakovski, 4142 Stryama, Bulgaria

Manufacturing and assembly of medium, low and high voltage electro-technical and electronic products.

ИА "БСА"
Рег. № 2 ОСС
ОРГАН ПО СЕРТИФИКАЦИЯ НА СИСТЕМИ