ABB ABILITY™ SMART SUBSTATION CONTROL AND PROTECTION FOR ELECTRICAL SYSTEMS

SSC600

IEC 60870-5-104 Communication Protocol Manual

Document ID: 2NGA000789
Issued: 2021-11-26
Revision: C
Product version: 1.0 FP3

Copyright

Trademarks

Open Source Software

This product contains open source software. For license information refer to product documentation at *https://new.abb.com/*

Warranty

Please inquire about the terms of warranty from your nearest ABB representative.

www.abb.com/mediumvoltage

Copyright

Trademarks

ABB and Relion are registered trademarks of the ABB Group. All other brand or product names mentioned in this document may be trademarks or registered trademarks of their respective holders. SSC600 is an approved Intel® IoT Market Ready Solution.

Open Source Software

This product contains open source software. For license information refer to product documentation at *www.abb.com*.

Warranty

Please inquire about the terms of warranty from your nearest ABB representative.

www.abb.com/mediumvoltage

Disclaimer

The data, examples and diagrams in this manual are included solely for the concept or product description and are not to be deemed as a statement of guaranteed properties. All persons responsible for applying the equipment addressed in this manual must satisfy themselves that each intended application is suitable and acceptable, including that any applicable safety or other operational requirements are complied with. In particular, any risks in applications where a system failure and/or product failure would create a risk for harm to property or persons (including but not limited to personal injuries or death) shall be the sole responsibility of the person or entity applying the equipment, and those so responsible are hereby requested to ensure that all measures are taken to exclude or mitigate such risks.

This product has been designed to be connected and communicate data and information via a network interface which should be connected to a secure network. It is the sole responsibility of the person or entity responsible for network administration to ensure a secure connection to the network and to take the necessary measures (such as, but not limited to, installation of firewalls, application of authentication measures, encryption of data, installation of anti virus programs, etc.) to protect the product and the network, its system and interface included, against any kind of security breaches, unauthorized access, interference, intrusion, leakage and/or theft of data or information. ABB is not liable for any such damages and/or losses.

This document has been carefully checked by ABB but deviations cannot be completely ruled out. In case any errors are detected, the reader is kindly requested to notify the manufacturer. Other than under explicit contractual commitments, in no event shall ABB be responsible or liable for any loss or damage resulting from the use of this manual or the application of the equipment. In case of discrepancies between the English and any other language version, the wording of the English version shall prevail.

Conformity

This product complies with the directive of the Council of the European Communities on the approximation of the laws of the Member States relating to electromagnetic compatibility (EMC Directive 2014/30/EU) and concerning electrical equipment for use within specified voltage limits (Low-voltage directive 2014/35/EU). This conformity is the result of tests conducted by the third party testing laboratory Intertek in accordance with the product standard EN 60255-26 for the EMC directive, and with the product standards EN 60255-1 and EN 60255-27 for the low voltage directive. The product is designed in accordance with the international standards of the IEC 60255 series.

Contents

1 Introduction

1.1 This manual

The communication protocol manual describes a communication protocol supported by the protection relay. The manual concentrates on vendor-specific implementations.

1.2 Intended audience

This manual addresses the communication system engineer or system integrator responsible for pre-engineering and engineering the communication setup in a substation from a protection relay's perspective.

The system engineer or system integrator must have a basic knowledge of communication in protection and control systems and thorough knowledge of the specific communication protocol.

1.3 Product documentation

1.3.1 Product documentation set

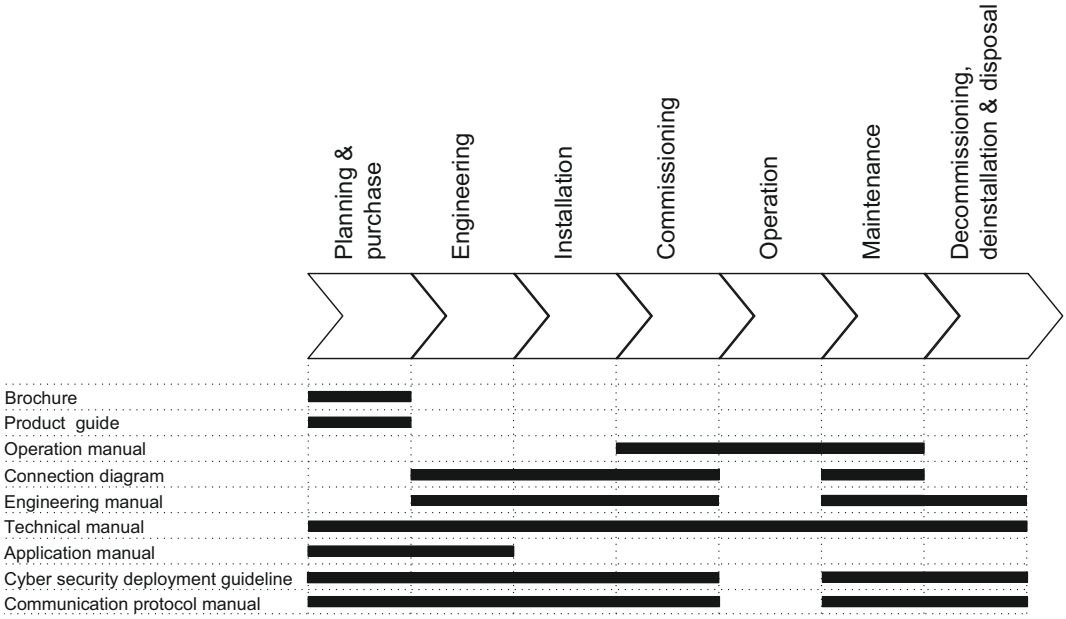

Figure 1: The intended use of documents during the product life cycle

1.3.2 Document revision history

Document revision/date	Product series version	History
B/2020-11-12	1.0 FP2	First release
C/2021-11-26	1.0 FP3	Content updated

1.3.3 Related documentation

Download the latest documents from the ABB Web site *www.abb.com/mediumvoltage*.

1.4 Symbols and conventions

1.4.1 Symbols

The warning icon indicates the presence of a hazard which could result in electrical shock or other personal injury.

The caution icon indicates important information or warning related to the concept discussed in the text. It might indicate the presence of a hazard which could result in corruption of software or damage to equipment or property.

The information icon alerts the reader of important facts and conditions.

The tip icon indicates advice on, for example, how to design your project or how to use a certain function.

Although the warning hazards are related to personal injury, it is necessary to understand that under certain operational conditions, operation of damaged equipment may result in degraded process performance leading to personal injury or death. Therefore, comply fully with all warning and caution notices.

1.4.2 Document conventions

A particular convention may not be used in this manual.

- Abbreviations and acronyms are spelled out in the glossary. The glossary also contains definitions of important terms.
- Menu paths are presented in bold.

  Select **Main menu/Settings**.
- Parameter names are shown in italics

  The function can be enabled and disabled with the *Operation* setting.
- Parameter values are indicated with quotation marks.

  The corresponding parameter values are "On" and "Off".
- Input/output messages and monitored data names are shown in Courier font.

  When the function starts, the `START` output is set to TRUE.
- This document assumes that the parameter setting visibility is "Advanced".

1.4.3 Functions, codes and symbols

Table 1: Functions included in the relay

Function	IEC 61850	IEC 60617	ANSI
Protection			
Distance protection	DSTPDIS	Z<	21P,21N
Three-phase non- directional overcurrent protection, low stage	PHLPTOC	3I>	51P-1
Three-phase non- directional overcurrent protection, high stage	PHHPTOC	3I>>	51P-2
Three-phase non- directional overcurrent protection, instantaneous stage	PHIPTOC	3I>>>	50P
Three-phase directional overcurrent protection, low stage	DPHLPDOC	3I> ->	67P/51P-1
Three-phase directional overcurrent protection, high stage	DPHHPDOC	3I>> ->	67P/51P-2
Non-directional earth-fault protection, low stage	EFLPTOC	Io>	51G/51N-1
Non-directional earth-fault protection, high stage	EFHPTOC	Io>>	51G/51N-2
Non-directional earth-fault protection, instantaneous stage	EFIPTOC	Io>>>	50G/50N
Directional earth-fault protection, low stage	DEFLPDEF	Io> ->	67G/N-1 51G/N-1
Directional earth-fault protection, high stage	DEFHPDEF	Io>> ->	67G/N-1 51G/N-2
Admittance-based earth-fault protection	EFPADM	Yo> ->	21NY
Multifrequency admittance-based earth-fault protection	MFADPSDE	Io> -> Y	67NYH
Wattmetric-based earth-fault protection	WPWDE	Po> ->	32N
Transient/intermittent earth-fault protection	INTRPTEF	Io> -> IEF	67NTEF/NIEF
Negative-sequence overcurrent protection	NSPTOC	I2>M	46M
Phase discontinuity protection	PDNSPTOC	I2/I1>	46PD
Residual overvoltage protection	ROVPTOV	Uo>	59G/59N

Table continues on the next page

Function	IEC 61850	IEC 60617	ANSI
Three-phase undervoltage protection	PHPTUV	3U<	27
Three phase overvoltage variation protection	PHVPTOV	3Urms>	59.S1
Three-phase overvoltage protection	PHPTOV	3U>	59
Positive-sequence undervoltage protection	PSPTUV	U1<	27PS
Negative-sequence overvoltage protection	NSPTOV	U2>	59NS
Frequency protection	FRPFRQ	f>/f<,df/dt	81
Three-phase thermal protection for feeders, cables and distribution transformers	T1PTTR	3Ith>F	49F
Three-phase thermal overload protection, two time constants	T2PTTR	3Ith>T/G/C	49T/G/C
Low-voltage ride-through protection	LVRTPTUV	UU	27RT
Directional reactive power undervoltage protection	DQPTUV	Q> -> ,3U<	32Q,27
Reverse power/ directional overpower protection	DOPPDPR	P>/Q>	32R/32O
Three-phase underimpedance protection	UZPDIS	ZZ	21G
Negative-sequence overcurrent protection for machines	MNSPTOC	I2>M	46M
Loss of load supervision	LOFLPTUC	3I<	37
Motor load jam protection	JAMPTOC	Ist>	50TDJAM
Motor start-up supervision	STTPMSU	Is2t n<	49,66,48,50TDLR
Phase reversal protection	PREVPTOC	I2>>	46R
Thermal overload protection for motors	MPTTR	3Ith>M	49M
Stabilized and instantaneous differential protection for two-winding transformers	TR2PTDF	3dI>T	87T
Numerical stabilized low-impedance restricted earth-fault protection	LREFPNDF	dIoLo>	87NLI
Circuit breaker failure protection	CCBRBRF	3I>/Io>BF	50BF
Three-phase inrush detector	INRPHAR	3I2f>	68HB

Table continues on the next page

Function	IEC 61850	IEC 60617	ANSI
Master trip	TRPPTRC	Master Trip	94/86
Arc protection	ARCSARC	ARC	AFD
Load-shedding and restoration	LSHDPFRQ	UFLS/R	81LSH
Multipurpose protection	MAPGAPC	MAP	MAP
Load blinder	LBRDOB	LB	21LB
Busbar differential protection	BBPBDF	3Id/I	87BL
Busbar zone selection	ZNRSRC	ZNRSRC	ZNRSRC
Control			
Circuit-breaker control	CBXCBR	I <-> O CB	52
Disconnector control	DCXSWI	I <-> O DCC	29DS
Earthing switch control	ESXSWI	I <-> O ESC	29GS
Disconnector position indication	DCSXSWI	I <-> O DC	29DS
Earthing switch position indication	ESSXSWI	I <-> O ES	29GS
Emergency start-up	ESMGAPC	ESTART	EST,62
Autoreclosing	DARREC	O -> I	79
Synchronism and energizing check	SECRSYN	SYNC	25
Tap changer control with voltage regulator	OL5ATCC	COLTC	90V
Condition monitoring and supervision			
Circuit-breaker condition monitoring	SSCBR	CBCM	52CM
Runtime counter for machines and devices	MDSOPT	OPTS	OPTM
Measurement			
Three-phase current measurement	CMMXU	3I	IA, IB, IC
Sequence current measurement	CSMSQI	I1, I2, I0	I1, I2, I0
Residual current measurement	RESCMMXU	Io	IG
Three-phase voltage measurement	VMMXU	3U	VA, VB, VC
Residual voltage measurement	RESVMMXU	Uo	VG/VN
Sequence voltage measurement	VSMSQI	U1, U2, U0	V1, V2, V0
Three-phase power and energy measurement	PEMMXU	P, E	P, E
Frequency measurement	FMMXU	f	f
Tap changer position indication	TPOSYLTC	TPOSM	84T

Table continues on the next page

Function	IEC 61850	IEC 60617	ANSI
Power quality			
Voltage variation	PHQVVR	PQMU	PQMV SWE,SAG,INT
Voltage unbalance	VSQVUB	PQUUB	PQMV UB
Traditional LED indication			
LED indication control	LEDPTRC	LEDPTRC	LEDPTRC
Individual virtual LED control	LED	LED	LED
Logging functions			
Disturbance recorder (common functionality)	RDRE	DR	DFR
Disturbance recorder, binary channels	RBDR	RBDR	RBDR
Fault recorder	FLTRFRC	FAULTREC	FR
Other functionality			
Parameter setting groups	PROTECTION	PROTECTION	PROTECTION
Time master supervision	GNRLLTMS	GNRLLTMS	GNRLLTMS
IEC 61850-1 MMS	MMSLPRT	MMSLPRT	MMSLPRT
IEC 61850-1 GOOSE	GSELPRT	GSELPRT	GSELPRT
IEC 60870-5-104 protocol	I5CLPRT	I5CLPRT	I5CLPRT
OR gate with two inputs	OR	OR	OR
OR gate with six inputs	OR6	OR6	OR6
OR gate with twenty inputs	OR20	OR20	OR20
AND gate with two inputs	AND	AND	AND
AND gate with six inputs	AND6	AND6	AND6
AND gate with twenty inputs	AND20	AND20	AND20
XOR gate with two inputs	XOR	XOR	XOR
NOT gate	NOT	NOT	NOT
Real maximum value selector	MAX3	MAX3	MAX3
Real minimum value selector	MIN3	MIN3	MIN3
Rising edge detector	R_TRIG	R_TRIG	R_TRIG
Falling edge detector	F_TRIG	F_TRIG	F_TRIG
Real switch selector	SWITCHR	SWITCHR	SWITCHR
Integer 32-bit switch selector	SWITCHI32	SWITCHI32	SWITCHI32
SR flip-flop, volatile	SR	SR	SR
RS flip-flop, volatile	RS	RS	RS
Minimum pulse timer second resolution, two channels	TPSGAPC	TPS	62TPS

Table continues on the next page

Function	IEC 61850	IEC 60617	ANSI
Minimum pulse timer minutes resolution, two channels	TPMGAPC	TPM	62TPM
Pulse timer, eight channels	PTGAPC	PT	62PT
Time delay off, eight channels	TOFGAPC	TOF	62TOF
Time delay on, eight channels	TONGAPC	TON	62TON
SR flip-flop, eight channels, nonvolatile	SRGAPC	SR	SR
Boolean value event creation	MVGAPC	MV	MV
Integer value event creation	MVI4GAPC	MVI4	MVI4
Analog value event creation with scaling	SCA4GAPC	SCA4	SCA4
Generic control points	SPCGAPC	SPC	SPCG
Local/Remote control	CONTROL	CONTROL	CONTROL
Voltage switch	VMSWI	VSWI	VSWI
Current sum	CMSUM	CSUM	CSUM
Current switch	CMSWI	CMSWI	CMSWI
SMV stream receiver (IEC 61850-9-2LE)	SMVRCV	SMVRCV	SMVRCV
Redundant Ethernet channel supervison	RCHLCCH	RCHLCCH	RCHLCCH
Ethernet channel supervision	SCHLCCH	SCHLCCH	SCHLCCH
Received GOOSE binary information	GOOSERCV_BIN	GOOSERCV_BIN	GOOSERCV_BIN
Received GOOSE double binary information	GOOSERCV_DP	GOOSERCV_DP	GOOSERCV_DP
Received GOOSE measured value information	GOOSERCV_MV	GOOSERCV_MV	GOOSERCV_MV
Received GOOSE 8-bit integer value information	GOOSERCV_INT8	GOOSERCV_INT8	GOOSERCV_INT8
Received GOOSE 32- bit integer value information	GOOSERCV_INT32	GOOSERCV_INT32	GOOSERCV_INT32
Received GOOSE interlocking information	GOOSERCV_INTL	GOOSERCV_INTL	GOOSERCV_INTL
Received GOOSE measured value (phasor) information	GOOSERCV_CMV	GOOSERCV_CMV	GOOSERCV_CMV
Received GOOSE enumerator value information	GOOSERCV_ENUM	GOOSERCV_ENUM	GOOSERCV_ENUM
Bad signal quality	QTY_BAD	QTY_BAD	QTY_BAD
Good signal quality	QTY_GOOD	QTY_GOOD	QTY_GOOD

Table continues on the next page

Function	IEC 61850	IEC 60617	ANSI
GOOSE communication quality	QTY_GOOSE_COMM	QTY_GOOSE_COMM	QTY_GOOSE_COMM
GOOSE data health	T_HEALTH	T_HEALTH	T_HEALTH
Fault direction evaluation	T_DIR	T_DIR	T_DIR
Enumerator to boolean conversion	T_TCMD	T_TCMD	T_TCMD
32-bit integer to binary command conversion	T_TCMD_BIN	T_TCMD_BIN	T_TCMD_BIN
Binary command to 32-bit integer conversion	T_BIN_TCMD	T_BIN_TCMD	T_BIN_TCMD
Switching device status decoder - CLOSE position	T_POS_CL	T_POS_CL	T_POS_CL
Switching device status decoder - OPEN position	T_POS_OP	T_POS_OP	T_POS_OP
Switching device status decoder - OK status	T_POS_OK	T_POS_OK	T_POS_OK
Security application	GSAL	GSAL	GSAL

2 IEC 60870-5-104 overview

2.1 IEC 60870-5-104 protocol

The IEC 60870-5-104 protocol standard is officially named “Network access for IEC 60870-5-101 using standard transport profiles”. The protocol is based on existing IEC 61870-5-101 application and transport layer profiles while also including a network link layer specification for Ethernet/TCP communication. Sometimes IEC 60870-5-104 is referred to as IEC 60870-5-101 over Ethernet/TCP.

2.2 Standard documentation

Table 2: Standard documentation

Document	Description
IEC 60870-5-104: Network access for IEC 60870-5-101 using standard transport profiles.	This document includes combined definitions of the application layer parts of IEC 60870-5-101 used by the 104 protocol and the Ethernet TCP/IP transport functions used by the 104 protocol.
IEC 60870-5-101: Companion standard for basic telecontrol task (incl. amendments).	This document includes the application layer parts of the 101 standard which are used by the IEC 60870-5-104 protocol.
IEC 60870-5-1 Transmission frame formats IEC 60870-5-2 Link transmission procedures IEC 60870-5-3 General Structure of application data IEC 60870-5-4 Definition and coding of application data elements IEC 60870-5-5 Basic application functions IEC 60870-5-7 Transmission procedures, extension for secure communication	These documents include a detailed description of the protocol-related data and tasks.

2.3 Communication link modes

Two alternative communication link modes, unbalanced or balanced mode, are available for the communication between the client (controlling station) and the server (controlled station). In this case, since the IEC 60870-5-104 client establishes separate TCP (point-to-point) connections towards each IEC 60870-5-104 server, the balanced mode is the most commonly used.

In the balanced link mode, both the client and the server can initiate message transfers. In the unbalanced mode, the client initiates the transmission with a request to which the server responds.

2.4 Basic protocol functionality

The server (controlled station) delivers various data to the client.

- Data object values reported upon changes
- Data object values reported cyclically
- Responses to control commands
- Responses to read requests

The client can at any time request the present process data values by issuing interrogation commands. The command may be a general interrogation (GI) request, where all data objects with GI indication configured “ON” are reported. The data objects’ GI indication configuration can also define that the data object belongs to a particular interrogation group, 1...16. In such a case, the client can request data interrogation values only from a specific interrogation group. A GI request reports values from all interrogation groups.

Integrated totals counter objects can be read on demand by the client using a counter interrogation request. Integrated totals objects can also be configured to report the counter values when counter freeze operations occur.

The client can issue single or double commands to single- or double-point control objects. Single controls are always direct control operations. For double command control objects (circuit breakers, controllable disconnectors), select-execute operations can be performed if the controllable target object allows it, but direct control of double-point objects is always possible. Controls can be given with or without time tags.

3 Vendor-specific implementation

3.1 Protocol instances

The protocol can be started and run in up to five instances, one instance for each possible IEC 60870-5-104 client attached. The instances operate independently of one another so it is possible to use different network link (TCP) and transport layer settings for each instance.

The protocol is not in use by default in the device. A function block I5CLPRT1…5 representing the protocol instance must first be dragged to the application configuration sheet using Application Configuration. If only one instance is used, instance block 1 should be chosen. Additional instances can then be added freely.

After the function block has been added to the application configuration sheet, it needs to be enabled by assigning the protocol setting parameter *Operation* to "1-On".

In order for the protocol instance to populate its own database based on the point mapping defined by the *Map Select* parameter, the device must be restarted once. So whenever *Operation* or *Map Select* settings are changed, the device must be restarted for the protocol instance to be properly set up according to the new configuration.

3.2 IEC 60870-5-104 data objects

Most of the device's internal IEC 61850 process data objects can be mapped to the IEC 60870-5-104 protocol. However, the potential protocol objects are not pre-mapped by default, so these objects should be mapped using Communication Management in PCM600.

The potential protocol objects have been pre-assigned into specific protocol ASDU types based on the source objects' IEC 61850 common data class (CDC) types. This pre-assignment cannot be changed.

3.2.1 Single-point information

Single-point information is derived from several IEC 61850 boolean data attributes (CDC.attribute/attribute/ …).

- SPS.stVal
- SPC.stVal
- DPC.stSeld
- ACD.general/phsA/phsB/phsC/neut
- ACT.general/phsA/phsB/phsC/neut

Table 3: Single-point information

Type	ASDU		
GI	1	M_SP_NA_1	Single point
Event	30	M_SP_TB_1	Single point with CP56Time2a

3.2.2 Double-point information

Double-point information is derived from several IEC 61850 data attributes.

- DPS.stVal
- DPC.stVal

Table 4: Double-point information

Type	ASDU		
GI	3	M_DP_NA_1	Double point
Event	31	M_DP_TB_1	Double point with CP56Time2a

3.2.3 Measured value, short floating point

The short floating-point type (float32) is derived from the IEC 61850 data classes/ attributes defined for measurand values. The default scaling for the IEC 60870-5-104 value is 1, making it identical to the corresponding IEC 61850 measurand value (CDC.attribute/attribute/ …).

- MV.mag.f
- CMV.cVal.mag.f
- DEL.phsAB.cVal.mag.f/phsBC.cVal.mag.f/phsCA.cVal.mag.f
- WYE.phsA.cVal.mag.f/phsB.cVal.mag.f/phsC.cVal.mag.f
- WYE.neut.cVal.mag.f/res.cVal.mag.f/net.cVal.mag.f
- SEQ.c1.cVal.mag.f/c2.cVal.mag.f/c3.cVal.mag.f

Table 5: Measured value, short floating point

Type	ASDU		
GI	13	M_ME_NC_1	Measurand, float32
Event	36	M_ME_TF_1	Measurand, float32 with CP56Time2a

3.2.4 Measured value, scaled integer

A scaled integer (int16) is derived from the IEC 61850 data classes/attributes defined for integer values, that is, the common data classes dealing with either integer or enumeral values. The default scaling for the IEC 60870-5-104 value is 1, making it identical to the corresponding IEC 61850 value (CDC.attribute/attribute/…).

- INS.stVal
- INC.stVal
- ENS.stVal
- ENC.stVal

Table 6: Measured value, scaled integer

Type	ASDU		
GI	11	M_ME_NB_1	Measurand, scaled integer
Event	33	M_ME_TE_1	Measurand, scaled integer with CP56Time2a

3.2.5 Integrated totals

Integrated totals counter values are derived from the IEC 61850 BCR (binary counter) class. Counter freezing means that the IEC 60870-5-104 stack latches the current BCR.actVal attribute to itself.

- BCR.actVal

Table 7: Integrated totals

Type	ASDU		
GI	15	M_IT_NA_1	Integrated totals
Event	37	M_IT_TB_1	Integrated totals with CP56Time2a

3.2.6 Step position

Tap changer step position information (-64…63) is derived from the IEC 61850 class BCS (binary controlled step position).

- BCS.ValWTr.stVal

Table 8: Step position

Type	ASDU		
GI	5	M_ST_NA_1	Step position
Event	32	M_ST_TB_1	Step position with CP56Time2a

3.2.7 Single command

Single-command control operations can be performed towards SPC (controllable single point) data class objects. Only direct controls are allowed.

- SPC.Oper.ctlVal

Table 9: Single command

Type	ASDU		
Control	45	C_SC_NA_1	Single command
Control	58	C_SC_TA_1	Single command with CP56Time2a

3.2.8 Double command

Double-command control operations can be performed towards DPC (controllable double point) data class objects. Direct controls are always possible. Two-step select-execute controls are also possible if the target DPC object allows it. There are two different control objects available for the direct and select-execute alternatives.

- DPC.Oper.ctlVal

Table 10: Double command

Type	ASDU		
Control	46	C_DC_NA_1	Double command
Control	59	C_DC_TA_1	Double command with CP56Time2a

3.3 Value change detection

The IEC 60870-5-104 data objects begin producing change events if the corresponding source IEC 61850 data objects reside in an IEC 61850 data set which is enabled for change reporting. Only the IEC 61850 data objects which reside in a data set are checked for value changes by the system.

Not all IEC 61850 data objects reside in data sets by default and not all data sets are enabled for reporting by default. The IEC 60870-5-104 protocol stack automatically checks the internal change reporting situation for all the single-point and double-point objects. If needed, the objects are assigned to an internal (hidden) data set. However, for measurand objects, the change reporting situation should be checked using Dataset editor in PCM600.

1. The IEC 60870-5-104 data objects are selected and located in the address space using IEC 60870-5-104 Communication Management.
2. In Communication Management, the data objects' *Event Enable* and *Interrogation Group* default settings are updated if necessary. If only general interrogation (GI) is performed, the point can be assigned to any interrogation group.
3. The corresponding IEC 61850 data objects are checked using Dataset editor. It must be ensured that the corresponding objects are located in a data set which is enabled for reporting.

An IEC 60870-5-104 data object works to some extent even if the object does not reside in a data set, or if it resides in a data set which is not enabled for reporting. In such a case, the IEC 60850-5-104 protocol does an internal, periodical polling of the native IEC 61850 value. If data object changes are noticed, the protocol reports them. However, this internal protocol polling cycle is slow, and thus value change updates are also slow.

3.4 IEC 60870-5-104 internal event buffering

The protocol stack instance internally stores change events based on ASDU event types. The buffer sizes are 800 events per ASDU event type. The protocol stack sends as many event data objects as possible of the same ASDU event type in one APDU frame.

3.5 Control operations

3.5.1 Single command

Single-command controls are performed towards SPC (controllable single point) IEC 61850 target objects. The command can be given with or without a time stamp (C_SC_NA_1, C_SC_TA_1). Only direct type operations are allowed.

If time-tagged commands are used, it is important to ensure the master and the relay times are synchronized. Also, time zone related settings need to be correct, such as the *Time zone* (UTC or local) setting and *local time offset* in general time settings if local time is used. The maximum accepted delay between the command time stamp and the relay time can be adjusted by the *Command delay* setting.

Many target SPC objects, such as acknowledgement or reset objects, are "transient only" objects. For these objects, only "On" control is relevant. If an "Off" control is performed to them, most often a positive acknowledgement is returned from the target function block, but the object's action, for example, acknowledgement or reset, is not performed.

3.5.2 Double command

Double-command controls are performed towards DPC (controllable double point) IEC 61850 target objects, that is, circuit breakers and controllable disconnector objects. The command can be given with or without a time stamp (C_DC_NA_1, C_DC_TA_1).

If time-tagged commands are used, it is important to ensure the master and the relay times are synchronized. Also, time zone related settings need to be correct, such as the *Time zone* (UTC or local) setting and *local time offset* in general time settings if local time is used. The maximum accepted delay between the command time stamp and the relay time can be adjusted by the *Command delay* setting.

Each double-point DPC object has two predefined IEC 60870-5-104 control objects: one intended for direct operation and the other one for select-execute (select-before-operate) operation. The difference can be seen in the control object's signal name trailing text.

…DPC-ctlVal-Direct

…DPC-ctlVal-SBO

3.5.2.1 Direct operation

Direct operation is always possible for the double command regardless of the control model (direct or SBO) configured for the target IEC 61850 DPC object. If the control model is SBO, the IEC 60870-5-104 stack automatically performs the two needed operations (select and operate) towards the DPC object.

3.5.2.2 Select-execute operation

A two-step select-and-execute operation is possible only if the target DPC object's control model is configured as select-before-operate (SBO). For most target DPC objects, the default control model setting mode is SBO.

IEC 60870-5-104 selection timeout is defined by the protocol instance's *Selection Timeout* setting parameter. When a command is performed from the IEC 60870-5-104 instance, the selection timeout setting configured for the IEC 61850 DPC target object is overridden.

3.5.2.3 Cause of transmission and selected status

The relay's native IEC 61850 data model does not include any cause of transmission (COT) information data. Therefore, monitoring object transmissions from the IEC 60870-5-104 stack can only include the following cause of transmission values.

- 1 = Cyclical
- 3 = Spontaneous
- 20 = General interrogation
- 21...36 = Group 1...16 interrogation

The control command's response message returned to the controlling client includes COT value 11 = Remote command, but the controlled object value change in monitoring direction is always COT=3 (Spontaneous). While this information is not

so important for the controlling client, it can be for another client in a multiple-client environment.

In IEC 61850, it is thought that the other client should monitor the DPC .stSeld (selected status) indication object. If the object goes ON, the DPC object has been selected for control operation. Based on the Local/Remote setting, this control selection is done either locally or remotely. The .stSeld indication object is activated only if the DPC object's control model is configured as SBO.

3.6 Integrated totals objects

Integrated totals objects M_IT_NA_1 (IT objects) are mainly cross-referenced from IEC 61850 binary counter (BCR) type objects. Forward or reverse energy is typically measured in these object types. The IT objects' time-tagged change reporting M_IT_TB_1 is optional and triggered by a freeze operation.

3.6.1 Integrated totals object grouping

The existing IT objects can individually be configured to belong to any IT object group 1…4. When an IT master command is performed, it can be directed only to a specific IT object group or to all IT object groups. There are two commands related to counter groups.

- Freeze counters, C_CI_NA_1 (FRZ) - Freezes/latches momentary counter values simultaneously and saves them as internal frozen counter values
- Read frozen counters, C_RD_NA_1 (RQT) - Requests the internally saved frozen counter values

3.6.2 Freeze operation alternatives

A freeze operation can be issued either by a master command C_CI_NA_1 (QCC=FRZ), or by an internal freeze pulse applied to the I5CLPRT function block's input `IT_FRZ`.

The new frozen counter values can be either sent spontaneously to the master, or they can remain internally in the protocol stack for later reading by the master using command C_CI_NA_1 (QCC=RQT).

A new freeze operation overwrites the previously stored frozen counter values.

The freeze command operation C_CI_NA_1 (QCC=FRZ) can be defined to be "freeze only" or "freeze and reset". In the latter case, the protocol tries to reset the counters after the value freezing. Some IEC 61850 counters cannot be physically reset. The counters in this device are globally reset for all possible readers, for example, for other protocols and for reading via HMI.

Two setting parameters define how the freeze operation is handled.

- *Freeze mode* defines if the I5CLPRT function block's `IT_FRZ` input is used, and if the externally triggered operation is "freeze only" or "freeze and reset".
- *Counter reporting* defines what happens after the counters have been frozen. Frozen counters can be configured for spontaneous reporting with this setting.

The IEC 60870-5 standard terms “memorize” and “memorize and increment” correspond to “freeze” and “freeze and reset”.

3.7 Commissioning

None of the available protocol instances are enabled by default. To take into use any instance (n), the setting *Operation* under **Application Configuration** > **Protocols** > **IEC 60870-5-101** > **104 (n)** must be configured "On".

3.7.1 Communication link settings

Table 11: Communication link settings

Setting	Description
Operation	This enables the IEC 60870-5-104 protocol instance to work on the Ethernet link. This setting should be set to "On".
Client IP	The IP address of the IEC 60870-5-104 client for which this instance is intended. Only a TCP connection request from this client IP address is accepted for this instance. If the IP address is set to 0.0.0.0, any client is accepted. In such a case, it is possible to distinguish between different clients through different TCP connection port socket configurations for each instance.
TCP Port	TCP connection port socket used by this instance. The combination of the *Client IP* and *TCP Port* settings defines to which IEC 60870-5-104 client the instance is given.
Device address	Device address of this IEC 60870-5-104 instance. The default setting of *Link address length* parameter is "1" octet, which enables only Device address values 1...255.
ASDU address	Standard “Common address of ASDU”. In most cases, this value should be the same as *Device address*. If it is set to another value, it may also have to be configured on the client side. The default setting of *ASDU address length* parameter is "1" octet, which enables only *ASDU address* values 1...255.
Link mode	Defines if the communication link is balanced or unbalanced. The default setting, balanced, is mostly used by IEC 60870-5-104 links. However, the unbalanced mode can also be used even though it is more common for serial IEC 60870-5-101 links.
COT length	Length (number of octets used) of the Cause Of Transmission field. The default value is "2". The additional information included in the *COT length* = 2 alternative is however not supported by this IEC 60870-5-104 implementation.

Table continues on the next page

Setting	Description
IOA length	Information Object Address field length (number of octets used) definition. This means the object addresses of IEC 60870-5-104 data points. The default setting is "3" octets. In Communication Management of PCM600, 16-bit addresses are supported. Consequently, if this setting is changed to "1", it must be ensured that no point addresses higher than 255 are defined.
Link address length	Length (number of octets used) of the Link address field. The default setting is "2" octets. The length must match the configuration throughout the network. This field is filled with the Device address value.
ASDU address length	Length (number of objects used) of the “Common address of ASDU” field. The default setting is "2". This must be equal to *Link address length* because *Device address* and “Common address of ASDU“ are equal. The length must also match the configuration throughout the network.
TX window (k)	Sliding window protocol (k) transmit window setting. This is the maximum difference between the receive sequence and the send state variable, that is, the maximum number of outstanding I (information) format APDUs. The default setting is "12". The value range is 1...20.
RX window (w)	Sliding window protocol (w) receive window setting. This is the maximum distance to the latest acknowledged I-format APDU. The default setting is "8". The value range is 1-20. The standard recommends that this setting should not exceed two thirds of the Tx window (k) setting.
TX timeout (t1)	Timeout for confirmation of application or test APDU messages. The default setting is 30 seconds [30000 ms]. Adjustable between 1 ms and 60 s.
RX timeout (t2)	Timeout for acknowledgements in case of no data messages. The default setting is 10 seconds [10000 ms]. Adjustable between 1 ms and 60 s. (t2) should be less than (t1).
Test interval (t3)	Timeout for sending test APDU frames in case of long idle state (no line activity). The default setting is 20 seconds [20000 ms]. Adjustable between 1 ms and 60 s.

3.7.1.1 Field length setting parameters

The client’s field length configuration must match the setting of the IEC 60870-5-104 instance. Sometimes it may not be possible to configure these fields in the client. In such a case, the IEC 60870-5-104 settings must be forced to adjust to match the client.

Regarding *Device address* and “Common address of ASDU”, a decision whether to use 1 or 2 octets addressing must be taken. The default setting of *Link address length* and *ASDU address length*, 1 octet, means that no higher addresses than 255 can be used.

The configuration of the field length and the actual setting value for the field are not cross-checked. If, for example, *IOA length* is set to "1" octet, all configured data

points with higher object addresses than 255 get their higher address byte masked out. For example, IOA address 4500 (Hex 1194) occurs as 148 (Hex 94). If another data point with address 148 has been created, these objects overlap one another.

3.7.1.2 Sliding window protocol and timeout settings

The link procedures are described in the standard IEC 60870-5-104/Part 5-104: Transmission protocols – Network access for IEC 60870-5-101 using standard transport profiles, *Chapter 4 IEC 60870-5-104 interoperability*.

If the IEC 60870-5-104 client disappears, the established TCP/IP socket connection is closed by the relay or server. This occurs either as a TCP socket keep-alive failure or as time-outs t1 and t2, whichever happens first.

3.7.2 IEC 60870-5-104 application level settings

The settings are located under **Application Configuration** > **Protocols** > **IEC 60870-5-101** > **104 (n)**.

Table 12: IEC 60870-5-104 application level settings

Setting	Description
Map Select	Selects one of the protocol data point mappings, 1 or 2, to be used by this instance. The data point mappings can be created using Communication Management in PCM600. Several IEC 60870-5-104 protocol instances can use the same mappings.
Show bad time	Enabled by default. The relay has an internal, fixed criterion for tagging change event's time stamps as "bad". It means that the relay has not been time-synchronized for a specific time period. The "bad" time stamp criterion is based on the accuracy demands stated for the native IEC 61850 standard change events. The IEC 60870-5-104 change events are derived from these native events. It is possible to discard the "bad time" tag for IEC 60870-5-104 events.
Time zone	The change event time stamps can be reported in either UTC or local time. The default setting is UTC time. This setting is also relevant when using IEC 60870-5-104 control commands with time tags. The client-provided time stamp must be given in this defined time format. The setup of the local time, meaning the relative time adjustment to be made between UTC (GMT) time and local time, is done elsewhere in the relay.
Overflow mode	In case of internal indication event buffer overflow, it is possible to define whether to keep the oldest or the newest events in the buffer. The default setting keeps the oldest events and also adds an overflow event as the last event. It is possible to omit overflow handling by setting this parameter to "Keep newest" and defining *OvInd IOA* to value "0".

Table continues on the next page

Setting	Description
OvInd IOA	Single-point object address for the overflow indication. The default value is address "60000". Value "0" means that no overflow indication object exists. When an overflow indication occurs, the client can trigger a GI request.
OvInd NoGI IOA	Single-point object address for overflow indications occurring in objects which are not subject to GI. If overflow from these objects occurs, a GI request from the client does not reveal any lost data and thus GI request is unnecessary. It is possible to make this address equal to the *OvInd IOA* address, and thus generate overflow indication for all data object types.
Selection timeout	Protocol-dependent timeout between select and execute control commands. The controllable object also has a timeout setting configured, mainly intended for local control operation. When the control command is performed remotely from this protocol, the configured timeout is temporarily overridden by this setting. The default timeout value is 30 seconds.
Counter reporting	Counter objects, that is, integrated totals, can be reported spontaneously or be read on demand by the client using a counter interrogation request. This setting enables or disables the spontaneous counter reporting based on freeze operation. The freeze operation can be given from the client as a request or also be triggered externally through the protocol function block's physical `EC_FRZ` control input.
Freeze Mode	Defines if the counter freeze operation should only freeze (latch) the current counter values or also reset the counters. The default setting is "Not in use", meaning that the client should read (interrogate) the counters on demand.
IT_FRZ	Control point for counter freeze operation. This control is logically connected to the function block's `EC_FRZ` input. For test purposes, it is possible to manually trigger a counter freeze operation and spontaneous transmission with this setting.
Cyclical period	Event-generating data objects can alternatively be configured for cyclical transmission. This data point specific configuration can be done by Communication Management in PCM600. The *Cyclical period* setting defines the periodical reporting time of these cyclical data objects.
Command delay	Defines the maximum delta time (internal delay) allowed for client control commands with time stamps.

3.7.3 Diagnostic values

The diagnostic values can be edited via **Application Configuration** > **Protocols** > **IEC 60870-5-101** > **104 (n)**.

Table 13: Diagnostic values

Setting	Description
STATUS	True if the protocol instance is active
Reset counters	Diagnostic counters reset. As defined by the standard, this does not reset the security diagnostic counters (see Table 16).
Received frames	Number of received IEC 60870-5-104 protocol frames
Transmitted frames	Number of IEC 60870-5-104 protocol frames
Link errors	Number of link layer errors
Physical errors	Number of physical layer errors
Transport errors	Number of transport layer errors
CnReject no sockets	Number of rejected TCP connections due to unavailable sockets
CnReject unregistered	Number of rejected TCP connections due to an unregistered client

4 IEC 60870-5-104 interoperability

4.1 Overview

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

The selected parameters should be marked in the white boxes.

☐ Function or ASDU is not used

☒ Function or ASDU is used as standardized (default)

☐ Function or ASDU is used in reverse mode

☐ Function or ASDU is used in standard and reverse mode

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

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

4.2 System or device

(System-specific parameter, indicate the station's function by marking one of the following with “X”.)

☐ System definition

☐ Controlling station definition (master)

☒ Controlled station definition (slave)

4.3 Network configuration

(Network-specific parameter, all configurations that are used are to be marked with “X”.)

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

4.4 Link layer

(Network-specific parameter, mark all used options with an “X“. Specify the maximum frame length. If a non-standard assignment of class 2 messages is implemented for unbalanced transmission, indicate the Type ID and COT of all messages assigned to class 2.)

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

Link transmission procedure		Address field of the link	
[X]	Balanced transmission	[ ]	Not present (balanced transmission only)
[X]	Unbalanced transmission	[X]	One octet
		[X]	Two octets
		[X]	Structured
		[X]	Unstructured

Frame length

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

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

4.5 Application layer

Transmission mode for application data

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

Common address of ASDU

(System-specific parameter, mark all used configurations with an “X“.)

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

Information object address

(System-specific parameter, mark all used configurations with an “X“.)

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

Cause of transmission

(System-specific parameter, mark all used configurations with an “X“.)

- [X] One octet
- [X] Two octets (with originator address). Originator address is set to zero if not used

Selection of standard ASDUs

Process information in monitor direction

(Station-specific parameter, mark each Type ID with an “X“ if it is only used in the standard direction, “R“ if only used in the reverse direction, and “B“ if used in both directions.)

[X]	<1>:= Single-point information	M_SP_NA_1
[ ]	<2>:= Single-point information with time tag	M_SP_TA_1
[X]	<3>:= Double-point information	M_DP_NA_1
[ ]	<4>:= Double-point information with time tag	M_DP_TA_1

Table continues on the next page

X	<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
X	<11>:= Measured value, scaled value	M_ME_NB_1
	<12>:= Measured value, scaled value with time tag	M_ME_TB_1
X	<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
X	<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_SP_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
	<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
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

Table continues on the next page

[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> or of the set <30...40> are used.

Process information in control direction

(Station-specific parameter, mark each Type ID with an “X“ if it is only used in the standard direction, “R“ if only used in the reverse direction, and “B“ if used in both directions.)

[X]	<45>:= Single command	C_SC_NA_1
[X]	<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
[X]	<58>:= Single command with CP56Time2a	C_SC_TA_1
[X]	<57>;= Double command with CP56Time2a	C_DC_TA_1

System information in monitor direction

(Station-specific parameter, mark with an “X“ if it is only used in the standard direction, “R“ if only used in the reverse direction, and “B“ if used in both directions.)

[ ]	<70> := End of initialization	M_EI_NA_1

System information in control direction

(Station-specific parameter, mark each Type ID with an “X“ if it is only used in the standard direction, “R“ if only used in the reverse direction, and “B“ if used in both directions.)

[X]	<100>:= Interrogation command	C_IC_NA_1
[X]	<101>:= Counter interrogation command	C_CI_NA_1

Table continues on the next page

X	<102>:= Read command	C_RD_NA_1
X	<103>:= Clock synchronization command (option see 7.6)	C_CS_NA_1
X	<104>:= Test command	C_TS_NA_1
	<105>:= Reset process command	C_RP_NA_1
X	<106>:= Delay acquisition command	C_CD_NA_1

Parameter in control direction

(Station-specific parameter, mark each Type ID with an “X“ if it is only used in the standard direction, “R“ if only used in the reverse direction, and “B“ if used in both directions.)

	<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, mark each Type ID with an “X“ if it is only used in the standard direction, “R“ if only used in the reverse direction, and “B“ if used in both directions.)

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

Type identifier and cause of transmission assignments

(Station-specific parameters)

Shaded boxes: option not required.

Blank: functions or ASDU not used.

Mark the Type Identification/cause of transmission combinations.

"X" if only used in the standard direction

"R" if only used in the reverse direction

"B" if used in both directions

Type identification		Cause of transmission																	
		Periodic, cyclic	Background scan	Spontaneous	Initialized	Request or requested	Activation	Activation confirmation	Deactivation	Deactivation confirmation	Activation termination	Return info caused by a remote cmd	Return info caused by a local cmd	File transfer	Interrogated by group <number>	Request by group <n> counter request	Unknown type identification	Unknown cause of transmission	Unknown common address of ASDU	Unknown information object address
		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					
<2>	M_SP_TA_1																			
<3>	M_DP_NA_1			X		X									X					
<4>	M_DP_TA_1																			
<5>	M_ST_NA_1			X	X															
<6>	M_ST_TA_1																			
<7>	M_BO_NA_1																			
<8>	M_BO_TA_1																			
<9>	M_ME_NA_1																			
<10>	M_ME_TA_1																			
<11>	M_ME_NB_1	X		X		X									X					
<12>	M_ME_TB_1																			
<13>	M_ME_NC_1	X		X		X									X					
<14>	M_ME_TC_1																			
<15>	M_IT_NA_1															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																			

Table continues on the next page

Type identification		Cause of transmission																	
		Periodic, cyclic	Background scan	Spontaneous	Initialized	Request or requested	Activation	Activation confirmation	Deactivation	Deactivation confirmation	Activation termination	Return info caused by a remote cmd	Return info caused by a local cmd	File transfer	Interrogated by group <number>	Request by group <n> counter request	Unknown type identification	Unknown cause of transmission	Unknown common address of ASDU	Unknown information object address
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**20 to 36**	**37 to 41**	**44**	**45**	**46**	**47**
<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															
<33>	M_BO_TB_1																			
<34>	M_ME_TD_1																			
<35>	M_ME_TE_1			X		X														
<36>	M_ME_TF_1			X		X														
<37>	M_IT_TB_1			X												X				
<38>	M_EP_TD_1																			
<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																			
<48>	C_SE_NA_1																			
<49>	C_SE_NB_1																			
<50>	C_SE_NC_1																			
<51>	C_BO_NA_1																			
<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
<70>	M_EI_NA_1[1]																			
<100>	C_IC_NA_1						X	X	X	X	X						X	X	X	X
<101>	C_CI_NA_1						X	X			X						X	X	X	X
<102>	C_RD_NA_1					X														

Table continues on the next page

Type identification		Cause of transmission																	
		Periodic, cyclic	Background scan	Spontaneous	Initialized	Request or requested	Activation	Activation confirmation	Deactivation	Deactivation confirmation	Activation termination	Return info caused by a remote cmd	Return info caused by a local cmd	File transfer	Interrogated by group <number>	Request by group <n> counter request	Unknown type identification	Unknown cause of transmission	Unknown common address of ASDU	Unknown information object address
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**20 to 36**	**37 to 41**	**44**	**45**	**46**	**47**
<103>	C_CS_NA_1			X			X	X									X	X	X	X
<104>	C_TS_NA_1																			
<105>	C_RP_NA_1																			
<106>	C_CD_NA_1																			
<110>	P_ME_NA_1																			
<111>	P_ME_NB_1																			
<112>	P_ME_NC_1																			
<113>	P_AC_NA_1																			
<120>	F_FR_NA_1																			
<121>	F_SR_NA_1																			
<122>	F_SC_NA_1																			
<123>	F_LS_NA_1																			
<124>	F_AF_NA_1																			
<125>	F_SG_NA_1																			
<126>	F_DR_TA_1[1]																			

4.6 Basic application functions

Station initialization

(Station-specific parameter, mark with an “X“ if the function is used.)

☐ Remote initialization

[1] Blank or X only

Cyclic data transmission

(Station-specific parameter, mark with an “X“ if the function is only used in the standard direction, “R“ if only used in the reverse direction, and “B“ if used in both directions.)

☒ Cyclic data transmission

Read procedure

(Station-specific parameter, mark with an “X“ if the function is only used in the standard direction, “R“ if only used in the reverse direction, and “B“ if used in both directions.)

☒ Read procedure

Spontaneous transmission

(Station-specific parameter, mark with an “X“ if the function is only used in the standard direction, “R“ if only used in the reverse direction, and “B“ if used in both directions.)

☒ Spontaneous transmission

Double transmission of information objects with cause of transmission spontaneous

(Station-specific parameter, mark each information type with an “X“ where both a Type ID without time and a corresponding Type ID with time are issued in response to a single spontaneous change of a monitored object.)

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

☐ Double-point information M_DP_NA_1, M_DP_TA_1 and M_DP_TB_1

☐ Step position information M_ST_NA_1, M_ST_TA_1 and M_ST_TB_1

☐ Bitstring of 32 bit M_BO_NA_1, M_BO_TA_1 and M_BO_TB_1 (if defined for a specific project)

☐ Measured value, normalized value M_ME_NA_1, M_ME_TA_1, M_ME_ND_1 and M_ME_TD_1

☐ Measured value, scaled value M_ME_NB_1, M_ME_TB_1 and M_ME_TE_1

☐ Measured value, short floating point number M_ME_NC_1, M_ME_TC_1 and M_ME_TF_1

Station interrogation

(Station-specific parameter, mark with an “X“ if the function is only used in the standard direction, “R“ if only used in the reverse direction, and “B“ if used in both directions.)

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.

Clock synchronization

(Station-specific parameter, mark with an “X“ if the function is only used in the standard direction, “R“ if only used in the reverse direction, and “B“ if used in both directions.)

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

Command transmission

(Object-specific parameter, mark with an “X“ if the function is only used in the standard direction, “R“ if only used in the reverse direction, and “B“ if used in both directions.)

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

Transmission of integrated totals

(Station- or object-specific parameter, mark with an “X“ if the function is only used in the standard direction, “R“ if only used in the reverse direction, and “B“ if used in both directions.)

- [X] Mode A: Local freeze with spontaneous transmission
- [ ] 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

- [X] Counter read
- [X] Counter freeze without reset
- [X] 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

Parameter loading

(Object-specific parameter, mark with an “X“ if the function is only used in the standard direction, “R“ if only used in the reverse direction, and “B“ if used in both directions.)

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

Parameter activation

(Station-specific parameter, mark with an “X“ if the function is only used in the standard direction, “R“ if only used in the reverse direction, and “B“ if used in both directions.)

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

Test procedure

(Station-specific parameter, mark with an “X“ if the function is only used in the standard direction, “R“ if only used in the reverse direction, and “B“ if used in both directions.)

☐ Test procedure

File transfer

(Station-specific parameter, mark with an “X“ if the function is used.)

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

Background scan

(Station-specific parameter, mark with an “X“ if the function is only used in the standard direction, “R“ if only used in the reverse direction, and “B“ if used in both directions.)

☐ Background scan

Acquisition of transmission delay

(Station-specific parameter, mark with an “X“ if the function is only used in the standard direction, “R“ if only used in the reverse direction, and “B“ if used in both directions.)

☒ Acquisition of transmission delay

5 Glossary

APDU	Application Protocol Data Unit
ASDU	Application-layer Service Data Unit
CA	Certification Authority
COT	Cause Of Transmission
Data object	Also known as DO. Part of a logical node object representing specific information, for example status or measurement. From an object-oriented point of view, a data object is an instance of a class data object. DOs are normally used as transaction objects; that is, they are data structures.
Data set	The content basis for reporting and logging containing references to the data and data attribute values
DPC	Double-Point Control
EMC	Electromagnetic Compatibility
Ethernet	A standard for connecting a family of frame-based computer networking technologies into a LAN
GI	General interrogation
HMI	Human-Machine Interface
IEC	International Electrotechnical Commission
IEC 60870-5	IEC standard for telecontrol equipment and systems. Part 5 defines transmission protocols.
IEC 60870-5-101	Companion standard for basic telecontrol tasks
IEC 60870-5-104	Network access for IEC 60870-5-101
IEC 61850	International standard for substation communication and modeling
MAC	Media Access Control
PCM600	Protection and Control IED Manager
SBO	Select-Before-Operate
SPC	Single-point status of a controllable object
TCP	Transmission Control Protocol
TCP/IP	Transmission Control Protocol/Internet Protocol
TLS	Transport Layer Security
UTC	Coordinated Universal Time

ABB Distribution Solutions
Digital Substation Products
P.O. Box 699
FI-65101 VAASA, Finland
Phone +358 10 22 11

www.abb.com/mediumvoltage
www.abb.com/relion
www.abb.com/substationautomation

2NGA000789 C