Relion® Protection and Control

670 series 2.0 IEC
IEC 60870-5-103 Communication Protocol Manual

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Section 1 Introduction

1.1 This manual

The communication protocol manual describes the communication protocols supported by the IED. The manual concentrates on the vendor-specific implementations.

1.2 Intended audience

This manual addresses the communication system engineer or system integrator responsible for pre-engineering and engineering for communication setup in a substation from an IED 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

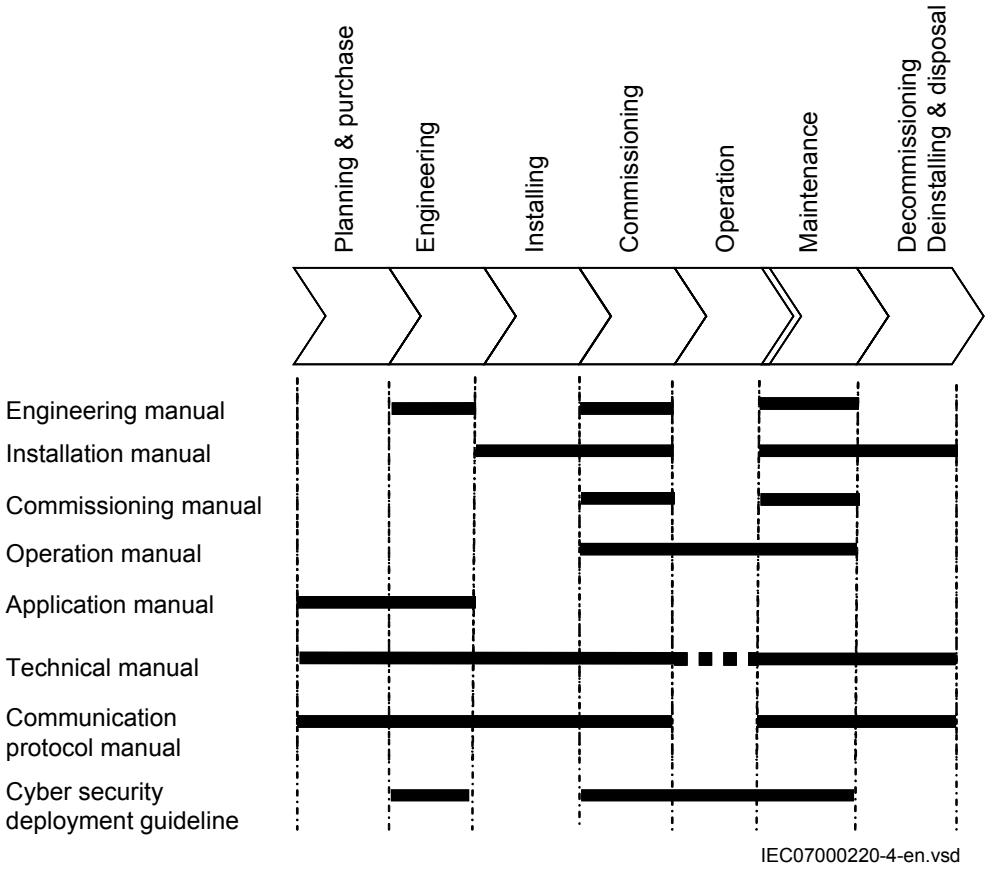

Figure 1: The intended use of manuals throughout the product lifecycle

The engineering manual contains instructions on how to engineer the IEDs using the various tools available within the PCM600 software. The manual provides instructions on how to set up a PCM600 project and insert IEDs to the project structure. The manual also recommends a sequence for the engineering of protection and control functions, LHMI functions as well as communication engineering for IEC 60870-5-103, IEC 61850 and DNP3.

The installation manual contains instructions on how to install the IED. The manual provides procedures for mechanical and electrical installation. The chapters are organized in the chronological order in which the IED should be installed.

The commissioning manual contains instructions on how to commission the IED. The manual can also be used by system engineers and maintenance personnel for assistance during the testing phase. The manual provides procedures for the checking of external circuitry and energizing the IED, parameter setting and

configuration as well as verifying settings by secondary injection. The manual describes the process of testing an IED in a substation which is not in service. The chapters are organized in the chronological order in which the IED should be commissioned. The relevant procedures may be followed also during the service and maintenance activities.

The operation manual contains instructions on how to operate the IED once it has been commissioned. The manual provides instructions for the monitoring, controlling and setting of the IED. The manual also describes how to identify disturbances and how to view calculated and measured power grid data to determine the cause of a fault.

The application manual contains application descriptions and setting guidelines sorted per function. The manual can be used to find out when and for what purpose a typical protection function can be used. The manual can also provide assistance for calculating settings.

The technical manual contains application and functionality descriptions and lists function blocks, logic diagrams, input and output signals, setting parameters and technical data, sorted per function. The manual can be used as a technical reference during the engineering phase, installation and commissioning phase, and during normal service.

The communication protocol manual describes the communication protocols supported by the IED. The manual concentrates on the vendor-specific implementations.

The point list manual describes the outlook and properties of the data points specific to the IED. The manual should be used in conjunction with the corresponding communication protocol manual.

The cyber security deployment guideline describes the process for handling cyber security when communicating with the IED. Certification, Authorization with role based access control, and product engineering for cyber security related events are described and sorted by function. The guideline can be used as a technical reference during the engineering phase, installation and commissioning phase, and during normal service.

1.3.2 Document revision history

Document revision/date	History
-/May 2014	First release

1.3.3 Related documents

Documents related to REB670	Identify number
Application manual	1MRK 505 302-UEN
Commissioning manual	1MRK 505 304-UEN
Product guide	1MRK 505 305-BEN
Technical manual	1MRK 505 303-UEN
Type test certificate	1MRK 505 305-TEN

Documents related to REC670	Identify number
Application manual	1MRK 511 310-UEN
Commissioning manual	1MRK 511 312-UEN
Product guide	1MRK 511 313-BEN
Technical manual	1MRK 511 311-UEN
Type test certificate	1MRK 511 313-TEN

Documents related to RED670	Identify number
Application manual	1MRK 505 307-UEN
Commissioning manual	1MRK 505 309-UEN
Product guide	1MRK 505 310-BEN
Technical manual	1MRK 505 308-UEN
Type test certificate	1MRK 505 310-TEN

Documents related to REG670	Identify number
Application manual	1MRK 502 051-UEN
Commissioning manual	1MRK 502 053-UEN
Product guide	1MRK 502 054-BEN
Technical manual	1MRK 502 052-UEN
Type test certificate	1MRK 502 054-TEN

Documents related to REL670	Identify number
Application manual	1MRK 506 338-UEN
Commissioning manual	1MRK 506 340-UEN
Product guide	1MRK 506 341-BEN
Technical manual	1MRK 506 339-UEN
Type test certificate	1MRK 506 341-TEN

Documents related to RET670	Identify number
Application manual	1MRK 504 138-UEN
Commissioning manual	1MRK 504 140-UEN
Product guide	1MRK 504 141-BEN
Technical manual	1MRK 504 139-UEN
Type test certificate	1MRK 504 141-TEN

670 series manuals	Identify number
Operation manual	1MRK 500 118-UEN
Engineering manual	1MRK 511 308-UEN
Installation manual	1MRK 514 019-UEN
Communication protocol manual, IEC 60870-5-103	1MRK 511 304-UEN
Communication protocol manual, IEC 61850 Edition 1	1MRK 511 302-UEN
Communication protocol manual, IEC 61850 Edition 2	1MRK 511 303-UEN
Communication protocol manual, LON	1MRK 511 305-UEN
Communication protocol manual, SPA	1MRK 511 306-UEN
Accessories guide	1MRK 514 012-BEN
Cyber security deployment guideline	1MRK 511 309-UEN
Connection and Installation components	1MRK 513 003-BEN
Test system, COMBITEST	1MRK 512 001-BEN

1.4 Document symbols and conventions

1.4.1 Symbols

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 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. It is important that the user fully complies with all warning and cautionary notices.

1.4.2 Document conventions

- Abbreviations and acronyms in this manual are spelled out in the glossary. The glossary also contains definitions of important terms.
- Push button navigation in the LHMI menu structure is presented by using the push button icons.
  For example, to navigate between the options, use and .
- HMI menu paths are presented in bold.
  For example, select **Main menu/Settings**.
- LHMI messages are shown in Courier font.
  For example, to save the changes in non-volatile memory, select `Yes` and press .
- Parameter names are shown in italics.
  For example, the function can be enabled and disabled with the *Operation* setting.
- Each function block symbol shows the available input/output signal.
  - the character ^ in front of an input/output signal name indicates that the signal name may be customized using the PCM600 software.
  - the character * after an input/output signal name indicates that the signal must be connected to another function block in the application configuration to achieve a valid application configuration.
- Logic diagrams describe the signal logic inside the function block and are bordered by dashed lines.
  - Signals in frames with a shaded area on their right hand side represent setting parameter signals that are only settable via the PST or LHMI.
  - If an internal signal path cannot be drawn with a continuous line, the suffix -int is added to the signal name to indicate where the signal starts and continues.
  - Signal paths that extend beyond the logic diagram and continue in another diagram have the suffix ”-cont.”

1.4.3 Functions included in 670 series IEDs

Table 1: Main protection functions

IEC 61850 or function name	ANSI	Description
Differential protection		
BBP3PH4B	87B	Busbar differential protection, 2 zones, three phase/4 bays Package including functions BUTPTRC_B1-BUTPTRC_B4, BCZTPDIF, BZNTPDIF_A, BZNTPDIF_B, BZITGGIO, BUTSM4
BBP3PH8B	87B	Busbar differential protection, 2 zones, three phase/8 bays Package including functions BUTPTRC_B1-BUTPTRC_B8, BCZTPDIF, BZNTPDIF_A, BZNTPDIF_B, BZITGGIO, BUTSM8
BBP1PH12B	87B	Busbar differential protection, 2 zones, single phase/12 bays Package including functions BUSPTRC_B1-BUSPTRC_B12, BCZSPDIF, BZNSPDIF_A, BZNSPDIF_B, BZISGGIO, BUSSM12
BBP1PH24B	87B	Busbar differential protection, 2 zones, single phase/24 bays Package including functions BUSPTRC_B1-BUSPTRC_B24, BCZSPDIF, BZNSPDIF_A, BZNSPDIF_B, BZISGGIO, BUSSM24
BDCGAPC	87B	Status of primary switching object for busbar protection zone selection
T2WPDIF	87T	Transformer differential protection, two winding
T3WPDIF	87T	Transformer differential protection, three winding
HZPDIF	87	1Ph High impedance differential protection
GENPDIF	87G	Generator differential protection
REFPDIF	87N	Restricted earth fault protection, low impedance
L3CPDIF	87L	Line differential protection, 3 CT sets, 23 line ends
L6CPDIF	87L	Line differential protection, 6 CT sets, 35 line ends
LT3CPDIF	87LT	Line differential protection 3 CT sets, with inzone transformers, 23 line ends
LT6CPDIF	87LT	Line differential protection 6 CT sets, with inzone transformers, 35 line ends
LDLPSCH	87L	Line differential coordination function
LDRGFC	11REL	Additional security logic for differential protection
Impedance protection		
ZMQAPDIS, ZMQPDIS	21	Distance protection zone, quadrilateral characteristic
ZDRDIR	21D	Directional impedance quadrilateral
ZMCPDIS, ZMCAPDIS	21	Distance measuring zone, quadrilateral characteristic for series compensated lines
ZDSRDIR	21D	Directional impedance quadrilateral, including series compensation
FDPSPDIS	21	Phase selection, quadrilateral characteristic with fixed angle
ZMHPDIS	21	Full-scheme distance protection, mho characteristic
ZMMPDIS, ZMMAPDIS	21	Fullscheme distance protection, quadrilateral for earth faults
ZDMRDIR	21D	Directional impedance element for mho characteristic
ZDARDIR		Additional distance protection directional function for earth faults
ZSMGAPC		Mho Impedance supervision logic
FMPSPDIS	21	Faulty phase identification with load enchroachment
ZMRPDIS, ZMRAPDIS	21	Distance protection zone, quadrilateral characteristic, separate settings
FRPSPDIS	21	Phase selection, quadrilateral characteristic with settable angle

Table continues on next page

IEC 61850 or function name	ANSI	Description
ZMFPDIS	21	High speed distance protection
ZMFCPDIS	21	High speed distance protection for series compensated lines
ZMCAPDIS		Additional distance measuring zone, quadrilateral characteristic
ZMRPSB	68	Power swing detection
PSLPSCH		Power swing logic
PSPPPAM	78	Pole slip/out-of-step protection
OOSPPAM	78	Out-of-step protection
ZCVPSOF		Automatic switch onto fault logic, voltage and current based
LEXPDIS	40	Loss of excitation
PPLPHIZ		Phase preference logic
ROTIPHIZ	64R	Sensitive rotor earth fault protection, injection based
STTIPHIZ	64S	100% stator earth fault protection, injection based
ZGVPDIS	21	Underimpedance protection for generators and transformers

Table 2: Backup protection functions

IEC 61850 or function name	ANSI	Description
Current protection		
PHPIOC	50	Instantaneous phase overcurrent protection
OC4PTOC	51_67	Four step phase overcurrent protection
PH4SPTOC	51	Four step single phase overcurrent protection
EFPIOC	50N	Instantaneous residual overcurrent protection
EF4PTOC	51N_67N	Four step residual overcurrent protection
NS4PTOC	46I2	Four step directional negative phase sequence overcurrent protection
SDEPSDE	67N	Sensitive directional residual over current and power protection
LCPTTR	26	Thermal overload protection, one time constant, Celsius
LFPTTR	26	Thermal overload protection, one time constant, Fahrenheit
TRPTTR	49	Thermal overload protection, two time constants
CCRBRF	50BF	Breaker failure protection
CCSRBRF	50BF	Breaker failure protection, single phase version
STBPTOC	50STB	Stub protection
CCPDSC	52PD	Pole discordance protection
GUPPDUP	37	Directional underpower protection
GOPPDOP	32	Directional overpower protection
BRCPTOC	46	Broken conductor check
CBPGAPC		Capacitor bank protection
NS2PTOC	46I2	Negative sequence time overcurrent protection for machines
AEGPVOC	50AE	Accidental energizing protection for synchronous generator

Table continues on next page

IEC 61850 or function name	ANSI	Description
VRPVOC	51V	Voltage restrained overcurrent protection
GSPTTR	49S	Stator overload protection
GRPTTR	49R	Rotor overload protection
Voltage protection		
UV2PTUV	27	Two step undervoltage protection
OV2PTOV	59	Two step overvoltage protection
ROV2PTOV	59N	Two step residual overvoltage protection
OEXPVPH	24	Overexcitation protection
VDCPTOV	60	Voltage differential protection
STEFPHIZ	59THD	100% Stator earth fault protection, 3rd harmonic based
LOVPTUV	27	Loss of voltage check
PAPGAPC	27	Radial feeder protection
Frequency protection		
SAPTUF	81	Underfrequency protection
SAPTOF	81	Overfrequency protection
SAPFRC	81	Rate-of-change frequency protection
FTAQFVR	81A	Frequency time accumulation protection
Multipurpose protection		
CVGAPC		General current and voltage protection

Table 3: Control and monitoring functions

IEC 61850 or function name	ANSI	Description
Control		
SESRSYN	25	Synchrocheck, energizing check, and synchronizing
SMBRREC	79	Autorecloser
TR1ATCC	90	Automatic voltage control for tap changer, single control
TR8ATCC	90	Automatic voltage control for tap changer, parallel control
TCMYLTC	84	Tap changer control and supervision, 6 binary inputs
TCLYLTC	84	Tap changer control and supervision, 32 binary inputs
SLGAPC		Logic Rotating Switch for function selection and LHMI presentation
VSGAPC		Selector mini switch
DPGAPC		Generic communication function for Double Point indication
SPC8GAPC		Single Point Generic Control 8 signals
AUTOBITS		AutomationBits, command function for DNP3.0
SINGLECMD		Single command, 16 signals Command function block for LON and SPA
VCTRSEND		Horizontal communication via GOOSE for VCTR
GOOSEVCTRRCV		Horizontal communication via GOOSE for VCTR

Table continues on next page

IEC 61850 or function name	ANSI	Description
I103CMD		Function commands for IEC60870-5-103
I103GENCMD		Function commands generic for IEC60870-5-103
I103POSCMD		IED commands with position and select for IEC60870-5-103
I103IEDCMD		IED commands for IEC60870-5-103
I103USRCMD		Function commands user defined for IEC60870-5-103
Apparatus control and interlocking		
SCILO	3	Logical node for interlocking
BB_ES	3	Interlocking for busbar earthing switch
A1A2_BS	3	Interlocking for bus-section breaker
A1A2_DC	3	Interlocking for bus-section disconnector
ABC_BC	3	Interlocking for bus-coupler bay
BH_CONN	3	Interlocking for 1 1/2 breaker diameter
BH_LINE_A	3	Interlocking for 1 1/2 breaker diameter
BH_LINE_B	3	Interlocking for 1 1/2 breaker diameter
DB_BUS_A	3	Interlocking for double CB bay
DB_BUS_B	3	Interlocking for double CB bay
DB_LINE	3	Interlocking for double CB bay
ABC_LINE	3	Interlocking for line bay
AB_TRAFO	3	Interlocking for transformer bay
SCSWI		Switch controller
SXCBR		Circuit breaker
SXSWI		Switch controller
RESIN1		Reservation input 1
RESIN2		Reservation input 2
POS_EVAL		Evaluation of position indication
QCRSV		Bay reservation
QCBAY		Apparatus control Function for handling the status of Local/Remote switch
LOCREM		Handling of LRswitch positions
LOCREMCTRL		LHMI control of PSTO Function for handling Internal Local/Remote switch
Secondary system supervision		
CCSSPVC	87	Current circuit supervision
FUFSPVC		Fuse failure supervision
VDSPVC	60	Fuse failure supervision based on voltage difference
Logic		
SMPPTRC	94	Tripping logic
TMAGAPC		Trip matrix logic
ALMCALH		Logic for group alarm
WRNCALH		Logic for group warning

Table continues on next page

IEC 61850 or function name	ANSI	Description
INDCALH		Logic for group indication
AND		Configurable logic blocks, AND
OR		Configurable logic blocks, OR
INV		Configurable logic blocks, inverter
PULSETIMER		Configurable logic blocks, PULSETIMER
GATE		Configurable logic blocks, controllable gate
TIMERSET		Configurable logic blocks, timer
XOR		Configurable logic blocks, exclusive OR
LLD		Configurable logic blocks, LLD
SRMEMORY		Configurable logic blocks, set-reset memory
RSMEMORY		Configurable logic blocks, reset-set memory
ANDQT		Configurable logic blocks Q/T, ANDQT
ORQT		Configurable logic blocks Q/T, ORQT
INVERTERQT		Configurable logic blocks Q/T, INVERTERQT
XORQT		Configurable logic blocks Q/T, XORQT
SRMEMORYQT		Configurable logic Q/T, set-reset with memory
RSMEMORYQT		Configurable logic Q/T, reset-set with memory
TIMERSETQT		Configurable logic Q/T, settable timer
PULSETIMERQT		Configurable logic Q/T, pulse timer
INVALIDQT		Configurable logic Q/T, INVALIDQT
INDCOMBSPQT		Configurable logic Q/T, single-indication signal combining
INDEXTSPQT		Configurable logic Q/T, single-indication signal extractor
FXDSIGN		Fixed signal function block
B16I		Boolean 16 to Integer conversion
BTIGAPC		Boolean 16 to Integer conversion with Logic Node representation
IB16		Integer to Boolean 16 conversion
ITBGAPC		Integer to Boolean 16 conversion with Logic Node representation
TIGAPC		Delay on timer with input signal integration
TEIGAPC		Elapsed time integrator with limit transgression and overflow supervision
Monitoring		
CVMMXN, CMMXU, VMMXU, CMSQI VMSQI, VNMMXU		Measurements
AISVBAS		Function block for service value presentation of secondary analog inputs
SSIMG	63	Gas medium supervision
SSIML	71	Liquid medium supervision
SSCBR		Circuit breaker condition monitoring
EVENT		Event function Function for event reporting for LON and SPA

Table continues on next page

IEC 61850 or function name	ANSI	Description
DRPRDRE, A1RADR-A4RADR, B1RBDR-B6RBDR		Disturbance report
SPGAPC		Generic communication function for Single Point indication
SP16GAPC		Generic communication function for Single Point indication 16 inputs
MVGAPC		Generic communication function for Measured Value
BINSTATREP		Logical signal status report
RANGE_XP		Measured value expander block
LMBRFLO		Fault locator
I103MEAS		Measurands for IEC60870-5-103
I103MEASUSR		Measurands user defined signals for IEC60870-5-103
I103AR		Function status auto-recloser for IEC60870-5-103
I103EF		Function status earth-fault for IEC60870-5-103
I103FLTPROT		Function status fault protection for IEC60870-5-103
I103IED		IED status for IEC60870-5-103
I103SUPERV		Supervison status for IEC60870-5-103
I103USRDEF		Status for user defiend signals for IEC60870-5-103
L4UFCNT		Event counter with limit supervision
Metering		
PCFCNT		Pulse-counter logic
ETPMMTR		Function for energy calculation and demand handling
System protection and control		
SMAIHPAC		Multipurpose filter

Table 4: Station communication functions

IEC 61850 or function name	ANSI	Description
Station communication		
SPA		SPA communication protocol
ADE		LON communciation protocol
PROTOCOL		Operation selection between SPA and IEC60870-5-103 for SLM
CHSERRS485		DNP3.0 for TCP/IP and EIA-485 communication protocol
DNPFREC		DNP3.0 fault records for TCP/IP and EIA-485 communication protocol
IEC61850-8-1		Parameter setting function for IEC61850
GOOSEINTLKRCV		Horizontal communication via GOOSE for interlocking
GOOSEBINRCV		Goose binary receive
GOOSEDPRCV		GOOSE function block to receive a double point value
GOOSEINTRCV		GOOSE function block to receive an integer value
GOOSEMVRCV		GOOSE function block to receive a measurand value

Table continues on next page

IEC 61850 or function name	ANSI	Description
GOOSESPRCV		GOOSE function block to receive a single point value
GOOSEVCTRCONF		GOOSE VCTR configuration for send and receive
VCTRSEND		Horizontal communication via GOOSE for VCTR
GOOSEVCTRRCV		Horizontal communication via GOOSE for VCTR
MULTICMDRCV, MULTICMDSND		Multiple command and transmit
FRONT, LANABI, LANAB, LANCDI, LANCD		Ethernet configuration of links
MU1_4I_4U MU2_4I_4U MU3_4I_4U MU4_4I_4U MU5_4I_4U MU6_4I_4U		Process bus communication IEC61850-9-2
PRP		Duo driver configuration
Scheme communication		
ZCPSCH	85	Scheme communication logic for distance or overcurrent protection
ZC1PPSCH	85	Phase segregated Scheme communication logic for distance protection
ZCRWPSCH	85	Current reversal and weak-end infeed logic for distance protection
ZC1WPSCH	85	Current reversal and weak-end infeed logic for phase segregated communication
ZCLCPSCH		Local acceleration logic
ECPSCH	85	Scheme communication logic for residual overcurrent protection
ECRWPSCH	85	Current reversal and weak-end infeed logic for residual overcurrent protection
Direct transfer trip		
LAPPGAPC	37_55	Low active power and power factor protection
COUVGAPC	59_27	Compensated over- and undervoltage protection
SCCVPTOC	51	Sudden change in current variation
LCCRPTRC	94	Carrier receive logic
LCNSPTOV	47	Negative sequence overvoltage protection
LCZSPTOV	59N	Zero sequence overvoltage protection
LCNSPTOC	46	Negative sequence overcurrent protection
LCZSPTOC	51N	Zero sequence overcurrent protection
LCP3PTOC	51	Three phase overcurrent
LCP3PTUC	37	Three phase undercurrent

Table 5: Basic IED functions

IEC 61850 or function name	Description
INTERRSIG	Self supervision with internal event list
SELFSUPEVLST	Self supervision with internal event list
TIMESYNCHGEN	Time synchronization module

Table continues on next page

IEC 61850 or function name	Description
SYNCHBIN, SYNCHCAN, SYNCHCMPPS, SYNCHLON, SYNCHPPH, SYNCHPPS, SYNCHSNTP, SYNCHSPA, SYNCHCMPPS	Time synchronization
TIMEZONE	Time synchronization
DSTBEGIN, DSTENABLE, DSTEND	GPS time synchronization module
IRIG-B	Time synchronization
SETGRPS	Number of setting groups
ACTVGRP	Parameter setting groups
TESTMODE	Test mode functionality
CHNGLCK	Change lock function
LONGEN	Misc Base Common
SMBI	Signal matrix for binary inputs
SMBO	Signal matrix for binary outputs
SMMI	Signal matrix for mA inputs
SMAI1 - SMAI20	Signal matrix for analog inputs
3PHSUM	Summation block 3 phase
ATHSTAT	Authority status
ATHCHCK	Authority check
AUTHMAN	Authority management
FTPACCS	FTP access with password
SPACOMMMAP	SPA communication mapping
SPATD	Date and time via SPA protocol
DOSFRNT	Denial of service, frame rate control for front port
DOSLANAB	Denial of service, frame rate control for OEM port AB
DOSLANCD	Denial of service, frame rate control for OEM port CD
DOSSCKT	Denial of service, socket flow control
GBASVAL	Global base values for settings
PRIMVAL	Primary system values
ALTMS	Time master supervision
ALTIM	Time management
ALTRK	Service tracking
ACTIVLOG	Activity logging parameters
FSTACCS	Field service tool access via SPA protocol over ethernet communication
PCMACCS	IED Configuration Protocol
SECALARM	Component for mapping security events on protocols such as DNP3 and IEC103

Table continues on next page

IEC 61850 or function name	Description
DNPGEN	DNP3.0 communication general protocol
DNPGENTCP	DNP3.0 communication general TCP protocol
CHSEROPT	DNP3.0 for TCP/IP and EIA-485 communication protocol
MSTSER	DNP3.0 for serial communication protocol
OPTICAL103	IEC60870-5-103 Optical serial communication
RS485103	IEC60870-5-103 serial communication for RS485
IEC61850-8-1	Parameter setting function for IEC61850
HORZCOMM	Network variables via LON
LONSPA	SPA communication protocol
LEDGEN	General LED indication part for LHMI

Section 2 IEC 60870-5-103 overview

2.1 IEC 60870-5-103 standard

IEC 60870-5-103 is defined as a companion standard for the informative element of protection equipment. While the official IEC 60870-5-103 standard dates back to 1997, the protocol has its roots in the VDEW6 communication protocol from the late 1980's. A VDEW6 device can be seen as a subset of an IEC 60870-5-103 device but not the opposite.

IEC 60870-5-103 defines communication for a serial, unbalanced link only. Communication speeds are defined as either 9600 or 19200 baud.

Standard documentation

This manual assumes that the reader has some basic knowledge of the IEC 60870-5-103 protocol and the standard IEC 60870 documents relating to the protocol.

Table 6: Standard IEC 60870 documents relating to IEC 60870-5-103

IEC 60870 document part	Description
5-1	Transmission frame formats
5-2	Link transmission procedures
5-3	General structure of application data
5-4	Definition and coding of application information elements
5-5	Basic application functions
5-6	Conformance testing guidelines
5-103	Companion standard for the informative interface of protection equipment.

The IEC 60870-5-1…6 parts are also used in communication protocols like IEC 60870-5-101 and IEC 60870-5-104.

Interoperability and interchangeability

An IEC 60870-5-103 device can be interoperable and interchangeable, or only interoperable. Interoperability means that any required application data in the device, which can be coded into an IEC 60870-5-103 data type, can be mapped into the IEC 60870-5-103 address space. This data is recognized by any IEC 60870-5-103 master.

Interchangeability means supporting the application data (informative elements) whose semantics are pre-defined by the IEC 60870-5-103 standard. However, only a very limited set of application data informative elements has been defined by the

standard. It should also be noticed that these sets of data are mainly defined for a single function protection IED. 670 series IEDs in turn are multifunctional protection and control IEDs whose internal data model is based on the IEC 61850 standard.

Interoperability list

The standard requires the IEC 60870-5-103 device to provide an interoperability list, which actually is more an interchangeability list. See the section *Interoperability* in this manual for the interoperability list.

Data mapping principle

Whenever possible, process data is mapped into standard IEC 60870-5-103 function types and information numbers. When this is not possible the process data is mapped into private function types and information numbers. General principle of the mapping is to keep all process data belonging to the same function design inside the same IEC 60870-5-103 function type definition. However, if this default mapping principle causes interoperability problems with older installations, the user can freely remap every available IEC 60870-5-103 process data point by using PCM600.

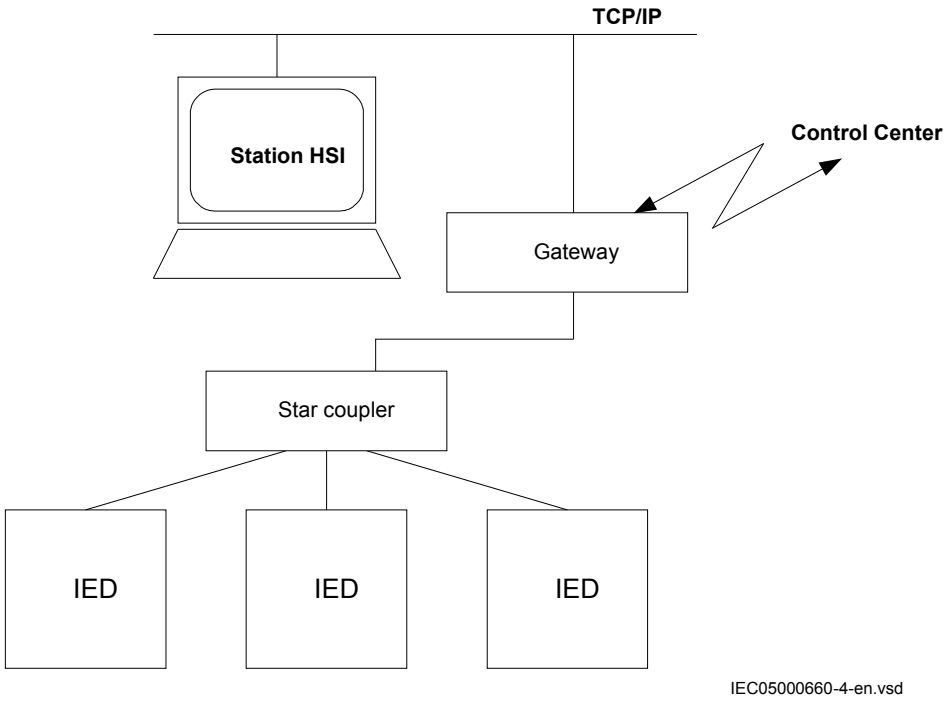

Figure 2: Example of IEC 60870-5-103 communication structure for a substation automation system

IEC 60870-5-103 communication protocol is mainly used when a protection IED communicates with a third party control or monitoring system. This system must have software that can interpret the IEC 60870-5-103 communication messages.

When communicating locally in the station using a Personal Computer (PC) or a Remote Terminal Unit (RTU) connected to the Communication and processing module, the only hardware needed is optical fibres and an opto/electrical converter for the PC/RTU, or a RS-485 connection depending on the used IED communication interface.

Section 3 IEC 60870-5-103 communication engineering

3.1 IEC 60870-5-103 engineering in PCM600

3.1.1 Engineering in PCM600

The Application Configuration tool (ACT) and the Parameter Setting tool (PST) in PCM600 are used to configure the communication for IEC 60870-5-103 protocol.

1. Add the desired IEC 60870-5-103 function blocks to the application configuration in the Application Configuration tool.
2. Connect the outputs of desired protection and monitoring function in the application configuration to the inputs of the corresponding IEC 60870-5-103 function block.
3. Set the function type and desired information number, where an information number must be supplied, for each IEC 60870-5-103 function block instance in the Parameter Setting tool.
4. Set the general communication settings for IEC 60870-5-103 and time synchronization parameters in the Parameter Setting tool.

3.2 Settings for RS485 and optical serial communication

General settings

SPA, DNP and IEC 60870-5-103 can be configured to operate on the SLM optical serial port while DNP and IEC 60870-5-103 only can utilize the RS485 port. A single protocol can be active on a given physical port at any time.

Two different areas in the HMI are used to configure the IEC 60870-5-103 protocol.

1. The port specific IEC 60870-5-103 protocol parameters are configured under: **Main menu/Configuration/Communication/Station Communication/ IEC6870-5-103/**
   - <config-selector>
   - SlaveAddress
   - BaudRate
   - RevPolarity (optical channel only)
   - CycMeasRepTime
   - MasterTimeDomain
   - TimeSyncMode

- EvalTimeAccuracy
- EventRepMode
- CmdMode

<config-selector> is:

- “OPTICAL103:1” for the optical serial channel on the SLM
- “RS485103:1” for the RS485 port

2. The protocol to activate on a physical port is selected under:
   Main menu/Configuration/Communication/Station Communication/Port configuration/
   - RS485 port
     - RS485PROT:1 (off, DNP, IEC103)
   - SLM optical serial port
     - PROTOCOL:1 (off, DNP, IEC103, SPA)

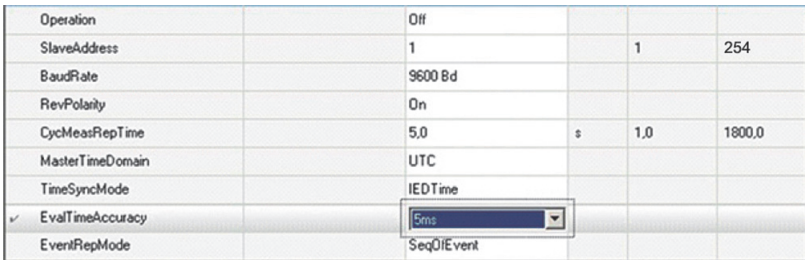

Figure 3: Settings for IEC 60870-5-103 communication

The general settings for IEC 60870-5-103 communication are the following:

- *SlaveAddress* and *BaudRate*: Settings for slave number and communication speed (baud rate).
  The slave number can be set to any value between 1 and 254. The communication speed, can be set either to 9600 bits/s or 19200 bits/s.
- *RevPolarity*: Setting for inverting the light (or not). Standard IEC 60870-5-103 setting is *On*.
- *CycMeasRepTime*: See I103MEAS function block for more information.
- *EventRepMode*: Defines the mode for how events are reported. The event buffer size is 1000 events.

Event reporting mode

If *SeqOfEvent* is selected, all GI and spontaneous events will be delivered in the order they were generated by BSW. The most recent value is the latest value delivered. All GI data from a single block will come from the same cycle.

If *HiPriSpont* is selected, spontaneous events will be delivered prior to GI event. To prevent old GI data from being delivered after a new spontaneous event, the

pending GI event is modified to contain the same value as the spontaneous event. As a result, the GI dataset is not time-correlated.

The settings for communication parameters slave number and baud rate can be found on the local HMI under: **Main menu/Configuration/Communication / Station configuration /SPA/SPA:1** and then select a protocol.

3.2.1 IEC 60870-5-103 time synchronization

An IED with IEC 60870-5-103 protocol can be used for time synchronization, but for accuracy reasons, it is not recommended. In some cases, however, this kind of synchronization is needed, for example, when no other synchronization is available.

First, set the IED to be synchronized via IEC 60870-5-103 either from **IED Configuration/Time/Synchronization/TIMESYNCHGEN:1** in PST or from the local HMI.

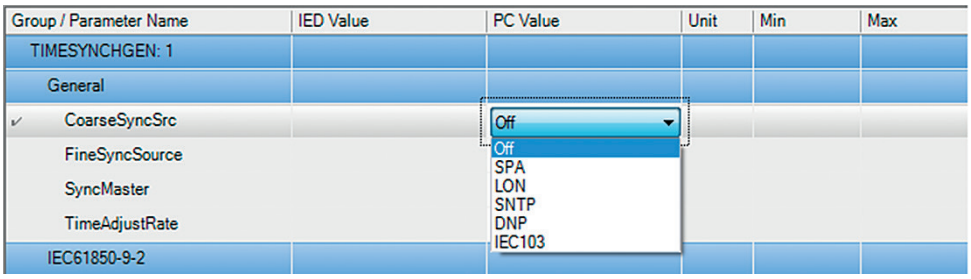

Figure 4: Settings under TIMESYNCHGEN:1 in PST

Only *CoarseSyncSrc* can be set to 103, not *FineSyncSource*.

After setting up the time synchronization source, the user must check and modify the IEC 60870-5-103 time synchronization specific settings, under **Main menu/ Configuration/Communication/Station communication/IEC60870-5-103**.

- *MasterTimeDomain* specifies the domain of time sync sent by the master. It also defines the domain in which time stamps are delivered to the master. (Format is CP56Time2a or CP32Time2a). Domain can be:
  - Coordinated Universal Time (*UTC*)
  - Local time set in the master (*Local without DST*)
  - Local time set in the master adjusted according to daylight saving time (*Local with DST*)
- *TimeSyncMode* specifies the time sent by the IED. The time synchronisation is done using the following ways:
  - *IEDTime*: The IED sends the messages with its own time.
  - *LinMastTime*: The IED measures the offset between its own time and the master time, and applies the same offset for the messages sent as in the

IEDTimeSkew. But in *LinMastTime* it applies the time changes occurred between two synchronization messages.

- *IEDTimeSkew*: The IED measures the offset in between its own time and the master time and applies the same offset for the messages sent.

- *EvalTimeAccuracy* evaluates time accuracy for invalid time. Specifies the accuracy of the synchronization (5, 10, 20 or 40 ms). If the accuracy is less than the specified value, the “Bad Time” flag is raised. To accommodate those masters that are really bad in time sync, the *EvalTimeAccuracy* can be set to *Off*.

If IEC-103 is time-sync master and no IEC-103 time-sync is received within 23 hours then time-sync is considered lost and the no-sync flag will be raised. Other protocols used for time-sync will have other criteria for lost-sync. IEC-103 will report bad time if sync lost regardless of sync protocol.

3.2.2 Settings

Table 7: RS485103 Non group settings (basic)

Name	Values (Range)	Unit	Step	Default	Description
SlaveAddress	1 - 254	-	1	1	Slave address
BaudRate	9600 Bd 19200 Bd	-	-	9600 Bd	Baudrate on serial line
CycMeasRepTime	1.0 - 1800.0	s	0.1	5.0	Cyclic reporting time of measurments
MasterTimeDomain	UTC Local Local with DST	-	-	UTC	Master time domain
TimeSyncMode	IEDTime LinMastTime IEDTimeSkew	-	-	IEDTime	Time synchronization mode
EvalTimeAccuracy	Off 5ms 10ms 20ms 40ms	-	-	5ms	Evaluate time accuracy for invalid time
EventRepMode	SeqOfEvent HiPriSpont	-	-	SeqOfEvent	Event reporting mode
CmdMode	MultiCmd SingleCmd	-	-	SingleCmd	Command handling mode

Table 8: OPTICAL103 Non group settings (basic)

Name	Values (Range)	Unit	Step	Default	Description
SlaveAddress	1 - 254	-	1	1	Slave address
BaudRate	9600 Bd 19200 Bd	-	-	9600 Bd	Baudrate on serial line
RevPolarity	Off On	-	-	On	Invert polarity
CycMeasRepTime	1.0 - 1800.0	s	0.1	5.0	Cyclic reporting time of measurments

Table continues on next page

Name	Values (Range)	Unit	Step	Default	Description
MasterTimeDomain	UTC Local without DST Local with DST	-	-	UTC	Master time domain
TimeSyncMode	IEDTime LinMastTime IEDTimeSkew	-	-	IEDTime	Time synchronization mode
EvalTimeAccuracy	Off 5ms 10ms 20ms 40ms	-	-	5ms	Evaluate time accuracy for invalid time
EventRepMode	SeqOfEvent HiPriSpont	-	-	SeqOfEvent	Event reporting mode
CmdMode	MultiCmd SingleCmd	-	-	SingleCmd	Command handling mode

Section 4 IEC 60870-5-103 vendor specific implementation

The signal and setting tables specify the information types supported by the IEDs with the communication protocol IEC 60870-5-103 implemented.

The information types are supported when corresponding functions are included in the protection and control IED.

Be aware of that different cycle times for function blocks must be considered to ensure correct time stamping.

4.1 Signals in monitoring direction

4.1.1 Measurands for IEC 60870-5-103 I103MEAS

4.1.1.1 Functionality

103MEAS is a function block that reports all valid measuring types depending on connected signals.

The set of connected input will control which ASDUs (Application Service Data Units) are generated.

- **9** Will be generated if at least IL1 is connected. IL2, IL3, UL1, UL2, UL3, P, Q, F are optional but there can be no holes.
- **3.4** Will be generated if IN and UN are present.
- **3.3** Will be generated if IL2, Ul1L2, P and Q present.
- **3.2** Will be generated if IL2, UL1L2 and P or Q missing.
- **3.1** Will be generated if IL2 present and IL1 missing (otherwise IL2 in 9).

Description for I103MEAS function block:

9 = IL1

3.4 = IN AND UN

3.3 = IL2 AND UL1L2 AND P AND Q

3.2 = IL2 AND UL1L2 AND NOT 3.3

3.1 = IL2 AND NOT (3.2 OR 3.3 OR 9)

4.1.1.2 Function block

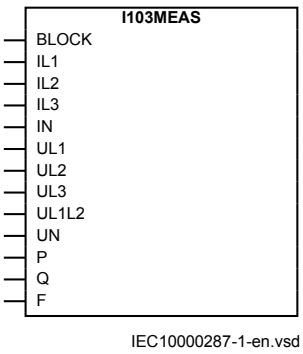

Figure 5: I103MEAS function block

4.1.1.3 Signals

Table 9: I103MEAS Input signals

Name	Type	Default	Description
BLOCK	BOOLEAN	0	Block of service value reporting
IL1	REAL	0.0	Service value for current phase L1
IL2	REAL	0.0	Service value for current phase L2
IL3	REAL	0.0	Service value for current phase L3
IN	REAL	0.0	Service value for residual current IN
UL1	REAL	0.0	Service value for voltage phase L1
UL2	REAL	0.0	Service value for voltage phase L2
UL3	REAL	0.0	Service value for voltage phase L3
UL1L2	REAL	0.0	Service value for voltage phase-phase L1-L2
UN	REAL	0.0	Service value for residual voltage UN
P	REAL	0.0	Service value for active power
Q	REAL	0.0	Service value for reactive power
F	REAL	0.0	Service value for system frequency

4.1.1.4 Settings

Table 10: I103MEAS Non group settings (basic)

Name	Values (Range)	Unit	Step	Default	Description
FunctionType	1 - 255	-	1	1	Function type (1-255)
MaxIL1	1 - 99999	A	1	3000	Maximum current phase L1
MaxIL2	1 - 99999	A	1	3000	Maximum current phase L2
MaxIL3	1 - 99999	A	1	3000	Maximum current phase L3
MaxIN	1 - 99999	A	1	3000	Maximum residual current IN

Table continues on next page

Name	Values (Range)	Unit	Step	Default	Description
MaxUL1	0.05 - 2000.00	kV	0.05	230.00	Maximum voltage for phase L1
MaxUL2	0.05 - 2000.00	kV	0.05	230.00	Maximum voltage for phase L2
MaxUL3	0.05 - 2000.00	kV	0.05	230.00	Maximum voltage for phase L3
MaxUL1-UL2	0.05 - 2000.00	kV	0.05	400.00	Maximum voltage for phase-phase L1-L2
MaxUN	0.05 - 2000.00	kV	0.05	230.00	Maximum residual voltage UN
MaxP	0.00 - 2000.00	MW	0.05	1200.00	Maximum value for active power
MaxQ	0.00 - 2000.00	MVAr	0.05	1200.00	Maximum value for reactive power
MaxF	45.0 - 66.0	Hz	1.0	51.0	Maximum system frequency

4.1.1.5 Supported information types

Measurands in public range, I103MEAS

Number of instances: 1

The IED reports all valid measuring types depending on connected signals.

Upper limit for measured currents, active/reactive-power is 2.4 times rated value.

Upper limit for measured voltages and frequency is 1.2 times rated value.

The upper limit is the maximum value that can be encoded into the ASDU (Application Service Data Unit). Any value higher than this value will be tagged as OVERFLOW. The factors 1.2 and 2.4 are taken from the 103 standard and require that a rated value to use as base exists, and then use 1.2 or 2.4 times <rated> as *maxVal*. You can use 2.4 times rated as *maxVal*, but as there is no way to propagate value to client, the use of a scale factor on <rated> does not make much difference.

You can configure client:`client-scaled-max ::= 1.2 * <rated>` or `client-scaled-max ::= 1.0 * <maxVal>`

If the client has a hard-coded gain of 1.2 * <rated> then `client-scaled-max ::= 1.2 times <maxVal>/1.2`

Resolution is <maxVal> / 4095 and hence the lowest possible *maxVal* yields the best accuracy.

Table 11: I103MEAS supported indications

INF	Description
148	IL1
144, 145, 146, 148	IL2
148	IL3
147	IN, Neutral current
148	UL1
148	UL2
Table continues on next page	

INF	Description
148	UL3
145, 146	UL1-UL2
147	UN, Neutral voltage
146, 148	P, active power
146, 148	Q, reactive power
148	f, frequency

4.1.2 Measurands user defined signals for IEC 60870-5-103 I103MEASUSR

4.1.2.1 Functionality

I103MEASUSR is a function block with user defined input measurands in monitor direction. These function blocks include the *FunctionType* parameter for each block in the private range, and the Information number parameter for each block.

4.1.2.2 Function block

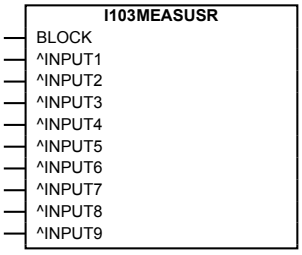

Figure 6: I103MEASUSR function block

4.1.2.3 Signals

Table 12: I103MEASUSR Input signals

Name	Type	Default	Description
BLOCK	BOOLEAN	0	Block of service value reporting
INPUT1	REAL	0.0	Service value for measurement on input 1
INPUT2	REAL	0.0	Service value for measurement on input 2
INPUT3	REAL	0.0	Service value for measurement on input 3
INPUT4	REAL	0.0	Service value for measurement on input 4
INPUT5	REAL	0.0	Service value for measurement on input 5
INPUT6	REAL	0.0	Service value for measurement on input 6
Table continues on next page			

Name	Type	Default	Description
INPUT7	REAL	0.0	Service value for measurement on input 7
INPUT8	REAL	0.0	Service value for measurement on input 8
INPUT9	REAL	0.0	Service value for measurement on input 9

4.1.2.4 Settings

Table 13: I103MEASUSR Non group settings (basic)

Name	Values (Range)	Unit	Step	Default	Description
FunctionType	1 - 255	-	1	25	Function type (1-255)
InfNo	1 - 255	-	1	1	Information number for measurands (1-255)
MaxMeasur1	0.05 - 10000000000.00	-	0.05	1000.00	Maximum value for measurement on input 1
MaxMeasur2	0.05 - 10000000000.00	-	0.05	1000.00	Maximum value for measurement on input 2
MaxMeasur3	0.05 - 10000000000.00	-	0.05	1000.00	Maximum value for measurement on input 3
MaxMeasur4	0.05 - 10000000000.00	-	0.05	1000.00	Maximum value for measurement on input 4
MaxMeasur5	0.05 - 10000000000.00	-	0.05	1000.00	Maximum value for measurement on input 5
MaxMeasur6	0.05 - 10000000000.00	-	0.05	1000.00	Maximum value for measurement on input 6
MaxMeasur7	0.05 - 10000000000.00	-	0.05	1000.00	Maximum value for measurement on input 7
MaxMeasur8	0.05 - 10000000000.00	-	0.05	1000.00	Maximum value for measurement on input 8
MaxMeasur9	0.05 - 10000000000.00	-	0.05	1000.00	Maximum value for measurement on input 9

4.1.2.5 Supported information types

Measurands in private range, I103MeasUsr

Number of instances: 3

Function type parameter for each block in private range.

Information number must be selected for measurands.

Table 14: I103MeasUsr supported indications

INF	FUN	GI	TYP	COT	Description
*1)	*2)	No, polled with CL2	*3)	2,7	Meas1
*	*	No, polled with CL2	*	2,7	Meas2
*	*	No, polled with CL2	*	2,7	Meas3
*	*	No, polled with CL2	*	2,7	Meas4
*	*	No, polled with CL2	*	2,7	Meas5
*	*	No, polled with CL2	*	2,7	Meas6
*	*	No, polled with CL2	*	2,7	Meas7
*	*	No, polled with CL2	*	2,7	Meas8
*	*	No, polled with CL2	*	2,7	Meas9

1) * User defined information value (PARAM.3)
2) * User defined information value (PARAM.2)
3) 9 = Measurands II, Format = Measurand II (7.3.1.8 in IEC 60870-5-103:1997), semantics per IE is defined by semantics of connected source.

<Number of information elements> is defined by index of first input not connected.

Example: Input1, Input2, and Input4 are connected, Input3 is not connected.

<Number of information elements> will be 3 (Input3 NOT connected) -1 = 2, that is, only Input1 and Input2 will be transmitted.

4.1.3 Function status auto-recloser for IEC 60870-5-103 I103AR

4.1.3.1 Functionality

I103AR is a function block with defined functions for autorecloser indications in monitor direction. This block includes the *FunctionType* parameter, and the information number parameter is defined for each output signal.

4.1.3.2 Function block

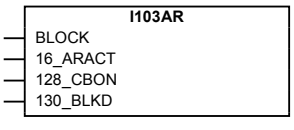

Figure 7: I103AR function block

4.1.3.3 Signals

Table 15: I103AR Input signals

Name	Type	Default	Description
BLOCK	BOOLEAN	0	Block of status reporting
16_ARACT	BOOLEAN	0	Information number 16, auto-recloser active
128_CBON	BOOLEAN	0	Information number 128, circuit breaker on by auto-recloser
130_BLKD	BOOLEAN	0	Information number 130, auto-recloser blocked

4.1.3.4 Settings

Table 16: I103AR Non group settings (basic)

Name	Values (Range)	Unit	Step	Default	Description
FunctionType	1 - 255	-	1	1	Function type (1-255)

4.1.3.5 Supported information types

Autorecloser indications in monitor direction, I103AR

Indication block for autorecloser in monitor direction with defined functions.

Number of instances: 1

Function type is selected with parameter *FunctionType*.

Information number is defined for each output signal.

Table 17: I103AR supported indications

INF	Description
16	Autorecloser active
128	CB on by Autorecloser
130	Autorecloser blocked

4.1.4 Function status earth-fault for IEC 60870-5-103 I103EF

4.1.4.1 Functionality

I103EF is a function block with defined functions for earth fault indications in monitor direction. This block includes the *FunctionType* parameter, and the information number parameter is defined for each output signal.

4.1.4.2 Function block

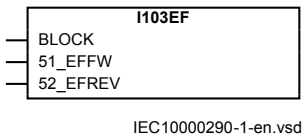

Figure 8: I103EF function block

4.1.4.3 Signals

Table 18: I103EF Input signals

Name	Type	Default	Description
BLOCK	BOOLEAN	0	Block of status reporting
51_EFFW	BOOLEAN	0	Information number 51, earth-fault forward
52_EFREV	BOOLEAN	0	Information number 52, earth-fault reverse

4.1.4.4 Settings

Table 19: I103EF Non group settings (basic)

Name	Values (Range)	Unit	Step	Default	Description
FunctionType	1 - 255	-	1	160	Function type (1-255)

4.1.4.5 Supported information types

Earth fault indications in monitor direction, I103EF

Indication block for earth fault in monitor direction with defined functions.

Number of instances: 1

Function type is selected with parameter *FunctionType*.

Information number is defined for each output signal.

Table 20: I103EF supported indications

INF	Description
51	Earth fault forward
52	Earth fault reverse

4.1.5 Function status fault protection for IEC 60870-5-103 I103FLTPROT

4.1.5.1 Functionality

I103FLTPROT is used for fault indications in monitor direction. Each input on the function block is specific for a certain fault type and therefore must be connected to a correspondent signal present in the configuration. For example: 68_TRGEN represents the General Trip of the device, and therefore must be connected to the general trip signal SMPPTRC_TRIP or equivalent.

The delay observed in the protocol is the time difference in between the signal that is triggering the Disturbance Recorder and the respective configured signal to the IEC 60870-5-103 I103FLTPROT.

4.1.5.2 Function block

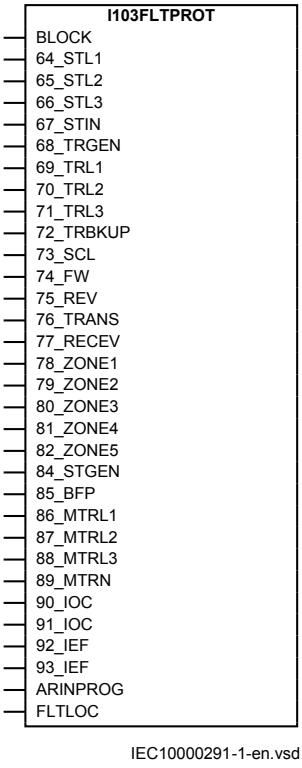

Figure 9: I103FLTPROT function block

4.1.5.3 Signals

Table 21: I103FLTPROT Input signals

Name	Type	Default	Description
BLOCK	BOOLEAN	0	Block of status reporting.
64_STL1	BOOLEAN	0	Information number 64, start phase L1
65_STL2	BOOLEAN	0	Information number 65, start phase L2
66_STL3	BOOLEAN	0	Information number 66, start phase L3
67_STIN	BOOLEAN	0	Information number 67, start residual current IN
68_TRGEN	BOOLEAN	0	Information number 68, trip general
69_TRL1	BOOLEAN	0	Information number 69, trip phase L1
70_TRL2	BOOLEAN	0	Information number 70, trip phase L2
71_TRL3	BOOLEAN	0	Information number 71, trip phase L3
72_TRBKUP	BOOLEAN	0	Information number 72, back up trip I>>
73_SCL	REAL	0	Information number 73, fault location in ohm
74_FW	BOOLEAN	0	Information number 74, forward/line
75_REV	BOOLEAN	0	Information number 75, reverse/busbar
76_TRANS	BOOLEAN	0	Information number 76, signal transmitted
77_RECEV	BOOLEAN	0	Information number 77, signal received
78_ZONE1	BOOLEAN	0	Information number 78, zone 1
79_ZONE2	BOOLEAN	0	Information number 79, zone 2
80_ZONE3	BOOLEAN	0	Information number 80, zone 3
81_ZONE4	BOOLEAN	0	Information number 81, zone 4
82_ZONE5	BOOLEAN	0	Information number 82, zone 5
84_STGEN	BOOLEAN	0	Information number 84, start general
85_BFP	BOOLEAN	0	Information number 85, breaker failure
86_MTRL1	BOOLEAN	0	Information number 86, trip measuring system phase L1
87_MTRL2	BOOLEAN	0	Information number 87, trip measuring system phase L2
88_MTRL3	BOOLEAN	0	Information number 88, trip measuring system phase L3
89_MTRN	BOOLEAN	0	Information number 89, trip measuring system neutral N
90_IOC	BOOLEAN	0	Information number 90, over current trip, stage low
91_IOC	BOOLEAN	0	Information number 91, over current trip, stage high
92_IEF	BOOLEAN	0	Information number 92, earth-fault trip, stage low
93_IEF	BOOLEAN	0	Information number 93, earth-fault trip, stage high
ARINPROG	BOOLEAN	0	Autorecloser in progress (SMBRREC- INPROGR)
FLTLOC	BOOLEAN	0	Faultlocator faultlocation valid (LMBRFLO-CALCMADE)

4.1.5.4 Settings

Table 22: I103FLTPROT Non group settings (basic)

Name	Values (Range)	Unit	Step	Default	Description
FunctionType	1 - 255	-	1	128	Function type (1-255)

4.1.5.5 Supported information types

Function status fault protection for IEC 60870-5-103, I103FLTPROT

Number of instances: 1

Function type is selected with parameter *FunctionType*.

Information number is defined for each input signals.

Table 23: I103FLTPROT supported functions

INF	Description	TYP	GI	COT
64	Start phase L1	2	Y	1,7,9
65	Start phase L2	2	Y	1,7,9
66	Start phase L3	2	Y	1,7,9
67	Start residual current IN	2	Y	1,7,9
68	Trip general	2	N	1,7
69	Trip phase L1	2	N	1,7
70	Trip phase L2	2	N	1,7
71	Trip phase L3	2	N	1,7
72	Back up trip I>>	2	N	1,7
73	Fault location in ohm	4	N	1,7
74	Forward/line	2	N	1,7
75	Reverse/busbar	2	N	1,7
76	Signal transmitted	2	N	1,7
77	Signal received	2	N	1,7
78	Zone 1	2	N	1,7
79	Zone 2	2	N	1,7
80	Zone 3	2	N	1,7
81	Zone 4	2	N	1,7
82	Zone 5	2	N	1,7
84	Start general	2	Y	1,7,9
85	Breaker failure	2	N	1,7
86	Trip measuring system phase L1	2	N	1,7
87	Trip measuring system phase L2	2	N	1,7
88	Trip measuring system phase L3	2	N	1,7
89	Trip measuring system neutral N	2	N	1,7

Table continues on next page

INF	Description	TYP	GI	COT
90	Over current trip, stage low	2	N	1,7
91	Over current trip, stage high	2	N	1,7
92	Earth-fault trip, stage low	2	N	1,7
93	Earth-fault trip, stage high	2	N	1,7

4.1.6 IED status for IEC 60870-5-103 I103IED

4.1.6.1 Functionality

I103IED is a function block with defined IED functions in monitor direction. This block uses parameter as *FunctionType*, and information number parameter is defined for each input signal.

4.1.6.2 Function block

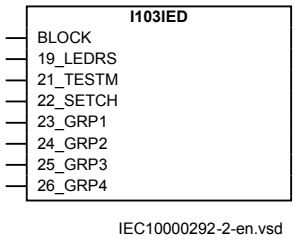

Figure 10: I103IED function block

4.1.6.3 Signals

Table 24: I103IED Input signals

Name	Type	Default	Description
BLOCK	BOOLEAN	0	Block of status reporting
19_LEDRS	BOOLEAN	0	Information number 19, reset LEDs
21_TESTM	BOOLEAN	0	Information number 21, test mode is active
22_SETCH	BOOLEAN	0	Information number 22, setting changed
23_GRP1	BOOLEAN	0	Information number 23, setting group 1 is active
24_GRP2	BOOLEAN	0	Information number 24, setting group 2 is active
25_GRP3	BOOLEAN	0	Information number 25, setting group 3 is active
26_GRP4	BOOLEAN	0	Information number 26, setting group 4 is active

4.1.6.4 Settings

Table 25: I103IED Non group settings (basic)

Name	Values (Range)	Unit	Step	Default	Description
FunctionType	1 - 255	-	1	1	Function type (1-255)

4.1.6.5 Supported information types

Terminal status indications in monitor direction, I103IED

Indication block for status in monitor direction with defined IED functions.

Number of instances: 1

Function type is selected with parameter *FunctionType*.

Information number is defined for each input signals.

Table 26: I103IED supported functions

INF	Description
19	LED reset
21	TestMode
22	Local Parameter setting
23	Setting group 1 active
24	Setting group 2 active
25	Setting group 3 active
26	Setting group 4 active

4.1.7 Supervison status for IEC 60870-5-103 I103SUPERV

4.1.7.1 Functionality

I103SUPERV is a function block with defined functions for supervision indications in monitor direction. This block includes the *FunctionType* parameter, and the information number parameter is defined for each output signal.

4.1.7.2 Function block

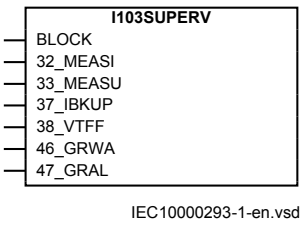

Figure 11: I103SUPERV function block

4.1.7.3 Signals

Table 27: I103SUPERV Input signals

Name	Type	Default	Description
BLOCK	BOOLEAN	0	Block of status reporting
32_MEASI	BOOLEAN	0	Information number 32, measurand supervision of I
33_MEASU	BOOLEAN	0	Information number 33, measurand supervision of U
37_IBKUP	BOOLEAN	0	Information number 37, I high-high back-up protection
38_VTFF	BOOLEAN	0	Information number 38, fuse failure VT
46_GRWA	BOOLEAN	0	Information number 46, group warning
47_GRAL	BOOLEAN	0	Information number 47, group alarm

4.1.7.4 Settings

Table 28: I103SUPERV Non group settings (basic)

Name	Values (Range)	Unit	Step	Default	Description
FunctionType	1 - 255	-	1	1	Function type (1-255)

4.1.7.5 Supported information types

Supervision indications in monitor direction, I103SUPERV

Indication block for supervision in monitor direction with defined functions.

Number of instances: 1

Function type is selected with parameter *FunctionType*.

Information number is defined for output signals.

Table 29: I103SUPERV supported functions

INF	Description	TYP	GI	COT
32	Measurand supervision I	1	Y	1,7,9
33	Measurand supervision U	1	Y	1,7,9
37	I>>back-up operation	1	Y	1,7,9
38	VT fuse failure	1	Y	1,7,9
46	Group warning	1	Y	1,7,9
47	Group alarm	1	Y	1,7,9

4.1.8 Status for user defined signals for IEC 60870-5-103 I103USRDEF

4.1.8.1 Functionality

I103USRDEF is a function blocks with user defined input signals in monitor direction. These function blocks include the *FunctionType* parameter for each block in the private range, and the information number parameter for each input signal.

I103USRDEF: 1					
FunctionType		5		1	255
NAME1		INPUT1			13 character(s
InfNo_1		**17**		1	255
NAME2		INPUT2			13 character(s
InfNo_2		**18**		1	255
NAME3		INPUT3			13 character(s
InfNo_3		**20**		1	255
NAME4		INPUT4			13 character(s
InfNo_4		**35**		1	255

Figure 12:

4.1.8.2 Function block

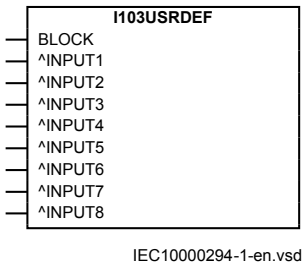

Figure 13: I103USRDEF function block

4.1.8.3 Signals

Table 30: I103USRDEF Input signals

Name	Type	Default	Description
BLOCK	BOOLEAN	0	Block of status reporting
INPUT1	BOOLEAN	0	Binary signal Input 1
INPUT2	BOOLEAN	0	Binary signal input 2
INPUT3	BOOLEAN	0	Binary signal input 3
INPUT4	BOOLEAN	0	Binary signal input 4
INPUT5	BOOLEAN	0	Binary signal input 5
INPUT6	BOOLEAN	0	Binary signal input 6
INPUT7	BOOLEAN	0	Binary signal input 7
INPUT8	BOOLEAN	0	Binary signal input 8

4.1.8.4 Settings

Table 31: I103USRDEF Non group settings (basic)

Name	Values (Range)	Unit	Step	Default	Description
FunctionType	1 - 255	-	1	5	Function type (1-255)
InfNo_1	1 - 255	-	1	1	Information number for binary input 1 (1-255)
InfNo_2	1 - 255	-	1	2	Information number for binary input 2 (1-255)
InfNo_3	1 - 255	-	1	3	Information number for binary input 3 (1-255)
InfNo_4	1 - 255	-	1	4	Information number for binary input 4 (1-255)
InfNo_5	1 - 255	-	1	5	Information number for binary input 5 (1-255)
InfNo_6	1 - 255	-	1	6	Information number for binary input 6 (1-255)
InfNo_7	1 - 255	-	1	7	Information number for binary input 7 (1-255)
InfNo_8	1 - 255	-	1	8	Information number for binary input 8 (1-255)

4.1.8.5 Supported information types

Function status indications in monitor direction, user-defined, I103UserDef

Function indication blocks in monitor direction with user-defined input signals.

Number of instances: 20

Function type is selected with parameter *FunctionType* for each function block instance in private range.

Information number is required for each input signal. Default values are defined in range 1 - 8.

Table 32: I103UserDef supported indications

INF	Description
1[1)]	Input signal 01
2*	Input signal 02
3*	Input signal 03
4*	Input signal 04
5*	Input signal 05
6*	Input signal 06
7*	Input signal 07
8*	Input signal 08

1) * User defined information number

4.2 Commands in control direction

4.2.1 Function commands for IEC 60870-5-103 I103CMD

4.2.1.1 Functionality

I103CMD is a command function block in control direction with pre-defined output signals. The signals are in steady state, not pulsed, and stored in the IED in case of restart.

4.2.1.2 Function block

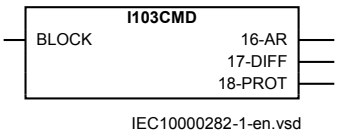

Figure 14: I103CMD function block

4.2.1.3 Signals

Table 33: I103CMD Input signals

Name	Type	Default	Description
BLOCK	BOOLEAN	0	Block of commands

Table 34: I103CMD Output signals

Name	Type	Description
16-AR	BOOLEAN	Information number 16, off/on of autorecloser
17-DIFF	BOOLEAN	Information number 17, block of differential protection
18-PROT	BOOLEAN	Information number 18, block of protection

4.2.1.4 Settings

Table 35: I103CMD Non group settings (basic)

Name	Values (Range)	Unit	Step	Default	Description
FunctionType	1 - 255	-	1	1	Function type (1-255)

4.2.1.5 Supported information types

Function commands in control direction, pre-defined I103CMD

Function command block in control direction with defined output signals.

Number of instances: 1

Function type is selected with parameter *FunctionType*.

Information number is defined for each output signals.

Table 36: Pre-defined I103CMD supported indications

INF	Description
16	Auto-recloser on/off
17	Teleprotection on/off
18	Protection on/off

4.2.2 IED commands for IEC 60870-5-103 I103IEDCMD

4.2.2.1 Functionality

I103IEDCMD is a command block in control direction with defined IED functions. All outputs are pulsed and they are NOT stored. Pulse-time is a hidden parameter.

4.2.2.2 Function block

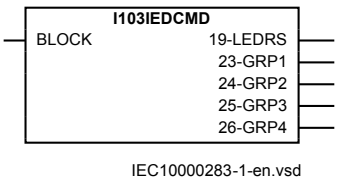

Figure 15: I103IEDCMD function block

4.2.2.3 Signals

Table 37: I103IEDCMD Input signals

Name	Type	Default	Description
BLOCK	BOOLEAN	0	Block of commands

Table 38: I103IEDCMD Output signals

Name	Type	Description
19-LEDRS	BOOLEAN	Information number 19, reset LEDs
23-GRP1	BOOLEAN	Information number 23, activate setting group 1
24-GRP2	BOOLEAN	Information number 24, activate setting group 2
25-GRP3	BOOLEAN	Information number 25, activate setting group 3
26-GRP4	BOOLEAN	Information number 26, activate setting group 4

4.2.2.4 Settings

Table 39: I103IEDCMD Non group settings (basic)

Name	Values (Range)	Unit	Step	Default	Description
FunctionType	1 - 255	-	1	255	Function type (1-255)

4.2.2.5 Supported information types

Commands in control direction, I103IEDCMD

Command block in control direction with defined output signals.

Number of instances: 1

Function type is selected with parameter *FunctionType*.

Information number is defined for each output signals.

Table 40: I103IEDCMD supported indications

INF	Description
19	LED Reset
23	Activate setting group 1
24	Activate setting group 2
25	Activate setting group 3
26	Activate setting group 4

4.2.3 Function commands user defined for IEC 60870-5-103 I103USRCMD

4.2.3.1 Functionality

I103USRCMD is a command block in control direction with user defined output signals. These function blocks include the *FunctionType* parameter for each block in the private range, and the Information number parameter for each output signal.

4.2.3.2 Function block

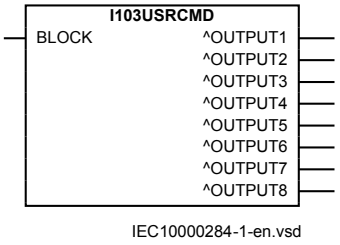

Figure 16: I103USRCMD function block

4.2.3.3 Signals

Table 41: I103USRCMD Input signals

Name	Type	Default	Description
BLOCK	BOOLEAN	0	Block of commands

Table 42: I103USRCMD Output signals

Name	Type	Description
OUTPUT1	BOOLEAN	Command output 1
OUTPUT2	BOOLEAN	Command output 2
OUTPUT3	BOOLEAN	Command output 3
OUTPUT4	BOOLEAN	Command output 4
Table continues on next page		

Name	Type	Description
OUTPUT5	BOOLEAN	Command output 5
OUTPUT6	BOOLEAN	Command output 6
OUTPUT7	BOOLEAN	Command output 7
OUTPUT8	BOOLEAN	Command output 8

4.2.3.4 Settings

Table 43: I103USRCMD Non group settings (basic)

Name	Values (Range)	Unit	Step	Default	Description
FunctionType	1 - 255	-	1	1	Function type (1-255)
PulseMode	Steady Pulsed	-	-	Pulsed	Pulse mode
PulseLength	0.200 - 60.000	s	0.001	0.400	Pulse length
InfNo_1	1 - 255	-	1	1	Information number for output 1 (1-255)
InfNo_2	1 - 255	-	1	2	Information number for output 2 (1-255)
InfNo_3	1 - 255	-	1	3	Information number for output 3 (1-255)
InfNo_4	1 - 255	-	1	4	Information number for output 4 (1-255)
InfNo_5	1 - 255	-	1	5	Information number for output 5 (1-255)
InfNo_6	1 - 255	-	1	6	Information number for output 6 (1-255)
InfNo_7	1 - 255	-	1	7	Information number for output 7 (1-255)
InfNo_8	1 - 255	-	1	8	Information number for output 8 (1-255)

4.2.3.5 Supported information types

Function commands in control direction, user-defined, I103UserCMD

Function command blocks in control direction with user-defined output signals.

Number of instances: 4

Function type for each function block instance in private range is selected with parameter *FunctionType*.

Information number must be selected for each output signal. Default values are 1 - 8.

Table 44: I103UserCMD supported indications

INF	Description
1[1)]	Output signal 01
2*	Output signal 02
3*	Output signal 03
4*	Output signal 04
5*	Output signal 05
Table continues on next page	

INF	Description
6*	Output signal 06
7*	Output signal 07
8*	Output signal 08

1) * User defined information number

4.2.4 Function commands generic for IEC 60870-5-103 I103GENCMD

4.2.4.1 Functionality

I103GENCMD is used for transmitting generic commands over IEC 60870-5-103. The function has two outputs signals CMD_OFF and CMD_ON that can be used to implement double-point command schemes.

The I103GENCMD component can be configured as either 2 pulsed ON/OFF or 2 steady ON/OFF outputs. The ON output is pulsed with a command with value 2, while the OFF output is pulsed with a command value 1. If in steady mode is ON asserted and OFF deasserted with command 2 and vice versa with command 1. Steady mode is selected by setting PulseLength=0. The I103GENCMD is retained, and a command in steady mode will be reissued on restart.

4.2.4.2 Function block

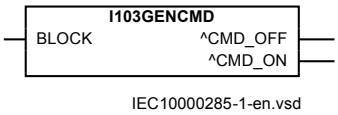

Figure 17: I103GENCMD function block

4.2.4.3 Signals

Table 45: I103GENCMD Input signals

Name	Type	Default	Description
BLOCK	BOOLEAN	0	Block of command

Table 46: I103GENCMD Output signals

Name	Type	Description
CMD_OFF	BOOLEAN	Command output OFF
CMD_ON	BOOLEAN	Command output ON

4.2.4.4 Settings

Table 47: I103GENCMD Non group settings (basic)

Name	Values (Range)	Unit	Step	Default	Description
FunctionType	1 - 255	-	1	1	Function type (1-255)
PulseLength	0.000 - 60.000	s	0.001	0.400	Pulse length
InfNo	1 - 255	-	1	1	Information number for command output (1-255)

4.2.4.5 Supported information types

Function commands generic for IEC60870-5-103, I103GENCMD

Number of instances: 50

Function type for each function block instance is selected with parameter *FunctionType*.

Information number must be selected for command output.

4.2.5 IED commands with position and select for IEC 60870-5-103 I103POSCMD

4.2.5.1 Functionality

I103POSCMD has double-point position indicators that are getting the position value as an integer (for example from the POSITION output of the SCSWI function block) and sending it over IEC 60870-5-103 (1=OPEN; 2=CLOSE). The standard does not define the use of values 0 and 3. However, when connected to a switching device, these values are transmitted.

The BLOCK input will block only the signals in monitoring direction (the position information), not the commands via IEC 60870-5-103. The SELECT input is used to indicate that the monitored apparatus has been selected (in a select-before-operate type of control)

4.2.5.2 Function block

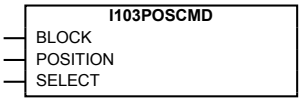

Figure 18: I103POSCMD function block

4.2.5.3 Signals

Table 48: I103POSCMD Input signals

Name	Type	Default	Description
BLOCK	BOOLEAN	0	Block of command
POSITION	INTEGER	0	Position of controllable object
SELECT	BOOLEAN	0	Select of controllable object

4.2.5.4 Settings

Table 49: I103POSCMD Non group settings (basic)

Name	Values (Range)	Unit	Step	Default	Description
FunctionType	1 - 255	-	1	1	Fucntion type (1-255)
InfNo	160 - 196	-	4	160	Information number for command output (1-255)

4.2.5.5 Supported information types

IED commands with position and select for IEC60870-5-103, I103POSCMD

Number of instances: 50

Function type for each function block instance is selected with parameter *FunctionType*.

Information number must be selected for command output.

Table 50: Each I103POSCMD has four INF forming four commands and two indications

INF	Inst 1	Inst 2	Inst 3	Type	Purpose	Comment
Base + 0	160	164	168	20	Direct operate	Set position direct
Base + 1	161	165	169	20	Select	Select before operate
Base + 2	162	166	170	20	Operate	Set position
Base + 3	163	167	171	20	Cancel	Cancel select
Base + 0	160	164	168	1	Position	Current position
Base + 1	161	165	169	1	Selected	Device selected

4.3 Disturbance recorder file transfer

4.3.1 Disturbance recordings

- The transfer functionality is based on the Disturbance recorder function. The analog and binary signals recorded will be reported to the master by polling. The eight last disturbances that are recorded are available for transfer to the master. A file that has been transferred and acknowledged by the master cannot be transferred again.
- The binary signals that are included in the disturbance recorder are those that are connected to the disturbance function blocks B1RBDR to B6RBDR. These function blocks include the function type and the information number for each signal. For more information on the description of the Disturbance report in the Technical reference manual. The analog channels, that are reported, are those connected to the disturbance function blocks A1RADR to A4RADR. The eight first ones belong to the public range and the remaining ones to the private range.

4.3.2 Disturbance recordings

The following elements are used in the ASDUs (Application Service Data Units) defined in the standard.

Analog signals, 40-channels: the channel number for each channel has to be specified. Channels used in the public range are 1 to 8 and with:

- I_{L1} connected to channel 1 on disturbance function block A1RADR
- I_{L2} connected to channel 2 on disturbance function block A1RADR
- I_{L3} connected to channel 3 on disturbance function block A1RADR
- I_{N} connected to channel 4 on disturbance function block A1RADR
- U_{L1E} connected to channel 5 on disturbance function block A1RADR
- U_{L2E} connected to channel 6 on disturbance function block A1RADR
- U_{L3E} connected to channel 7 on disturbance function block A1RADR
- U_{EN} connected to channel 8 on disturbance function block A1RADR

Channel number used for the remaining 32 analog signals are numbers in the private range 64 to 95.

Binary signals, 96-channels: for each channel the user can specify a FUNCTION TYPE and an INFORMATION NUMBER.

4.3.3 Disturbance Recordings

For each input of the Disturbance recorder function there is a setting for the information number of the connected signal. The function type and the information

number can be set to any value between 0 and 255. To get INF and FUN for the recorded binary signals there are parameters on the disturbance recorder for each input. The user must set these parameters to whatever he connects to the corresponding input.

Refer to description of Main Function type set on the local HMI.

Recorded analog channels are sent with ASDU26 and ASDU31. One information element in these ASDUs is called ACC and indicates the actual channel to be processed. The channels on disturbance recorder will be sent with an ACC according to the following table:

DRA#-Input	ACC	IEC103 meaning
1	1	IL1
2	2	IL2
3	3	IL3
4	4	IN
5	5	UL1
6	6	UL2
7	7	UL3
8	8	UN
9	64	Private range
10	65	Private range
11	66	Private range
12	67	Private range
13	68	Private range
14	69	Private range
15	70	Private range
16	71	Private range
17	72	Private range
18	73	Private range
19	74	Private range
20	75	Private range
21	76	Private range
22	77	Private range
23	78	Private range
24	79	Private range
25	80	Private range
26	81	Private range
27	82	Private range
28	83	Private range
29	84	Private range
30	85	Private range

Table continues on next page

DRA#-Input	ACC	IEC103 meaning
31	86	Private range
32	87	Private range
33	88	Private range
34	89	Private range
35	90	Private range
36	91	Private range
37	92	Private range
38	93	Private range
39	94	Private range
40	95	Private range

Disturbance upload

All analog and binary signals that are recorded with disturbance recorder can be reported to the master. The last eight disturbances that are recorded are available for transfer to the master. A successfully transferred disturbance (acknowledged by the master) will not be reported to the master again.

When a new disturbance is recorded by the IED a list of available recorded disturbances will be sent to the master, an updated list of available disturbances can be sent whenever something has happened to disturbances in this list. For example, when a disturbance is deleted (by other client, for example, SPA) or when a new disturbance has been recorded or when the master has uploaded a disturbance.

Deviations from the standard

Information sent in the disturbance upload is specified by the standard; however, some of the information are adapted to information available in disturbance recorder in 670 series.

This section describes all data that is not exactly as specified in the standard.

ASDU23

In ‘list of recorded disturbances’ (ASDU23) an information element named SOF (status of fault) exists. This information element consists of 4 bits and indicates whether:

- Bit TP: the protection equipment has tripped during the fault
- Bit TM: the disturbance data are currently being transmitted
- Bit TEST: the disturbance data have been recorded during normal operation or test mode.
- Bit OTEV: the disturbance data recording has been initiated by another event than start

The only information that is easily available is test-mode status. The other information is always set (hard coded) to:

TP	Recorded fault with trip. [1]
TM	Disturbance data waiting for transmission [0]
OTEV	Disturbance data initiated by other events [1]

Another information element in ASDU23 is the FAN (fault number). According to the standard this is a number that is incremented when a protection function takes action. In 670 series FAN is equal to disturbance number, which is incremented for each disturbance.

ASDU26 / ASDU31

When a disturbance has been selected by the master by sending ASDU24, the protection equipment answers by sending ASDU26, which contains an information element named NOF (number of grid faults). This number must indicate fault number in the power system,that is, a fault in the power system with several trip and auto-reclosing has the same NOF (while the FAN must be incremented). NOF is in 670 series, just as FAN, equal to disturbance number.

Section 5 Interoperability

5.1 Physical layer

5.1.1 Electrical interface

Table 51: Electrical Interface

	Supported
EIA RS-485	Yes
Number of loads	32

5.1.2 Optical interface

Table 52: Optical interface

	Supported
Glass fibre	Yes
Plastic fibre	Yes
F-SMA type connector	No
BFOC/2,5 type connector	Yes
HFBR snap-in type connector	Yes

5.1.3 Transmission speed

Table 53: Transmission speed

	Supported
9 600 bit/s	Yes
19 200 bit/s	Yes

5.2 Link layer

There are no choices for the link layer.

5.3 Application layer

5.3.1 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.

5.3.2 Common address of ASDU

Table 54: Common address of ASDU

	Supported
One COMMON ADDRESS OF ASDU (identical with station address)	Yes
More than one COMMON ADDRESS OF ASDU	No

5.3.3 Selection of standard information numbers in monitor direction

5.3.3.1 System functions in monitor direction

Table 55: System functions in monitor direction

INF	Semantics	Supported
0	End of general interrogation	Yes
0	Time synchronization	Yes
2	Reset FCB	Yes
3	Reset CU	Yes
4	Start/restart	Yes
5	Power on	Yes

5.3.3.2 Status indications in monitor direction

Table 56: Status indications in monitor direction

INF	Semantics	Supported
16	Auto-recloser active	Yes
17	Teleprotection active	No
18	Protection active	No
19	LED reset	Yes
20	Monitor direction blocked	No
21	Test mode	Yes
22	Local parameter setting	Yes
Table continues on next page		

INF	Semantics	Supported
23	Characteristic 1	Yes
24	Characteristic 2	Yes
25	Characteristic 3	Yes
26	Characteristic 4	Yes
27	Auxiliary input 1	No
28	Auxiliary input 2	No
29	Auxiliary input 3	No
30	Auxiliary input 4	No

5.3.3.3 Supervision indications in monitor direction

Table 57: Supervision indications in monitor direction

INF	Semantics	Supported
32	Measurand supervision I	Yes
33	Measurand supervision U	Yes
35	Phase sequence supervision	No
36	Trip circuit supervision	No
37	I>> back-up operation	Yes
38	VT fuse failure	Yes
39	Teleprotection disturbed	No
46	Group warning	Yes
47	Group alarm	Yes

5.3.3.4 Earth-fault indications in monitor direction

Table 58: Earth-fault indications in monitor direction

INF	Semantics	Supported
48	Earth fault L_1	No
49	Earth fault L_2	No
50	Earth fault L_3	No
51	Earth fault forward, i.e. Line	Yes
52	Earth fault reverse, i.e. Busbar	Yes

5.3.3.5 Fault indications in monitor direction

Table 59: Fault indications in monitor direction

INF	Semantics	Supported
64	Start /pick-up L_1	Yes
65	Start /pick-up L_2	Yes
66	Start /pick-up L_3	Yes
67	Start /pick-up N	Yes
68	General trip	Yes
69	Trip L_1	Yes
70	Trip L_2	Yes
71	Trip L_3	Yes
72	Trip I>> (back-up operation)	Yes
73	Fault location X in ohms	Yes
74	Fault forward/line	Yes
75	Fault reverse/busbar	Yes
76	Teleprotection signal transmitted	Yes
77	Teleprotection signal received	Yes
78	Zone 1	Yes
79	Zone 2	Yes
80	Zone 3	Yes
81	Zone 4	Yes
82	Zone 5	Yes
83	Zone 6	No
84	General start/pick-up	Yes
85	Breaker failure	Yes
86	Trip measuring system L_1	Yes
87	Trip measuring system L_2	Yes
88	Trip measuring system L_3	Yes
89	Trip measuring system E	Yes
90	Trip I>	Yes
91	Trip I>>	Yes
92	Trip IN>	Yes
93	Trip IN>>	Yes

5.3.3.6 Auto-reclosure indications in monitor direction

Table 60: Auto-reclosure indications in monitor direction

INF	Semantics	Supported
128	CB 'on' by AR	Yes
129	CB 'on' by long-time AR	No
130	AR blocked	Yes

5.3.3.7 Measurands in monitor direction

Table 61: Measurands in monitor direction

INF	Semantics	Supported
144	Measurand I	Yes
145	Measurands I, U	Yes
146	Measurands I, U, P, Q	Yes
147	Measurands I_N, U_{EN}	Yes
148	Measurands $I_{L1,2,3,}$ $U_{L1,2,3,}$ P, Q, f	Yes

5.3.3.8 Generic functions in monitor direction

Table 62: Generic functions in monitor direction

INF	Semantics	Supported
240	Read headings of all defined groups	No
241	Read values or attributes of all entries of one group	No
243	Read directory of a single entry	No
244	Read value or attribute of a single entry	No
245	End of general interrogation of generic data	No
249	Write entry with confirmation	No
250	Write entry with execution	No
251	Write entry aborted	No

5.3.4 Selection of standard information numbers in control direction

5.3.4.1 System functions in control direction

Table 63: System functions in control direction

INF	Semantics	Supported
0	Initiation of general interrogation	Yes
0	Time synchronization	Yes

5.3.4.2 General commands in control direction

Table 64: General commands in control direction

INF	Semantics	Supported
16	Auto-recloser on/off	Yes
17	Teleprotection on/off	Yes
18	Protection on/off	Yes
19	LED reset	Yes
23	Activate characteristic 1	Yes
24	Activate characteristic 2	Yes
25	Activate characteristic 3	Yes
26	Activate characteristic 4	Yes

5.3.4.3 Generic functions in control direction

Table 65: Generic functions in control direction

INF	Semantics	Supported
240	Read headings of all defined groups	No
241	Read values or attributes of all entries of one group	No
243	Read directory of a single entry	No
244	Read value or attribute of a single entry	No
245	General interrogation of generic data	No
248	Write entry	No
249	Write entry with confirmation	No
250	Write entry with execution	No
251	Write entry abort	No

5.3.5 Basic application functions

Table 66: Basic application functions

	Supported
Test mode	Yes
Blocking of monitor direction	No
Disturbance data	Yes
Generic services	No
Private data	Yes

5.3.6 Miscellaneous

Measurands are transmitted with ASDU 3 as well as with ASDU 9. As defined in 7.2.6.8, the maximum MVAL can either be 1,2 or 2,4 times the rated value. No different rating shall be used in ASDU 3 and ASDU 9, i.e. for each measurand there is only one choice.

Table 67: Miscellaneous

Measurand	Max. MVAL = rated value times	
	1,2	2,4
Current L_1	No	Yes
Current L_2	No	Yes
Current L_3	No	Yes
Voltage L_{1-E}	Yes	No
Voltage L_{2-E}	Yes	No
Voltage L_{3-E}	Yes	No
Active power P	No	Yes
Reactive power Q	No	Yes
Frequency f	Yes	No
Voltage L_1 - L_2	Yes	No

Section 6 Glossary

6.1 Glossary

AC	Alternating current
ACC	Actual channel
ACT	Application configuration tool within PCM600
A/D converter	Analog-to-digital converter
ADBS	Amplitude deadband supervision
ADM	Analog digital conversion module, with time synchronization
AI	Analog input
ANSI	American National Standards Institute
AR	Autoreclosing
ASCT	Auxiliary summation current transformer
ASD	Adaptive signal detection
ASDU	Application service data unit
AWG	American Wire Gauge standard
BBP	Busbar protection
BFOC/2,5	Bayonet fibre optic connector
BFP	Breaker failure protection
BI	Binary input
BIM	Binary input module
BOM	Binary output module
BOS	Binary outputs status
BR	External bistable relay
BS	British Standards
BSR	Binary signal transfer function, receiver blocks
BST	Binary signal transfer function, transmit blocks
C37.94	IEEE/ANSI protocol used when sending binary signals between IEDs
CAN	Controller Area Network. ISO standard (ISO 11898) for serial communication

CB	Circuit breaker
CBM	Combined backplane module
CCITT	Consultative Committee for International Telegraph and Telephony. A United Nations-sponsored standards body within the International Telecommunications Union.
CCM	CAN carrier module
CCVT	Capacitive Coupled Voltage Transformer
Class C	Protection Current Transformer class as per IEEE/ ANSI
CMPPS	Combined megapulses per second
CMT	Communication Management tool in PCM600
CO cycle	Close-open cycle
Codirectional	Way of transmitting G.703 over a balanced line. Involves two twisted pairs making it possible to transmit information in both directions
COM	Command
COMTRADE	Standard Common Format for Transient Data Exchange format for Disturbance recorder according to IEEE/ANSI C37.111, 1999 / IEC60255-24
Contra-directional	Way of transmitting G.703 over a balanced line. Involves four twisted pairs, two of which are used for transmitting data in both directions and two for transmitting clock signals
COT	Cause of transmission
CPU	Central processing unit
CR	Carrier receive
CRC	Cyclic redundancy check
CROB	Control relay output block
CS	Carrier send
CT	Current transformer
CU	Communication unit
CVT or CCVT	Capacitive voltage transformer
DAR	Delayed autoreclosing
DARPA	Defense Advanced Research Projects Agency (The US developer of the TCP/IP protocol etc.)
DBDL	Dead bus dead line
DBLL	Dead bus live line
DC	Direct current
DFC	Data flow control

DFT	Discrete Fourier transform
DHCP	Dynamic Host Configuration Protocol
DIP-switch	Small switch mounted on a printed circuit board
DI	Digital input
DLLB	Dead line live bus
DNP	Distributed Network Protocol as per IEEE Std 1815-2012
DR	Disturbance recorder
DRAM	Dynamic random access memory
DRH	Disturbance report handler
DSP	Digital signal processor
DTT	Direct transfer trip scheme
EHV network	Extra high voltage network
EIA	Electronic Industries Association
EMC	Electromagnetic compatibility
EMF	Electromotive force
EMI	Electromagnetic interference
EnFP	End fault protection
EPA	Enhanced performance architecture
ESD	Electrostatic discharge
F-SMA	Type of optical fibre connector
FAN	Fault number
FCB	Flow control bit; Frame count bit
FOX 20	Modular 20 channel telecommunication system for speech, data and protection signals
FOX 512/515	Access multiplexer
FOX 6Plus	Compact time-division multiplexer for the transmission of up to seven duplex channels of digital data over optical fibers
FUN	Function type
G.703	Electrical and functional description for digital lines used by local telephone companies. Can be transported over balanced and unbalanced lines
GCM	Communication interface module with carrier of GPS receiver module
GDE	Graphical display editor within PCM600
GI	General interrogation command
GIS	Gas-insulated switchgear

GOOSE	Generic object-oriented substation event
GPS	Global positioning system
GSAL	Generic security application
GTM	GPS Time Module
HDLC protocol	High-level data link control, protocol based on the HDLC standard
HFBR connector type	Plastic fiber connector
HMI	Human-machine interface
HSAR	High speed autoreclosing
HV	High-voltage
HVDC	High-voltage direct current
IDBS	Integrating deadband supervision
IEC	International Electrical Committee
IEC 60044-6	IEC Standard, Instrument transformers – Part 6: Requirements for protective current transformers for transient performance
IEC 60870-5-103	Communication standard for protection equipment. A serial master/slave protocol for point-to-point communication
IEC 61850	Substation automation communication standard
IEC 61850–8–1	Communication protocol standard
IEEE	Institute of Electrical and Electronics Engineers
IEEE 802.12	A network technology standard that provides 100 Mbits/s on twisted-pair or optical fiber cable
IEEE P1386.1	PCI Mezzanine Card (PMC) standard for local bus modules. References the CMC (IEEE P1386, also known as Common Mezzanine Card) standard for the mechanics and the PCI specifications from the PCI SIG (Special Interest Group) for the electrical EMF (Electromotive force).
IEEE 1686	Standard for Substation Intelligent Electronic Devices (IEDs) Cyber Security Capabilities
IED	Intelligent electronic device
I-GIS	Intelligent gas-insulated switchgear
IOM	Binary input/output module
Instance	When several occurrences of the same function are available in the IED, they are referred to as instances of that function. One instance of a function is identical to another of the same kind but has a different number in the

	IED user interfaces. The word "instance" is sometimes defined as an item of information that is representative of a type. In the same way an instance of a function in the IED is representative of a type of function.
IP	1. Internet protocol. The network layer for the TCP/IP protocol suite widely used on Ethernet networks. IP is a connectionless, best-effort packet-switching protocol. It provides packet routing, fragmentation and reassembly through the data link layer. 2. Ingression protection, according to IEC 60529
IP 20	Ingression protection, according to IEC 60529, level 20
IP 40	Ingression protection, according to IEC 60529, level 40
IP 54	Ingression protection, according to IEC 60529, level 54
IRF	Internal failure signal
IRIG-B:	InterRange Instrumentation Group Time code format B, standard 200
ITU	International Telecommunications Union
LAN	Local area network
LIB 520	High-voltage software module
LCD	Liquid crystal display
LDCM	Line differential communication module
LDD	Local detection device
LED	Light-emitting diode
LNT	LON network tool
LON	Local operating network
MCB	Miniature circuit breaker
MCM	Mezzanine carrier module
MIM	Milli-ampere module
MPM	Main processing module
MVAL	Value of measurement
MVB	Multifunction vehicle bus. Standardized serial bus originally developed for use in trains.
NCC	National Control Centre
NOF	Number of grid faults
NUM	Numerical module
OCO cycle	Open-close-open cycle
OCP	Overcurrent protection

OEM	Optical Ethernet module
OLTC	On-load tap changer
OTEV	Disturbance data recording initiated by other event than start/ pick-up
OV	Overvoltage
Overreach	A term used to describe how the relay behaves during a fault condition. For example, a distance relay is overreaching when the impedance presented to it is smaller than the apparent impedance to the fault applied to the balance point, that is, the set reach. The relay “sees” the fault but perhaps it should not have seen it.
PCI	Peripheral component interconnect, a local data bus
PCM	Pulse code modulation
PCM600	Protection and control IED manager
PC-MIP	Mezzanine card standard
PMC	PCI Mezzanine card
POR	Permissive overreach
POTT	Permissive overreach transfer trip
Process bus	Bus or LAN used at the process level, that is, in near proximity to the measured and/or controlled components
PSM	Power supply module
PST	Parameter setting tool within PCM600
PT ratio	Potential transformer or voltage transformer ratio
PUTT	Permissive underreach transfer trip
RASC	Synchrocheck relay, COMBIFLEX
RCA	Relay characteristic angle
RISC	Reduced instruction set computer
RMS value	Root mean square value
RS422	A balanced serial interface for the transmission of digital data in point-to-point connections
RS485	Serial link according to EIA standard RS485
RTC	Real-time clock
RTU	Remote terminal unit
SA	Substation Automation
SBO	Select-before-operate
SC	Switch or push button to close
SCL	Short circuit location

SCS	Station control system
SCADA	Supervision, control and data acquisition
SCT	System configuration tool according to standard IEC 61850
SDU	Service data unit
SLM	Serial communication module.
SMA connector	Subminiature version A, A threaded connector with constant impedance.
SMT	Signal matrix tool within PCM600
SMS	Station monitoring system
SNTP	Simple network time protocol – is used to synchronize computer clocks on local area networks. This reduces the requirement to have accurate hardware clocks in every embedded system in a network. Each embedded node can instead synchronize with a remote clock, providing the required accuracy.
SOF	Status of fault
SPA	Strömberg Protection Acquisition (SPA), a serial master/ slave protocol for point-to-point communication
SRY	Switch for CB ready condition
ST	Switch or push button to trip
Starpoint	Neutral point of transformer or generator
SVC	Static VAr compensation
TC	Trip coil
TCS	Trip circuit supervision
TCP	Transmission control protocol. The most common transport layer protocol used on Ethernet and the Internet.
TCP/IP	Transmission control protocol over Internet Protocol. The de facto standard Ethernet protocols incorporated into 4.2BSD Unix. TCP/IP was developed by DARPA for Internet working and encompasses both network layer and transport layer protocols. While TCP and IP specify two protocols at specific protocol layers, TCP/IP is often used to refer to the entire US Department of Defense protocol suite based upon these, including Telnet, FTP, UDP and RDP.
TEF	Time delayed earth-fault protection function
TM	Transmit (disturbance data)
TNC connector	Threaded Neill-Concelman, a threaded constant impedance version of a BNC connector

TP	Trip (recorded fault)
TPZ, TPY, TPX, TPS	Current transformer class according to IEC
TRM	Transformer Module. This module transforms currents and voltages taken from the process into levels suitable for further signal processing.
TYP	Type identification
UMT	User management tool
Underreach	A term used to describe how the relay behaves during a fault condition. For example, a distance relay is underreaching when the impedance presented to it is greater than the apparent impedance to the fault applied to the balance point, that is, the set reach. The relay does not “see” the fault but perhaps it should have seen it. See also Overreach.
UTC	Coordinated Universal Time. A coordinated time scale, maintained by the Bureau International des Poids et Mesures (BIPM), which forms the basis of a coordinated dissemination of standard frequencies and time signals. UTC is derived from International Atomic Time (TAI) by the addition of a whole number of "leap seconds" to synchronize it with Universal Time 1 (UT1), thus allowing for the eccentricity of the Earth's orbit, the rotational axis tilt (23.5 degrees), but still showing the Earth's irregular rotation, on which UT1 is based. The Coordinated Universal Time is expressed using a 24-hour clock, and uses the Gregorian calendar. It is used for aeroplane and ship navigation, where it is also sometimes known by the military name, "Zulu time." "Zulu" in the phonetic alphabet stands for "Z", which stands for longitude zero.
UV	Undervoltage
WEI	Weak end infeed logic
VT	Voltage transformer
X.21	A digital signalling interface primarily used for telecom equipment
$3I_O$	Three times zero-sequence current.Often referred to as the residual or the earth-fault current
$3U_O$	Three times the zero sequence voltage. Often referred to as the residual voltage or the neutral point voltage

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