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 chronological order in which the IED should be commissioned.

The operation manual contains instructions on how to operate the IED once it has been commissioned. The manual provides instructions for monitoring, controlling and setting 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 service manual contains instructions on how to service and maintain the IED. The manual also provides procedures for de-energizing, de-commissioning and disposal of the IED.

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 be used when 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 a communication protocol supported by the IED. The manual concentrates on 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 service manual is not available yet.

1.3.2 Document revision history

Document revision/date	Product series version	History
-/February 2011	1.1	First release

1.3.3 Related documents

Documents related to REB650	Identity number
Application manual	1MRK 505 262-UEN
Technical manual	1MRK 505 263-UEN
Commissioning manual	1MRK 505 264-UEN

Table continues on next page

Documents related to REB650	Identity number
Product Guide, configured	1MRK 505 265-BEN
Type test certificate	1MRK 505 265-TEN

Documents related to REL650	Identity number
Application manual	1MRK 506 325-UEN
Technical manual	1MRK 506 326-UEN
Commissioning manual	1MRK 506 327-UEN
Product Guide, configured	1MRK 506 328-BEN
Type test certificate	1MRK 506 328-TEN

Documents related to RET650	Identity number
Application manual	1MRK 504 124-UEN
Technical manual	1MRK 504 125-UEN
Commissioning manual	1MRK 504 126-UEN
Product Guide, configured	1MRK 504 127-BEN
Type test certificate	1MRK 504 127-TEN

Documents related to REC650	Identity number
Application manual	1MRK 511 246-UEN
Technical manual	1MRK 511 247-UEN
Commissioning manual	1MRK 511 248-UEN
Product Guide	1MRK 511 249-BEN
Type test certificate	1MRK 511 249-TEN

Documents related to REG650	Identity number
Application manual	1MRK 502 033-UEN
Technical manual	1MRK 502 034-UEN
Commissioning manual	1MRK 502 035-UEN
Product Guide	1MRK 502 036-BEN
Type test certificate	1MRK 502 036-TEN
Rotor Earth Fault Protection with Injection Unit RXTTE4 and REG670	1MRG001910

Documents related to REQ650	Identity number
Application manual	1MRK 505 266-UEN
Technical manual	1MRK 505 267-UEN
Commissioning manual	1MRK 505 268-UEN
Product Guide	1MRK 505 269-BEN
Type test certificate	1MRK 505 269-TEN

650 series manuals	Identity number
Communication protocol manual, DNP3	1MRK 511 241-UEN
Communication protocol manual, IEC 61850	1MRK 511 242-UEN
Communication protocol manual, IEC 60870-5-103	1MRK 511 243-UEN
Point list manual, DNP3	1MRK 511 244-UEN
Engineering manual	1MRK 511 245-UEN
Operation manual	1MRK 500 093-UEN
Installation manual	1MRK 514 014-UEN

1.4 Symbols and conventions

1.4.1 Safety indication 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. Therefore, comply fully with all warning and caution notices.

1.4.2 Manual conventions

Conventions used in IED manuals. A particular convention may not be used in this manual.

- 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.
- The ^ character in front of an input or output signal name in the function block symbol given for a function, indicates that the user can set an own signal name in PCM600.
- The * character after an input or output signal name in the function block symbol given for a function, indicates that the signal must be connected to another function block in the application configuration to achieve a valid application configuration.

1.4.3 Functions included in 650 series IEDs

Table 1: Main protection functions

IEC 61850 / Function block name	ANSI	Function description
Differential protection		
T2WPDIF	87T	Transformer differential protection, two winding
T3WPDIF	87T	Transformer differential protection, three winding
REFPDIF	87N	Restricted earth fault protection, low impedance
HZPDIF	87	1Ph High impedance differential protection
GENPDIF	87G	Generator differential protection
Impedance protection		
ZQDPDIS	21	Five-zone distance protection, quadrilateral characteristic
FDPSPDIS	21	Phase selection with load enchroachment, quadrilateral characteristic
ZMOPDIS	21	Five-zone distance protection, mho characteristic
FMPSPDIS	21	Faulty phase identification with load enchroachment for mho
ZDNRDIR	21	Directional impedance quadrilateral and mho
PPLPHIZ		Phase preference logic
ZMRPSB	68	Power swing detection
ZCVPSOF		Automatic switch onto fault logic, voltage-and current-based
ZGPDIS	21G	Underimpedance protection for generators and transformers
LEXPDIS	40	Loss of excitation
OOSPPAM	13	Out-of-step protection
LEPDIS		Load enchroachment

Table 2: Backup protection functions

IEC 61850 / Function block name	ANSI	Function description
Current protection		
PHPIOC	50	Instantaneous phase overcurrent protection
SPTPIOC	50	Instantaneous phase overcurrent protection
OC4PTOC	51/67	Four-step phase overcurrent protection
OC4SPTOC	51/67	Four-step phase overcurrent protection
EFPIOC	50N	Instantaneous residual overcurrent protection
EF4PTOC	51N/67N	Four-step directional residual overcurrent protection
SDEPSDE	67N	Sensitive directional residual overcurrent and power protection
UC2PTUC	37	Time-delayed two-step undercurrent protection
LPTTR	26	Thermal overload protection, one time constant
TRPTTR	49	Thermal overload protection, two time constants
CCRBRF	50BF	Breaker failure protection
CSPRBRF	50BF	Breaker failure protection
STBPTOC	50STB	Stub protection
CCRPLD	52PD	Pole discordance protection
BRCPTOC	46	Broken conductor check
GUPPDUP	37	Directional underpower protection
GOPPDOP	32	Directional overpower protection
DNSPTOC	46	Negative sequence-based overcurrent function
AEGGAPC	50AE	Accidental energizing protection for synchronous generator
NS2PTOC	46I2	Negative-sequence time overcurrent protection for machines
VR2PVOC	51V	Voltage-restrained time overcurrent 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
LOVPTUV	27	Loss-of-voltage check
STEFPHIZ	64	100% Stator earth fault protection, 3rd harmonic based
Frequency protection		
SAPTUF	81	Underfrequency function
SAPTOF	81	Overfrequency function
SAPFRC	81	Rate-of-change frequency protection

Table 3: Control and monitoring functions

IEC 61850 / Function block name	ANSI	Function description
Control		
SESRSYN	25	Synchrocheck, energizing check and synchronizing
SMBRREC	79	Autorecloser
STBRREC	79	Autorecloser
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		Circuit switch
POS_EVAL		Evaluation of position indication
SELGGIO		Select release
QCBAY		Bay control
LOCREM		Handling of LR-switch positions
LOCREMCTRL		LHMI control of PSTO
APC8		Apparatus control for single bay, max 8 app. (1CB) incl. interlocking
TR8ATCC	90	Automatic voltage control for tap changer, parallel control
TCMYLTC	84	Tap changer control and supervision, 6 binary inputs
SLGGIO		Logic-rotating Switch for function selection and LHMI presentation
VSGGIO		Selector mini switch extension
DPGGIO		IEC61850 generic communication I/O functions double point
SPC8GGIO		Single-point generic control 8 signals
AUTOBITS		AutomationBits, command function for DNP3.0
I103CMD		Function commands for IEC60870-5-103
I103IEDCMD		IED commands for IEC60870-5-103
I103USRCMD		Function commands user defined for IEC60870-5-103
I103GENCMD		Function commands generic for IEC60870-5-103

Table continues on next page

IEC 61850 / Function block name	ANSI	Function description
I103POSCMD		IED commands with position and select for IEC60870-5-103
Secondary system supervision		
CCSRDIF	87	Current circuit supervision
SDDRFUF		Fuse failure supervision
TCSSCBR		Breaker close/trip circuit monitoring
Logic		
SMPPTRC	94	Tripping logic
SPTPTRC	94	Tripping logic
TMAGGIO		Trip matrix logic
OR		Configurable logic blocks, OR
INVERTER		Configurable logic blocks, Inverter
PULSETIMER		Configurable logic blocks, PULSETIMER
GATE		Configurable logic blocks, Controllable gate
XOR		Configurable logic blocks, exclusive OR
LOOPDELAY		Configurable logic blocks, loop delay
TimeSet		Configurable logic blocks, timer
AND		Configurable logic blocks, AND
SRMEMORY		Configurable logic blocks, set-reset memory
RSMEMORY		Configurable logic blocks, reset-set memory
ANDQT		Configurable logic Q/T, ANDQT
ORQT		Configurable logic Q/T, ORQT
INVERTERQT		Configurable logic Q/T, INVERTERQT
XORQT		Configurable logic 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
B16IFCVI		Boolean 16 to Integer conversion with logic node representation
IB16A		Integer to Boolean 16 conversion
IB16FCVB		Integer to boolean 16 conversion with logic node representation
Monitoring		
CVMMXN		Measurements
CMMXU		Phase current measurement

Table continues on next page

IEC 61850 / Function block name	ANSI	Function description
VMMXU		Phase-phase voltage measurement
CMSQI		Current sequence component measurement
VMSQI		Voltage sequence measurement
VNMMXU		Phase-neutral voltage measurement
AISVBAS		Function block for service values presentation of the analog inputs
TM_P_P2		Function block for service value presentation of primary analog inputs 600TRM
AM_P_P4		Function block for service value presentation of primary analog inputs 600AIM
TM_S_P2		Function block for service value presentation of secondary analog inputs 600TRM
AM_S_P4		Function block for service value presentation of secondary analog inputs 600AIM
CNTGGIO		Event counter
DRPRDRE		Disturbance report
AxRADR		Analog input signals
BxRBDR		Binary input signals
SPGGIO		IEC61850 generic communication I/O functions
SP16GGIO		IEC61850 generic communication I/O functions 16 inputs
MVGGIO		IEC61850 generic communication I/O functions
MVEXP		Measured value expander block
LMBRFLO		Fault locator
SPVNZBAT		Station battery supervision
SSIMG	63	Insulation gas-monitoring function
SSIML	71	Insulation liquid-monitoring function
SSCBR		Circuit breaker condition monitoring
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		Supervision status for IEC60870-5-103
I103USRDEF		Status for user defiend signals for IEC60870-5-103
Metering		
PCGGIO		Pulse counter logic
ETPMMTR		Function for energy calculation and demand handling

Table 4: Designed to communicate

IEC 61850 / Function block name	ANSI	Function description
Station communication		
IEC61850-8-1		IEC61850 communication protocol
DNPGEN CH1TCP CH2TCP CH3TCP CH4TCP MST1TCP MST2TCP MST3TCP MST4TCP		DNP3.0 for TCP/IP communication protocol
DNPFREC		DNP3.0 fault records for TCP/IP communication protocol
IED61870-5-103		IEC60870-5-103 serial communication via COM02
GOOSEINTLKRCV		Horizontal communication via GOOSE for interlocking
GOOSEBINRCV		GOOSE binary receive
GOOSEVCTRCONF		GOOSE VCTR configuration for send and receive
VCTRSEND		Voltage control sending block for GOOSE
GOOSEVCTRRCV		Voltage control receiving block for GOOSE
ETHFRNT ETHLAN1 GATEWAY		Ethernet configuration of front port, LAN1 port and gateway
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
GOOSESPRCV		GOOSE function block to receive a single point value
Scheme communication		
ZCPSCH	85	Scheme communication logic for distance or overcurrent protection
ZCRWPSCH	85	Current reversal and weak end infeed logic for distance protection
ZCWPSCH	85	Current reversal and weak end infeed logic for distance protection
ZCLCPLAL		Local acceleration logic
ECRSCH	85	Scheme communication logic for residual overcurrent protection
ECRWPSCH	85	Current reversal and weak end infeed logic for residual overcurrent protection

Table 5: Basic IED functions

IEC 61850 / Function block name	Function description
Basic functions included in all products	
INTERRSIG	Self-supervision with internal event list
SELFSUPEVLST	Self-supervision with internal event list
TIMESYNCHGEN	Time synchronization
SNTP	Time synchronization

Table continues on next page

IEC 61850 / Function block name	Function description
DTSBEGIN	Time synchronization
DTSEND	Time synchronization
TIMEZONE	Time synchronization
IRIG-B	Time synchronization
SETGRPS	Setting group handling
ACTVGRP	Parameter setting groups
TESTMODE	Test mode functionality
CHNGLCK	Change lock function
ATHSTAT	Authority status
ATHCHCK	Authority check
TERMINALID	IED identifiers
PRODINF	Product information
PRIMVAL	Primary system values
SMAI_20_1 - SMAI_20_12	Signal Matrix for analog inputs
3PHSUM	Summation block 3 phase
GBASVAL	Global base values for settings
DOSFRNT	Denial of service, frame rate control for front port
DOSLAN1	Denial of service, frame rate control for LAN1 port
DOSSCKT	Denial of service, socket flow control

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. 650 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 vendor specific implementation section in this manual for the interoperability list.

Data mapping principle

Almost all IEC 60870-5-103 process data in the IED 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 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.

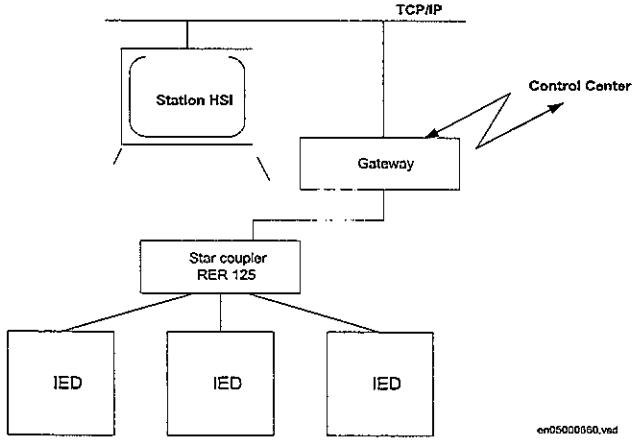


Figure 2: Example of IEC 60870-5-103 communication structure for a substation automation system

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 (glass/plastic) and an opto/ electrical converter for the PC/RTU.

Table 7: Max distances between IED/nodes

Connector	Distance
glass (ST connector)	< 1000 m according to optical budget

Section 3 IEC 60870-5-103 communication engineering

3.1 IEC 60870-5-103 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.

3.2 Specific IEC 60870-5-103 settings

Set parameter *Operation* to *On* either in Parameter Setting tool or from the local HMI.

Parameter *Operation* is found under **Main menu/Configuration/Communication/ Station/communication/1:IEC60870-5-103** in local HMI. The IED is automatically restarted when parameter *Operation* is set.

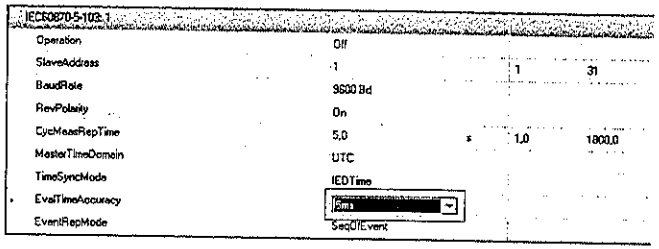


Figure 3: Settings under IEC60870-5-103:1 in Local HMI

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 31. The communication speed, can be set either to 9600 bits/s or 19200 bits/s
- *RevPolarity*: Setting for inverting the light (or not).
- *CycMeasRepTime*: Setting for *CycMeasRepTime* must be coordinated with the *xDbRepInt* and *xAngDbRepInt* reporting setting on the MMXU measurement function blocks. See I103MEAS function block for more information.
- *EventRepMode*: Defines the mode for how events are reported.
  The event buffer size is 1000 events.

3.2.1 Settings

Table 8: IEC60870-5-103 Non group settings (basic)

Name	Values (Range)	Unit	Step	Default	Description
Operation	Off On	-	-	Off	Operation
SlaveAddress	1 - 31	-	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
MasterTimeDomain	UTC Local Local with DST	-	-	UTC	Master time domain
TimeSyncMode	IEDTime LlnMastTime IEDTimeSkew	-	-	IEDTime	Time synchronization mode
EvalTimeAccuracy	5ms 10ms 20ms 40ms Off	-	-	5ms	Evaluate time accuracy for invalid time
EventRepMode	SoqOfEvent HiPrtSpont	-	-	SoqOfEvent	Event reporting mode

3.3 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.

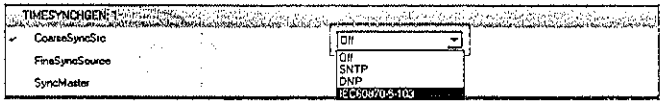


Figure 4: Settings under TIMESYNCHGEN:1 in PST

Only *CoarseSyncSrc* can be set to IEC 60870-5-103, 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: **IED Configuration/Communication/Station communication/IEC60870-5-103:1.**

- *MasterTimeDomain* specifies the format of the time sent by the master. Format can be:
  - Coordinated Universal Time (UTC)
  - Local time set in the master (Local)
  - 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.
  - *LinMasTime*: 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 *LinMasTime* it applies the time changes occurred between two synchronised 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 worse 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*.

According to the standard, the "Bad Time" flag is reported when synchronization has been omitted in the protection for >23 h.

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.

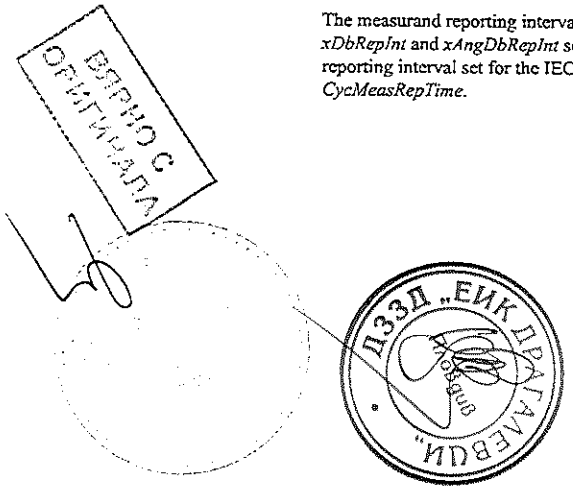
4.1 Signals in monitoring direction

4.1.1 Measurands for IEC 60870-5-103 I103MEAS

4.1.1.1 Functionality

I03MEAS is a function block that reports all valid measuring types depending on connected signals.

The measurand reporting interval set for MMXU function blocks, using the *xDbRepInt* and *xAngDbRepInt* settings, must be coordinated with the event reporting interval set for the IEC 60870-5-103 communication using setting *CycMeasRepTime*.



CMMXU:1				
Operation	Off			
GlobalBaseSel	1		1	6
ILDbRepInt	10	Type	1	300
ILZeroDb	500	m%	0	100000
ILHiHiLim	1200	A	0	500000
ILHiLim	1100	A	0	500000
ILLowLim	0	A	0	500000
ILLowLowLim	0	A	0	500000
ILMin	0	A	0	500000
ILMax	1300	A	0	500000
ILRepTyp	Cyclic			
ILLimHys	5,000	%	0,000	100,000
ILAngDbRepInt	10	Type	1	300
IAmpComp5	0,000	%	-10,000	10,000
IAmpComp30	0,000	%	-10,000	10,000
IAmpComp100	0,000	%	-10,000	10,000
IAngComp5	0,000	Deg	-10,000	10,000
IAngComp30	0,000	Deg	-10,000	10,000
IAngComp100	0,000	Deg	-10,000	10,000

Figure 5: Settings for CMMXU: 1

All input signals to IEC 60870-5-103 I103MEAS must be connected in application configuration. Connect an input signals on IEC 60870-5-103 I103MEAS that is not connected to the corresponding output on MMXU function, to outputs on the fixed signal function block.

4.1.1.2 Function block

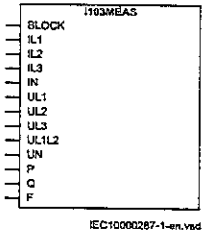


Figure 6: I103MEAS function block

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
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	MVA	0.05	1200.00	Maximum value for reactive power
MaxF	50.0 - 60.0	Hz	10.0	50.0	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.

Info. no.	Message	Supported
148	IL1	Yes
144, 145, 148	IL2	Yes
148	IL3	Yes
147	IN, Neutral current	Yes
148	UL1	Yes
148	UL2	Yes
148	UL3	Yes
145, 146	UL1-UL2	Yes
147	UN, Neutral voltage	Yes
146, 148	P, active power	Yes
146, 148	Q, reactive power	Yes
148	f, frequency	Yes

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

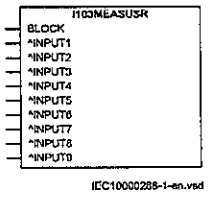


Figure 7: I103MEASUSR function block

4.1.2.3 Signals

Table 11: 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
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 12: 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. Default values are defined in private range 25 – 27. One for each instance.

Information number must be selected for measurands.

Info.	Message	Supported
*1)	Meas1	Yes
*	Meas2	Yes
*	Meas3	Yes
*	Meas4	Yes
*	Meas5	Yes
*	Meas6	Yes
*	Meas7	Yes
*	Meas8	Yes
*	Meas9	Yes

1) * User defined information number

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

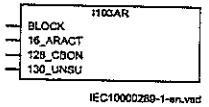


Figure 8: I103AR function block

4.1.3.3 Signals

Table 13: I103AR Input signals

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

4.1.3.4 Settings

Table 14: 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
Number of instances: 1

Function type is selected with parameter *FunctionType*.

Information number is defined for each output signal.

Info. no.	Message	Supported
16	Autorecloser active	Yes
17	Teleprotection active	No
18	Protection active	No
128	CB on by Autorecloser	Yes
129	CB 'on' by long-time AR	No
130	Autorecloser blocked	Yes

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

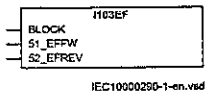


Figure 9: I103EF function block

4.1.4.3 Signals

Table 15: 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 16: 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
Number of instances: 1

Function type is selected with parameter *FunctionType*.

Information number is defined for each output signal.

Info. no.	Message	Supported
48	Earth fault L1	No
49	Earth fault L2	No
50	Earth fault L3	No
51	Earth fault forward	Yes
52	Earth fault reverse	Yes

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

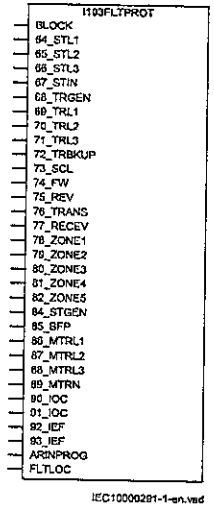


Figure 10: I103FLTPROT function block

4.1.5.3 Signals

Table 17: 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>>

Table continues on next page

Name	Type	Default	Description
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 18: 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 IEC60870-5-103, I103FLTPROT
Number of instances: 1

Function type is selected with parameter *FunctionType*.

Information number is defined for each input signals.

Info. no.	Message	Supported	TYPE	GI	COT
64	Start phase L1	Yes	2	Y	1,7,9
65	Start phase L2	Yes	2	Y	1,7,9
66	Start phase L3	Yes	2	Y	1,7,9
67	Start residual current IN	Yes	2	Y	1,7,9
68	Trip general	Yes	2	N	1,7
69	Trip phase L1	Yes	2	N	1,7
70	Trip phase L2	Yes	2	N	1,7
71	Trip phase L3	Yes	2	N	1,7
72	Back up trip I>>	Yes	2	N	1,7
73	Fault location in ohm	Yes	4	N	1,7
74	Forward/line	Yes	2	N	1,7
75	Reverse/busbar	Yes	2	N	1,7
76	Signal transmitted	Yes	2	N	1,7
77	Signal received	Yes	2	N	1,7
78	Zone 1	Yes	2	N	1,7
79	Zone 2	Yes	2	N	1,7
80	Zone 3	Yes	2	N	1,7
81	Zone 4	Yes	2	N	1,7
82	Zone 5	Yes	2	N	1,7
83	Zone 6	No	2	N	1,7
84	Start general	Yes	2	Y	1,7,9
85	Breaker failure	Yes	2	N	1,7
86	Trip measuring system phase L1	Yes	2	N	1,7
87	Trip measuring system phase L2	Yes	2	N	1,7
88	Trip measuring system phase L3	Yes	2	N	1,7
89	Trip measuring system neutral N	Yes	2	N	1,7
90	Over current trip, stage low	Yes	2	N	1,7
91	Over current trip, stage high	Yes	2	N	1,7
92	Earth-fault trip, stage low	Yes	2	N	1,7
93	Earth-fault trip, stage high	Yes	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

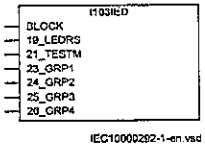


Figure 11: I103IED function block

4.1.6.3 Signals

Table 19: 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
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 20: 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

Number of instances: 1

Function type is selected with parameter *FunctionType*.

Information number is defined for each input signals.

Info. no.	Message	Supported
19	LED reset	Yes
20	Monitor direction blocked	No
21	TestMode	No
22	Local Parameter setting	Yes

Table continues on next page

Info. no.	Message	Supported
23	Setting group 1 active	Yes
24	Setting group 2 active	Yes
25	Setting group 3 active	Yes
26	Setting group 4 active	Yes

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

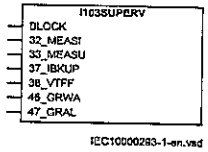


Figure 12: I103SUPERV function block

4.1.7.3 Signals

Table 21: 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 22: 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

Number of instances: 1

Function type is selected with parameter *FunctionType*.

Information number is defined for output signals.

Info. no.	Message	Supported	Type	GI	COT
32	Measurand supervision I	Yes	1	Y	1,7,9
33	Measurand supervision U	Yes	1	Y	1,7,9
35	Phase sequence supervision	No	1	Y	1,7,9
36	Trip circuit supervision	No	1	Y	1,7,9
37	I>>back-up operation	Yes	1	Y	1,7,9
38	VT fuse failure	Yes	1	Y	1,7,9
39	Teleprotection disturbed	No	1	Y	1,7,9
46	Group warning	Yes	1	Y	1,7,9
47	Group alarm	Yes	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 can be used, for example in mapping the INF numbers not supported directly by specific function blocks, like: INF17, INF18, INF20 or INF35. After connecting the appropriate signals to the I103USRDEF inputs, the user must also set the *InfNo_x* values in the settings.

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 13: IEC 60870-5-103I103USRDEF:1

4.1.8.2 Function block

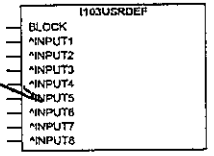


Figure 14: I103USRDEF function block

4.1.8.3 Signals

Table 23: 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 24: 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, I103USRDEF

Number of instances: 20

Function type is selected with parameter *FunctionType* for each function block instance in private range. Default values are defined in private range 5 - 24. One for each instance.

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

Info. no.	Message	Supported
1	Input signal 01	Yes
2	Input signal 02	Yes
3	Input signal 03	Yes
4	Input signal 04	Yes
5	Input signal 05	Yes
6	Input signal 06	Yes
7	Input signal 07	Yes
8	Input signal 08	Yes

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.

4.2.1.2 Function block

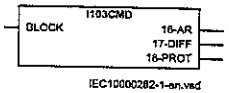


Figure 15: I103CMD function block

4.2.1.3 Signals

Table 25: I103CMD Input signals

Name	Type	Default	Description
BLOCK	BOOLEAN	0	Block of commands

Table 26: I103CMD Output signals

Name	Type	Description
16-AR	BOOLEAN	Information number 16, block 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 27: 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
Number of instances: 1

Function type is selected with parameter *FunctionType*.

Information number is defined for each output signals.

Info. no.	Message	Supported
16	Auto-reclosar on/off	Yes
17	Teleprotection on/off	Yes
18	Protection on/off	Yes

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.

4.2.2.2 Function block

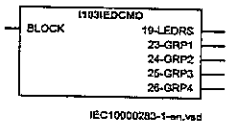


Figure 16: I103IEDCMD function block

4.2.2.3 Signals

Table 28: I103IEDCMD Input signals

Name	Type	Default	Description
BLOCK	BOOLEAN	0	Block of commands

Table 29: 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 30: 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
Number of instances: 1

Function type is selected with parameter *FunctionType*.

Information number is defined for each output signals.

Info. no	Message	Supported
19	LED Reset	Yes
23	Activate setting group 1	Yes
24	Activate setting group 2	Yes
25	Activate setting group 3	Yes
26	Activate setting group 4	Yes

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

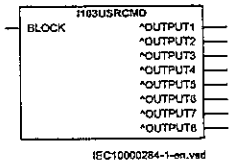


Figure 17: I103USRCMD function block

4.2.3.3 Signals

Table 31: I103USRCMD Input signals

Name	Type	Default	Description
BLOCK	BOOLEAN	0	Block of commands

Table 32: 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
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 33: 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, I103USRCMD
Number of instances: 4

Function type for each function block instance in private range is selected with parameter *FunctionType*. Default values are defined in private range 1 - 4. One for each instance.

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

Info. no.	Message	Supported
1	Output signal 01	Yes
2	Output signal 02	Yes
3	Output signal 03	Yes
4	Output signal 04	Yes
5	Output signal 05	Yes
6	Output signal 06	Yes
7	Output signal 07	Yes
8	Output signal 08	Yes

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.

4.2.4.2 Function block

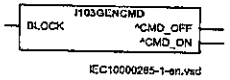


Figure 18: I103GENCMD function block

4.2.4.3 Signals

Table 34: I103GENCMD Input signals

Name	Type	Default	Description
BLOCK	BOOLEAN	0	Block of command

Table 35: I103GENCMD Output signals

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

4.2.4.4 Settings

Table 36: I103GENCMD Non group settings (basic)

Name	Values (Range)	Unit	Step	Default	Description
FunctionType	1 - 127	-	1	1	Function type (1-255)
PulseLength	0.000 - 60.000	s	0.001	0.400	Pulse length
InfNo	32 - 239	-	1	32	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); as per standard, *0* and *3* values of the position are not supported.

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

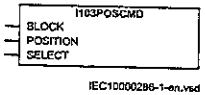


Figure 19: I103POSCMD function block

4.2.5.3 Signals

Table 37: 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 38: I103POSCMD Non group settings (basic)

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

The current implementation of the IEC 60870-5-103 commands will reject any new command if a previously issued command has not yet been completed.

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 reported by polling 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.

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
- V_{L1E} connected to channel 5 on disturbance function block A1RADR
- V_{L2E} connected to channel 6 on disturbance function block A1RADR
- V_{L3E} connected to channel 7 on disturbance function block A1RADR
- V_{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.

For each input of the Disturbance recorder function there is a setting for the information number of the connected signal. The information number can be set to any value between 0 and 255.

Furthermore, there is a setting on each input of the Disturbance recorder function for the function type. Refer to description of Main Function type set on the local HMI.

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 deteceted (by other client, for example, SPA) or when a new disturbance has been recorded or when the master has uploaded a disturbance.

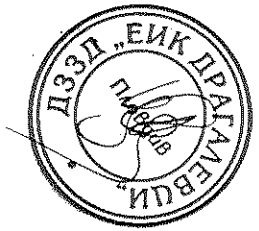
Deviations from the standard

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:

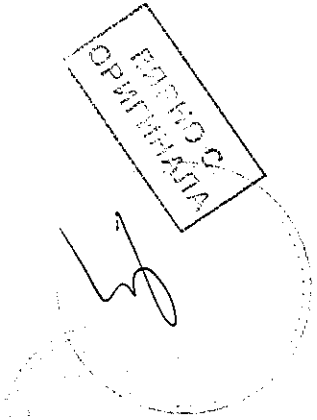
- Bit TP: the protection equipment has tripped during the fault
- Bit TM: the disturbance data are currently being transmitted
- Bit TEST: the disturbance data have been recorded during normal operation or test mode.
- Bit OTEV: the disturbance data recording has been initiated by another event than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



ASDU26

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).

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.

Section 5 Interoperability

5.1 Physical layer

Table 39: Electrical interface

	Supported
EIA RS-485	No
number of loads	No

5.1.1 Optical interface

Table 40: Optical interface

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

5.1.2 Transmission speed

Table 41: Transmission speed

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

5.2 Application layer

5.2.1 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.

5.2.2 Common address of ASDU

Table 42: Common address of ASDU

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

5.2.3 Selection of standard information numbers in monitor direction

5.2.3.1 System functions in monitor direction

Table 43: 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	No

5.2.3.2 Status indications in monitor direction

Table 44: 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 paramotor setting	No
23 to 26	Characteristic 1 to Characteristic 4	Yes
27 to 30	Auxiliary input 1 to Auxiliary input 4	No

5.2.3.3 Supervision indications in monitor direction

Table 45: Supervision indications in monitor direction

INF	Semantics	Supported
32	Measurand supervision I	Yes
33	Measurand supervision V	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

5.2.3.4 Earth fault indications in monitor direction

Table 46: Earth fault indications in monitor direction

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

5.2.3.5 Fault indications in monitor direction

Table 47: Fault indications in monitor direction

INF	Semantics	Supported
64 to 66	Start /pick-up L_1 to Start /pick-up L_3	Yes
67	Start /pick-up N	Yes
68	General trip	Yes
69 to 71	Trip L_1 to 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 to 82	Zone 1 to Zone 5	Yes
83	Zone 6	No

Table continues on next page

INF	Semantics	Supported
84	General start/pick-up	Yes
85	Breaker failure	Yes
86 to 88	Trip measuring system L_1 to 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

5.2.3.6 Auto-reclosure indications in monitor direction

Table 48: 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

5.2.3.7 Measurands in monitor direction

Table 49: Measurands in monitor direction

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

5.2.3.8 Generic functions in monitor direction

Table 50: 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

5.2.4 Selection of standard information numbers in control direction

5.2.4.1 System functions in control direction

Table 51: System functions in control direction

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

5.2.4.2 General commands in control direction

Table 52: 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 to 26	Activate characteristic 1 to Activate characteristic 4	Yes

5.2.4.3 Generic functions in control direction

Table 53: 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

5.2.5 Basic application functions

Table 54: Basic application functions

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

5.2.6 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 55: Miscellaneous

Measurand	Max. MVAL = rated value times	
	1,2	2,4
Current L_1	Yes	Yes
Current L_2	Yes	Yes
Current L_3	Yes	Yes
Voltage L_{1-E}	Yes	Yes
Voltage L_{2-E}	Yes	Yes
Voltage L_{3-E}	Yes	Yes
Active power P	Yes	Yes
Reactive power Q	Yes	Yes
Frequency f	Yes	Yes
Voltage L_1 - L_2	Yes	Yes

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
Table continues on next page		

DRA#-Input	ACC	IEC103 meaning
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
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

Section 6 Glossary

AC	Alternating current
ACT	Application configuration tool within PCM600
A/D converter	Analog-to-digital converter
ADBS	Amplitude deadband supervision
AI	Analog input
ANSI	American National Standards Institute
AR	Autoreclosing
ASCT	Auxiliary summation current transformer
ASD	Adaptive signal detection
AWG	American Wire Gauge standard
BI	Binary input
BOS	Binary outputs status
BR	External bistable relay
BS	British Standards
CAN	Controller Area Network. ISO standard (ISO 11898) for serial communication
CB	Circuit breaker
CCITT	Consultative Committee for International Telegraph and Telephony. A United Nations-sponsored standards body within the International Telecommunications Union.
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
COMTRADE	Standard format according to IEC 60255-24
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

CPU	Central processor unit
CR	Carrier receive
CRC	Cyclic redundancy check
CROB	Control relay output block
CS	Carrier send
CT	Current transformer
CVT	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/ANSI Std. 1379-2000
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	(Electric Motive Force)
EMI	Electromagnetic interference
EnFP	End fault protection
EPA	Enhanced performance architecture
ESD	Electrostatic discharge
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
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
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 61850	Substation automation communication 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).
IED	Intelligent electronic device

I-GIS	Intelligent gas-insulated switchgear
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 standard
IP 20	Ingression protection, according to IEC standard, level 20
IP 40	Ingression protection, according to IEC standard, level 40
IP 54	Ingression protection, according to IEC standard, 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
LDD	Local detection device
LED	Light-emitting diode
MCB	Miniature circuit breaker
MCM	Mezzanine carrier module
MVB	Multifunction vehicle bus. Standardized serial bus originally developed for use in trains.
NCC	National Control Centre
OCO cycle	Open-close-open cycle
OCP	Overcurrent protection
OLTC	On-load tap changer
OV	Over-voltage
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
PISA	Process interface for sensors & actuators
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
RFPP	Resistance for phase-to-phase faults
RFPE	Resistance for phase-to-earth faults
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
SCS	Station control system
SCADA	Supervision, control and data acquisition
SCT	System configuration tool according to standard IEC 61850
SDU	Service data unit

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.
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.
TNC connector	Threaded Neill-Concelman, a threaded constant impedance version of a BNC connector
TPZ, TPY, TPX, TPS	Current transformer class according to IEC
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.
U/I-PISA	Process interface components that deliver measured voltage and current values
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

$3I_0$ Three times zero-sequence current. Often referred to as the residual or the earth-fault current

$3U_0$ Three times the zero sequence voltage. Often referred to as the residual voltage or the neutral point voltage

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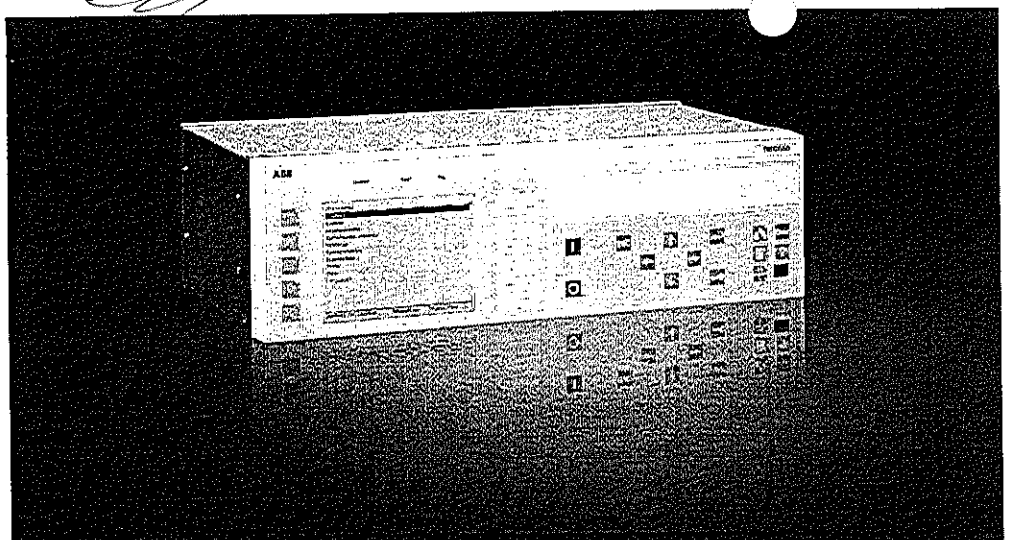

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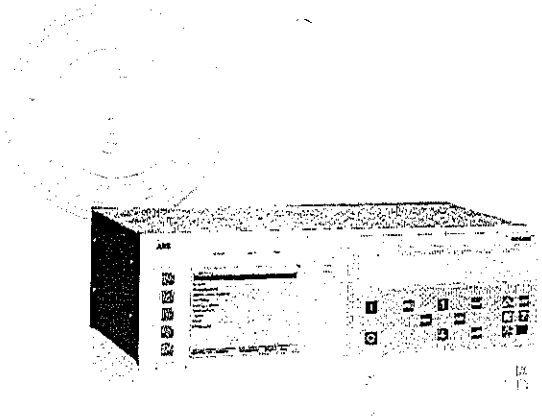

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635

Disclaimer

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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 2004/108/EC) and concerning electrical equipment for use within specified voltage limits (Low-voltage directive 2006/95/EC). This conformity is the result of tests conducted by ABB in accordance with the product standards EN 50263 and 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.

Table of contents

Section 1 Introduction

1.1 This manual

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 DNP 3.0.

Intended audience

This manual addresses system and project engineers involved in the engineering process of a project, and installation and commissioning personnel, who use technical data during engineering, installation and commissioning, and in normal service.

The system engineer must have a thorough knowledge of protection and/or control systems, protection and/or control equipment, protection and/or control functions and the configured functional logics in the IEDs. The installation and commissioning personnel must have a basic knowledge of handling electronic equipment.

1.3 Product documentation

1.3.1 Product documentation set

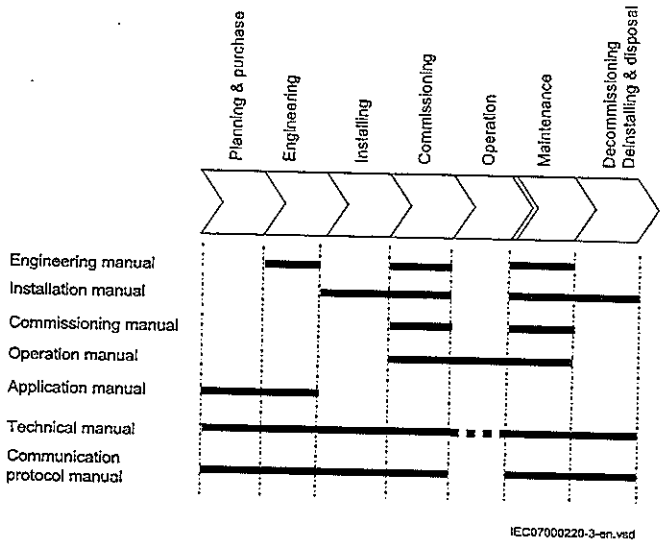


Figure 1: The intended use of manuals throughout the product lifecycle

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 DNP 3.0.

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 provides 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.

1.3.2 Document revision history

Document revision/date	History
-/March 2013	First release
A/October 2016	Minor corrections made

1.3.3 Related documents

650 series manuals	Identity number
Communication protocol manual, DNP 3.0	1MRK 511 280-UEN
Communication protocol manual, IEC 61850–8–1	1MRK 511 281-UEN
Communication protocol manual, IEC 60870-5-103	1MRK 511 282-UEN
Cyber Security deployment guidelines	1MRK 511 285-UEN
Point list manual, DNP 3.0	1MRK 511 283-UEN
Engineering manual	1MRK 511 284-UEN
Operation manual	1MRK 500 096-UEN
Installation manual	1MRK 514 016-UEN
Accessories, 650 series	1MRK 513 023-BEN

Table continues on next page

650 series manuals	Identity number
MICS	1MRG 010 656
PICS	1MRG 010 660
PIXIT	1MRG 010 658

1.4 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.

Operation of damaged equipment could, under certain operational conditions, result in degraded process performance leading to information or property loss. Therefore, comply fully with all 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.

1.4.3 Functions included in 650 series IEDs

Table 1: Main protection functions

IEC 61850 or Function name	ANSI	Function description
Differential protection		
T2WPDIF	87T	Transformer differential protection, two winding
T3WPDIF	87T	Transformer differential protection, three winding
GENPDIF	87G	Generator differential protection
REFPDIF	87N	Restricted earth fault protection, low impedance
HZPDIF	87	1Ph High impedance differential protection
Impedance protection		
FDPSPDIS	21	Phase selection with load enchroachment, quadrilateral characteristic
FMPSPDIS	21	Faulty phase identification with load enchroachment for mho
ZDNRDIR	21D	Directional impedance quadrilateral and mho
PPLPHIZ		Phase preference logic
ZMRPSB	68	Power swing detection
ZCVPSOF		Automatic switch onto fault logic, voltage-and current-based
LEXPDIS	40	Loss of excitation
OOSPPAM	78	Out-of-step protection
LEPDIS		Load enchroachment

Table 2: Backup protection functions

IEC 61850 or Function name	ANSI	Function description
Current protection		
PHPIOC	50	Instantaneous phase overcurrent protection, 3-phase output
SPTPIOC	50	Instantaneous phase overcurrent protection, phase segregated output
OC4PTOC	51/67	Four-step phase overcurrent protection, 3-phase output
OC4SPTOC	51/67	Four-step phase overcurrent protection, phase segregated output

Table continues on next page

IEC 61850 or Function name	ANSI	Function description
EFPIOC	50N	Instantaneous residual overcurrent protection
EF4PTOC	51N/67N	Four step residual overcurrent protection, zero/negative sequence direction
SDEPSDE	67N	Sensitive directional residual overcurrent and power protection
UC2PTUC	37	Time-delayed two-step undercurrent 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, 3-phase activation and output
CSPRBRF	50BF	Breaker failure protection, phase segregated activation and output
STBPTOC	50STB	Stub protection
CCRPLD	52PD	Pole discordance protection
BRCPTOC	46	Broken conductor check
GUPPDUP	37	Directional Under-power protection
GOPPDOP	32	Directional Over-power protection
DNSPTOC	46	Negative sequence based overcurrent function
AEGGAPC	50AE	Accidental energizing protection for synchronous generator
NS2PTOC	46I2	Negative-sequence time overcurrent protection for machines
VRPVOC	51V	Voltage-restrained time overcurrent protection
Voltage protection		
UV2PTUV	27	Two-step undervoltage protection
OV2PTOV	59	Two-step overvoltage protection
ROV2PTOV	59N	Two-stop residual overvoltage protection
OEXPVPH	24	Overexcitation protection
LOVPTUV	27	Loss-of-voltage check
STEFPHIZ	59THD	100% Stator earth fault protection, 3rd harmonic based
Frequency protection		
SAPTUF	81	Underfrequency function
SAPTOF	81	Overfrequency function
SAPFRC	81	Rate-of-change frequency protection

Table 3: Control and monitoring functions

IEC 61850 or Function name	ANSI	Function description
Control		
SESRSYN	25	Synchrocheck, energizing check and synchronizing
SMBRREC	79	Autorecloser for 3-phase operation
STBRREC	79	Autorecloser for 1/3-phase operation
TR8ATCC	90	Automatic voltage control for tap changer, parallel control
TCMYLTC	84	Tap changer control and supervision, 6 binary inputs

Table continues on next page

IEC 61850 or Function name	ANSI	Function description
SLGGIO		Logic-rotating switch for function selection and LHMI presentation
VSGGIO		Selector mini switch extension
DPGGIO		IEC 61850 generic communication I/O functions
SPC8GGIO		Single Point Generic Control 8 signals
AUTOBITS		AutomationBits, command function for DNP3.0
I103CMD		Function commands for IEC 60870-5-103
I103IEDCMD		IED commands for IEC 60870-5-103
I103USRCMD		Function commands user defined for IEC 60870-5-103
I103GENCMD		Function commands generic for IEC 60870-5-103
I103POSCMD		IED commands with position and select for IEC 60870-5-103
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		Circuit switch
POS_EVAL		Evaluation of position indication
SELGGIO		Select release
QCBAY		Bay control
LOCREM		Handling of LR-switch positions
LOCREMCTRL		LHMI control of PSTO
Secondary system supervision		
CCSRDIF		Current circuit supervision
SDDRFUF		Fuse failure supervision
TCSSCBR		Breaker close/trip circuit monitoring
ZCRWPSCH	85	Current reversal and WEI logic for distance protection, 3-phase
ZCLCPLAL		Local acceleration logic
ECPSCH	85	Scheme communication logic for residual overcurrent protection

Table continues on next page

IEC 61850 or Function name	ANSI	Function description
ECRWPSCH	85	Current reversal and weak end infeed logic for residual overcurrent protection
Logic		
SMPPTRC	94	Tripping logic, common 3-phase output
SPTPTRC	94	Tripping logic, phase segregated output
TMAGGIO		Trip matrix logic
OR		Configurable logic blocks, OR
INVERTER		Configurable logic blocks, inverter
PULSETIMER		Configurable logic blocks, PULSETIMER
GATE		Configurable logic blocks, controllable gate
XOR		Configurable logic blocks, exclusive OR
LOOPDELAY		Configurable logic blocks, loop delay
TimerSet		Configurable logic blocks, timer
AND		Configurable logic blocks, AND
SRMEMORY		Configurable logic blocks, set-reset memory
RSMEMORY		Configurable logic blocks, reset-set memory
ANDQT		Configurable logic Q/T, ANDQT
ORQT		Configurable logic Q/T, ORQT
INVERTERQT		Configurable logic Q/T, INVERTERQT
XORQT		Configurable logic 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
B16IFCVI		Boolean 16 to Integer conversion with logic node representation
IB16A		Integer to Boolean 16 conversion
IB16FCVB		Integer to boolean 16 conversion with logic node representation
TEIGGIO		Elapsed time integrator with limit transgression and overflow supervision
Monitoring		
CVMMXN		Measurements
CMMXU		Phase current measurement
VMMXU		Phase-phase voltage measurement
CMSQI		Current sequence component measurement
VMSQI		Voltage sequence measurement
VNMMXU		Phase-neutral voltage measurement

Table continues on next page

IEC 61850 or Function name	ANSI	Function description
CNTGGIO		Event counter
L4UFCNT		Event counter with limit supervision
DRPRDRE		Disturbance report
AxRADR		Analog input signals
BxRBDR		Binary input signals
SPGGIO		IEC 61850 generic communication I/O functions
SP16GGIO		IEC 61850 generic communication I/O functions 16 inputs
MVGGIO		IEC 61850 generic communication I/O functions
MVEXP		Measured value expander block
LMBRFLO		Fault locator
SPVNZBAT		Station battery supervision
SSIMG	63	Insulation gas monitoring function
SSIML	71	Insulation liquid monitoring function
SSCBR		Circuit breaker condition monitoring
I103MEAS		Measurands for IEC 60870-5-103
I103MEASUSR		Measurands user defined signals for IEC 60870-5-103
I103AR		Function status auto-recloser for IEC 60870-5-103
I103EF		Function status earth-fault for IEC 60870-5-103
I103FLTPROT		Function status fault protection for IEC 60870-5-103
I103IED		IED status for IEC 60870-5-103
I103SUPERV		Supervision status for IEC 60870-5-103
I103USRDEF		Status for user defiend signals for IEC 60870-5-103
Metering		
PCGGIO		Pulse counter logic
ETPMMTR		Function for energy calculation and demand handling

Table 4: Station communication

IEC 61850 or Function name	ANSI	Function description
Station communication		
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
GOOSESPRCV		GOOSE function block to receive a single point value

633

Table 5: Basic IED functions

IEC 61850 or Function name	Function description
Basic functions included in all products	
INTERRSIG	Self-supervision with internal event list
ACTVGRP	Parameter setting groups
TESTMODE	Test mode functionality
CHNGLCK	Change lock function
ATHSTAT	Authority status
SMAI_20_1 - SMAI_20_12	Signal Matrix for analog inputs
3PHSUM	Summation block 3 phase
DOSFRNT	Denial of service, frame rate control for front port
DOSLAN1	Denial of service, frame rate control for LAN1 port
SECALARM	Component for mapping security events on protocols such as DNP3 and IEC103

Section 2 Engineering tool set

2.1 Introduction

The structure of a monitoring and control system for electrical substations has a principle structure as shown in Figure 2. It contains a number of IEDs for the various purposes.

For performance reasons, do not insert more than 150 IEDs of 650 series type in one PCM600 project. Larger projects can be divided into several PCM600 projects.

It can be subdivided in the three main parts:

- Bay level IEDs
- Station communication
- Station level IEDs

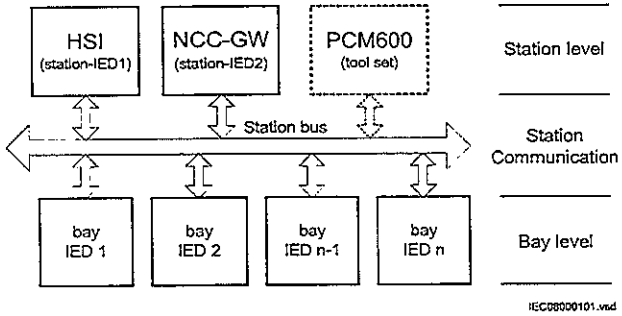


Figure 2: Principle structure of a monitoring and control system for a substation

All three parts require specific engineering and configuration. PCM600 is used to do the complete engineering and configuration activities needed for bay level IEDs.

Product type and version specific engineering data needed by PCM600 for protection, control and communication engineering of a particular bay IED is given in an IED connectivity package.

PCM600 communicates with the bay IEDs via an Ethernet connection. The connection allows to reading and writing all configuration data needed for proper operation from or to the IED. The IEDs have communication interfaces for protocols and media used for station communication. IEC 61850 communication files for a bay IED or a complete station can be exported from PCM600 to station engineering tools for engineering of station communication between bay IEDs and station IEDs.

A PC with PCM600 can be connected to any 650 series IED within a station using the Ethernet connection.

The Ethernet connection can then later also be used for service and maintenance purposes. The connection is also used to handle disturbance records in COMTRADE format from protection IEDs using the IEC 61850 file transfer.

The IEDs of today are designed on the concept of the IEC 61850 standard. This is mainly given for the organization of functions represented by an equivalent logical node in the IEC 61850 standard. The mapping between the logical node data model in the IED, following the structure and rules in part 7 of the IEC 61850 standard, and the function blocks in an IED configuration is given in the IEC 61850 communication protocol manual.

The concept is also used for DNP3 protocol. The signals used or delivered by a function block are automatically generated and available for station communication. This concept allows a very efficient cost saving signal engineering.

The IEC 60870-5-103 protocol is engineered in Application Configuration tool and Parameter Setting tool.

The engineering of the used communication protocols is a separate task and an addition to the engineering of protection and control functions.

PCM600 can be used for different purposes throughout the IED life cycle. A set of special tools is available for different applications.

The applications can be organized in:

- IED product engineering
- IED communication engineering per protocol
- IED system monitoring
- IED product diagnostic

This manual is valid for PCM600 supporting the 650 series product.

2.2 IED engineering process

PCM600 is used for various tasks in the IED engineering process. See Figure 3:

- IED engineering management

- Organizing the bay IEDs in the structure of the substation by defining voltage levels and bays below the substation. A PCM600 project can have only one substation.
- Configuring the IED functions (for example protection and control functions and LHMI functions) by using the Application Configuration tool.
- Configuring the parameters and setting values for the IED itself and for the process functionality by using the Parameter Setting tool.
- Drawing single line diagrams and do the link to dynamic process values by using the Graphical Display Editor tool. The single line diagrams are shown on the LHMI on the bay IED.
- Configuring connections between the application configuration function blocks and physical hardware input and outputs by using the Signal Matrix tool or the Application Configuration tool.

- Communication engineering
  - IEC 61850 station communication engineering can be done in two ways, with a separate tool, IET600 or with the PCM600 built in IEC 61850 configuration tool. PCM600 interacts with IET600 by importing and exporting SCL files. The built in tool can be used for small projects (about 10 IEDs) including ABB IEDs only.
  - Organizing GOOSE messages received and managing the used IO signal is done by using the Signal Matrix tool.
  - Communication engineering for the DNP3 protocol by using the Communication Management tool.
  - Communication engineering for the IEC 60870-5-103 protocol by using Application Configuration tool and Parameter Setting tool.
- Disturbance record management
  - Generating overviews about the available (disturbance) recordings in all connected protection IEDs by using the Disturbance Handling tool.
  - Manually reading the recording files (in COMTRADE format) from the protection IEDs by using the Disturbance Handling tool or automatically by using the PCM600 scheduler.
  - Managing recording files with the assistance of the Disturbance Handling tool.
  - Creating overview reports of recording file content for fast evaluation with assistance of the Disturbance Handling tool.
- Service management
  - Monitoring selected signals of an IED for commissioning or service purposes by using the Signal Monitoring tool.
  - Listing all actual existing IED internal events by using the Event Viewer tool.
  - Listing all actual pending process events as they are stored in the IED internal disturbance report event list by using the Event Viewer tool.

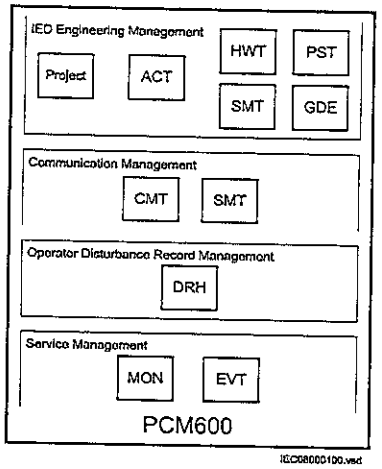


Figure 3: Organization of PCM600 in different management tasks

Additional functionality to manage the project and to organize the user rights:

- PCM600 user management
  - Organizing users with their rights, profile and password to use the different tools and activities within the tools.
  - Defining allowed activities for the user profiles to use tools in PCM600.
- IED user management
  - Organizing users with their rights, profile and password to read and write files of the IED.
  - Defining allowed activities for the user profiles to use the read and write function.

Once the engineering of the IED is done, the results must be written to the IED. Conversely some parts of the engineering information can be uploaded from the IED for various purposes.

The connection between the physical IED and PCM600 is established via an Ethernet link on the front or rear port on the IED.

Section 3 Engineering process

3.1 Workflow

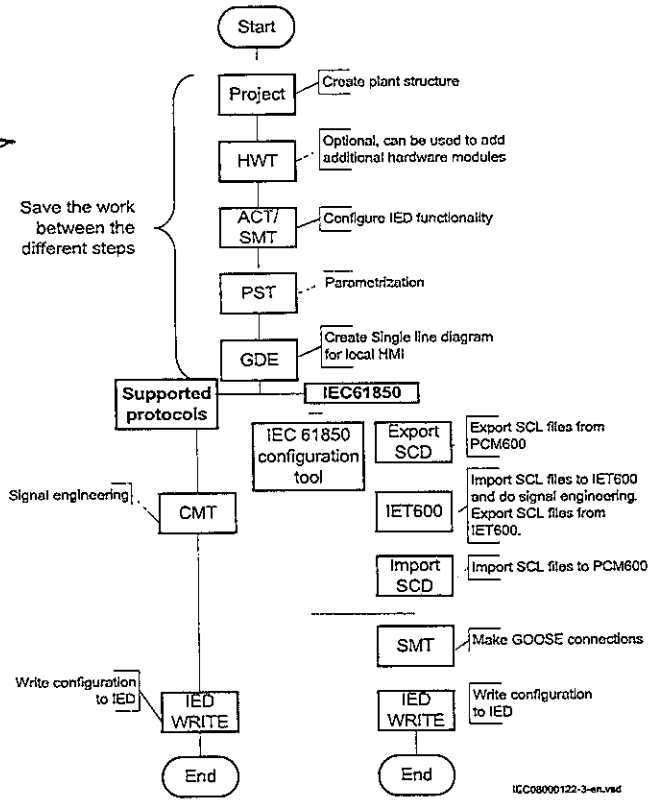


Figure 4: IED engineering workflow

The described sequence in Figure 4 is a proposal based on practical experience and dependencies of the steps. It is possible to do a different sequence based on the

available information at the time the project is started. This means that several iterations may be needed to finish the project.

- Setting up the PCM600 project
  - Build the plant structure according to the substation structure.

    For performance reasons, do not insert more than 150 IEDs of 650 series type in one PCM600 project. Larger projects can be divided into several PCM600 projects.

  - Insert an IED in plant structure which can be done in many ways. By inserting the IED in online mode where the configuration is read from the physical IED, by inserting an IED in offline mode, by importing a *.pcmi file or by selecting an IED template from the template library (*.pcmt).
  - Rename the IED objects in PCM600 to the projects definitions.
- ACT Application configuration
  - Configure the protection or control function for example for a transformer application as requested.
  - Save the configuration made with ACT to make the interfaces and signals available for other engineering tools within PCM600, for example for PST.
- PST Parameter setting and configuration
  - Check the configuration parameters of the physical IED for communication channels, CT and VT conversion values of the transformer module, for example.
  - Check and adjust if needed the setting values for example for:
    - Presentation parameters for local HMI.
    - Settings for protection or control functions.
    - Number of setting groups.
- GDE Single line diagram configuration
  - Create a single line diagram.
  - Include measurements when needed.
  - Link the dynamic elements to functions created in ACT, for example a breaker object to the switch function.
- Local HMI engineering
  - Include and engineer the function blocks for LHMI element groups with ACT.
  - Configure the function keys and LEDs with ACT.
  - Define the function key and LED behavior with PST.
- Communication protocol engineering
  - The engineering steps are protocol dependent.
  - Use the communication management tool (CMT) for DNP3 engineering.
  - Use the IET600 station configuration tool or the PCM600 IEC 61850 Configuration tool for IEC 61850 engineering. See the application manual for other protocols (IEC103).

The IED restarts automatically when writing an IED configuration where changes have been made to, for example, configuration parameters. It is not possible to communicate with the IED during the restart.

The IED does not restart after reconfiguring IEC61850 (regardless of whether the protocol is enabled or disabled prior to reconfiguring). The IED will reboot at the next PCM600 to IED write operation only in case there are errors while configuring the IEC61850 protocol at the most recent attempt.

Section 4 Setting up a project

4.1 PCM600 operates on projects

A typical project in PCM600 contains a plant structure including one or several IED objects, where each IED object contains the engineering data created or modified using the different PCM600 tools.

Several projects can be created and managed by PCM600, but only one project can be active at a time.

4.2 Installing Connectivity packages

A Connectivity package contains the complete description of the IED data signals, parameters and protocol addresses for a certain IED type and version. Several types of IEDs can be managed in one PCM600 project, thus the corresponding Connectivity package has to be installed on the PC. Connectivity Packages and Connectivity Package Updates are managed in the Update Manager.

PCM600 must be installed before the connectivity packages can be installed.

A Connectivity package for a specific IED type and version is divided in two parts. The IED connectivity package base module is common for all 650 series IEDs. The IED specific module is separate for each type of IED.

Installing IED Connectivity package

The Connectivity package is available on the CD that was distributed along with the IED.

Procedure

1. Close PCM600 before running the IED connectivity package installation.
2. Install the 650 series Connectivity package base.
3. Select and install the IED modules as required.
4. Install the documentation.

4.3 Setting technical key

Both a physical IED and an IED object in PCM600 have a technical key. The purpose of the technical key is to prevent download of a configuration to wrong IED. The technical key in the IED and PCM600 must be the same, otherwise it is not possible to download a configuration. Each IED in a PCM600 project must have a unique technical key. It is therefor not possible to set the same technical key for several IEDs in the same PCM600 project.

The technical key property in PCM600 corresponds to the IED name attribute in SCL files. Avoid changing the IED name attribute outside PCM600, because data in PCM600 might be lost when importing SCL files.

The IED technical key and the PCM600 technical key must be the same for successful communication between the IED and PCM600.

When using PCM600 for writing to the IED, it is important that the LHMI is not in a menu position where settings can be made. Only one active transaction, from LHMI or PCM600, is allowed at any one time.

When writing a configuration to the IED, PCM600 checks the mismatch between the IED object and the physical IED technical key, if any. For communication between the IED and PCM600 the technical key must be the same. Users have the option to read the technical key from the IED and update it to PCM600 or write the PCM600 technical key to the IED. The user can also define an own technical key. The error message displayed due to mismatch between PCM600 and IED technical key is shown in Figure 5.

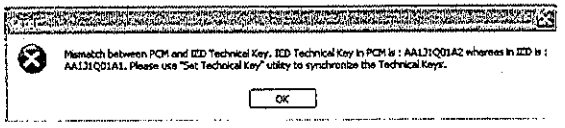


Figure 5: Error message due to mismatch between PCM600 and IED technical key

Be sure that the IED object in PCM600 has the same IP address as the physical IED, which is intended to be connected through the technical key concept.

The technical key for an IED object in PCM600 can also be changed in the *Object properties* window.

1. Select the *IED* in the *Plant Structure*.
2. Right-click and select *Set Technical Key*, see Figure 6.

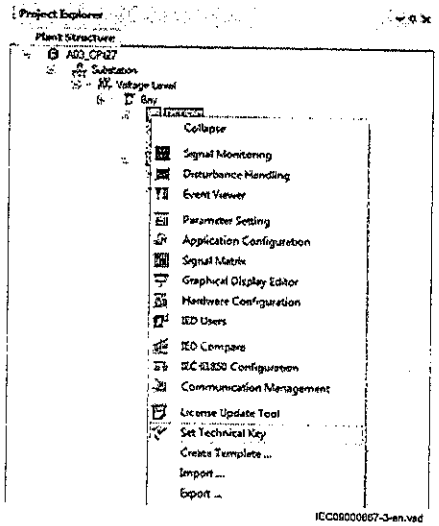


Figure 6: PCM600: Set technical key menu at IED level

A dialog window opens to inform about the technical key concept.

3. Click *OK* in the dialog window.
   The technical key is read from the IED and the technical key editor window opens, see Figure 7.

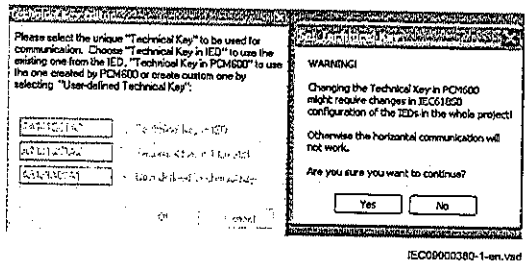


Figure 7: PCM600: Technical key editor

Using the *Technical Key Editor* the following selections are possible.

- use the existing technical key in the IED
- use the existing technical key defined for the IED object in PCM600 or
- set a user defined technical key, which changes the technical key for both the physical IED and IED object in PCM600.

Do not use a technical key with more than 13 characters.

4. Click *OK* to confirm the selection.
   It is not possible to set a user defined name or select the *Technical key in IED* if the value is the same as already given to another IED object in the PCM600 project. A dialog window opens if this is the case.

4.4 Setting up communication between PCM600 and the IED

The communication between the IED and PCM600 is independent of the communication protocol used within the substation or to the NCC.

The communication media is always Ethernet and the used protocol is TCP/IP.

Each IED has an RJ-45 Ethernet interface connector on the front. The front Ethernet connector shall be used for communication with PCM600..

When an Ethernet-based station protocol is used, PCM600 communication can use the same Ethernet port and IP address.

To connect PCM600 to the IED, two basic variants must be considered.

- Direct point-to-point link between PCM600 and the IED front port.
- Indirect link via a station LAN or from remote via a network.

The physical connection and the IP address must be configured in both cases to enable communication.

The communication procedures are the same in both cases.

1. If needed, set the IP address for the IEDs.
2. Set up the PC or workstation for a direct link (point-to-point), or
3. Connect the PC or workstation to the LAN/WAN network.
4. Configure the IED IP addresses in the PCM600 project for each IED to match the IP addresses of the physical IEDs.

Setting up IP addresses

The IP address and the corresponding mask must be set via the LHMI for each available Ethernet interface in the IED. Each Ethernet interface has a default factory IP address when the IED is delivered. This is not given when an additional Ethernet interface is installed or an interface is replaced.

- The default IP address for the IED front port is 10.1.150.3 and the corresponding subnetwork mask is 255.255.255.0, which can be set via the local HMI path **Main menu/Configuration/Communication/TCP-IP configuration/ETHFRNT:1**.

Setting up the PC or workstation for point-to-point access to IEDs front port

A special cable is needed to connect two physical Ethernet interfaces together without a hub, router, bridge or switch in between. The Tx and Rx signal wires must be crossed in the cable to connect Tx with Rx on the other side and vice versa. These cables are known as cross over cables. The maximum length is 2 m. The connector type is RJ-45.

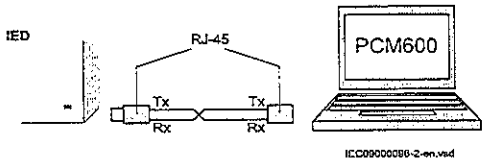


Figure 8: Point-to-point link between IED and PCM600 using a null-modem cable

The following description is an example valid for standard PCs using Microsoft Windows operating system. The example is taken from a Laptop with one Ethernet interface.

Administrator rights are required to change the PC communication setup. Some PCs have the feature to automatically detect that Tx signals from the IED are received on the Tx pin on the PC. Thus, a straight (standard) Ethernet cable can be used.

When a PC is connected to the IED and the setting *DHCPServer* is set to *On* via the local HMI path **Main menu/Configuration/Communication/TCP-IP configuration/ETHFRNT:1/DHCPServer**, the IEDs DHCP server for the front port assigns an IP address for the PC. The PC must be configured to obtain its IP address automatically as described in the following procedure.

1. Select **Search programs and files** in the **Start menu** in Windows.

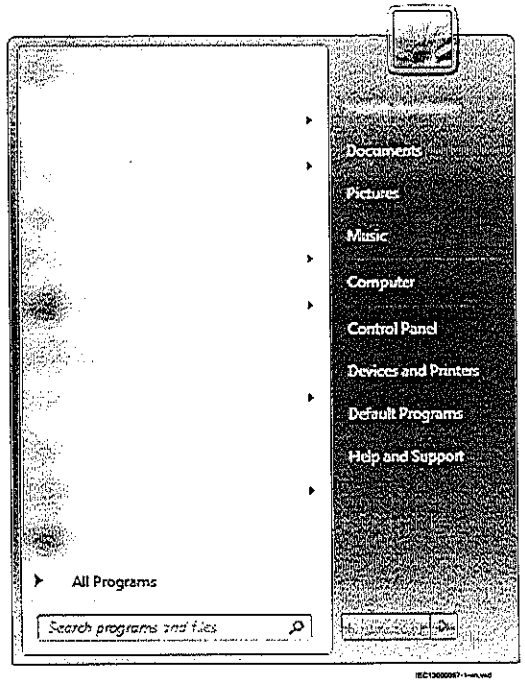


Figure 9: Select: Search programs and files

2. Type **View network connections** and click on the **View network connections** icon.

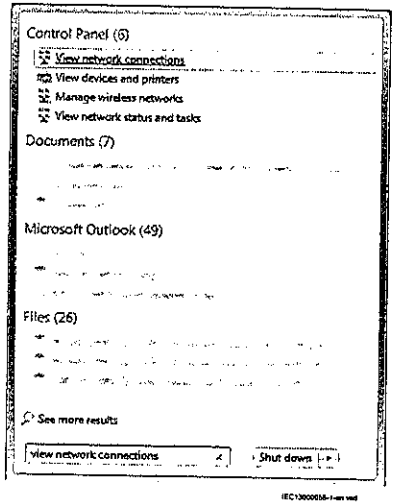


Figure 10: Click View network connections

3. Right-click and select **Properties**.

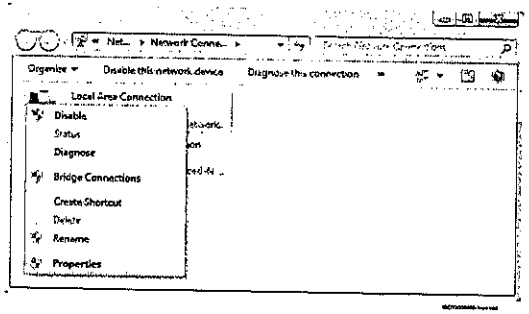


Figure 11: Right-click Local Area Connection and select Properties

4. Select the TCP/IPv4 protocol from the list of configured components using this connection and click **Properties**.

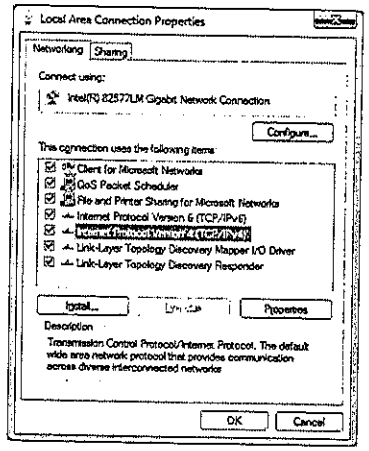


Figure 12: Select the TCP/IPv4 protocol and open Properties

5. Select **Obtain an IP address automatically** if the parameter *DHCPServer* is set to *On* in the IED.

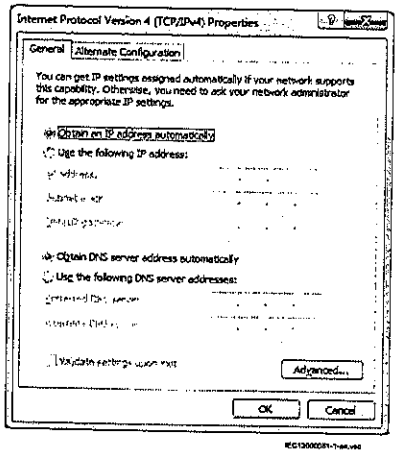


Figure 13: Select: Obtain an IP address automatically

6. Select **Use the following IP address** and define *IP address* and *Subnet mask* if the front port is used and if the *IP address* is not set to be obtained automatically

by the IED, see Figure 14. The IP address must be different from the IP address chosen for the IED.

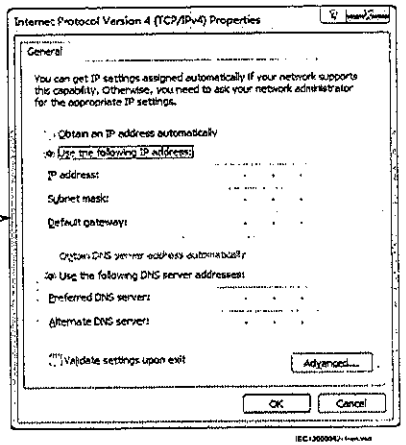


Figure 14: Select: Use the following IP address

7. Close all open windows and start PCM600.

Setting up the PC to access the IED via a network

This task depends on the used LAN/WAN network.

The PC and IED must belong to the same subnetwork for this set-up to work.

4.5 Project managing in PCM600

It is possible to:

- Open existing projects
- Import projects
- Create new projects
- Export projects
- Delete projects

- Rename projects
- Copy and paste projects
- Migrate projects from one product version to another

It is possible to open projects created in previous versions of PCM to the current version, but the opposite is not possible.

Extensions of the exported project file is *.pcmp and those files are only used for exporting and importing the projects between PCM600s.

Creating a new project

Procedure

1. Select *File* and *Open/Manage Project ...* to see the projects that are currently available in the PCMDataBases.
2. Open *Projects on my computer*.
3. Click the icon *New Project*. To create new project currently open projects and object tools shall be closed.
4. The *New Project* window opens, see Figure 15.

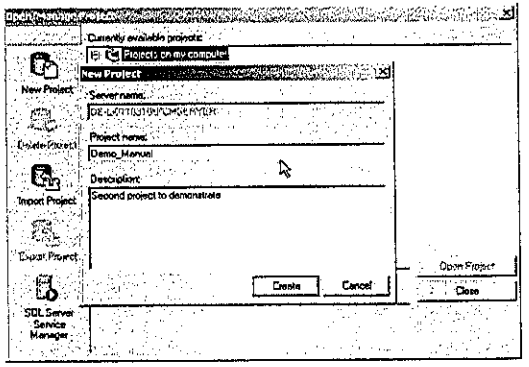


Figure 15: PCM600: Create a new project window

5. Name the project and include a description (optional) and click *Create*.
6. PCM600 sets up a new project that will be listed under *Projects on my computer*.

4.6 Building a plant structure

The plant structure is used to identify each IED in its location within the substation organization. It is a geographical image of the substation and the bays within the substation. The organization structure for the IEDs may differ from the structure of the primary equipment in the substation. In PCM600 it is possible to set up a hierarchical structure of five levels for the IED identification.

Build up the plant structure according to the project requirements. PCM600 offers several levels to build the hierarchical order from Center down to the IEDs in a bay.

The following levels are available:

1. Project = Project name
2. Substation = Name of the substation
3. Voltage Level = identifies to which grid type or part in the substation the IED belongs to
4. Bay = Bay within the voltage level
5. IED = selection of the IED, which is used in the bay. Several IEDs are possible within a bay, for example one control IED and two protection IEDs.

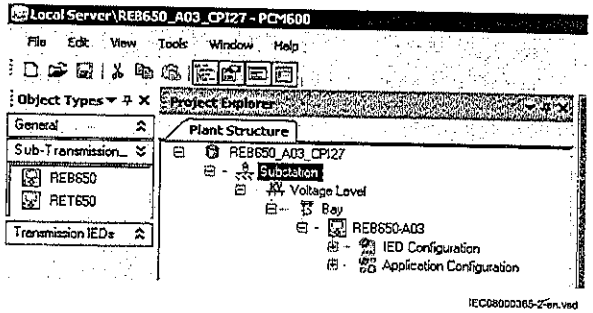


Figure 16: PCM600: Set up a plant structure

Once a plant structure is built the name of each level in the structure should be renamed by the names/identifications used in the grid. Use the right mouse button to build the plant structure by selecting the elements from the context menu. Rename the level after insertion, using the *Rename* possibility or the *Object Properties*. Figure 16 shows the start of a project with two IEDs placed but still not renamed.

The plant structure corresponds to the complete grid including the needed IEDs.

Procedure to build a plant structure:

- Right-click the plant structure and select *New* and *Create from Template ...*, or
- Right-click in the plant structure and select *New*, *General* and select one of the elements *IED Group* or *Substation*.
- Click *View* in the menu bar and select *Object Types*. Select the needed elements and drag and drop them into the plant structure. Close the window if it does not close automatically.

4.6.1 IEC 61850 naming conventions to identify an IED

This section is only valid when the IEC 61850 standard is used for station bus communication. According to the IEC 61850–6 clause 8.4, the SCL model allows two kinds of project designation in the object properties.

- A technical key is used on engineering drawings and for signal identifications. The technical key is used within SCL for referencing other objects. Observe that name is a relative identification within a hierarchy of objects.
- A user oriented textual designation is contained in attribute desc. Attributes are not allowed to contain carriage return, line feed or tab characters. The semantics of desc shall also be relative within an object hierarchy.

PCM600 takes care of these two possibilities. The two possible signal designations are available per object in the object properties for all hierarchical levels beginning with the station as the highest level.

The technical key is automatically generated based on the rules and type specifications of IEC 61346 and the extended definitions done for substations by a technical committee. The technical key is shown in the *Object Properties* under *SCL Technical Key* or *Technical Key*.

- The station level is predefined by "AA1", where 1 is the index.
- The voltage level is predefined by "J1", where 1 is the index.
- The bay level is predefined by "Q01", where 01 is the index.
- The IED is predefined by "A1", where 1 is the index.

The predefined full path name of the technical key for the IED would be AA1J1Q01A1.

For all practical engineering purposes (both towards the IED and towards the 61850 engineering process), the user should keep the default SCL technical key. It is however possible, due to for example company naming policies, to rename the SCL technical key for the station level, voltage level, bay level and IED level using the Object properties window as shown in Figure 17.

- The station level has been renamed as "DMSTAT"
- The voltage level has been renamed as "C1"
- The bay level has been renamed as "Q1"
- The IED has been renamed as "SB1"

The renamed full path name of the technical key for the IED would be DMSTATC1Q1SB1.

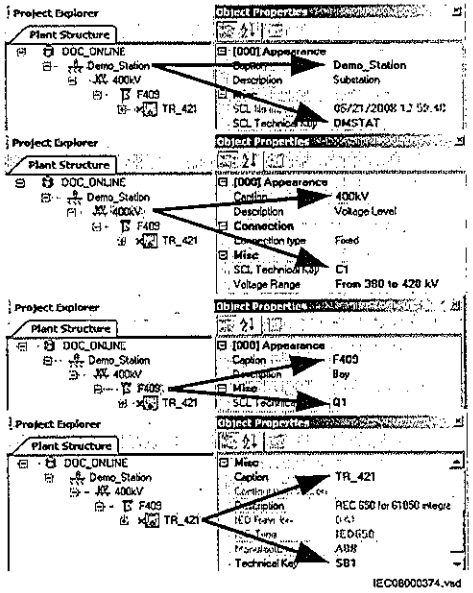


Figure 17: PCM600: IEC 61850 signal designation concept

4.7 Inserting an IED

The context menu or the *Object Types* view shows the available 650 series IEDs possible to insert, on the bay level in the plant structure, according to the installed connectivity package.

On the bay level in the plant structure it is possible to:

- Insert an IED in *Offline mode* or in *Online mode*:

  - Online mode: When the IED is already connected to PCM600 and the communication is established, PCM600 can read the configuration directly from the physical IED. This is useful when an order specific IED is used. The order configuration is written to the IED at the factory and can be accessed by PCM600. The housing type, the used overlay version for local HMI and the IO boards included in the IED will be read from the IED directly.
  - Offline mode: When the physical IED is not available or not connected to PCM600 the engineering steps are done without any synchronization with the IED. The offline configuration in PCM600 can be synchronized with the physical IED at a later state by connecting the IED to PCM600.
- Import a template IED available in the template library as a *.pcmt file.
- Import a configured IED available as a *.pcmi file.

Inserting an IED in online mode

Procedure

1. Right-click the Bay and select *New* and *Sub-Transmission IEDs*.
2. Select the IED type to insert.

   It is also possible to drag an IED from the Object Types window to the Bay level.

3. Select the *Online Configuration* mode, see Figure 18.

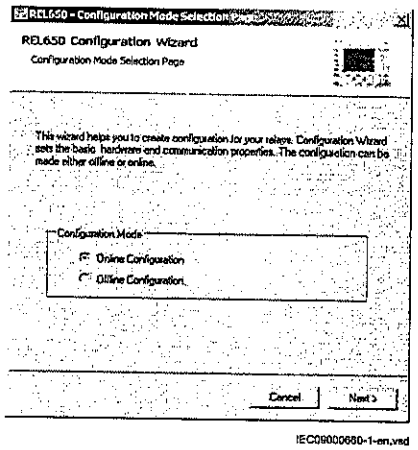


Figure 18: PCM600: Configuration mode selection wizard

4. Select the IED Communication protocol, see Figure 19.

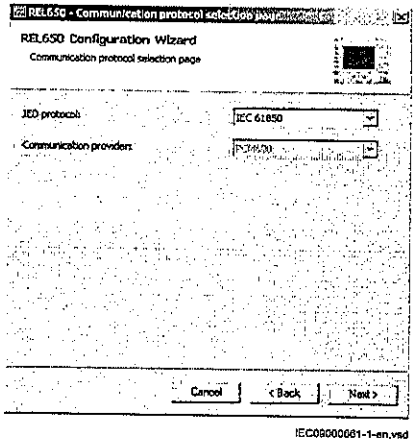


Figure 19: PCM600: Communication protocol selection wizard

5. Select the port and insert the IP address of the physical IED to configure, see Figure 20.

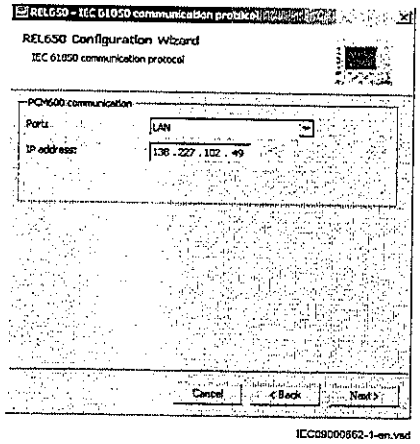


Figure 20: PCM600: Communication port and IP address

6. Cross-check that the IED whose IP address has been inserted has been detected online by PCM600, see Figure.

The user can not scan data from the IED or proceed further if the IED is not online or if the IP address is not correct.

7. Click the *Scan* option to scan/read the *IED Type* and *IED Version* for the IED that is online, see Figure 21.

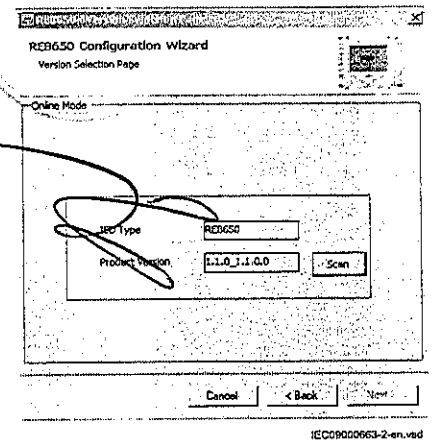


Figure 21: PCM600: IED Version detection

8. Click next to open the *Housing Selection Page* and select the housing and display type of the IED, see Figure 22

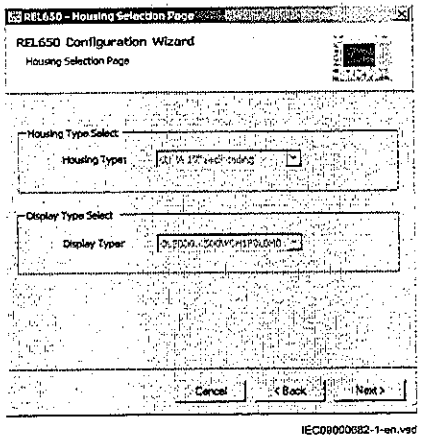


Figure 22: PCM600: IED housing and display type detection

9. The *Setup Complete Page* dialog shows the summary of the

IED Type, *IED Version* and *IP Address of IED*
see Figure 23. It is possible to *Cancel* the insertion or confirm the configuration and do the insertion with *Finish*

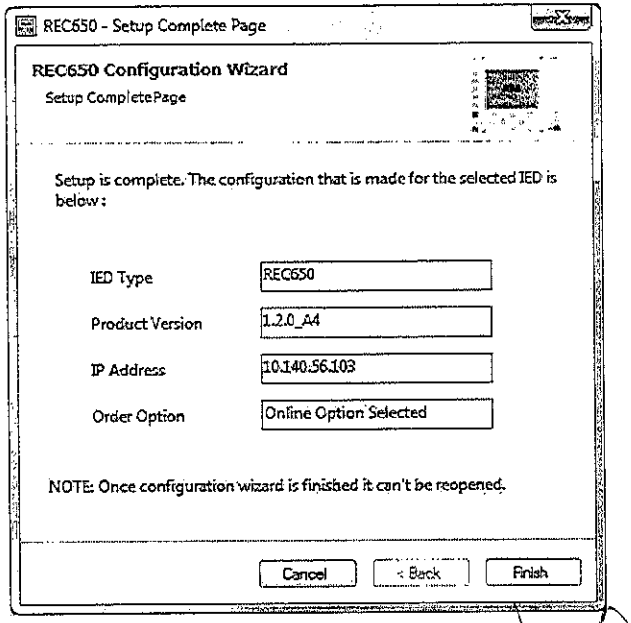


Figure 23: PCM600: IED Setup completion wizard

It is not possible to go back and do any modifications in the setup complete page. If an error is detected, the insertion has to be canceled and the IED has to be inserted again.

When the online configuration is completed, it is advised to read the configuration from the IED to ensure that the IED object in PCM600 has the same configuration data as the physical IED.

Inserting an IED in offline mode

Working in offline mode has an advantage compared to online mode that one can start preparing configuration even though IED is not available. Setting up an IED in offline mode is almost similar to that of an online mode; however with offline mode it is not necessary to type the correct IP address in the Communication port and IP address dialog.

The version information and order specific file needs to be selected, see Figure 24. The order specific file is delivered in a order confirmation E-mail. If no order specific file is available then select the *No Order Specific File* option, see Figure 25.

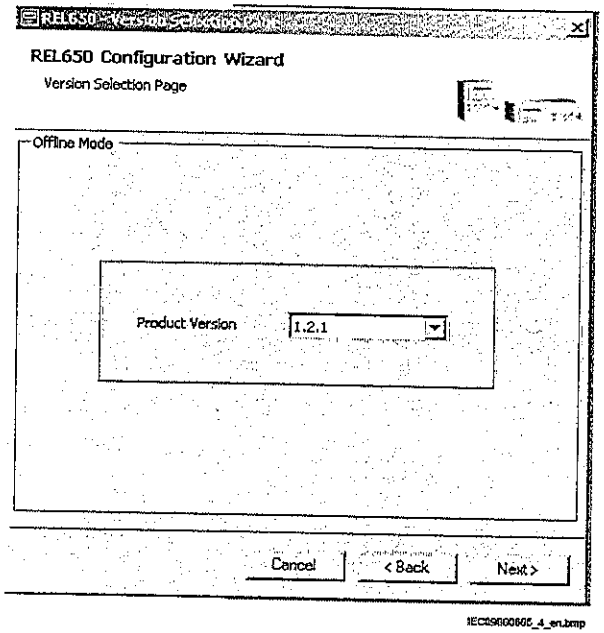


Figure 24: PCM600: IED Version selection

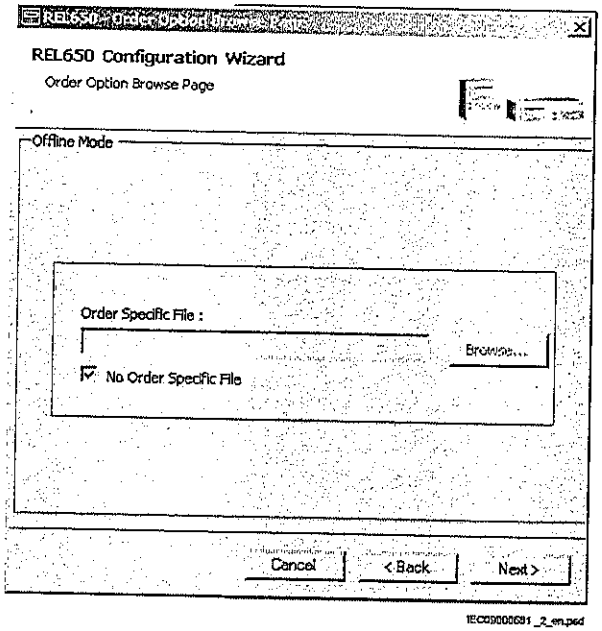


Figure 25: PCM600: IED Order code selection

Change hardware configuration after IED is inserted

In hardware tool it is possible to change the hardware configuration of the IED after it is inserted, for example if wrong selections were made in off line mode when no license file was used.

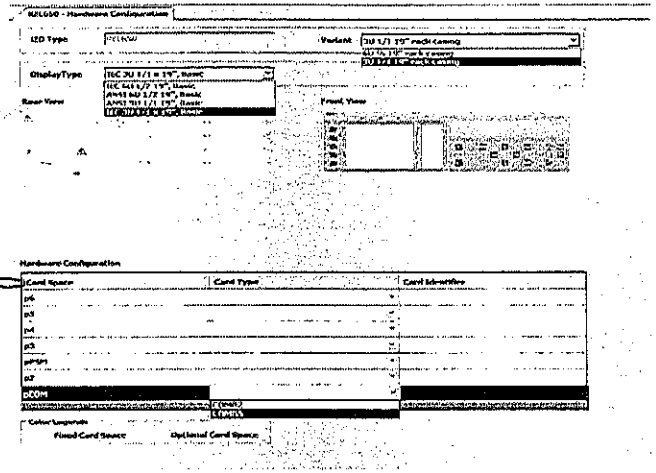


Figure 26: Hardware tool view of the IED

Inserting an IED from the template library

An IED in the plant structure can be exported as a template (*.pcmt). The user can build up a template library with all the exported IED templates. It is possible to insert an IED from the template library to create a new IED in the plant structure. Change the IP address, the name and the technical key that corresponds to the physical IED after a template IED has been imported.

A template IED can only be inserted when the bay is selected in the plant structure.

Procedure to insert a template IED

1. Right-click the *Bay* in the plant structure.
2. Select *New* and *Create from Template ...* to open the *Create New Object from Template* window, see Figure 27.

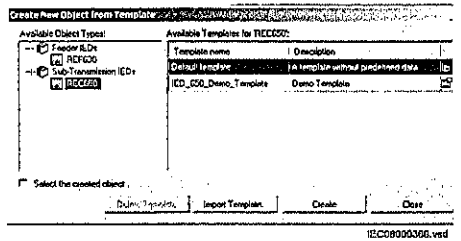


Figure 27: PCM600: Selecting IED from template library

3. Select the IED from the list of available IEDs.
4. Click the icon in the right column of the list of available templates to open the *Template Properties*. Verify the template information, see Figure 28 and click *Close* to close the window.

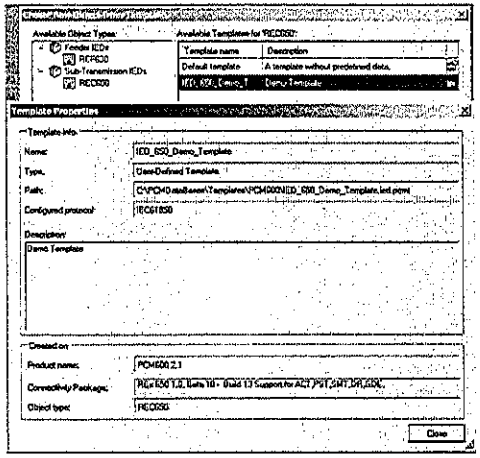


Figure 28: PCM600: IED Template Properties

5. Click *Delete Template* to delete the template, click *Import Template* to import a template from the selection window or click *Create* to insert the selected IED to the bay, see Figure 27.

It is possible to insert more than one IED from the *Create New Object from Template* window and the selection window remains open until the user clicks *Close*.

Inserting a configured IED in 650 series

Configured IEDs in 650 series in PCM600 are available as *.pcmi files and include all information that is related to the IED object in PCM600. The configured IEDs in 650 series is bound to a specific hardware configuration. Configured IEDs in 650 series are available on the Connpack DVD as .pcmi files under the file named User documentation.

Two alternatives to insert configured IEDs in 650 series:

- Use the configured IEDs in 650 series that has been ordered together with the IED.
- Create an own configuration, export the configuration as *.pcmi file and use it to configure other IEDs.

Procedure to insert a configured IED in 650 series

1. Right-click the bay and select *Import ...* to select the IED configuration file (*.pcmi) , see Figure 29.

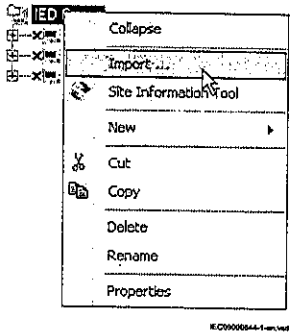


Figure 29: Import an IED from the context menu

2. Import the *.pcmi file from the bay level in the plant structure.
3. Click *OK* to insert the new IED object in the plant structure.
4. Modify the configuration according to the needed application.
5. Write the configuration to the IED.

Ordered default configurations are not locked. The user can use any of the available default configurations for a particular product type as a base to create an own configuration. The only requirement is that all needed hardware and software options are available.

It is possible to give the inserted IED in the plant structure a user defined name. Be sure to only user characters a-z, A-Z, 0-9 and _. Do not use space character in IED names.

4.7.1 Setting IED IP address in the project

There are two alternatives to set IP address of the IED object in PCM600. The IED object in PCM600 must have the same IP address and subnetwork mask as the front or rear port on the physical IED to which the PC is connected. The IP address of the physical IEDs front and rear port can not be set from PCM600 but only from LHMI.

- Via the first window of the wizard when including a new IED in a project, see Figure 30.

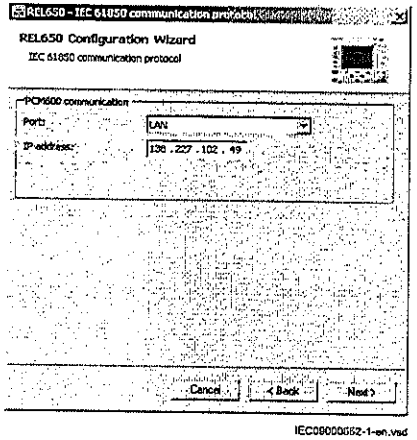


Figure 30: Alternative 1: IP address via first Wizard window

- Via the IP address property of the IED in the *Object Properties* window, see Figure 31.

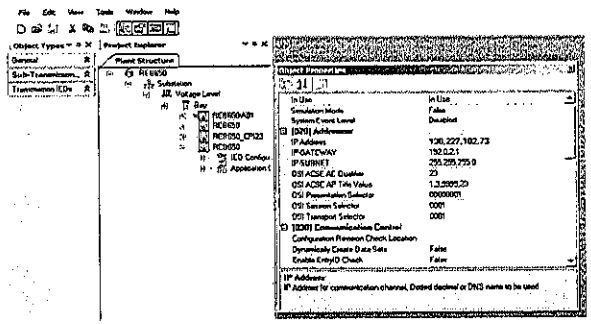


Figure 31: Alternative 2: IP address via IED Object Properties window

Procedure

1. Select the IED to enter the IP address.
2. Open the *Object Properties* window.
3. Place the cursor in the *IP address* row and enter the IP address.

The used alternative depends on the time at which the IP address is available.

Section 5 Protection and control engineering

5.1 Creating an application configuration with ACT

5.1.1 Overview

ACT is used to create the application configuration for an IED. The application configuration is built up with function blocks.

Function blocks are dedicated for different functionality, for example:

- Preprocessing blocks
- Control related functions
- Protection related functions
- Monitoring functions
- Communication

For detailed information about function blocks see the technical manual and the application manual.

Some function blocks are mapped as logical nodes according to the IEC 61850 standard. See the IEC 61850 communication protocol manual for detailed information. Other function blocks are not mapped as logical nodes, for example:

- Logical gates
- Timers

The basic general features of the Application configuration tool ACT:

- Organization of an application configuration
  - Organize an application configuration into a number of logical parts (MainApplication).
  - Organize a MainApplication over a number of pages.
- Features to program an application configuration:
  - Insert function blocks, make connections and create variables.
  - Include the hardware IO channels directly in the application configuration.
  - Set function blocks and signal visibility to SMT and PST.

SMT is not supporting signals of integer type or group signals. So, even if these types of signals are set as visible for SMT, they will not be shown in SMT.

- Document the application configuration, for example to make printouts.
- Test the application configuration online.

The function block signal values are updated in the online debug mode only if the function is enabled.

- Save application configurations as templates in an application library to reuse them in other IEDs.
- Validate the application configuration during the configuration process on demand and while writing the application configuration to the IED.

For instructions on how to perform the different tasks in PCM600, see PCM600 online help.

5.1.2 Function blocks

- Function blocks are the main elements of an application configuration. They are designed for a various number of functions and organized in type groups. The different function block types are shown in the Object Types View. Figure 32 presents an overview of the main parts that are relevant for function blocks.
- Set user defined names for function blocks and signals marked with blue text.

Signals that have a user defined name created in ACT, will only be visible in PST if the IED configuration is written to the IED and read back to PCM600. Otherwise the default signal name is shown in PST.

Do not use other characters than a-z, A-Z, 0-9 and _ when setting user defined names for signals and function blocks, since other characters might not display properly in local HMI. Also avoid using space character.

- Set IEC 61850, ANSI or IEC 60617 symbol standard.
- Set IEC or/and ANSI naming style.
- Lock function blocks.
- Set visibility for execution order, cycle time and instance number.
- Manage signals, for example hide, show and rearrange.
- Invert Boolean inputs and Boolean outputs.

Mandatory signals must be connected.

Function blocks with disconnected outputs are not executing and hence may show improper values on the outputs.

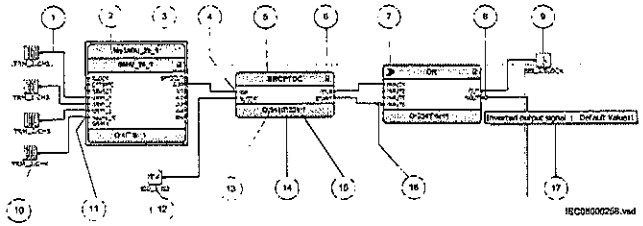


Figure 32: ACT: Function block overview

1 Connection(s)
2 User defined function block name
3 Function block, selected (red)
4 Mandatory signal (indicated by a red triangle if not connected)
5 Function block name
6 Function block, locked (red)
7 ANSI symbol
8 Inverted output
9 Hardware, binary output channel
10 Hardware, analog input channel
11 User defined signal name
12 Hardware, binary input channel
13 Execution order
14 Cycle time
15 Instance number
16 Inverted input
17 Signal description note

5.1.3 Signals and signal management

A function block has set of input and output signals.

A function block can contain more signals than needed in that application part. A signal that is not used in a particular application is possible to hide in the function block view in ACT. It is not necessary to connect all inputs and outputs at a function block. If not connected, the signals always have a default value. The default value can be seen when hove over the signal with the mouse.

Signals are located on both sides of the middle position up and down. When there is space left, move some signals up or down for a better visibility and connection routing.

Boolean input and output signals may need to be inverted to fulfill the logic. ACT supports to add the inversion logic to a binary signal.

The input signal on glue logic function blocks can only be inverted if a glue logic function block with lower execution order in the same cycle time is available. Similar, the output signal can only be inverted if a glue logic function block with higher execution order in the same cycle time is available. Up to two input signals and two output signals can be inverted for glue logic blocks in the same cycle time.

Even though current is injected to the IED and the IED is connected to PCM600 in online mode, the signal value in ACT is probably shown as zero.

All not mandatory input signals have a default value that will be used when not connected.

5.1.4 Function block execution parameters

Three function block execution parameters have influence on the runtime execution of the function block within the application configuration.

- Execution order
- Cycle time
- Instance number

Each time a new function block is selected these parameters have to be selected. In fixed mode user selects parameters from the drop down lists in ACT. In automatic mode best suitable instance is selected automatically. Depending on the function block type not all three parameters are selectable. The cycle time may be predefined to one value. The instance number is a counter for the total possible number of function blocks of that type used within an application configuration.

The *Execution Order* and *Instance Number* are a combination that is predefined within a product. It is possible to select a pair out of the list. Figure 33 shows an example how the drop down list could look like.

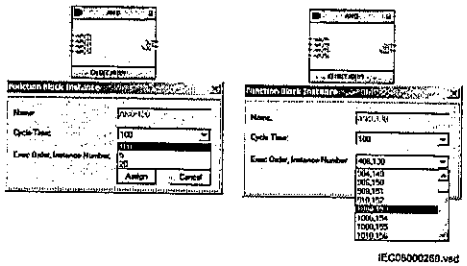


Figure 33: ACT: function block organization parameters

A minus sign in front of the cycle time, for example -200ms, indicates that the application is time driven, otherwise the application is analogue data driven. Analogue data driven applications require sample values from Analogue input modules - in case the physical module is broken, applications are not executed. Time driven applications are executed periodically regardless of the status of the analogue signal processing.

The *Cycle Time* can be selected to 5, 20 or 100 ms. Depending on function block type and the 650 series product only one, two or all three possibilities may be available.

The combination *Execution Order*, *Instance Number* is predefined by ABB. Mainly for basic logic function blocks like for example *AND*, *OR*, a set of combinations spread over the full range of execution orders is available. This gives the possibility to select a combination which fits to the execution order range needed in that application part.

Application configuration cycle time and execution order organization

The application execution within the 650 series products is organized in three time classes, see Figure 34.

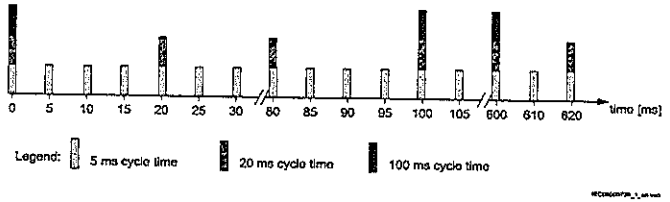


Figure 34: ACT: Possible MainApplication cycle times

For the same time point, faster cycle times are executed first.

A function block that is placed after a function block in the execution flow must have the same or a higher cycle time and/or execution order. See Figure 35.

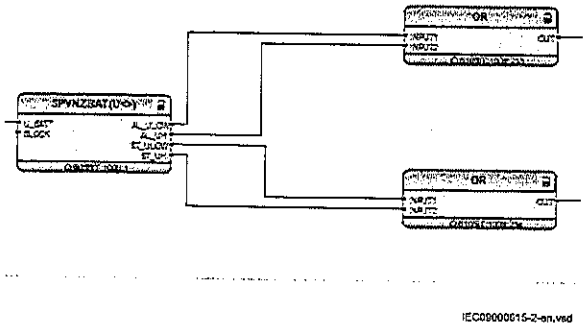


Figure 35: Cycle time and execution order

A function block type can be defined to be a member of one or several cycle times. A function block instance can be set only to one cycle time.

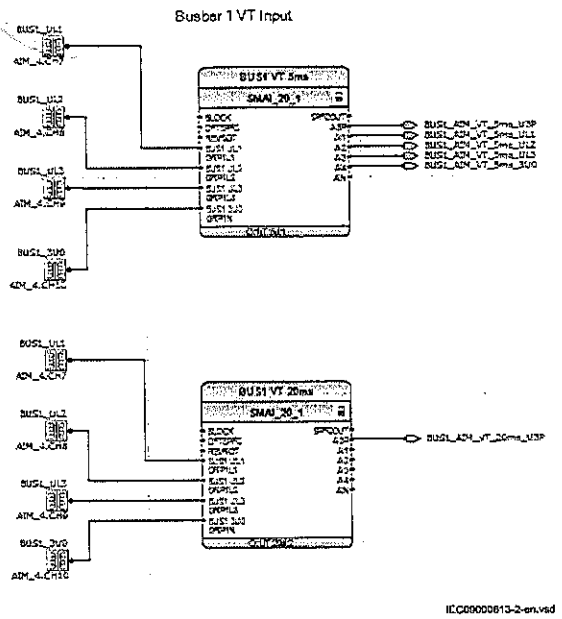


Figure 38: ACT: HW signal channels

5.1.8 Validation

Validation checks the application configuration on errors about the rules and restrictions defined for doing a MainApplication on three levels.

- During creating the logic while doing a connection or placing a function block.
- On demand by starting the validation.
- When writing the application configuration into the IED.

Validation when creating the application configuration

Validation is made when creating the application configuration, for example:

- A connection between two input signals or two output signals is not possible.
- A connection between two different data types is not possible, for example a binary output to an analog input.

Validation on demand

To check the validity of an application configuration, click the 'Validate Configuration' icon in the toolbar. ACT will check the application configuration for formal correctness. Found problems are qualified in:

- Warnings, marked by a yellow warning icon
  - Example: A variable connected to an output signal that is not connected.
  - Example: If the user connects output from higher execution order function to inputs of lower execution order function.
- Errors, marked by a red circle with a cross
  - Example: A mandatory input signal that is not connected.

Warnings will not prevent writing to the IED. Errors have to be corrected before writing the application configuration to the IED. An application configuration can be saved and ACT can be closed with open errors, but not written to the IED, see Figure 39.

These problems are listed in the *Output View* under the Tab *Application Configuration*. A double-click in the error or warning row will navigate to the MainApplication>Page>Area where the problems are identified.

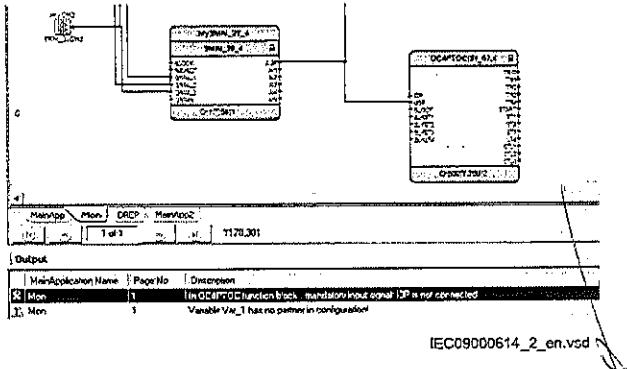


Figure 39: ACT: Validation on demand

Validation when writing to the IED

When writing the application configuration to the IED an automatic validation is performed. The validation is the same as the manually demanded validation. Errors will abort the writing.

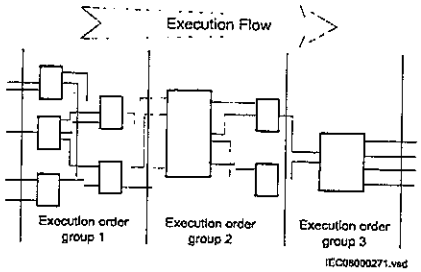


Figure 36: ACT: Concept of Execution order sequence

In the conceptual MainApplication example in Figure 36, the execution order of the main function block in the execution order group 2 defines the execution orders needed in group 1 and 3. The preceding logic done with function blocks in group 1 must have a lower execution order than the ones in group 2. The following function blocks in group 3 must have a higher execution order than the main function block in group 2.

5.1.5 Configuration parameters

Configuration parameters are found in the parameter setting tool. For example, the SMAI function block has to be configured to support AC-current values or AC-voltage values.

5.1.6 Connections and variables

A connection is the link or "wire" between function block outputs and inputs.

Rules and methods to do connections:

- Drag a line between two signals.
- Link two signals by using variables.

It is possible to search and replace variable names in ACT.

Connection validation

A connection is only useful and possible between two signals of the same data type, see Figure 37.

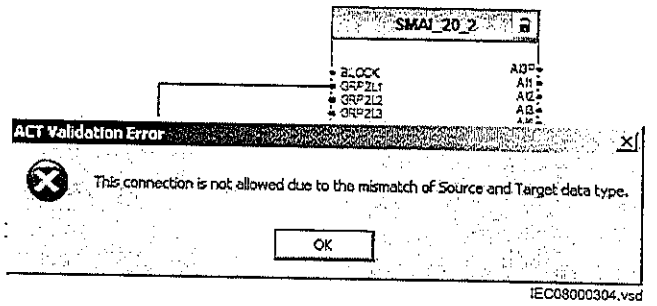


Figure 37: ACT: Warning message by signal mismatch for a connection

5.1.7 Hardware channels

Hardware channels can only be connected to a function block input or output. A hardware connection can be established in ACT or SMT. When a hardware channel is connected a graphical symbol appears in ACT, see Figure 38. The connection is also represented in SMT with a cross mark. Hardware channels are always visible in SMT.

Supported hardware channels are:

- Binary input channels
- Binary output channels
- Analog input channels

A hardware input channel can be used as often as it is needed. A hardware binary output channel is taken from the list of available channels when a new channel is requested. That prevents for using a hardware binary output channel twice. As an example, see Figure 38.

5.2 Setting configuration and setting parameters in PST

Configuration parameters and settings parameters are changeable either from LHMI or from PST in PCM600.

Note that the some parameters are only visible in PST and some are only visible on LHMI.

A common write from PCM600 to the IED, where parameters are changed in PST, will overwrite any parameter changes made locally from LHMI.

To export parameters from PST, both XRIO and CSV formats are supported.

Do not make PST read/write operation to IED when disturbance recorder is storing data since that causes PCM600 to report that the IED is offline or having communication problems.

All variables listed and shown in the parameter list can be sorted into two groups:

- Configuration parameter or
- Setting parameter

Configuration parameter

A configuration parameter specifies an operation mode of an application function or of the IED. These are basic configurations, which are normally configured only once and then settled. The IED configures itself at start-up according to the given configuration parameter values.

Setting parameter

A setting parameter (short form only "setting") is a parameter that can be changed in the IED at runtime.

Setting group

Nearly all settings used by the IED for the protection application functions are organized in a group of settings. Up to four setting groups can be configured with different values. The IED supports the selection of a setting group at runtime.

IED parameters organization

The organization of the parameters in a tree structure is visible in the plant structure by expanding the setting tree. For each function, the parameters are organized in basic and advanced groups. The advanced settings are used for application optimization.

During a common write both the basic and advanced settings are written to the IED.

5.3 Connecting signals in SMT

SMT is used to do cross references, see Figure 40:

- between physical IO signals and function blocks.
- for the GOOSE engineering.

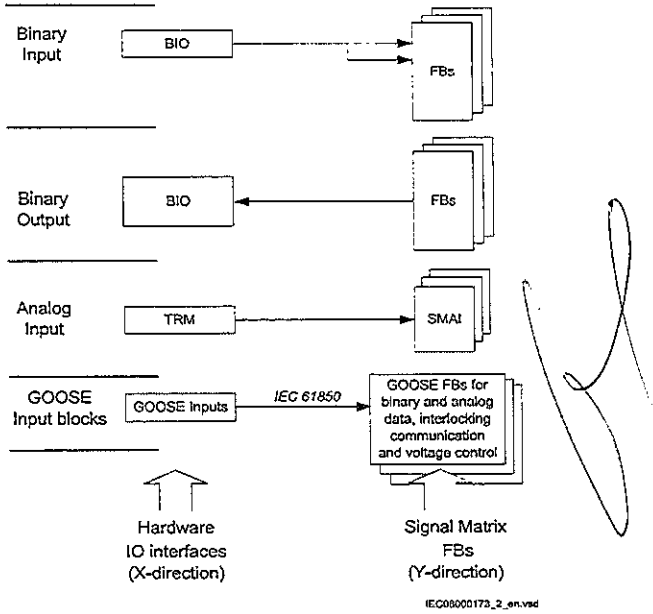


Figure 40: SMT: Operation principles

A binary input channel can be connected to one or several function block inputs, see Figure 41. If a binary input channel is connected to several different function blocks in ACT, the connection will appear as glue logic in SMT.

A binary output channel can only be activated from one function block output. If it should be activated from more than one function block output, glue logic has to be used. Glue logic means inserting a logical gate (OR and AND blocks) between the function blocks and the binary output channel. This can be engineered in SMT.

Connections made in SMT are automatically shown in ACT.
Connections made in ACT are automatically shown in SMT.

It is possible to group and collapse hardware channels in SMT to get a better overview.

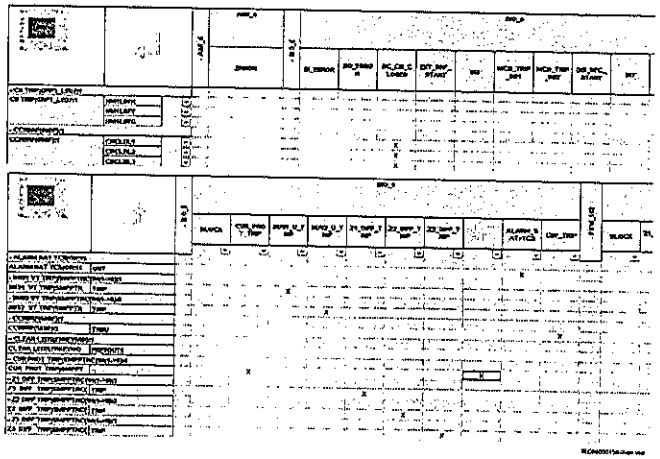


Figure 41: SMT Connection between binary input channels to binary input signals

Depending on the IED capability, SMT has a separate sheet for each possible combination.

The possible sheets are:

- Binary Inputs
- Binary Outputs
- Analog Inputs
- GOOSE Receive

Section 6 Local HMI engineering

6.1 LED and function key engineering

6.1.1 Local HMI engineering process

The engineering process of the LEDLHMI involves several steps. Figure 42 presents the pre-engineering step, the main steps in the engineering process and the required sequences.

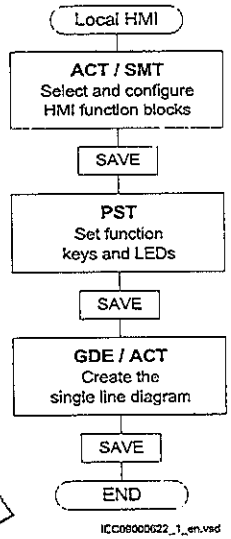


Figure 42: LHMI: Engineering process flowchart

- Application Configuration tool with possible assistance of Signal Matrix tool

  - To use the function keys and LEDs on LHMI it is needed to insert the corresponding special function blocks for these operation element groups.
  - The function blocks for the LEDs are organized as single function block per LED but indexed to the group identification, for example GRP1_LED3 (indication LED 3 in virtual LED group 1).
  - The function blocks for LHMI are visible by default for Parameter Setting tool.
  - Use Application Configuration tool to connect start and trip signals from application functions to LED function blocks.
- Parameter Setting tool
  - The operation mode of the function keys and the LEDs is defined in Parameter Setting tool.
  - The presented text labels on the LCD for LHMI keys and LEDs.
- Graphical Display Editor with assistance of Application Configuration tool, for example
  - to make the single line diagram of the primary process part.
  - to make the dynamic links for the apparatus.
  - to make the dynamic links for measurements.

Application Configuration tool and local HMI function blocks

A set of special function blocks is available for all the operation element groups on LHMI.

See the technical manual for more information about function blocks.

List of LHMI function blocks that are available in Application Configuration tool:

- LHMICTRL
- FNKEYMD1 to FNKEYMD5
- LEDGEN
- GRP1_LED1 to GRP1_LED15
- GRP2_LED1 to GRP2_LED15
- GRP3_LED1 to GRP3_LED15

The function blocks for the LEDs are organized in function blocks per LED. They can be placed close to the logic where the information per LED is built in Application Configuration tool.

Figure describes the basic LHMI and the operation element groups. These are the 15 LEDs and their belonging text elements on the LCD [A]. They are operated by the keys [a] and [b].

The other group is the five function keys with their IEDs and the corresponding text elements on the LCD [B].

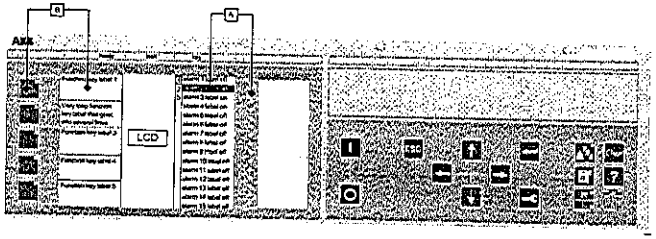


Figure 43: Local HMI: Placement of local HMI operation elements

Function block LEDGEN

- Handles an external acknowledge signal as source to acknowledge the LEDs.
- Generates an additional pulse for general purposes whenever the LEDs are acknowledged by the operator.
- Generates a pulse whenever a new LED signal occurs. It may be used to trigger an acoustical alarm.
- Handles the timer *tReset* and *tMax* for the LED operation mode 'LatchedReset-S'.

Function block GRP1_LED1 to GRP3_LED15

- The 15 LEDs on the right side of the LCD can indicate in total 45 alarms, warnings or other signals to the operator. They are organized in three groups 1 to 3.
- Each signal group belongs to one function block.
- Each LED illuminates in one of the three colors: RED, YELLOW or GREEN.
- The organization of flashing, acknowledgment and group selection is done directly between the function blocks and the basic LHMI keys, the 'Multifunction' key [a] to toggle between the three groups or the 'Clear' key [b] to acknowledge or reset the LEDs.
- Only the programming of the signals is needed for the LEDs.
- The operation mode of the LEDs is defined in Parameter Setting tool.

Function block FNKEYMD1 to 5

- Every function key has an own FNKEYMD function block.
- The 5 function keys on the left side of the LCD [B] can be used to process demands.
- The function block handles the signal for the LED included in the key as input signals.
- The LED signal of the key is independent of the key function and must be programed to process demands.
- The function block handles the operators command when the key is pressed as output signal.
- The functions are activated whenever a key is pressed the first time. The corresponding text elements for the five keys appear on the left side of the LCD.

No execution of the function is done. So the first push is used to activate the presentation only.
- The next key push is handled as activate function and the output signal of the function block is set.
- The operation mode of the function key is defined in Parameter Setting tool (pulse, toggle).

Parameter Setting tool and function block configuration

The operation mode of the function keys and the LEDs must be defined per key and LED in Parameter Setting tool.

The function key can operate as:

- Pulsed signal
  - Each push forces a pulse of a configured time.
  - The pulse time can be set in Parameter Setting tool.
  - The default pulse time is 200 ms.
- Toggle signal
  - Each push changes the state of the signal: OFF-ON-OFF-ON-OFF...
  - The default position after power up or reset is OFF.
- Menu shortcut
  - When pressing a key configured for that purpose, the function key panel is hidden and LHMI opens directly in the configured menu.

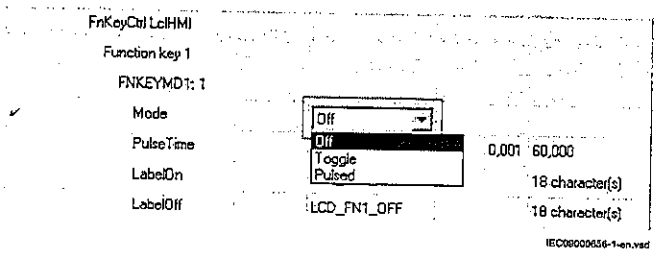


Figure 44: LHMI: Function key operation mode

The LEDs have a number of different operation modes, see Figure 45:

- General definitions
  - Each LED can illuminate in one of three colors: RED, YELLOW, GREEN.
  - Only one color is illuminated at a time.
  - The priority for illumination and the color is linked.

- Prio 1 = RED
- Prio 2 = YELLOW
- Prio 3 = GREEN
- When RED and YELLOW are ON at the same time, the LED will illuminate in RED.

- The operator's acknowledge for the LED signals is done for all three signals (RED, YELLOW, GREEN) of the LED.
- A reset of the LLEDs operates also on all three signals of the LEDs.

- Follow-S
  - The LED illumination follows the status of the signal. The LED illuminates steady (S).
- Follow-F
  - The LED illumination follows the status of the signal. The LED illuminates flashing (F).
- LatchedAck-F-S
  - The LED latches the signal change OFF-ON and flashes (F) until it is acknowledged.
  - When the signal is still ON at the time the signal is acknowledged the LED changes to steady (S) mode.
  - When the signal has already changed to OFF before the time it is acknowledged, the LED turns to OFF.
- LatchedAck-S-F
  - The same as LatchedAck-F-S but the LED starts with steady state and flashes after acknowledgment.
- LatchedColl-S
  - The LED illuminates in all cases in steady mode only
  - The LED latches a signal change from OFF-ON until it is acknowledged by the operator.
  - The LED stays in steady mode when it is reset and the signal is still in ON state.
  - The LED is OFF only after the signal has changed to OFF state AND it is reset by the operator via 'Clear' operation.
- LatchedReset-S
  - This mode is used for all LEDs that are used to indicate a disturbance. The LEDs will stay in the last state after the disturbance run time until they are reset after a defined time.
  - The timers are set in Parameter Setting tool in the function block LEDGEN.

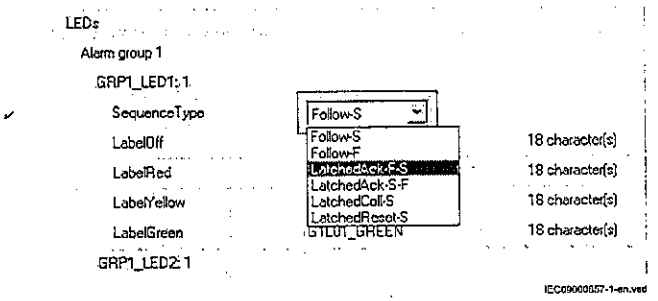


Figure 45: LHMI: LED operation mode

6.1.2 LED operation modes

Description of different operation modes for LEDs to be configured in Application Configuration tool and Parameter Setting tool.

Six operation modes are listed in the drop down menu in Parameter Setting tool.

- Follow-S
- Follow-F
- LatchedAck-F-S
- LatchedAck-S-F
- LatchedColl-S
- LatchedReset-S

LED operation mode Follow-S

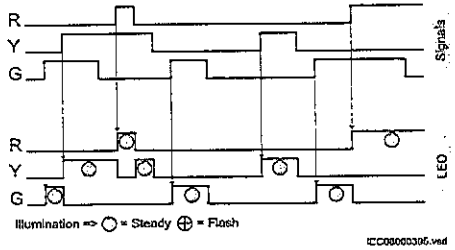


Figure 46: LHMI: LED operation mode Follow-S

Monitoring a signal with a LED is a simple mode, where the LED follows the signal state. More than one signal per LED can be used when applicable. See Figure 46 for the valid priority rules. The LED illuminates always in steady state.

LED operation mode Follow-F

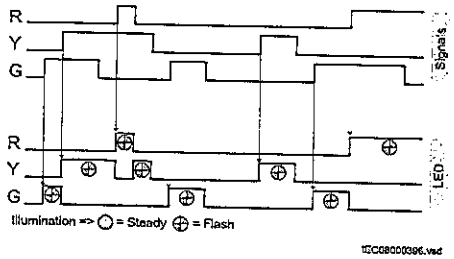


Figure 47: LHMI: LED operation mode Follow-F

This is the same mode as Follow-S but the LED illuminates flashing, see Figure 47. This mode may be used to indicate that a tap changer or Petersen coil is moving.

LED operation mode LatchedAck-F-S

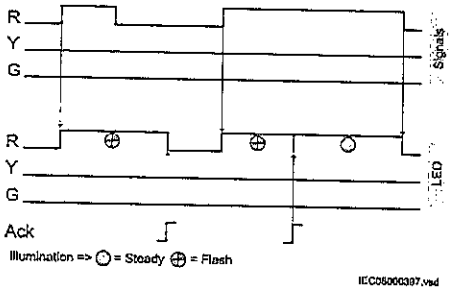


Figure 48: LHMI: LED operation mode LatchedAck-F-S / Base

The classical mode to indicate incoming alarms or warnings, which the operator has not seen since the last acknowledgement, is presented in Figure 48 as a basic operation mode. Two possibilities for the operator to acknowledge:

- The signal is already gone when acknowledged, the LED turns *OFF* (at least for this color).
- The signal is still *ON*, the LED stays illuminated and changes to steady state.

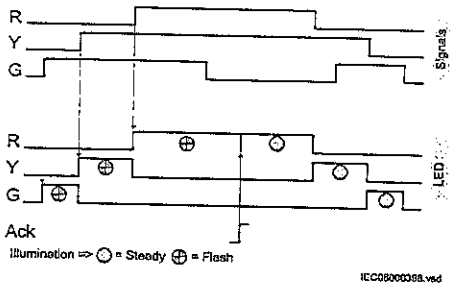


Figure 49: LHMI LED operation mode LatchedAck-F-S Ack Prio / 1

When more than one color is used the rules for priority are valid. Two basic principles are:

- Two or more signals are still *ON* when the LED is acknowledged.
  - All colors (signals) are acknowledged and they will illuminate in steady state.
  - Incoming additional signals with lower priority will illuminate when they become the highest priority in steady mode.
- One or more signals with higher priority are changing to *ON* after an acknowledgement.
  - The higher priority color (signal) will illuminate in flash mode.

See Figure 49 and Figure 50 for these two principles.

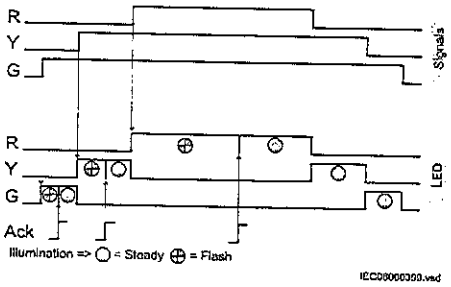


Figure 50: LHMI LED operation mode LatchedAck-F-S Prio / 2

LED operation mode LatchedAck-S-F

This operation mode operates exactly as the one described above (LatchedAck-F-S). The only difference is that the illumination mode is changed. Flash mode instead of steady mode and steady mode instead of flash mode.

LED operation mode LatchedColl-S

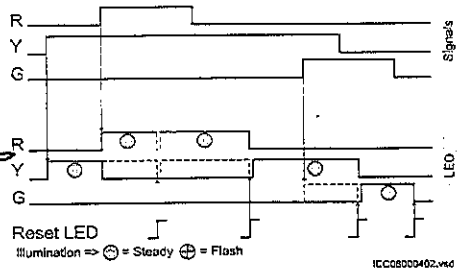


Figure 51: LHMI: LED operation mode LatchedColl-S

This mode catches a signal change to *ON* and the LED stays *ON* until the operator resets the LEDs for this group.

If the signal is still *ON* when a reset LED is done, the LED will illuminate again. This occurs when the application configuration accesses the signal again in the next cycle after reset. The thin dashed lines in Figure 51 shows the internal state of the LED following the signal and reset, when no higher prior signal is given.

The LED illuminates always in steady mode.

LED operation mode LatchedReset-S

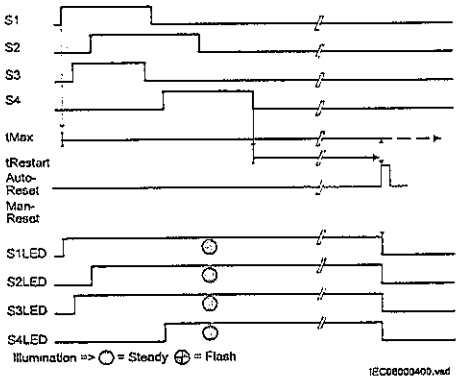


Figure 52: LHMI: LED operation mode LatchedReset-S

This mode is useful to monitor signals that are involved in case of a disturbance, see Figure 52. The signal state after the disturbance allows a fast overview about the disturbance. To get always the situation of the last occurred disturbance, the LEDs are reset after a predefined time (tReset). So this is the longest time a disturbance can be monitored by the LED situation.

In case a second disturbance occurs before the tReset time has elapsed, see Figure 53, the signals that are still ON at the end of tReset will return to ON with the next application configuration cycle after tReset. To clear these LEDs, a second timer tMax is used. TMax is started when the first signal of the disturbance changes to ON. tMax is stopped, when tReset could clear all LEDs.

A disturbance runs for a maximum of some seconds, while tReset can be in the range of 60 to 90 seconds.

The timer tReset and tMax are configured in Parameter Setting tool as part of the function block LEDGEN

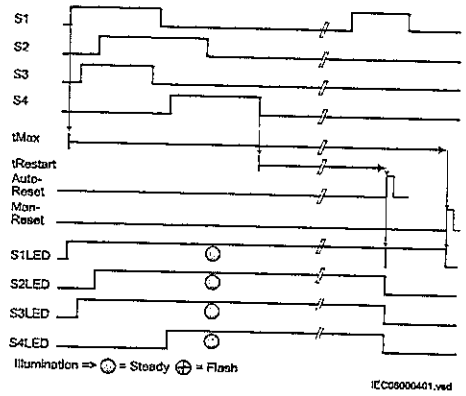


Figure 53: LHMI LED operation mode LatchedReset-S / 2

Single-line diagram engineering

Phase angles are shown as radians in the single line diagram (GDE measurand) symbols but in degrees in other views on the LHMI.

6.2.1 Concept description to present and generate diagrams in graphical display editor

Additional concept information to use GDE, see Figure 54:

- Different GDE windows
- HMI display raster layouts
- Drawing lines (doing a Link)

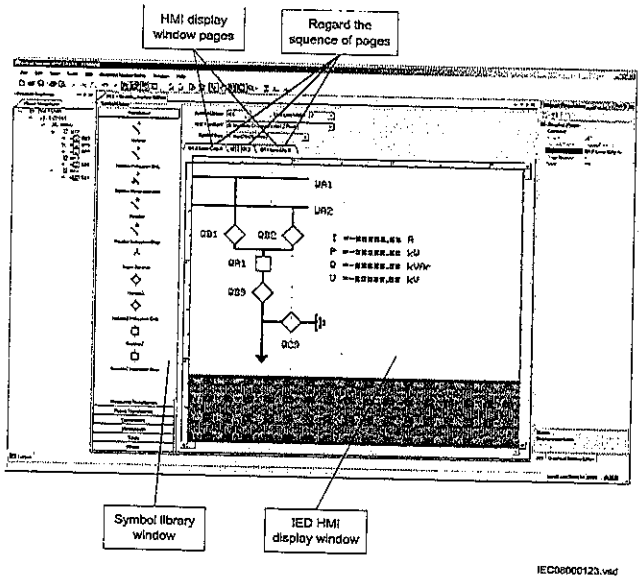


Figure 54: GDE: Screen image with active GDE

Procedure

1. Start GDE to open a presentation of the tool.
2. GDE has a fixed symbol library window on the left side of the display.
3. The presentation is empty when no page exists for the IED.

Display window and sequence order

It is important to link correctly between the HMI display page and the corresponding bay that is presented as a single line diagram on this HMI page.

Rules to handle HMI pages:

- Several single line diagrams can be created for one bay.
- The IED supports one bay.
- The sequence order of the HMI pages in the Graphical Display Editor starts from left to right.
- Measurements and the single line diagram can be shown on the page in any possible order and placement.
- All symbol objects, for example apparatus, text and measurement, on the HMI page must be linked to the correct function block in the application configuration in order to present the correct process values.

Symbol library

The symbol library window contains some panes that include drawing symbols or elements to create a single line diagram, measurements and texts on a page. Click on the name bar of the selected element to open the pane.

The library shows the symbols either in ANSI standard or in IEC standard. The standard is selected by the drop down list box located on top of the display window.

When changing to the other library standard, GDE closes the library windows, changes the symbols according to the selected new standard and redraws the single line diagram in the display window.

Select the different panes and their symbols to become familiar with the available symbols.

Measurements (Measurands) are presented in one format that explains itself when selected. Select the format and drop it in the drawing area. Use the object properties to make adaptations.

Special symbols for dynamic text

In the text pane the symbol library contains a set of special symbols to present text that depends on the status of variables. A set of three symbols are either valid to present a double point information or to present an integer value position out of 32 binary outputs. The corresponding function blocks in ACT are VSGGIO and SLGGIO.

- *Dynamic Text* or *Indication* button is used when a position shall be monitored on single line diagram, Figure 55
- *Select Button* is used when the functions shall be manoeuvred from a single line diagram.

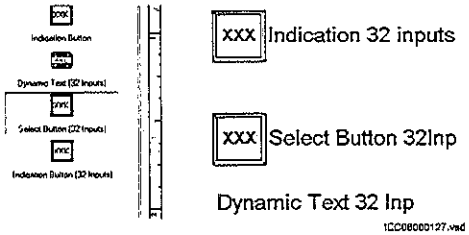


Figure 55: GDE: Dynamic Text symbols

The standard (IEC or ANSI) for the symbols and the selection of the font size for the text elements can be changed using the two selector boxes on top of the page window.

HMI display raster layout and text font selection

The raster in the page changes from symbol presentation to text presentation when a text object is selected and vice versa.

The text can be presented in two different font sizes:

- UniCode characters (6 x 12 pixel)
- UniCode characters (13 x 14 pixel)

The total size of the presented white area (page) represents the visible part of the local HMI display without header and foot-line.

The visible display for a single line diagram is organized in a raster of 13 x 8 (columns x rows). Each symbol presented by 24 x 24 pixels included by the drag and drop method must be dropped in a raster box. The apparatus object name can be placed in all four directions around the symbol. The name is part of the apparatus object.

Handling text

The raster switches when text is selected in a raster of 45 x 15 (columns x rows). One raster box is the placeholder for one character. A text element must be placed in the position of the raster. The signal name can changed either by double click or via the property window. Unit and scaling of the signal can only be changed via the property window.

Select and toggle *Show Texts using the IED Fonts* to get a view how it will look like later on the real HMI display.

Doing Link to draw lines

The line width has to fit to the line width used for the symbols. The standard size is 2. Choose the line width in a selection box placed in the upper area above the page. A line

that is not connected to a symbol may be done in any line width in the range 1 - 5. But it needs to be simple connection points to be drawn.

For the procedure to draw lines when the apparatus symbols are placed, see Figure 56.

1. Place the apparatus or transformer symbols by drag and drop in a raster box.
2. Place the connections symbols by drag and drop in a raster box.
3. Click the *Link* icon to enable direct line drawing.
4. Center the mouse pointer on the center of a connection point; visible in two circles at the endpoints of a line, to draw a line.
5. Click to start and move the mouse pointer to the destination connection point. Center once again the mouse pointer and click to drop the line.
6. Draw all line elements that are necessary.
7. Click *Select* in the menu bar to finish the line drawing.

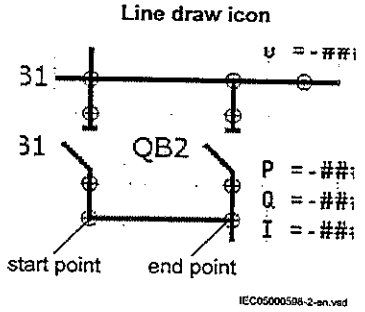


Figure 56: GDE: Drawing a line

6.2.2 Supported single-line diagram symbols

Table 6: Supported symbols

Category	IEC Symbol Name	Symbol Type	IEC Symbol Definitions	ANSI Y32.2/ IEEE 315 Symbol Definitions	Function Block Type
Connections	Junction	1			
Connections	Busbar junction	2			
Connections	Earth	10			

Table continues on next page

Category	IEC Symbol Name	Symbol Type	IEC Symbol Definitions	ANSI Y32.2/ IEEE 315 Symbol Definitions	Function Block Type
Connections	Feeder end	21			
Measuring transformers	Current transformer	5			
Measuring transformers	Voltage transf. 2 windings	6			

Table continues on next page

Category	IEC Symbol Name	Symbol Type	IEC Symbol Definitions	ANSI Y32.2/ IEEE 315 Symbol Definitions	Function Block Type
Measurands	Measurand	11			CMMXU
					SMBRREC
					TRPTTR
					VMMXU
					CMSQI
					VMSQI
					VNMMXU
					TCMYLTC
					PCGGIO
					SSCBR
					SSIML
					SSIMG
					CNTGGIO
					STBRREC
					HZPDIF
					GENPDIF
					TR8ATCC
					T2WPDIF
					T3WPDIF
					MVGGIO
					SPVNZBAT
					SESRSYN
					LCPTTR
					LFPTTR
					LMBRFLO
					OEXPVPH
					L4UFCNT
					SXSWI
					CVMMXN
					TEIGGIO
					SXCBR
					ETPMMTR
Others	Capacitor	7			
Others	Surge arrester	8			

Table continues on next page

Category	IEC Symbol Name	Symbol Type	IEC Symbol Definitions	ANSI Y32.2/ IEEE 315 Symbol Definitions	Function Block Type
Others	Generator	9			
Others	Reactor	14			
Others	Motor	15			
Others	Coil	18			
Power transformers	Transformer 2 winding	16			
Power transformers	Transformer 3 winding	17			
Power transformers	Autotransformer	23			
Switchgear	Isolator, 00 = middle position	3			SCSWI
	Isolator, 01 = Open				
	Isolator, 10 = Closed				
	Isolator, 11 = Undefined				
Switchgear	Breaker, 00 = Middle position	4			SCSWI
	Breaker, 01 = Open				
	Breaker, 10 = Closed				
	Breaker, 11 = Undefined				
Switchgear	Truck, 00 = Middle position	22			SXSWI, SXCBR
	Truck, 01 = Open				
	Truck, 10 = Closed				
	Truck, 11 = Undefined				

Table continues on next page

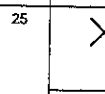
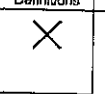
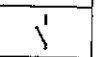
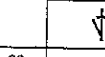
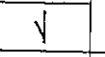
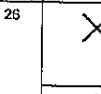
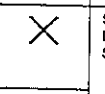
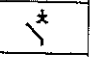
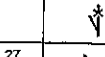
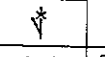
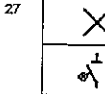
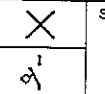
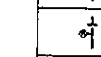
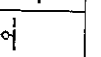
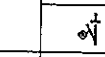
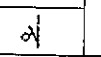
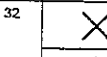
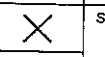
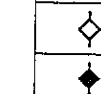
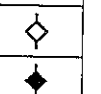
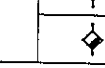
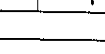
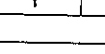
Category	IEC Symbol Name	Symbol Type	IEC Symbol Definitions	ANSI Y32.2/ IEEE 315 Symbol Definitions	Function Block Type
Switchgear	Isolator indication only, 00 = Middle position	25			SCSWI, DPGGIO, SXSWI
	Isolator indication only, 01 = Open				
	Isolator indication only, 10 = Closed				
	Isolator indication only, 11 = Undefined				
Switchgear	Breaker indication only, 00 = Middle position	26			SCSWI, DPGGIO, SXCBR
	Breaker indication only, 01 = Open				
	Breaker indication only, 10 = Closed				
	Breaker indication only, 11 = Undefined				
Switchgear	Isolator motor operated, 00 = Middle position	27			SCSWI
	Isolator motor operated, 01 = Open				
	Isolator motor operated, 10 = Closed				
	Isolator motor operated, 11 = Undefined				
Switchgear	Isolator2, 00 = Middle position	32			SCSWI
	Isolator2, 01 = Open				
	Isolator2, 10 = Closed				
	Isolator2, 11 = Undefined				

Table continues on next page

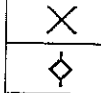
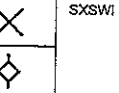
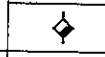
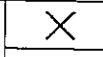
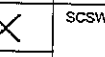
Category	IEC Symbol Name	Symbol Type	IEC Symbol Definitions	ANSI Y32.2/ IEEE 315 Symbol Definitions	Function Block Type
Switchgear	Isolator2 indication only, 00 = Middle position	33			SCSWI, DPGGIO, SXSWI
	Isolator2 indication only, 01 = Open				
	Isolator2 indication only, 10 = Closed				
	Isolator2 indication only, 11 = Undefined				
Switchgear	Breaker2, 00 = Middle position	34			SCSWI
	Breaker2, 01 = Open				
	Breaker2, 10 = Closed				
	Breaker2, 11 = Undefined				
Switchgear	Breaker2 indication only, 00 = Middle position	35			SCSWI, DPGGIO, SXCBR
	Breaker2 indication only, 01 = Open				
	Breaker2 indication only, 10 = Closed				
	Breaker2 indication only, 11 = Undefined				
Texts	Static text	0			
Texts	Dynamic text	29			VSGGIO
Texts	Select button, 00 = Middle position	30			VSGGIO
	Select button, 01 = Open				
	Select button, 10 = Closed				
	Select button, 11 = Undefined				

Table continues on next page

Category	IEC Symbol Name	Symbol Type	IEC Symbol Definitions	ANSI Y32.2/ IEEE 315 Symbol Definitions	Function Block Type
Texts	Indication button, 00 = Middle position	31	XXX	XXX	VSGGIO
	Indication button, 01 = Open		XXX	XXX	
	Indication button, 10 = Closed		XXX	XXX	
	Indication button, 11 = Undefined		XXX	XXX	
Texts	Dynamic text, 32	36			SLGGIO
Texts	Selector switch, 00 = Middle position	37	XXX	XXX	SLGGIO
	Selector switch, 01 = Open		XXX	XXX	
	Selector switch, 10 = Closed		XXX	XXX	
	Selector switch, 11 = Undefined		XXX	XXX	
Texts	Selector switch indicate, 00 = Middle position	38	XXX	XXX	SLGGIO
	Selector switch indicate, 01 = Open		XXX	XXX	
	Selector switch indicate, 10 = Closed		XXX	XXX	
	Selector switch indicate, 11 = Undefined		XXX	XXX	
Others	Resistor	39			
Others	Star point	40			
Others	Field winding	41			

6.2.3 Bay configuration engineering

A page with a single line diagram and measurements contains active living objects. The object values are updated by the IED periodically (measurement) or in case of an event. Once the symbols are placed on the HMI page they must be linked to the corresponding function block in the application configuration, which protects or controls the object that the symbol on the HMI page represents.

Creating a complete HMI display page

Procedure:

1. Make a sketch how to present the single line diagram.
2. Place the apparatus, transformer and other symbols that are needed for the single line diagram into the raster boxes.
3. Add connection points where needed.
4. Link the apparatus symbols with line elements.
5. Adjust the text symbols while writing to north, east, south or west. Use the object property window to do it.
6. Place measurements when needed.
7. Edit the name, unit and number of decimals of the measurements.
8. Select each object that has a dynamic link and do the link to the corresponding process object, see Figure 57.
9. Check to select the correct function block. Function blocks of the same type can have different instance numbers.
10. Validate that all links are done.
11. Save the complete picture.
12. Repeat the steps for all pages when more than one is needed.
13. Write the display configuration to IED from the GDE tool.

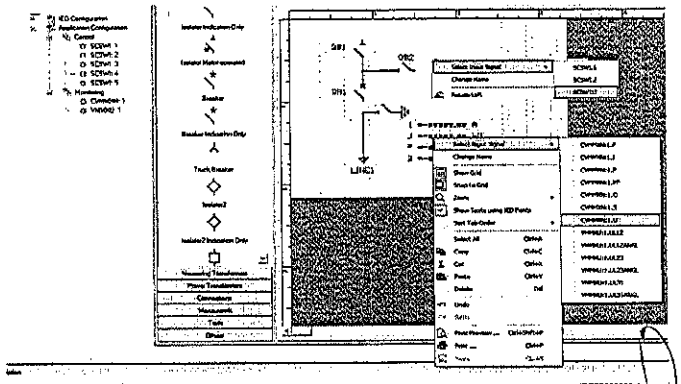


Figure 57: GDE: Establish a dynamic object link

Linking process objects

To describe a process object within an IED it needs to be established in the application configuration, configured when given with its parameters by PST and linked to be displayed in the HMI.

Three tools are involved for the described steps:

- ACT to program the application function block for apparatus and/or measurements.
- PST to adapt the settings and/or configuration parameter of the application function block.
- GDE to establish the link for updating the selected data attribute in the HMI of the application function block.

The following application function blocks are used to deliver the needed information:

- Switch controller (of type CSWI) for an apparatus.
- All configured function blocks with measurements (of type MMXU) for the measurements.
- VSGGIO for one bit indications for the dynamic text symbols.
- SLGGGIO for 32 bit indications for the dynamic text symbols.

Procedure

1. Right-click the apparatus symbol and select *Select Input Signal*. A list of engineered switch control application function blocks opens, see Figure 58.
2. Select the switch control application function block that corresponds to the selected apparatus.
3. Right-click the measurement symbol and select *Select Input Signal*. A list of the engineered measurement application function blocks opens.
4. Select the measurement application function block that corresponds to the selected symbol.

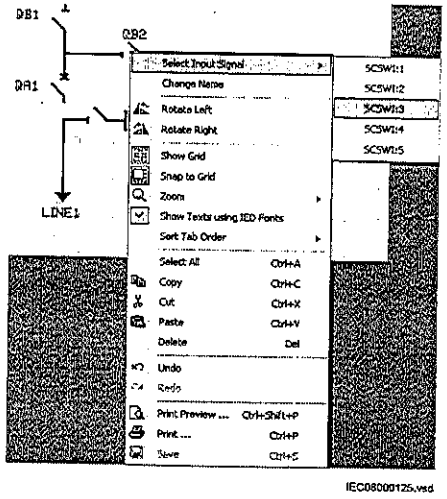


Figure 58: GDE: Input signal selection

The number of order in the selection window of the process objects corresponds to the number given in the PST tree and to the application function block in ACT.

Only those apparatus and measurements are shown that are configured in the application configuration program.

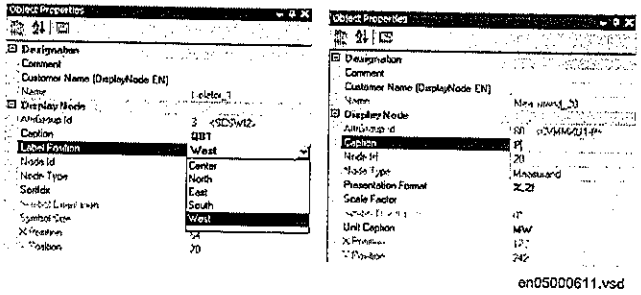


Figure 59: GDE: Object properties windows for text insertion

The single line diagram screen can display different values, with the help of the dynamic text fields. Please remember that these values are displayed by default in SI units (for example - active power is displayed in W). Modify the *Scale Factor* in the object properties (see Figure 60) to display values in more readable units (for example MW). Be sure to write the proper unit under the *Unit Text* field.

As the function delivers angles in radians, a scale factor of 180/pi = 57,3 shall be used to display the angle in degrees

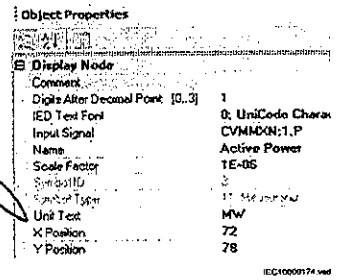


Figure 60: GDE: Object properties window for unit change

6.3 Events and indications

To get IED events to the LHMI event list and indications for *Ready*, *Start* and *Trip* indication LEDs, disturbance report needs to be engineered.

Detailed information about disturbance report subfunctions is found in the technical manual.

Section 7 IEC 61850 communication engineering

7.1 IEC 61850 interface in the IED and tools

For more information on the implementation of IEC 61850 standards in IEDs, see the IEC 61850 communication protocol manual.

7.1.1 Function view for IEC 61850 in PCM600

The IED function blocks have a design based on the demands and advantages of the IEC 61850 standard. This means that there is a strict relation between the function blocks and the logical node types. This relation is automatically handled by the PCM600 tools.

The concept in IED is such that the 61850 data for each function instantiated in ACT will be automatically created. This means that the user do not need to handle any instance information for the functions regarding IEC 61850.

7.1.2 IEC 61850 interface in IED

See Figure 61 for a principle view of the IEC 61850 logical node concept in the IED.

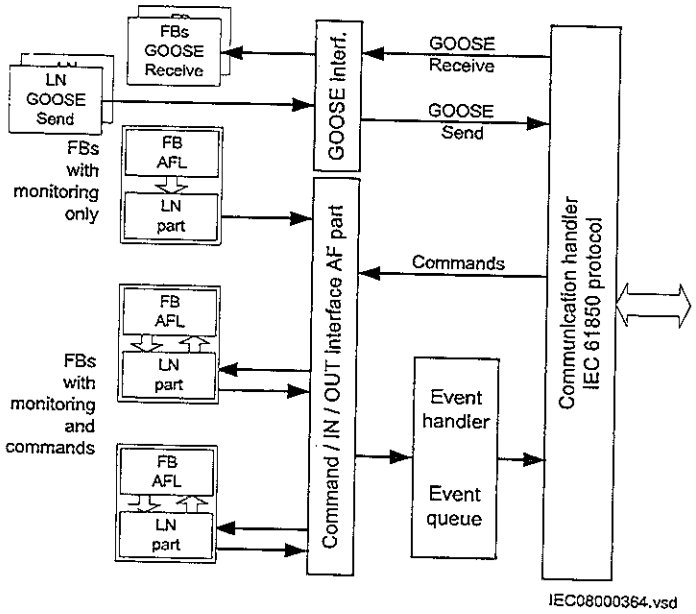


Figure 61: IEC 61850: Communication interface principle

IEC 61850 has as a concept for the identification of all signals for communication that belong to a function by a logical node as a placeholder. All signal information in command and monitoring direction, which belongs to a function, is available within the logical node.

Whenever a function block is instantiated in ACT, PCM600 automatically generates the corresponding logical node data. In Figure 61 this is shown by two parts per function block. The upper part is the visible function block in ACT and the lower part is the logical node data for the function block.

7.1.2.1 GOOSE data exchange

The IEC 61850 protocol supports a method to directly exchange data between two or more IEDs. This method is described in the IEC 61850–7–2 clause 15. The concept is based on sending a multicast over the Ethernet. Whoever needs the information detects the telegram by its source address and will read the telegram and deals with it. The telegrams are multicast sent and not acknowledged by the receiver.

For more details please refer to the IEC 61850 standards. In the following description it is assumed that PCM600 together with IET600 is used as system configuration tool.

A short form of a typical sequence is shown in Figure 63 when a complete station is exported as a SCD file.

1. Export SCL files from PCM600. In the scenario in Figure 63 it is a SCD file. Other SCL file types are possible to export.
2. Configure horizontal and vertical communication in the IET600 station configuration tool.
3. Import SCL files to PCM600 project. In the scenario in Figure 63 it is the updated SCD file.

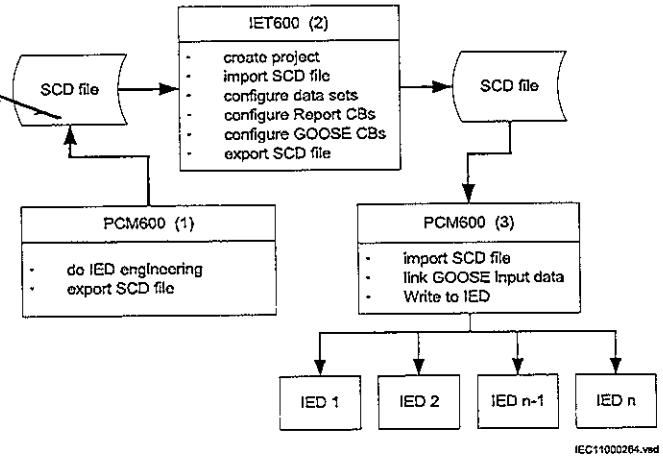


Figure 63: IEC 61850: Signal engineering procedure flow

7.3 Exporting SCL files from PCM600

A pre-condition is that all IEDs in the project must be engineered in PCM600. The hardware interface, for example the communication port, has to be selected and configured. The used interface addresses have to be set according to protocol and project definitions. The station communication port has to be activated in the IED, that is to set the IEC61850-8-1 *Operation* setting to *On*.

7.3.1 Exporting SCD files

Procedure to export the SCD file from PCM600:

1. Select the station in the plant structure, see Figure 64.

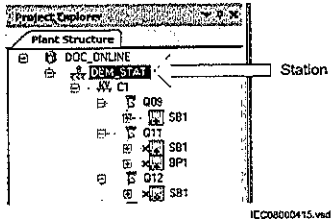


Figure 64: IEC 61850: Export SCD step 1

2. Right-click the station and select *Export ....*
3. Select a location from the open standard Windows menu to store the file and name it.
4. The *SCL Export Options* window opens, see Figure 65.

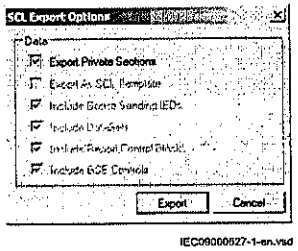


Figure 65: IEC 61850: SCL Export Options

5. Select *Export Private Sections* and click *Export* to export the private sections to the SCD file. A progress window shows the ongoing export of the station.

7.3.2 Exporting ICD or CID files

Procedure to select the export type, when the IED is selected in the plant structure:

1. Right-click the IED in the plant structure and select *Export* to open the *Export* window.
2. Select the type of file to export from the *Save as type* drop down list.

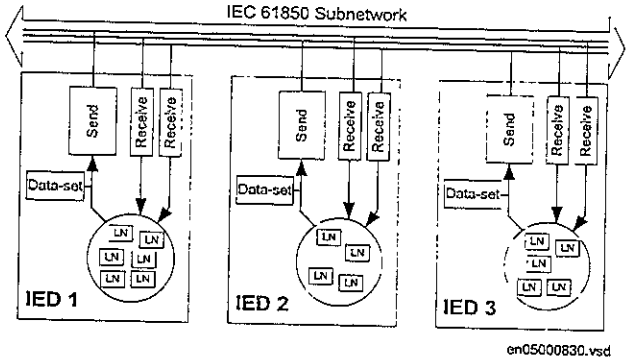


Figure 62: IEC 61850: Horizontal communication principle

Figure 62 shows an example with three IEDs where each one communicates with all the others.

When a GOOSE message is to be sent is defined by configuring the data set with the defined trigger option and the GOOSE control block (GoCB). This engineering process is done in the IET600 station configuration tool. The task involves configuring lists with the signal, value and quality (data attributes) that belong to the GOOSE message dataset.

In the opposite direction the standard only defines the IED as a receiver of the GOOSE message. How the GOOSE input signals are handled must be defined in the IED application configuration. The SCD file engineered by the IET600 station configuration tool contains these GOOSE data sets as input data. The input data must be connected to a GOOSE receive function block (GOOSEBINRCV, GOOSEINTLKRCV, GOOSESPRCV, GOOSEDPRCV, GOOSEINTRCV or GOOSEMVRCV) in SMT.

If the quality of the value is needed in the receiver IED, the quality must be included in the GOOSE data set. The receiver side will connect this automatically and if the quality is not in the data set, a warning message will occur in PCM.

7.1.3 Station configuration description file types

The IEC 61850 standard defines SCL-file types in the sequence of engineering. These files have a different definition, which is explained in IEC 61850-6. Three of these file types are used in the engineering process for an IED.

- ICD = IED Capability Description

The IED name in an exported .icd file is always named TEMPLATE.

  - Capability description of the IED in logical nodes and their data. No information about communication configuration, for example, is included.
  - An IED is already extended by default data sets. They are predefined by ABB. Changes or additional data sets, for example, have to be done with the IET600 station configuration tool.
- SCD = Station Configuration Description
  - Complete configuration description of all IEDs in a station and the full engineering of process signals and communication structure is included. This includes all needed data sets and all control blocks.
- CID = Configured IED Description
  - The CID file contains the information needed to configure just one specific IED.

The uploading of IEC 61850 communication configuration is not supported when reading a configuration from an online IED.

7.2 IEC 61850 engineering procedure

7.2.1 IEC 61850 protocol references and pre-conditions

To engineer the IEC 61850 protocol interface for the IED, the following additional manuals or knowledge of their contents is required.

- Knowledge of the IEC 61850 engineering process as described in the IEC 61850 standard.
- The Technical Manual describes function blocks defined as logical nodes.
- The IEC 61850 Communication Protocol Manual.
- The IEC 61850 conformance documents for the IED to be engineered.

7.2.2 Sequence for engineering of IEC 61850 protocol

The IEC 61850 standard defines the complete part needed for information communication in a substation. This can be split into the following parts:

- Description of the substation part including the used logical nodes
- Description of the IEDs with their logical nodes
- Description of the communication network
- Description of the engineering process

- Configured IED Description (*.cid) for the IEC 61850 structure as needed for the IED at runtime.
- IED Capability Description (*.icd) for the IEC 61850 structure, see Figure 66.

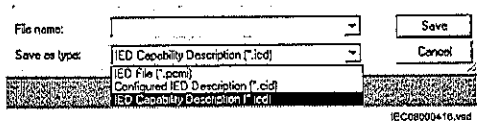


Figure 66: IEC 61850: Export IED file type selection

3. The *SCL Export Options* window opens.
4. Select *Export Private Sections*, *Export As SCL Template* or *Include Goose Sending IEDs* and click *Export*, see Figure 67. Note that the options in *SCL Export Options* window according to Figure 67 is only available when an ICD file is exported.

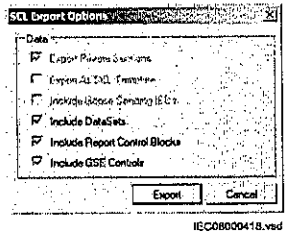


Figure 67: IEC 61850: Export IED file Options

7.4 Engineering of vertical and horizontal communication in IET600

For IEC 61850 engineering a separate system configuration tool is needed to be used with PCM600. In PCM600 Ver. 2.3 or earlier the recommended tool is CCT600. In PCM600 Ver. 2.4 or later the recommended tool is IET600, which is also included in the PCM600 Engineering Pro installation package. In PCM600 Ver. 2.5, a lot of engineering described below can be done in the PCM directly.

Procedure for signal engineering for the station by using IET600:

1. Create a project in IET600.
2. Import the SCD file exported from PCM600.

All data sets, report control blocks and GOOSE control blocks must be located at LD0/LLN0. Due to IED capability, there are limitations regarding the maximum number of data sets, number of entries in a data set and the number of report control blocks that can be used.

3. Add and/or reconfigure default data sets. The 650 series configured IED includes a number of predefined data sets, but it is possible to add additional data sets and/or reconfigure default data sets according to the requirements.

Note that reporting data sets shall only contain data intended to be used by clients, for example for event handling.

4. Configure report control blocks for each data set used for vertical communication. The 650 series configured IED includes a number of predefined report control blocks, but it is possible to add additional control blocks and/or reconfigure default control blocks according to the requirements.

Up to 8 report clients can be configured.

5. Connect the report control blocks to vertical IED clients. The report control blocks are connected to the vertical clients in the SCD file for a 650 series pre-configured IED. Check each IED client and configure them to the subnetwork before connecting report control blocks to the clients.
6. Create a GOOSE message data set for the sending IED. Define the content of the data set according to the requirements.

The data set for GOOSE may contain signals on data attribute level or on FCDA level. The latter is also called structured GOOSE.

Ensure that the same GoID is set for sending and receiving GOOSE messages.

Note that one data must only be included in one GOOSE data set. Data set for GOOSE can not be empty.

7. Create the GOOSE control block and connect it to the GOOSE message data set. Be sure to check the parameters for the GOOSE control block and update as required.
8. Connect the GOOSE control block to the client IEDs, subscribing for GOOSE.
9. Export the updated SCD file.

Please see the IET600 user manual for additional information about vertical and horizontal station communication engineering.

7.5 Importing SCL files to PCM600

The IED engineering tool must be able to receive a SCD file or an ICD file as import to receive the engineered communication extensions, for example for the different IEDs.

7.5.1 Importing SCD files

Procedure to import a SCD file to PCM600:

1. Select the station in the plant structure.
2. Right-click the station and select *Import* ...
3. Select the file to be imported from the open standard Windows menu and start the reading.
4. A *SCL Import Options* window opens, which queries how the file should be handled during import, see Figure 68.

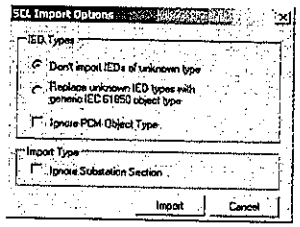


Figure 68: IEC 61850: Import SCD file

4.1. Click *Ignore Substation Section* to not import the "SSD-file" part of the SCD-file.
4.2. Click *Don't import IEDs of unknown type* to protect the existing IEDs in case the SCD file does not match the original configuration in PCM600.
4.3. Click *Replace unknown* ... can be used when it is known, that the file includes additional IEDs that are needed. The IED of type "Generic IEC 61850 IED" is used to integrate these kinds of IEDs in the plant structure etc.
4.4. Click *Ignore PCM Object Type* to update the IED object(s) in PCM600 from the IED type(s) in the SCD file, disregarding if the IED type(s) in the SCD file matches the IED object(s) in PM600 or not. (Can be used when

third party IED's are included in the SCD-file. For example sending GOOSE messages to ABB IED's included in the current project.)
4.5. Start *Import* when the file definition has been completed. A progress window presents the import procedure.

5. Make connections from sending IEDs to receiving function blocks in SMT.
5.1. Make connections between the signals that the server is sending and all the GOOSE receive interface function blocks included in the application configuration on the client's side.

If a client is defined for GOOSE receive then at least one cross in SMT is required to be able to write the configuration to the IED.

Be sure to set the setting *Operation* to *On* in PST for all included GOOSE receiving function blocks in the application configuration to enable GOOSE communication.

6. Write the configuration to the IED, see Figure 69.

Note that the engineered data is written to the IED when executing a common *Write to IED* operation.

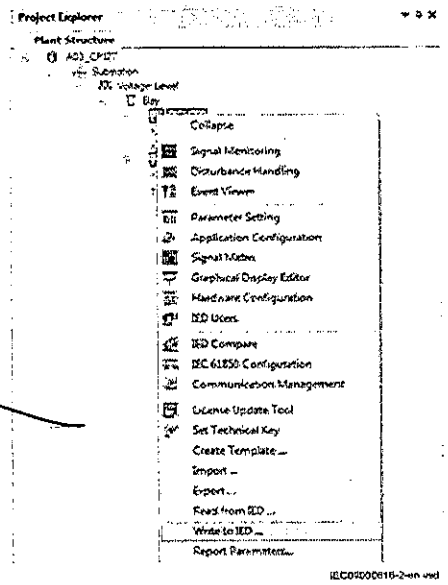


Figure 69: Common write menu

7.5.2 Importing ICD or CID files

Procedure to import a complete ICD file or CID file:

1. Select an existing IED to import IEC 61850 files.
2. Select the file type of IEC 61850 to import from the *Files of type* drop down list (ICD or CID)
3. The *SCL Import Option* menu opens, which queries how the file should be handled during import, see Figure 70.

3.1. Ignore *Substation Section* will not import the "SSD-file" part of the SCD-file.
3.2. *Don't import ...* protects the existing IEDs in case the SCD file does not match the original configuration in PCM600.
3.3. *Replace unknown ...* can be used when it is known that the file includes additional IEDs which are needed. The IED of type *Generic IEC 61850 IED* is used to integrate these kinds of IEDs in for example the plant structure.
3.4. Click *Ignore PCM Object Type* to update the IED object(s) in PCM600 from the IED type(s) in the SCD file, disregarding if the IED type(s) in the SCD file matches the IED object(s) in PM600 or not.
3.5. Start *Import* when the definition has been completed. A progress window presents the import procedure.

4.

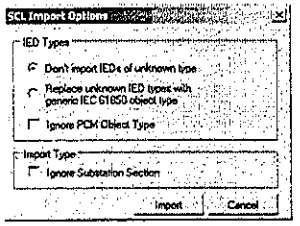


Figure 70: IEC 61850: SCL Import option

7.6 Writing communication configuration to IED

IEC communication depends on proper communication configuration in all IEDs that communicate via IEC 61850. It is not possible to read the communication configuration from the IED to PCM600.

However it is possible to make a configuration change in one IED, without affecting the communication engineering. For example, when the Application Configuration tool configuration is changed, but no changes are done for the instantiation or deletion of functions that represent a logical node.

When a changed configuration is written to the IED, the user is asked to update the communication configuration.

1. Select **Yes** in the **Update Communication** window to update the communication configuration part in the IED.
2. Click **No** in the **Update Communication** window to keep the communication configuration part in the IED. Other parts of the configuration will be updated.

If no changes have been done in the communication configuration part, click **No** in the **Update Communication** window.

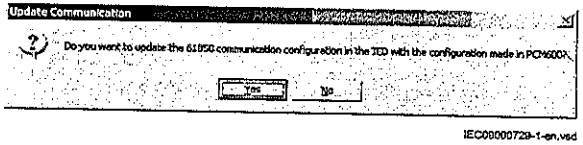


Figure 71: Update the communication configuration in the IED with the configuration made in PCM600

Section 8 IEC 60870-5-103 communication engineering

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, available in function RS485103 or OPTICAL103 depending on choice of serial interface, and time synchronization parameters in the Parameter Setting tool.

See the Communication protocol manual for IEC 60870-5-103 for more information about the IEC 60870-5-103 implementation in 650 series.

Both COM03 and COM05 modules are equipped with an optical serial and RS485 serial communication interface. IEC60870-5-103 can be communicated from either of these serial interfaces. The user must select in PST which interface to use.

8.1.1 Operation selection for RS485 and optical serial communication

Both COM03 and COM05 hardware modules are equipped with a serial optical and a RS485 communication interface. IEC 60870-5-103 can be configured to either of the two interfaces. Setting *ProtocolSel*, available in functions RS485PROT and OPTICALPROT, is used to select if IEC 60870-5-103 is communicated through the optical serial or the RS485 interface. The *ProtocolSel* setting is found under **Main menu/Configuration/Communication/Station communication/RS485 port/RS485PROT:1** for RS485 in local HMI and **Main menu/Configuration/Communication/Station communication/Optical serial port/OPTICALPROT:1** in local HMI for optical serial port.

The general communication settings for IEC 60870-5-103 optical serial communication is found in OPTICAL103 function under **Main menu/Configuration/Communication/Station communication/IEC60870-5-103/OPTICAL103:1** in local HMI.

The general communication settings for IEC 60870-5-103 serial communication for RS485 is found in RS485103 function under **Main menu/Configuration/Communication/Station communication/IEC60870-5-103/RS485103:1** in local HMI.

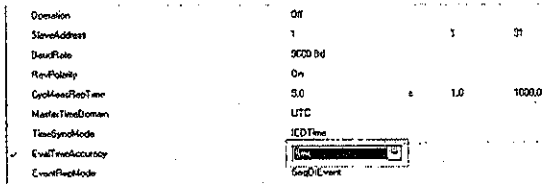


Figure 72: Settings for IEC 60870-5-103 communication

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 255. 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*: Setting for *CycMeasRepTime* must be coordinated with the *xDbRepInt* and *xAngDbRepInt* reporting setting on the MMXU measurement function blocks. See I103MEAS function block for more information.
- *EventRepMode*: Defines the mode for how events are reported. The event buffer size is 1000 events.

Section 9 DNP3 communication engineering

9.1 Signal configuration user information

Basic knowledge about DNP3 and the used definitions are required to use CMT. See the DNP3 communication protocol manual for information on the DNP3 implementation in the IED.

CMT is a part of PCM600 and allows to configure the signals that are used to communicate with clients or master units for DNP3 protocols.

On the left window CMT organizes all available signals from the application configuration in containers that are preselected as signal types.

On the right window CMT provides containers that are selected by tabs. Each container represents one communication channel. The number of possible communication channels is IED type dependent. The IED uses TCP/IP as communication channel. DNP3 can be tunneled over TCP/IP. Serial communication over RS485 or optical is supported. .

Use direction icons that are located between the windows to move all signals or a set of individual signals between the windows.

DNP3 signal types, index and default setting for classes are predefined in CMT. Adapt the signal configuration to project definitions. The signal type can not be modified due to the fact that the internal signal set up is fixed.

When the default configuration values are sufficient, the task is finished when all signal are moved according to the project requirements.

With the *Save* option, the signals are stored for the communication part of the IED according to the default selections.

Only for analog measurements additional configuration parameters are shown to do signal scaling to DNP3 protocol presentation. This can be done when the *Configuration Table View* is selected.

Finally, the signal configuration to the different DNP3 channels can be listed in a report on demand and per signal type.

9.2 Adding setting groups

In order to show for a DNP master which setting group is used, the following procedure can be performed.

In this example, only setting groups one and two are used. The DNP master will get two binary inputs: the first is set if setting group one is used, the second is set if setting group two is used.

1. Configure ACTVGRP (Basic IED functions) and SP16GGIO (Monitoring) with the Application Configuration Tool (ACT).

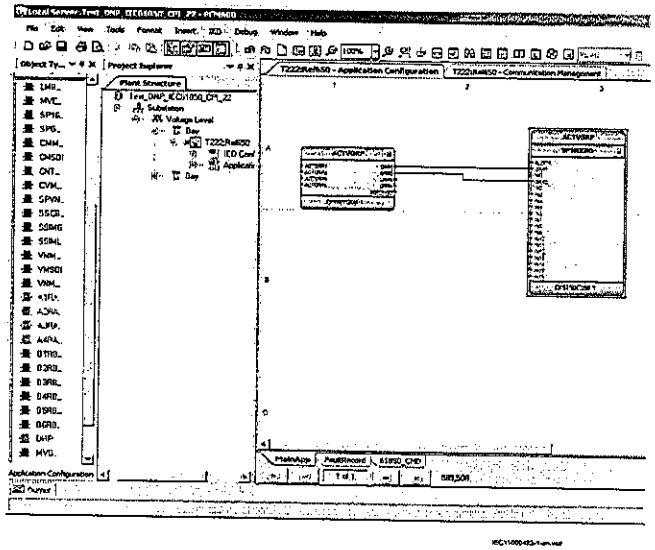


Figure 73: Application configuration tool

To make it easier to recognize the signals for the active setting group, the user-defined names are used.

2. Open the Communication Management Tool (CMT). Set the *Signal Type* to *Binary Input Object* and choose the connection of the master for which the values should be presented.

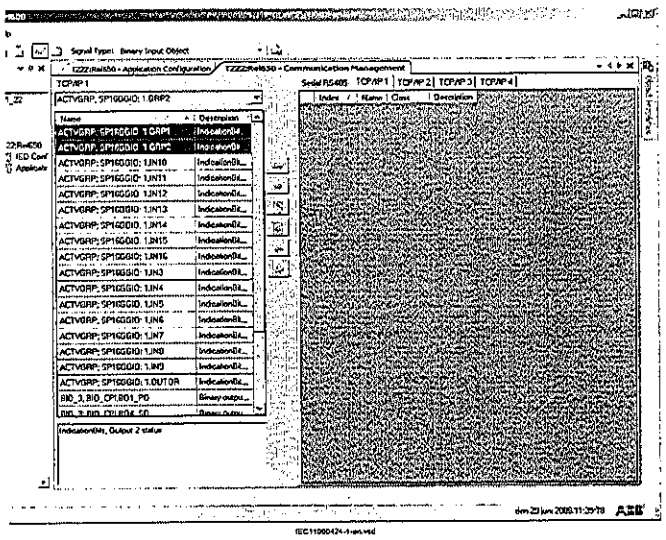


Figure 74: Communication Management tool

3. Select the signals and move them into the DNP signal list of the master. DNP point zero and one of the Binary Input Objects are used for indicating the active setting group in this case.

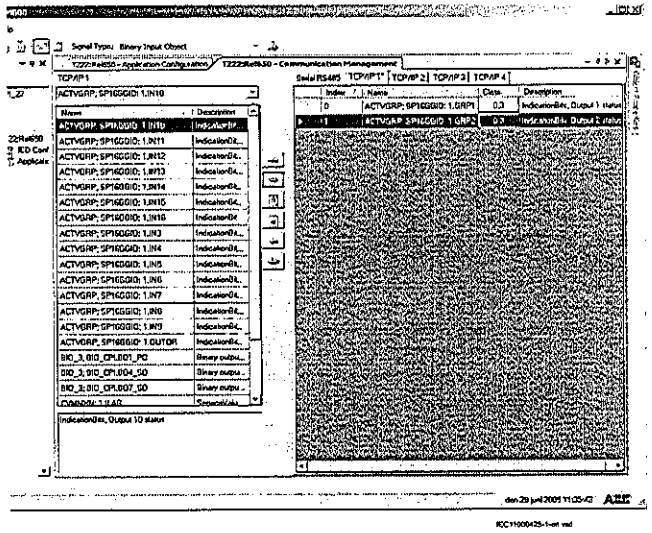


Figure 75: Selecting the signals into the DNP signal list

9.3 Configuring DNP3 protocol signals

1. Save the actual project configuration in PCM600 to make all signals visible for CMT.

Direct configured hardware channels in the application configuration (see Figure 76) appear in CMT (see Figure 77). Do not configure these hardware channels to be sent by DNP3, as they are not event-handled.

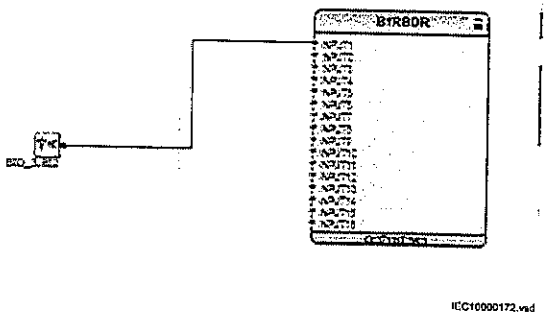


Figure 76: Configuring hardware channels directly to the function blocks

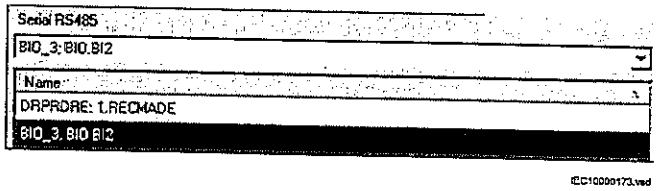


Figure 77: CMT: Hardware channels appearing in the Communication Management Tool

2. Right-click the IED in the plant structure and select *Communication Management* to start the Communication management tool.
3. Select the DNP3 protocol from the new window and click *OK*. Figure 78 presents the design of the two container windows, which open after the selection of DNP3.
   - The right window shows tabs for possible communication channels.
   - The left window has a drop down menu for signal selection and buttons for signal movement, see Figure 78.

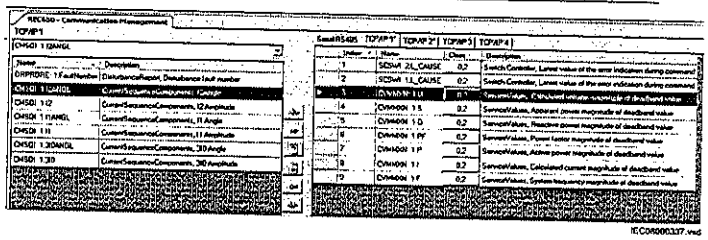


Figure 78: CMT: Container window design when selecting DNP3 protocol

Procedure to move signals:

1. Select one or several signals.
   - Click in the list of signals to select one signal.
   - Press *Shift* or *Ctrl* and several signals to select a set of signals.
   - Right-click in the list of signals, select *Select All* from the context menu or press *Ctrl+A* to select all signals.
2. Press the blue arrow button to insert the selected signals into the configuration.
3. Press the green double arrow button to insert all signals into the configuration, see Figure 79.

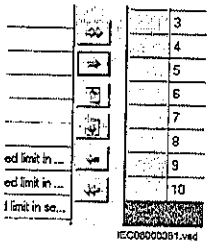


Figure 79: CMT: Move buttons

4. Click the drop down list *Signal Type:* to select the other signal types for this channel.
5. Repeat to move signals for all signal types and save the selection.

Content changes in the DNP3 container are marked with a star at the end of the name, see Figure 80. The star indicates that changes in the container have to be saved before leaving CMT.

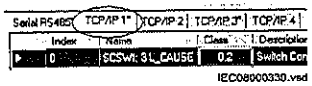


Figure 80: CMT: Marker to indicate changes in the container

9.4 Setting DNP3 signal parameters

Two parameters per signal can be set for all signal types:

- The index of the signal
- The class configuration

Procedure to set the index of the signal:

1. Click the two inner arrows to sort signals to another index sequence, or select *Set Index...* from the context menu to move one or a set of signals to another array, see Figure 81.

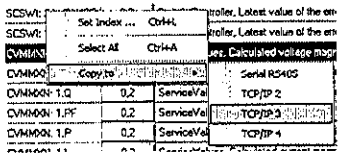


Figure 81: CMT: Context menu in DNP3 window

2. The selection window shows the number of signals selected, see Figure 82.

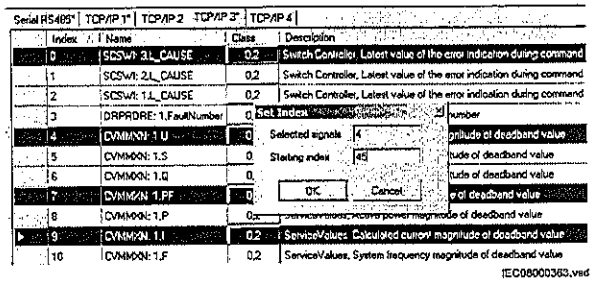


Figure 82: CMT: Set Index menu

3. Define the *Starting index* for this group and click *OK*.

Procedure to set class configuration:

1. Click in the class field of the signal to change the class configuration.
2. The *Select Class* window opens.
3. Make the selection according to the definitions in the project and click *OK* to close the window and get the new configuration, see Figure 83.

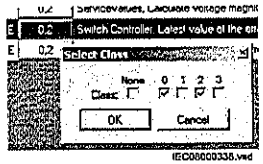


Figure 83: CMT: Select Class window

9.4.1 Configuring DNP3 class

In DNP3 the user classifies the signals and defines those signals that are not member of any class. CMT has a default predefined organization of classes per signal type. In the master station the classes can be polled in sequences according to the demands in the project. Unsolicited reporting is possible as well.

Modify the organization of the classes for each signal individually.

Procedure

1. Click in the *Class* field of the signal. A new window *Select Class* opens where the user classifies the signal.
2. Select the signal classes and choose between *None* and *0* to *3* according to the project demands.
3. Click *OK* to set the signal classification.
4. Write to IED.

9.4.2 Selecting to communicate DNP3 data via RS485 serial interface on COM03 or COM05 module

1. In PST, navigate to the *RS485PROT* function block located in **MainMenu/IEDConfiguration/Monitoring/RS485PROT:1**.
2. To enable the DNP3 protocol on the RS485 port, select *DNP* for setting *Operation*.
3. Navigate to the *MSTSERIAL* function block, located in **MainMenu/IEDConfiguration/Communication/DNP3.0/MSTSERIAL:1** and set *ChToAssociate* to *RS485*.

See DNP3 Communication protocol manual, chapter DNP3 parameters, for more detailed information.

9.4.2.1 RS485 specific parameters

There are a few parameters that are specific to RS485 and are separated from the protocols. This makes it possible to run RS485 hardware without defining any protocols. This enables the IED to operate correctly in a ring topology even if no protocols are configured to run.

9.4.3 Selecting to communicate DNP3 data via optical serial interface on COM03 or COM05 module

1. In PST, navigate to the *OPTICALPROT* function block located in **MainMenu/IEDConfiguration/Monitoring/OPTICALPROT:1**.
2. To enable the DNP3 protocol on optical serial port, select *DNP* for setting *Operation*.
3. Navigate to the *MSTSERIAL* function block, located in **MainMenu/IEDConfiguration/Communication/DNP3.0/MSTSERIAL:1**, and set *ChToAssociate* to *Optical*.

See DNP3 Communication protocol manual, chapter DNP3 parameters, for more detailed information.

Section 10 Glossary

AC	Alternating current
ACC	Actual channel
ACT	Application configuration tool within PCM600
A/D converter	Analog-to-digital converter
ADBS	Amplitude deadband supervision
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
BOS	Binary outputs status
BR	External bistable relay
BS	British Standards
CB	Circuit breaker
CCITT	Consultative Committee for International Telegraph and Telephony. A United Nations-sponsored standards body within the International Telecommunications Union.
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
COMTRADE	Standard format according to IEC 60255-24
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	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
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
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
FTP	File Transfer Protocal
FUN	Function type
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
GSE	Generic substation event
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 61869-2	IEC Standard, Instrument transformers
IEC 60870-5-103	Communication standard for protective 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
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 standard
IP 20	Ingression protection, according to IEC standard, level 20
IP 40	Ingression protection, according to IEC standard, level 40
IP 54	Ingression protection, according to IEC standard, 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
LCD	Liquid crystal display
LDD	Local detection device
LED	Light-emitting diode
LNT	LON network tool
MCB	Miniature circuit breaker
MVAL	Value of measurement
NCC	National Control Centre
NOF	Number of grid faults
NUM	Numerical module
OCO cycle	Open-close-open cycle
OCP	Overcurrent protection

OLTC	On-load tap changer
OTEV	Disturbance data recording initiated by other event than start/pick-up
OV	Over-voltage
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
PCM600	Protection and control IED manager
PC-MIP	Mezzanine card standard
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
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

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, 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
TLS	Transport Layer Security
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
$3I_0$	Three times zero-sequence current. Often referred to as the residual or the earth-fault current
$3U_0$	Three times the zero sequence voltage. Often referred to as the residual voltage or the neutral point voltage

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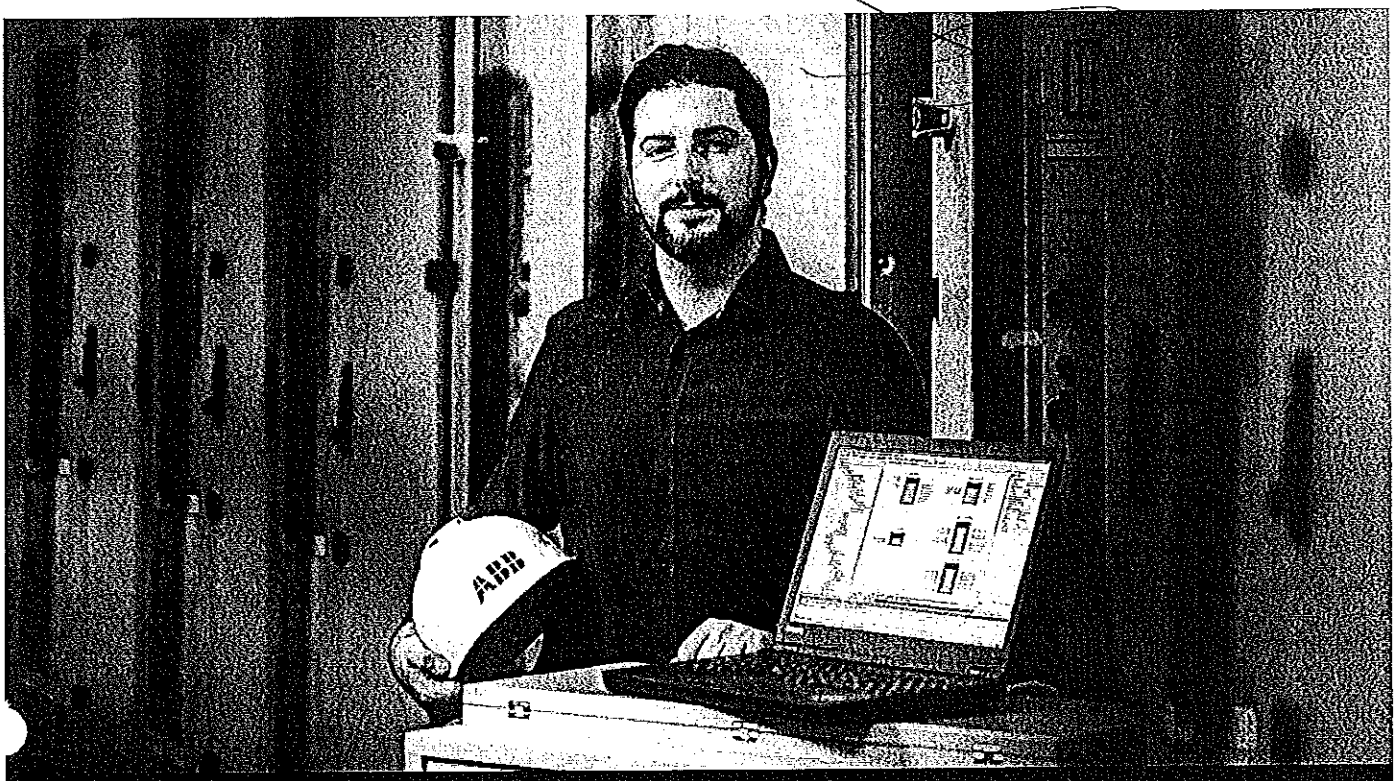


Protection and Control IED Manager PCM600 Product Guide

Power and productivity for a better world™

ABB

689

Contents

690

1. Description

The Protection and Control IED Manager PCM600 tool provides versatile functionalities for the entire life-cycle of all Relion® protection and control IED applications, at all voltage levels. This easy-to-handle tool helps the user to manage your protection and control equipment all the way from application and communication configuration to disturbance handling, including automatic disturbance reporting.

Designed to communicate, PCM600 interacts with intelligent electronic devices (IEDs) over the fast and reliable TCP/IP via corporate LAN or WAN, or alternatively directly through the communication port at the front of the IED. PCM600 tool is able to read and write all configuration and setting data of an IED with a single command.

The user interface, workflow and the IEC 61850-based data model in PCM600 are designed according to the same philosophy as the Relion® protection and control IEDs, ensuring smooth and seamless integration between the tool and the IEDs.

PCM600 has been designed from the beginning with the IEC 61850 standard in mind. All the functionality is modeled in a way that it reflects the IEC 61850 configuration directly during the engineering. Multivendor product and system interoperability is guaranteed with an independently verified IEC 61850 Edition 2 certificate.

PCM600 also secures the projects and data created with earlier versions of the PCM600 tool, which enables full backwards compatibility.

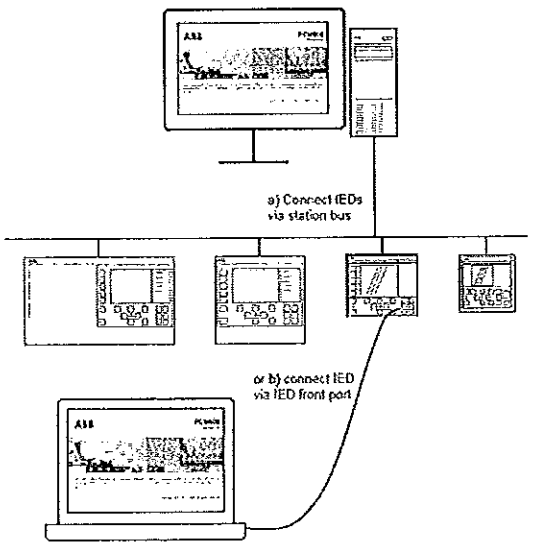


Figure 1. PCM600 connected locally or remotely to IEDs

2. Project explorer

The project explorer can be used to navigate to the used IEDs within a project / substation and furthermore within an IED to navigate to the different functionality of an IED. The user is able to create a plant structure with a substation, voltage levels, bays and IEDs.

New IEDs can also be created by use of IED templates. This enables the reuse of existing IED configurations. IEDs, bays, voltage levels or a whole substation can be copied and pasted in the plant structure. Selection of a specific IED in the project explorer gives access to the IED's tools. The function of importing and exporting descriptions of IEC 61850 substation configurations, configured devices and device functionality allows information to be shared with other engineering and system integration tools. By using the filtering feature of the project explorer the user can filter information of other tools according to the selection made.

3. Parameter setting

The parameter setting of PCM600 enables viewing and setting IED parameters offline (stored in the tool) and online (stored in both the tool and the IED). The parameters can be read from the IED to PCM600 or written from PCM600 to the IED while the IED is in service. In addition, the parameters can be exported and imported for test sets in the XRIO format (for example, Omicron Test Universe) or in the CSV format to be easily read and reused.

The parameter setting function can be used in two different modes. The normal mode allows a quick viewing and changing of the most commonly used parameters, whereas the advanced mode unveils all parameters that can be set.

PCM600 further offers a filtering function that allows the viewing of all IED parameters or the parameters related to a specific function block. In addition, it can be chosen to only view parameters that have been changed or parameters with values deviating from the IED's setting. Changed parameters with different values in the tool and in the IED are clearly indicated.

691

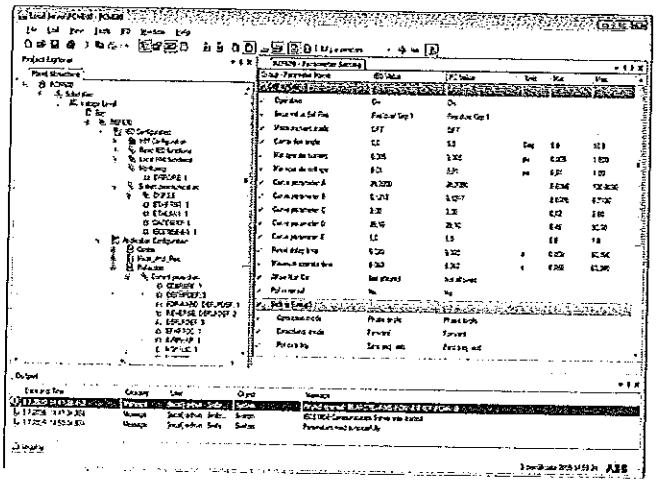


Figure 2. Parameter setting view

The graphical representation of the distance protection function supports in the visual verification of the parameter setting of the distance protection function.

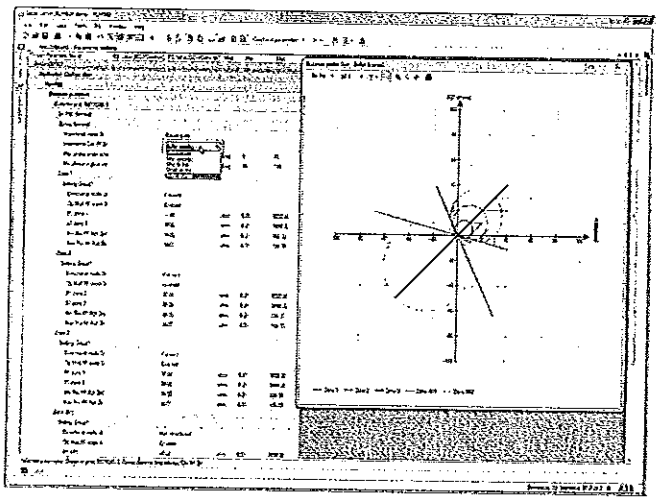


Figure 3. Graphical representation of the distance protection function

4. Graphical application configuration

The graphical application configuration functionality offers powerful ways to create, adapt and modify application configurations, which also can be made as templates for later re-use. PCM600 also enables presentation of the whole signal flow from input to output. It also assists the user during the creation of application configuration through colour indications of the function blocks to ensure that the mandatory inputs have been correctly connected. Before writing the configuration to an IED, the tool offers validation of the complete IED configuration which ensures that the configuration does not contain errors.

Additionally, the user can compare the configuration in the tool to the one in the IED. Further, the signal status on-line monitoring functionality helps to verify the real-time processes in the IED, which is extremely useful for troubleshooting.

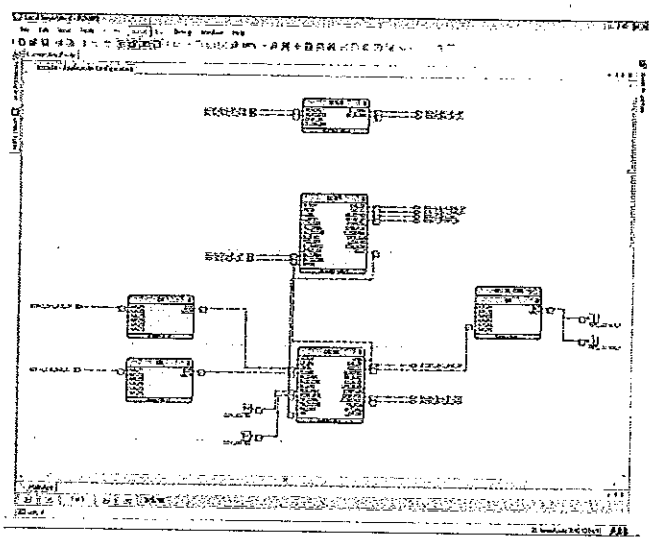


Figure 4. Application configuration, Online monitoring

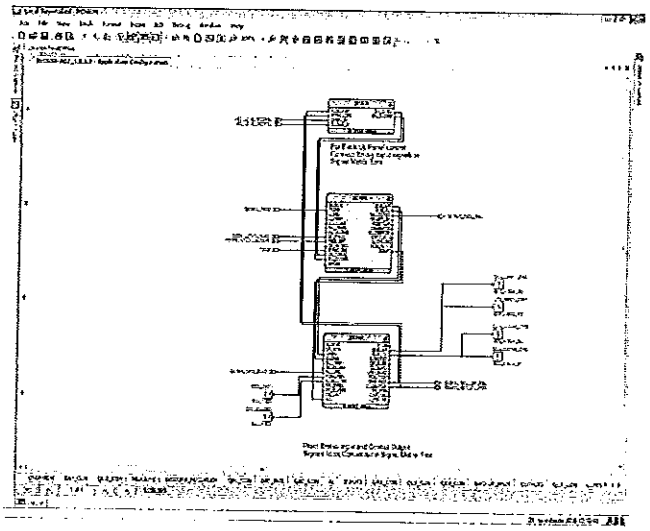


Figure 5. Application configuration, visual indication of the configuration

5. Signal matrix

The graphical signal matrix of PCM600 allows connecting efficiently CTs, VTs, binary input and output signals to the configuration. The configuration can also be changed from here. The tool can also be used for connecting the LEDs on the IED as well as for connection of the GOOSE signals between the IEDs.

Once the IEDs have been configured and parameterized, PCM600 enables the configuration of the horizontal bay-to-bay communication for station-wide interlocking and sends the complete IED description to a system engineering tool.

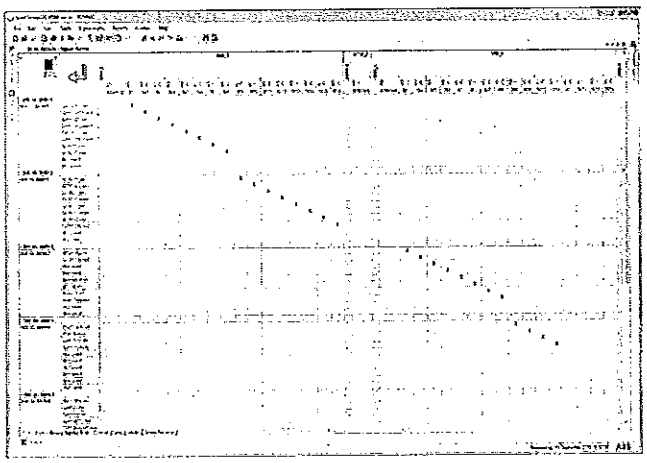


Figure 6. Signal matrix tool view

6. Graphical display editor

The graphical display editor is used for configuring the display of an IED. The graphical display consists of one or more pages. A display page contains the drawing area where the actual display configuration is made. A display is configured by dragging predefined graphical symbols from a library to the drawing area. The directed link tool can be used to draw connections between symbols. Every symbol type has a corresponding representation in both the ANSI and the IEC symbol palettes. Symbols can be connected to the application configuration.

The graphical display editor also supports the reuse of display page templates made for other IEDs.

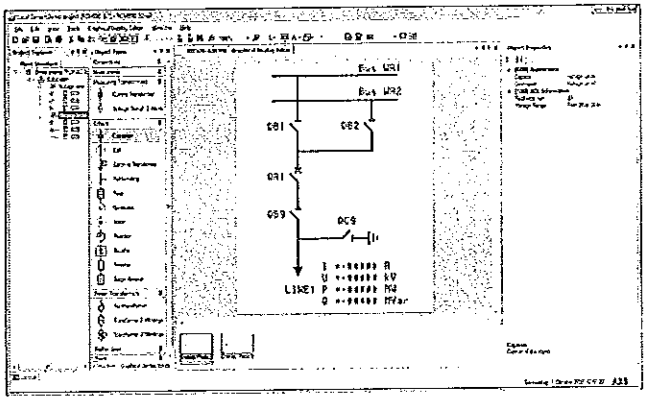


Figure 7. Graphical display editor, configuring the display of an IED

7. Hardware configuration

The hardware configuration can be used to get a quick overview of an IED and to add or change hardware modules. It is possible to view the front and back of the IED including card information and their slot position. Furthermore it is possible to compare the hardware configuration used in the tool to the actual one in the IED.

8. IED configuration comparison

IED comparison is used for comparing configurations of two IEDs of the same kind. Comparison can be made offline regardless of the IEDs being in the same PCM600 project or not. Additionally, the configuration of an IED can be compared to a loose PCMI file. When connected to the IED, it is possible to compare the configurations between the IED and the PCM600 online. A report of the differences between the two different IED configurations is provided as a result of the comparison.

9. IED summary

IED summary functionality can be used to document and view a quick snapshot of all the protection and control IEDs on the substation. PCM600 can collect all the important identification information from the IEDs and illustrate them in a user-friendly browser. IED summary result can be printed for documentation directly from the tool.

10. Signal monitoring

The signal monitoring function provides the user with online information about the measured values and displays the status of binary input and output signals of an IED. Furthermore, PCM600 facilitates commissioning and testing of physical connections via the signal monitoring tool (forcing of signals).

11. Event viewer

The event viewer of PCM600 enables viewing the IED sequence of events information including timestamps. The event log facilitates detailed post-fault analyses of faults and disturbances. Event viewer additionally enables reading the security events from the IED.

12. Disturbance handling

PCM600 offers effective handling and monitoring of disturbance records from the IEDs. The disturbance files stored in the standard COMTRADE format allow the user to view the disturbance record using Wavewin™ software or any commercially available disturbance analyzer supporting the COMTRADE format. If required, the report layout and contents can be adapted to user-specific needs.

By means of the task scheduler of PCM600, the records can be set to be automatically read from the IED. The task scheduler is an independent process and does not require PCM600 to be activated. After receiving the file, PCM600 automatically creates a disturbance report, which can immediately be forwarded to subscribers by e-mail. Such a notification shortens the time from disturbance detection to corrective action.

13. Communication management

The Communication Management tool is used to configure different communication protocols for an IED. DNP3, IEC 60870-5-101/103/104 or Modbus® are the communication protocols that can be engineered. Depending on the used protocol, the tool provides different views and capabilities to support in the selection or mapping of communication signals.

14. IEC 61850 configuration

The IEC 61850 configuration tool of PCM600 provides the viewing or engineering of the dataset and dataflow configuration for a vertical or horizontal IEC 61850 communication.

In the view mode, the tool supports the viewing of the IEC 61850 configuration, whereas in the engineering mode it is possible to configure IEC 61850 datasets and dataflow for the horizontal and vertical communication.

Table 1. Recommendations for using the IEC 61850 configuration tools

	IEC 61850 tools in a Substation automation system (SAS)	
	No external tool	IET600 or 3rd party system tool
ABB Relion IEDs	Engineering mode 1)	View mode 2)
ABB and 3rd party IEDs	View mode 2)	View mode 2)

1) Engineering mode of IEC 61850 configuration tool of PCM600 is recommended for simple applications. Advanced applications require an IEC 61850 system tool like IET600 and view mode.
2) View mode of IEC 61850 configuration tool of PCM600 for the transparency of IEC 61850 configuration made by an external IEC 61850 system tool like IET600.

15. Connectivity packages

PCM600 incorporates ABB's connectivity package concept, which simplifies protection engineering and reduces the risk of errors. The connectivity packages can be downloaded and installed using the PCM600 Update Manager tool. Furthermore, the IED connectivity packages for the 670 and 650 series are also available on a separate IED Connectivity Package DVD that is delivered with the IEDs, whereas the IED connectivity packages for the 630, 620, 615, 611 and 610 series, RIO600, SAM600, REX521, RE_54_, SPACOM and REF 542plus can be downloaded from the www.abb.com/substationautomation portal.

16. User management

PCM600 tool supports access management both for the tool and the IEDs. The user accounts in PCM600 can be linked to Windows user accounts or be defined as separate user accounts for PCM600. The user management feature allows the administrator to create user groups with different access rights and profiles.

The access management for the IEDs can be enabled or disabled with the IED user management tool in PCM600. PCM600 also includes functionality to activate central account management on IEDs, and manage certificates on the IEDs.

17. Project configuration data management

PCM600 offers functionality for managing configuration data of projects. Complete substation configurations can be exported and imported for long term archiving or for sharing between different engineers. All the configuration data on a workstation can be backed up with a simple manual operation or as scheduled automatic backup functionality.

18. Integrated help menus

All the necessary instructions for using the tool are integrated in PCM600. Context sensitive help menus and tool tips provide the user with information about the selected tools. The IED documentation and guides available from the connectivity package can be directly accessed from the help menus.

694

19. Data transfer

PCM600 offers improved data transfer between the IEDs and the IED management tool. The IEDs can be accessed remotely using the TCP/IP protocol via a local area network (LAN) and standard Ethernet cables, a secured wide area network (WAN), a secured wireless network (WLAN) or, locally, using the IEDs' front communication port.

20. System requirements

Table 2. Hardware requirements

Hardware	Minimum	Recommended
CPU	1.5 GHz	2.4 GHz
RAM	2 GB	4 GB
Free hard disk space	4 GB	8 GB
Monitor	1024 × 768	1280 × 1024
Ethernet port	Required	Required

Table 3. Supported operating systems

Operating system	Version
Microsoft Windows Server 2008 R2 (64-bit)	-
Microsoft Windows Server 2012 R2 (64-bit)	-
Microsoft Windows Vista (32-bit)	SP2
Microsoft Windows 7 (32-bit/64-bit)	SP1
Microsoft Windows 8 (32-bit/64-bit)	-
Microsoft Windows 8.1 (32-bit/64-bit)	-
Windows 10 (32-bit/64-bit)	-

Table 4. Communication

Protocols
TCP/IP via LAN or WLAN
Serial Port (RS-232) or USB/RS-232 converter if SPA-based communication is used
Opto/electrical (RS-232) cable for front communication if SPA-based communication is used

21. Ordering data

To order the protection and control IED manager PCM600, use the ordering data in the ordering code table.

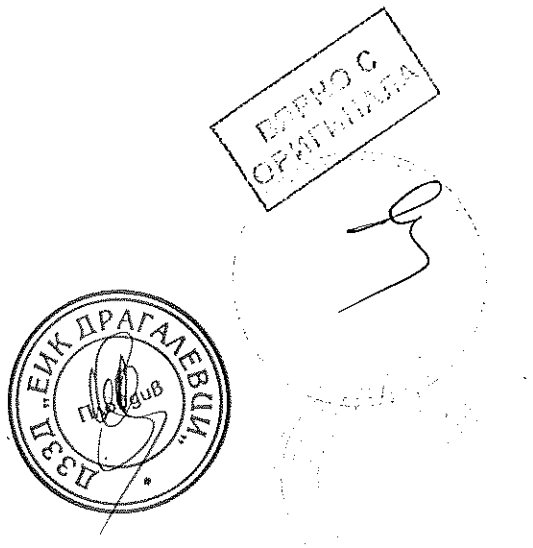
Table 5. Ordering code

Product name	Order code
PCM600 2.8	PCM600-28

695

22. Document revision history

Document revision/date	Product version	History
A/2007-12-20	2.0	First release
B/2008-05-30	2.0 SP1	Content updated
C/2009-03-03	2.0 SP2	Content updated
D/2009-07-06	2.1	Content updated to correspond to the product version
E/2009-11-23	2.2	Content updated to correspond to the product version
F/2010-05-28	2.3	Content updated to correspond to the product version
G/2011-04-08	2.4	Content updated to correspond to the product version
H/2013-01-10	2.5	Content updated to correspond to the product version
K/2013-12-10	2.6	Content updated to correspond to the product version
L/2015-11-20	2.7	Content updated to correspond to the product version
M/2016-09-29	2.8	Content updated to correspond to the product version



696

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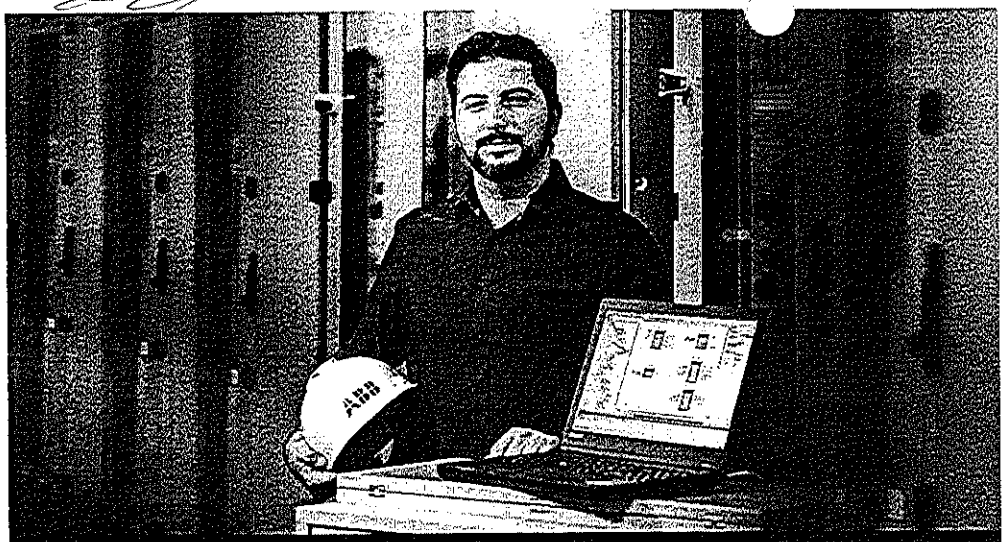

Protection and Control IED Manager PCM600 Getting Started Guide

Power and productivity for a better world™

ABB

Document ID: 1MRS757866
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Revision: B
Product version: 2.8

Copyright

Trademarks

Warranty

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

www.abb.com/substationautomation

Disclaimer

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.

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Table of contents

Section 1 Introduction

1.1 This manual

The getting started guide provides basic instructions on how to use PCM600. The manual provides instructions for typical use cases in operation and field, as well as for use cases in engineering and commissioning. The purpose of the manual is to describe the PCM600 tool functionality, and it can be seen as a complementary manual to the application-related instructions, such as the relay-specific operation or engineering manuals.

1.2 Intended audience

This manual addresses new users as well as not frequent users of PCM600, providing an easy start or refresh on using the tool. By presenting the typical PCM600 use cases, this manual offers quick assistance to operators and field personnel as well as engineering and commissioning personnel.

1.3 Product documentation

1.3.1 Product documentation set

The cyber security deployment guideline describes the process for handling cyber security when engineering and monitoring protection and control IEDs. The cyber security deployment guideline provides information on how to secure the engineering environment on which the IED is installed. The guideline can be used as a technical reference during the engineering phase, installation and commissioning phase, and during normal service. See also all IED-related cyber security deployment guidelines.

The getting started guide provides basic instructions on how to use PCM600. The manual provides instructions for typical use cases in operation and field, as well as for use cases in engineering and commissioning. The purpose of the manual is to describe the PCM600 tool functionality, and it can be seen as a complementary manual to the application-related instructions, such as the relay-specific operation or engineering manuals.

The online help contains instructions on how to use the software.

1.3.2 Document revision history

Document revision/date	Product version	History
A/2013-04-11	2.5	First release
B/2016-09-29	2.8	Content updated

1.3.3 Related documentation

Name of the document	Document ID
PCM600 Online Help	Available as online help in PCM600

1.3.4 Symbols and conventions

1.3.4.1 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.

Operation of damaged equipment could, under certain operational conditions, result in degraded process performance leading to information or property loss. Therefore, comply fully with all notices.

1.3.4.2 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**.
- Menu, tab, button, list and box names as well as window or dialog box titles are presented in bold.
  On the **File** menu, click **New Project**.
  Right-click the **MainApp** tab and select **Copy** from the shortcut menu.

Click **OK** to start the comparing.

- Shortcut keys are presented in uppercase letters.
  A page can also be added pressing the shortcut keys CTRL+SHIFT+P.
- Command prompt commands are shown in Courier font.
  Type `ping <devices_IP_address>/t` and wait for at least one minute to see if there are any communication breaks.

Section 2 Overview

2.1 Protection and Control IED Manager PCM600

PCM600 provides versatile functionalities for the entire life cycle of the protection and control IEDs in transmission and distribution applications.

- Planning
- Engineering
- Commissioning
- Operation and disturbance handling
- Functional analysis

With the individual tool components, it is possible to perform different tasks and functions and control the whole substation.

PCM600 is compliant with IEC 61850, which simplifies the IED engineering and enables information exchange with other IEC 61850 compliant tools. The hierarchical presentation model that reflects the real system topology enables efficient viewing and editing of the power system information.

Some features and functions are product-specific and not available for all the products.

2.1.1 User interface

The initial view of the PCM600 interface is divided into different windows.

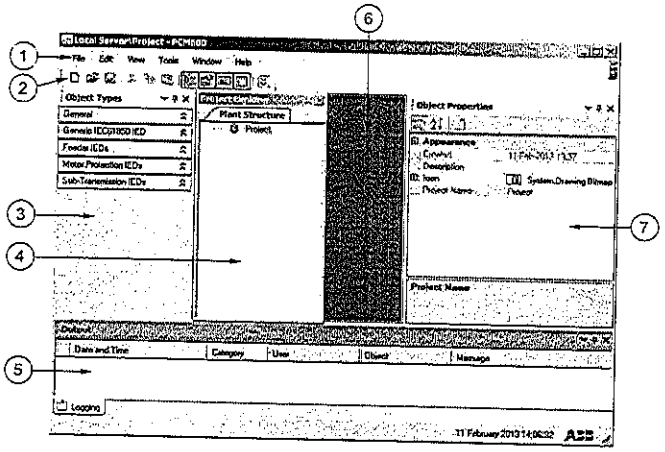


Figure 1: PCM600 interface

1 Menu bar
2 Toolbar
3 Object Types window
4 Project Explorer window
5 Output window
6 Tool window
7 Object Properties window

The menu bar and toolbar contents vary depending on the active object and tool.

The **Object Types** window shows all the available objects for the selected IED. The object list content depends on the IED type and the related connectivity package. Before the objects are shown on the list, the objects must be imported from the connectivity package to PCM600 by using Upload Manager.

The **Project Explorer** window is used to navigate to the used IEDs within a project/ substation and to different functions within an IED. A plant structure with a substation, voltage levels, bays and IEDs can be created in **Project Explorer**. All the configuration work, such as communication configuration, can be done via this structure by using the configuration wizard.

The tool window is the working space, where all the tools are opened.

The **Object Properties** window shows the properties of the selected object. The name of the object can be changed in this window.

The **Output** window shows log information about the PCM600 events.

2.1.2 Tool components

The availability of the tool components depends on the selected IED and the installed connectivity packages.

Table 1: Tool components in PCM600

Tool component	Description
Update Manager	Update Manager is used for downloading updates and managing the current installation of PCM600 and connectivity packages.
Project Explorer	Project Explorer is used for navigating, creating a plant structure, importing and exporting IED configurations, accessing and filtering the content of other tool components.
(Graphical) Application Configuration	Application Configuration is used for configuring the IEDs.
Parameter Setting	Parameter Setting is used for parameterizing the IEDs and viewing the parameter data for the selected node.
Signal Matrix	Signal Matrix is used to create connections between source and target objects in an IED configuration.
Signal Monitoring	Signal Monitoring is used for monitoring online the measured values and the status of the binary input and output signals of an IED and for commissioning and testing physical connections.
Disturbance Handling	Disturbance Handling is used for uploading and processing the disturbance files located in a specific IED, for viewing and processing the disturbance recording data and creating reports.
Event Viewer	Event Viewer displays the actual events stored in an IED.
Graphical Display Editor	Graphical Display Editor is used for configuring the graphical display of an IED.
Hardware Configuration	Hardware Configuration is used for viewing, adding and changing the hardware modules of an IED and for troubleshooting the IED hardware configuration.
Communication Management	Communication Management is used for configuring communication protocols for an IED and for mapping IED signals and outputs.
IEC 61850 Configuration	IEC 61850 Configuration is used for viewing the IEC 61850 data flow configuration and for engineering the dataflow between the IEDs and IEC 61850 clients.
IED Compare	IED Compare is used for comparing the IED configuration of two same type of IEDs.

2.2 Connectivity packages

A connectivity package is a software component that enables PCM600 or other ABB tools to communicate with an IED. It includes all the data used to describe the IED, for example, a list of the existing parameters, the data format used, the units, the setting range, the access rights and visibility of the parameter.

Connectivity packages are downloaded via PCM600 Update Manager, and their content depends on the functions supported by the IED.

2.2.1 Tool components in connectivity packages

Two types of tools are available for performing tasks and functions in a PCM600 project.

- PCM600 tools
- IED specific tools included in the connectivity packages

The PCM600 tool documentation is included in the PCM600 online help. The IED specific tool documentation is included in the related IED documentation.

Some features and functions are product-specific and not available for all the products.

2.3 PCM600 and IED connectivity package compatibility

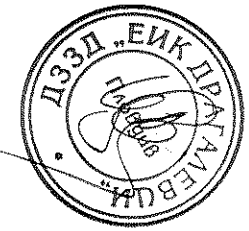
It is recommended to use the latest version of PCM600 and the latest version of the connectivity package available in Update Manager. More information on the compatibility between the versions of the IED, connectivity package and PCM600 is found in the IED documentation.

Section 3 Getting started

3.1 Installing PCM600

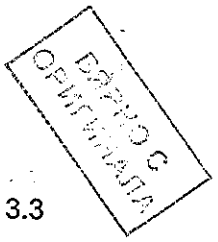
Download PCM600 from ABB Software Library and install the software following the instruction in the installation wizard. PCM600 is also available on CD.

3.2 Using Update Manager

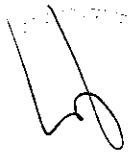


Update Manager is used for managing the current installation of PCM600 and connectivity packages, for notifying about available updates and for downloading the updates.

1. On the taskbar, click the **Start** button, and point to **All Programs**, point to **ABB**, and then click **Update Manager**.
2. From the list in the upper left corner, select the content to be shown in the **Update Manager** window.
   - Select **Manage Connectivity Packages** to display the current configuration of PCM600 and select the connectivity packages to be used.
   - Select **Software Updates** to display updates like PCM600 product updates, connectivity packages and other general updates like add-ons, service packs and hotfixes. Download and install the needed updates.
   - Select **Export Software Packages** to display all the available PCM600 add-ons, hotfixes and connectivity packages. From this view it is possible to download the needed updates and export to another location/removable disk.
3. Click **Close** to close Update Manager.



3.3 Installing connectivity packages



1. Download the connectivity package using Update Manager.
2. When the download is completed, click the **Install** button to start the installation.
3. Follow the steps in the installation wizard to install the connectivity package. If the **Download and Install** option is used, Update Manager will first download all the selected packages and then automatically install all of them.
4. Restart PCM600.

The directory where Update Manager downloads all the packages can be defined in the Settings view. Note that the connectivity packages are still installed on the Program Files directory on the same drive where Windows is installed. The installer needs to be run manually, if the connectivity packages need to be installed on some other directory.

3.4 Activating connectivity packages

The latest connectivity package is activated automatically by default. If wanted, older connectivity packages can also be activated in Update Manager. It is recommended to use the latest version of the connectivity package. The latest PCM600 and connectivity packages are backward compatible with older IED versions.

1. On the taskbar, click the **Start** button, and point to **All Programs**, point to **ABB**, and then click **Update Manager**.
2. Select **Manage Connectivity Packages** from the left navigation bar.
3. Under the tool version to be configured, select the connectivity package version to be used and click **Close**.
4. Restart PCM600.
   Restart is required to initialize the activated connectivity packages.

3.5 Downloading IED preconfigurations and documentation

Preconfigurations are available for some of the IED series. For downloading the preconfigurations, see the IED-specific documentation. The preconfiguration .pcmi files are available on the connectivity package DVD under the user documentation folder, or the files can be downloaded by using the Update Manager.

Enabling preconfiguration and documentation downloading can be done on the Settings view of Update Manager.

1. On the taskbar, click the **Start** button, and point to **All Programs**, point to **ABB**, and then click **Update Manager**.
2. Click **Settings** in the left navigation bar.
3. Check the documentation and preconfiguration options.
   Available documentation and preconfiguration packages are now available on **Software Updates** view.
4. To view the documentation for the IED, right-click the IED in **Plant Structure** and point to **Documentation**. Select the needed document from the list.

3.6 Installing language add-on packages

Install both the language add-ons for PCM600 and the language add-ons for the IED connectivity packages.

1. On the taskbar, click the **Start** button, and point to **All Programs**, point to **ABB**, and then click **Update Manager**.
2. Click **Settings** in the left navigation bar to enable the preferred languages.
3. From the list in the upper left corner, select **Show All Available Updates**.
4. Select the correct language add-on file and click **Download and Install**.

3.7 Selecting the system language

To change from the default language to another language, install first the language add-on packages. Different Connectivity Packages have different language add-ons available.

1. On the PCM600 menu bar, point to **Tools** and click **Options**.
2. Click **System Settings**.
3. Select the PCM600 and IED languages and click **OK**.
   - **PCM600 Language** defines which language is used in the user interface of PCM600.
   - **Default IED Configuration Language** determines the language of the IED specific content of newly created IEDs. The drop-down list contains all the languages supported by all the active connectivity packages. If the used connectivity package does not support the selected language, English is used. The IED's language can be later changed using the IED shortcut menu **Configuration Language**.

3.8 Installing software packages on a computer that is not connected to the Internet

1. To install software packages needed for PCM600 on an offline computer, first use a computer connected to the Internet.
   1.1. Open Update Manager and select **Export Software Packages**.
   1.2. Select the desired packages and click **Download and Export**.
   1.3. Select folder to export packages on removable disk or network.
2. After download and export, connect the removable disk or network to offline computer.

   2.1. Open Update Manager and select **Settings**.
   2.2. Choose **Other source(local/removable disk/network)** and specify folder location under **Directory path**.
   2.3. Select **Software Updates** or **Get Connectivity Packages**, and click **Install available packages**.

3.9 Customizing PCM600 menus

The **Tools** menu, the **Project Explorer** shortcut menu and the **Options** dialog box can be customized by defining which tools and tool functions are visible. Tools and functionality that are not needed can be hidden.

1. On the **Tools** menu, click **Options** and then click **Customized Menus**.
2. On the **Tools** tab, select the tools and functions to be shown in the menus. Plus (+) sign before the tool name indicates that the tool has functions for which the visibility can be separately defined. Clicking the plus sign shows the tool functions.
3. On the **Options** tab, select the items to be visible in the **Options** dialog box.
4. On the **Miscellaneous** tab, define the visibility of miscellaneous menu items.

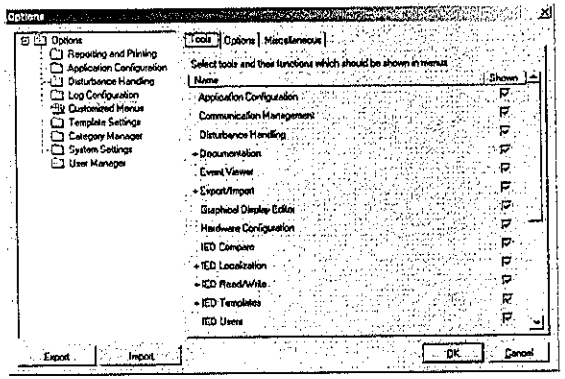


Figure 2: Options for customized menus

Customized menus can be enabled or disabled either using the toolbar button or the **View** menu. When **Customized Menus** is disabled, all functionality is visible in the menus.

The customized menu settings can be exported and imported for reuse.

3.10 Managing users

3.10.1 Managing PCM600 users

3.10.1.1 Creating user categories

The user management is based on the users and the user categories. The users have a user account for PCM600. Each user account is mapped to one user category, which defines the permission to access certain functions. There are three default user categories.

- System Engineer acts as an administrator for the system and has full rights to perform any function and can define the user accounts.
- Operator can perform certain simple tasks and has read-only access to certain functionality of PCM600.
- Application Engineer can access most of the functions and has read and write access to the IED engineering functionality.

The members of the System Engineer user category can create new user categories. The name of the user category must be unique. Privileges can be defined by a tool component for new user categories. For example, a user category can be defined to have either read or read/write access in Signal Matrix.

1. On the menu bar, click **Tools** and select **Options** to start the user management.
2. Select the **Category Manager** folder.
3. Click **Add New Category** to open the **Add New Category** dialog.
4. Type the name for the new user category.
5. Specify the rights to perform different functions under the **Functions And Rights** field.
6. Select **OK** to save the definition.

3.10.1.2 Creating users

The user authentication can be enabled or disabled in **Tools /Options /System settings**. When the user authentication is disabled, all the users get full rights to operate.

The authentication method can be defined to be PCM600 authentication or Windows authentication. The Windows authentication uses the current user's Windows account to determine if the user is allowed to log in to PCM600. The PCM600 authentication uses user name and password specified in the user management of PCM600.

Create a new user to PCM600 and define the user information.

- User name (mandatory)
- Real name of the user
- User category

The Windows account can be used to log in automatically. Multiple Windows account names can be used for a single PCM600 account. The Windows account names are separated by a semicolon (;). These Windows account names are only used for login, if the administrator has enabled the Windows authentication.

1. On the menu bar, click **Tools** and select **Options** to start the user management.
2. Select the **User Manager** folder.
   The default **Real Name** is System Administrator and makes it easier to find the user.
3. Click **Add New User** in the **User Profile** field.
   The **Add New User** dialog is displayed.
4. Type **User Name** and select **User Category** from the drop-down list.
   The user name must be at least three characters long.
5. Click **OK** to confirm.
   The new user is created.

The new user name has to be a member of a user category to have permission to PCM600 functions.

3.10.2 Managing IED users

The IED User Management tool component is used for editing user profiles, group memberships and group access rights for the IED functions and operations. The availability of the tool functionalities depends on whether the IED has a full user management control built in or not. For more information on IED-specific functions, see the corresponding IED documentation.

1. Right-click an IED in **Plant Structure** and then click **IED Users**.
2. In the **IED Users** tool window, edit the settings available for the IED.

3.10.2.1 Enabling communication to the IED

For some IEDs, when remote authentication is enabled, some changes are required in PCM600 to get the communication between the IED and PCM600 to work.

1. In **Plant Structure**, click the IED.
2. In the **Object Properties** window, change the values.

- For **Is Authentication Disabled**, select **False**.
- For **Is Password used**, select **True**.
- For **Password**, write the password.

For information on resolving communication problems, see Troubleshooting communication problems.

3.11 Reporting

The contents of each tool component can be viewed and printed.

- On the menu bar, click **File**, and then click either **Print** or **Print Review**.

Section 4 Use cases for operation and field

4.1 Using Project Explorer

4.1.1 Exporting projects

1. Open the project management by selecting **File/Open/Manage Project**.
2. Select the project from the **Currently available projects** box.
3. Right-click the project to open the shortcut menu.
4. Select **Export Project** from the shortcut menu to open the **Create target file for the project export** dialog.
5. Browse the target location and type the name for the exported file.

Exporting a project enables you to transfer project data between the based systems via different media, for instance in CD-ROM. The source and target computers do not have to be connected to the same network, thus data between two stand-alone computers can be transferred.

All project related data is compressed and saved to one file, which is named and located according to the definitions.

4.1.2 Importing projects

Importing a project enables transferring project data between the based systems via different media, for instance in CD-ROM. The source and target computers do not have to be connected to the same network, thus data between two stand alone computers can be transferred.

1. On the **File** menu, click **Open/Manage Project** to open the project management.
2. Right-click **Projects on my computer**.
3. On the shortcut menu, click **Import** to open the **Import project** dialog.
4. Browse the location and type the name for the imported file.

A new project is created containing all data from the imported file.

4.2 Setting up communication to IEDs

When adding IEDs to the object tree in **Plant Structure**, **Configuration Wizard** assists in building the communication structure needed for the tool components to communicate with the IEDs. When required, communication settings can also be defined manually in the **Object Properties** window.

1. In **Plant Structure**, click an IED to see the settings in the **Object Properties** window.
2. In **Object Properties**, set the communication properties.
   The IED **IP Address** in the PCM600 project has to match the IP address of the physical IED.

4.2.1 Setting the technical key

1. Right-click an IED in **Plant Structure**.
2. On the shortcut menu, click **Set Technical Key in IED**.
   A dialog box opens to inform about the technical key concept.
3. Click **OK**.
   The technical key is read from the IED and the **Set Technical Key** dialog box opens.
4. In **Set Technical Key** dialog box, select the techical key to be used.
   Select one of the given alternatives.
   - Use the existing technical key in the IED.
   - Use the existing technical key defined for the IED object in PCM600.
   - Set a user-defined technical key, which changes the technical key for both the physical IED and the IED object in PCM600

   The maximum length of the technical key is 20 characters. The key must begin with an alphabetic character (A-Z, a-z), but the remaining characters can be alphanumerics or the underscore (A-Z, a-z, 0-9, _).

5. Click **OK** to confirm the selection.

   The technical key must be unique within the same project. An error message is displayed if the same value is already given to another IED object in the PCM600 project.

4.2.2 Troubleshooting communication problems

- When starting troubleshooting, keep the **PCM600 Output** window open for notifications.

Table 2: Remedies to communication problems

Problem	Action
Is the network cable connected?	• Check the cables. • Check that the cables are connected to correct communication ports.
Is the IED responding to any communication?	• Open the command prompt. • Type `ping <devices_IP_address>/-t` and wait for at least one minute to see if there are any communication breaks. • If the ping does not work, check the communication settings: IP gateway, IP addresses, subnet masks and firewalls.
Is the IP address unique in the subnetwork?	• Unplug the communication cable from the IED and ping the IP address. • If there is a response to the ping, find the device with the same IP address from the network and remove it.
Is the SCL technical key correct?	If the technical key is not correct, a message is displayed in the PCM600 Output window. • Select the IED from the PCM600 tree structure and run Set Technical Key.
Are the communicating devices in the same subnetwork?	• Verify the PC and IED communication addresses and subnet masks.
Is the communication port set correctly?	• Select the IED from the PCM600 tree structure and check the Communication Port setting from the shortcut menu. • Verify that the IP address in the Object Properties window is correct.
Was PCM600 first connected to one relay with a certain IP address, and the cable then switched to another relay with the same IP address, and the communication is not working any more?	Windows creates an ARP table containing MAC address and IP address pairs. Clearing this table helps to get communication working when the pairs no longer match. Every relay communication card has a unique MAC address. However, for example in 615 series, the front port IP address is fixed. This can create a mismatched ARP table when several relays are used. Windows also refreshes the ARP table automatically, but this can take several minutes. • Click the Start button, write `cmd` in the search box and press ENTER to open the command prompt. • Type `arp -d` and press ENTER to clear the ARP table. If this command is not recognized or allowed, open the command prompt as an administrator.
Are there several PCM600 processes running simultaneously on the same PC?	Only one PCM600 process can communicate at a time. • Stop other PCM600 instances while communicating with the IED.
Is the parameter communication working?	• Open the parameter settings and try to read parameters. If the parameter setting works and if there is no other communication, the problem can be in the firewall settings.
Is the IED communication reserved by other clients?	• Determine the maximum amount of simultaneous clients. In the IEC 61850 communication, this can be seen in the device's SCL file. In some IEDs, the used clients from the IED can be checked manually from the WHMI. • Isolate the IED from other communication devices to make sure that the clients are not reserving the communication. • Try to communicate with the IED directly from the front port when the rear port cable is disconnected.
Does the communication work with other software than PCM600?	• If the IED supports the IEC 61850 communication, try to communicate with the IED with a third-party client. If the communication fails, check the network configuration.

Table continues on next page

Problem	Action
Does the communication work with the Windows Administrator rights?	Sometimes the communication configuration is updated wrongly with or without the administrator rights in the Windows Vista and Windows 7 operating systems. • If UAC is enabled, run PCM600 using the administrator account.
Does rebooting the IED help resolve the communication issues?	It is possible that the communication is occasionally reserved in the IED. • Reboot the IED.
Can multiple tools be used simultaneously to configure the IED?	In some cases, when two users access the same IED at the same time, the communication fails.
Can data be read from the IED by using multiple tools at the same time?	Some IEDs do not support the reading of disturbance recording simultaneously from two clients.
Is the IED under heavy load?	Operations in the IED can have a high priority and consume most of the IED resources. This can break the communication with PCM600. An example of a resource-exhausting operation is the storing of a disturbance recording. • Ensure that there are no ongoing processes in the IED and try to communicate again.
Are there multiple devices with the same MAC in the same network?	• Try to communicate with a device directly from the front port when the rear port cable is disconnected.
Are the external network devices working properly?	Sometimes routers, switches and media converters can malfunction. • Try to communicate with a device directly from the front port when the rear port cable is disconnected.

Is the communication time-out too short?	• In the Object Properties window, select the value Fixed with High Latency for Connection Type. The Time-out property becomes visible.
	• Define the time-out for long-delay networks.
	  • PCM communication uses the time-out value specified by the user.
	  • When selecting Fixed, the default time-out is used.

Does Online Configuration Wizard or reading configuration fail?	• Make sure that your personal firewall allows inbound FTP connections. Reading configuration files from certain IEDs requires the possibility for inbound FTP connections.
Is uploading recordings for REF615 Ver.5.1 with the scheduler interrupted and the error message "Could not connect to FTP server in IED" shown?	The secure connection to the IED has not been "trusted forever" before using the scheduler. • Click Trust forever, when a security warning appears while uploading manually from the Disturbance Handling tool. The recordings are then uploaded.

4.3 Using Read from IED and Write to IED

4.3.1 Reading a configuration from an IED

Ensure the IED is online and the communication parameters are correct.

1. In **Plant Structure**, right-click the IED.
2. Select **Read from IED** from the shortcut menu.
3. Click **Yes** to confirm. Clicking **No** cancels the operation.

The configuration is read from the IED.

4.3.2 Writing a configuration to an IED

Ensure the IED is online and the communication parameters are correct. Writing the configuration to a wrong IED can result in data loss.

1. In **Plant Structure**, right-click the IED.
2. Select **Write to IED** from the shortcut menu.
3. Click **Yes** to confirm. Clicking **No** cancels the operation.

The whole configuration is written to the IED.

The common writing from PCM600 to IED overwrites any parameter changes made locally using the LHMI.

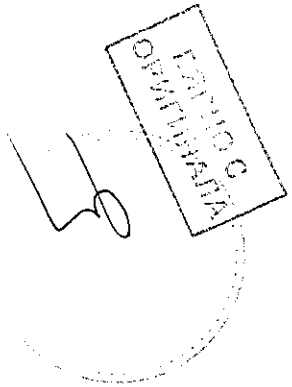
4.4 Using Parameter Setting

Parameter Setting is used for parameterizing the IED units.

1. In **Plant Structure**, select an IED or a function.
2. On the **Tools** menu, click **Parameter Setting**.
   Parameter Setting opens in the tool window and displays parameter data for the selected node. The content of the list displayed depends on the selected level in **Plant Structure**. Settings can be sorted into two groups.
   - Configuration parameters that specify the operation mode of an application function or the IED, and are normally configured only once.
   - Setting parameters that can be changed in the IED at runtime.

   To see the actual IED values, read them from the IED.
3. On the menu bar, click **View** and modify the parameter setting sheet view.
   - Click **Browse options**, and select **Display selected node + child nodes** or **Display only selected node**.

   Depending on the selected node in **Plant Structure**, the view can contain all the parameters of an IED or only the parameters of a specific function.



   - Click **Parameter layer**, and select **Basic parameters** or **Advanced parameters**.
   - Click **Setting group presentation**, and select **Vertical** or **Horizontal**.
   - Click **Parameter filter**, and select which parameters are to be shown.
   - Click **Group options**, and expand or collapse the selected group and its child groups.
   - Select **Column autosize** to autosize columns according to their content.
4. On the **View** menu, select **Parameter warnings** to enable displaying parameter warnings.
   Warnings are displayed in the **Output** window in certain situations.
   - Modifying a parameter affects other parameters.
   - Parameter reading or writing fails for some parameter.

   To find a parameter, press the shortcut keys CTRL+F.

4.4.1 Setting parameters

1. In the **Parameter Setting** sheet, locate the correct parameter, and click the **PC Value** cell.
2. Enter the new value.
   Parameter Setting supports several parameter types.
   - Numerical
   - SingleChoice
   - String
   - Date/Time
   - MultiChoice

   Parameter Setting checks that the given value is valid. The old value is shown as a tool tip in the status bar. If the new value is valid, it is shown in bold font. If the value is not valid, an error message is displayed describing the error and correct format for the parameter.
   If the changed parameter affects one or more other parameters and the parameter warnings are on, the dependencies are displayed in the **Output** window.
3. On the toolbar, click the Save button to save the change.

4.4.2 Writing parameters to an IED

In Parameter Setting, parameters can be written to an IED.

1. In **Plant Structure**, select an IED.
2. On the menu bar, click **IED** and select **Write parameters to IED.**
3. In the **Write Parameters to IED** window, select the **Parameter range** and the **Parameter options**.
4. Select **Read back** check box, if the parameters must be read back after writing.
5. Click **OK**.

In Parameter Setting, only the parameters are written to the IED, not the whole configuration.

If the writing of a single parameter fails, an error message is displayed. Continue by choosing one of the given options.

- Click **Retry** to write the parameter again.
- Click **Skip** to skip the parameter.
- Click **Skip all** to continue the writing of parameters and skip automatically the possible parameters that fail.
- Click **Cancel** to end the writing procedure.

Locked parameters are not written to IED before unlocking them. The locked parameters must first be unlocked by right-clicking the **PC value** field and selecting **Unlock parameter**.

4.4.3 Copying parameter values

In Parameter Setting, parameter values can be copied from one or several parameters to other/s. The copied parameter or parameter group has to be of the same type as the target parameter or group.

1. Select the parameter value or values.
   - For copying a single value, select the PC Value cell of a parameter.
   - For copying multiple values, select a parameter group header (indicated with a blue color) from the setting sheet. All parameters belonging to the selected group are marked with check marks.
2. On the **Edit** menu, click **Copy**.
3. Select the place to paste the parameter value or values.
   - To paste a single parameter value, select a parameter on the setting sheet.
   - To paste multiple parameter values, select a parameter group header on the setting sheet.
4. On the **Edit** menu, click **Paste**.

4.4.4 Copying setting group values

In Parameter Setting, parameter values can be copied from one setting group to another.

1. On the **Edit** menu, click **Copy/paste setting group**.
2. Select the groups in the **Source group** box and the **Target group** box, and click **OK**.
   All parameters currently visible in the setting sheet are copied from the source group to the target group.

4.4.5 Collapsing and expanding parameter groups

- To collapse or expand a single group, double-click the parameter group header in the setting sheet.
- Collapse or expand the selected group and it's child groups.
  - On the menu, select **View/Group options/Expand selected group + child groups** to expand the groups.
  - On the menu, select **View/Group options/Collapse selected group + child groups** to collapse the groups.
- On the toolbar, click the corresponding toolbar buttons.

4.4.6 Finding parameters

Search parameters in Parameter Setting with the **Find parameter** function.

1. On the **Edit** menu, click **Find parameter**.
2. In the **Find Parameter** dialog box, enter the find string and column where to find from.
3. Click **Find Next** to find the parameter.

4.4.7 Exporting parameters

Parameters can be exported from an IED in any level of the Plant Structure.

1. Click the Export parameters toolbar button or on the **File** menu, select **Export parameters**.
2. In the **Export** dialog box, define the export options.
   - File name
   - Path or location
   - File type (xrio, csv, txt)
3. Click **Save**.

4.4.8 Importing parameters

An exported parameter file contains all the IED functions which have parameters. In the import phase, the functions to be imported from the file can be defined.

Parameters can be imported in an IED in any level of the Plant Structure as a whole or partially.

1. Select the node from the tree structure in **Plant Structure** to import the parameters.
   To import all the parameters, select the IED node. To import the parameters related to a subnode, select the subnode by expanding the IED node.
2. Click the Import parameters toolbar button, or on the **File** menu select **Import parameters**.
3. Define the location of the import file.
   The import file must be in .xrio or .csv format.
4. Click **Open**, and in the **Open** dialog box, select the functions containing the parameters required for importing.
   All the functions are selected by default.
5. Click **OK**.

If a revision mismatch occurs between the source function in the import file and the target function in the PCM600 tool, the function is displayed in red font and it is not selected. The function can be selected and imported but all parameters may not be updated in the target function.

4.5 Using IED Compare

IED Compare is used to compare the configurations of two IEDs of the same type. The configurations to be compared can be stored in PCM600, IED or pcmi file. The result of the comparison is a report listing the differences in the IED configurations.

1. In **Plant Structure**, click **Substation**, **Voltage level**, **Bay** or **IED**.
2. On the **Tools** menu, click **IED Compare** to start the tool.
3. In the **IED Compare** tool window, select the online or offline comparison type from the given options.
4. Select the comparison objects from the **Select IED** tree and click **Compare**.
   The comparison report shows differences in the configuration of any two IEDs. The results are grouped to Hardware, Application, Display, GOOSE and Parameter(s) configuration differences.
5. Click **Save** to save the report.
   The report can be saved as Excel or as PDF.

The online comparison depends on the Connectivity Package and the IED's capability to read the selected configuration and parameters.

4.6 Using Disturbance Handling

Disturbance Handling is used for uploading and processing the disturbance files gathered by a specific IED, for viewing and processing the disturbance recording data and for creating reports.

1. In **Plant Structure**, click an IED.
2. On the **Tools** menu, click **Disturbance Handling**.
   Disturbance Handling opens in the tool window.
3. On the **Tools** menu, click **Options**, and then in the tree structure on the left, click **Disturbance Handling** to set the Disturbance Handling preferences.
   - Click the **General** tab and define where the recordings are stored and which tool to use for opening the recordings.
   - Click the **Column Preferences** tab and define the visibility, width and order of the columns in the Disturbance Handling tool window.
   - Click the **Email Settings** tab and define the options for sending the report via email.

   Click **OK** to confirm settings.
4. On the PCM600 toolbar, select the recording filter to define which recordings are shown in the window.

4.6.1 Reading recordings

The **Read Recordings from IED** operation uploads the selected COMTRADE recordings to the recordings folder in the local computer. On a successful read operation, the computer icon in the first column is enabled indicating that the recording is available locally in the computer for analysis.

The read operation is performed based on the IED's capability. If the IED is not capable of reading the subset of recordings, all the recordings are read. If no recordings are selected, all the recordings are read.

- On the PCM600 menu bar, select **IED/IED Recordings/Read Recordings from IED**.
- Click the **Read Recordings from IED** toolbar button.
- Right-click the **Disturbance Handling** window and select **Read Recordings from IED** in the shortcut menu.
- Double-click the IED recording.

The recordings with the IED icon enabled in the first column can only be read.

If a recording is already read in the local computer, a warning appears asking if the recording should be overwritten.

4.7 Using Event Viewer

Event Viewer displays the actual or history events stored in the IED. These events can be sorted and filtered for easier examination, or they can be printed or exported to a file.

1. In **Plant Structure**, click and IED.
2. On the **Tools** menu, click **Event Viewer**.
   The **Event Viewer** window containing two tabs opens.
   - **IED events** tab contains all events in a table format, the newest event on top.
   - **Security events** tab contains security events in a read-only format, the newest security event on top.

4.7.1 Filtering event data

Filtering allows reducing the amount of the displayed event data.

1. On the main menu, select **Event Viewer** and click **Filter On/Off**.
   A drop-down list box including the column´s values is shown for each header.
2. Select a value from the column's drop-down list box to display events that have the selected value.
   Filters can be selected for several columns which enables combining the filter conditions over these columns.
   - To use more advanced filtering options, select **Custom filter** from the drop-down list box of each column. The **Custom Filter for Event List Column** dialog box is shown where you can select filtering options for the selected column. Click **OK** to apply the filtering conditions. Advanced filtering can be selected for several columns which enables combining the filter conditions over these columns.
   - To turn off the filter condition on a specific column, select **No filter** from the column's drop-down list box.
3. To turn off all the filters, select **Event Viewer** on the main menu, and click **Filter On/Off** again.

The drop-down list boxes below the column headers disappear.

When closing Event Viewer, the filter settings are stored and applied when opening Event Viewer the next time.

4.7.2 Printing events

You can print the events that are currently displayed in Event Viewer. You need to have a printer installed on the computer.

1. On the **File** menu, click **Print**.
   - Preview the data to be printed by clicking **Print Preview**.
   - Click **Print Options** to select the columns to print. The **Print Options** menu is available only when Event Viewer contains both the IED events and Security events data.
2. In the **Print** dialog box, select the wanted options and click **OK**.

The **Print** and **Print Preview** functions are not available if no events are shown in the Event Viewer display, or if the default printer is not defined.

4.7.3 Exporting events to Excel file

Filtered events can be exported to an Excel file. Exporting to Excel file can be useful, for example, when the events of two IEDs need to be compared.

1. In Event Viewer, filter the event data for an IED.
2. Select **Reports** on the main menu and click **Export To Excel File**.
3. Select the file destination and click **OK**.

The event data is exported to the selected destination in Excel format.

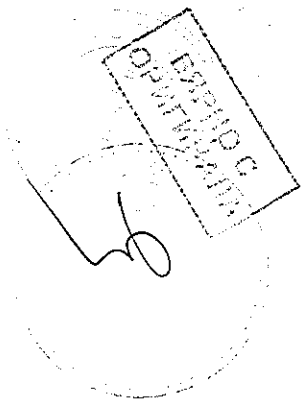
To export events to Excel file, you can also click the **Export to Excel File** button in the toolbar.

4.8 Using Signal Monitoring

1. In the **Plant Structure**, select an IED.
2. On the menu bar, click **Tools** and select **Signal Monitoring**.

Signal Monitoring opens in the tool window.

3. On the menu bar, point to **IED** to select the monitoring option.
   - Click **Read Latest Values From IED** to read the values and update the view manually.
   - Click **Toggle Continuous Reading** to update the view automatically when new values are received.
   - Click **Toggle Continuous Reading** again to turn it off and click **Forcing Session** to test the function of the IED.
4. To close Signal Monitoring, right-click the **Signal Monitoring** tab on top of the tool window, and then click **Close**.



Section 5 Use cases for engineering and commissioning

5.1 Using Project Explorer

Plant Structure is the default view in **Project Explorer**.

- On the menu bar, click **View** and then click **Project Explorer**.
  The **Project Explorer** window is opened and closed with the selection.

5.1.1 Creating new projects

1. On the **File** menu, click **New Project**.
2. Type the name of the project in the **Project name** box.
3. Type the optional description for the project in the **Description** box.
4. Click **Create** to create a new project to the default location.

5.1.2 Building the plant structure

1. Create IED group or substation level objects.
   1.1. In **Plant Structure**, right-click a project and select **New/ General** and then select **IED Group** or **Substation**.
   1.2. Rename the IED group or substation by the name or identification used in the grid. Right-click the level and select **Rename**.
2. Create voltage level objects.
   2.1. In **Plant Structure**, right-click a substation and select **New/ General/ Voltage Level**.
   2.2. Rename the voltage level by right-clicking the level and selecting **Rename**.
3. Create bay level objects.
   3.1. In **Plant Structure**, right-click a voltage level and select **New/ General/ Bay**.
   3.2. Rename the bay object by right-clicking the object and selecting **Rename**.

Objects can also be renamed by selecting the object and pressing F2.

5.1.3 Moving objects in the project tree

The drag-and-drop operation follows the typical windows principles.

- In **Plant Structure**, move an object in the project tree by dragging.

5.1.4 Creating IEDs

1. Select and add the IED in one of the alternative ways.
   - On the **View** menu, click **Object Types** and select the IED from the **Object Types** window, and drag it under the bay in **Plant structure**.
   - Right-click the bay in **Plant Structure**, and from the shortcut menu, point to **New** and select **Create from template**.
   - Right-click a bay object in **Plant Structure**, and on the shortcut menu, point to **New** and select the IED to be added.
2. In the **Configuration Wizard**, select the configuration mode and click **Next**.
   - Select **Online configuration** when the IED is already connected to PCM600.
   - Select **Offline Configuration** when the IED is not available or is not connected to PCM600.
3. Set up the IED following the steps in the **Configuration Wizard**.
   The available steps and settings depend on the IED.
   - Communication protocol
   - Port and IP address
   - IED version
   - Housing type
   - Display type
   - Order code
4. Click **Finish** to confirm the configuration.

5.1.5 Creating IEDs from templates

IEDs in **Plant Structure** can be exported to templates that can be used to create new IEDs including the IED application configuration, graphical display configuration, communication mappings and parameters.

1. In **Plant Structure**, right-click a bay and then select **New /Create from Template**.
2. Select the IED from the list of the available object types.
3. Click the icon on the right column in the list of available templates.
   The **Template Properties** dialog box opens.
4. Check the template information and click **Close** to close the window.
5. In the **Create New Object from Template** dialog box, click **Create** to insert the IED in the bay.
6. Set up the IED following the steps in **Configuration Wizard**.
   The steps and settings available depend on the IED.

After a template IED has been imported, the IP address, the **Caption** in **IED Object Properties** and the technical key that corresponds to the physical IED have to be changed.

5.1.6 Copying and pasting IEDs

1. In the **Plant Structure**, right-click the IED to be copied.
2. On the shortcut menu, click **Copy**.
3. Right-click the object level in **Plant Structure**, for example a bay, where the copied IED is to be inserted.
4. In the shortcut menu, click **Paste**.
   The IED is now visible in the object tree.

Complete Bays or Voltage Levels can also be copied and pasted.

The keyboard shortcuts CTRL+C and CTRL+V can also be used for copying an pasting.

5.1.7 Importing IEDs

A new IED object can be imported to a project in **Plant Structure** by importing an IED (.pcmi) file.

An IED file can only be imported when a bay or an IED group is selected in the plant structure.

1. In **Plant Structure**, right-click the bay and then click **Import**.
2. Select the IED file to be imported and click **Open**.
   After importing, the IED object is created in the plant structure.

After importing the IED file, change the IP address, the name and the technical key that correspond to the physical IED from the **Object Properties** window.

5.1.8 Importing preconfigured IEDs

A preconfigured IED includes all information related to the IED object in PCM600. Preconfigurations are bound to a specific hardware configuration. The License Update tool is needed to ensure that the configuration is compatible with the ordered device.

1. In **Plant Structure**, right-click an IED group or a bay and select **Import**.
2. Select the preconfiguration file saved in .pcmi format and click **Open**.
   The preconfiguration file is imported to the **Plant Structure**.
3. If needed, modify the configuration using the Application Configuration tool.
4. Write the configuration data to the IED by right-clicking the IED in **Plant Structure** and selecting **Write to IED**.
   - Click **Yes** to write the configuration data to IED.
   - Click **No** to cancel the operation.

You can rename the preconfigured IED in the **Plant Structure** by selecting the IED and pressing F2.

The ordered default configurations are not locked, and can be used as a base for other configurations providing that all the needed hardware and software options are available.

5.1.9 Exporting IEDs

1. In the **Plant Structure**, right-click the IED and then click **Export**.
   The **Information** dialog box is displayed with the supported file types and their descriptions.
2. Click **OK** to open the **Export** dialog box.
3. Write the file name, select the file type **IED File (*.pcmi)** and click **Save**.
   The IED file contains the whole IED configuration.

5.2 Using graphical Application Configuration

The graphical Application Configuration is used to create and modify application configurations for IEDs, that is, to define how the IEDs function.

1. In **Plant Structure**, select an IED.
2. On the **Tools** menu, click **Application Configuration**.
   Application Configuration opens in the tool window.
3. Create or modify the application configuration.
   - Organize into main applications over the needed amount of pages.
   - Insert function blocks, hardware channels and variables.
   - Make connections.
4. Click the Save button on the toolbar to save the configuration.
   The changes are shown in the **Plant Structure**.

When both Application Configuration and Parameter Setting are open for the same IED, the Parameter Setting view is synchronized with the view of Application configuration. If a function block is selected in Application Configuration, the same function block is shown in focus in the Parameter Setting window too, and vice versa.

5.2.1 Inserting main applications

A main application is the drawing area for creating or editing the application configuration. The main application can contain several pages. A configuration always has one default main application.

- On the **Insert** menu, click **MainApplication**.
- Click the Insert MainApplication button on the toolbar.

A new main application is created with the default name MainAppX, where X is a sequential number.

Copying main applications

The main application can be copied and pasted either within the same IED Configuration, or to a different IED Configuration with the same capabilities.

1. In **Application Configuration**, right-click the **MainApp** tab and select **Copy** from the shortcut menu.
2. Right-click the tab after which the main application has to be inserted and select **Paste** from the shortcut menu.

Function blocks, channels and other graphical symbols in the main application are pasted on a new **MainApp** tab.

5.2.3 Deleting main applications

1. In **Application Configuration**, right-click the **MainApp** tab and select **Delete** from the shortcut menu.
   If **Application Configuration** has only one **MainApp**, the delete option is not available.
2. To confirm the deletion, click **Yes**.

The main application is deleted.

5.2.4 Inserting pages

1. In the Application Configuration tool window, click the **MainApp** tab.
2. Scroll to the page after which the new page is to be added.
3. On the **Insert** menu, click **Page**.

A page can also be added using the shortcut menu, or pressing the shortcut keys CTRL +SHIFT+P.

5.2.5 Inserting variables

Input and output variables represent connections in the configuration.

1. On the **Insert** menu, point to **Variable**.
2. Select **Input** or **Output**.
3. Click the Application Configuration window to insert the variable.
   The variable is inserted with its default name.

Variables can also be inserted using a shortcut menu in Application Configuration, the View Variable List button on the toolbar or the shortcut keys CTRL+SHIFT+V.

5.2.6 Inserting function blocks

A function block can be inserted only in the configuration mode of Application Configuration.

1. On the **Insert** menu, click **FunctionBlock**.
2. Click in the **Application Configuration** window.
   The **Insert Function Block** dialog opens.
3. Select the function block and click **Insert**.
4. Enter the function block data and click **Assign**.

If the automatic mode is selected for the execution order from the PCM600 toolbar, the cycle time, execution order and instance number are automatically assigned. Otherwise, set them manually before assigning.

Function blocks can also be inserted in the drawing area by dragging, using the shortcut menu in Application Configuration, or by using the shortcut keys CTRL+SHIFT+F.

5.2.7 Renaming main applications and objects

Main applications and objects in the Application Configuration can be renamed in the **Object Properties** window.

1. Select the item to be renamed.
   - To rename a main application, click a **MainApp** tab.
   - To rename an object, click the object in the Application Configuration tool window.

   The data of the selected item is shown in the **Object Properties** window.
2. Enter the new name in the **Name** or **User Defined Name** field.
   The field cannot be left empty. If the maximum length is exceeded or unallowed characters are used, an error message is shown.
3. Click the Save button on the toolbar to save the new name.

Objects can also be renamed by right-clicking a function block in Application Configuration and selecting **Set User Defined Name**, or by pressing F2.

5.2.8 Finding application objects

In Application Configuration you can search and locate function blocks, variables, hardware channels, text, signals, comments or graphical objects.

1. On the menu bar, select **Edit** and click **Find**.
   - To use a simple search function, type in the text box search words, such as symbol name, and click **Find Next**.
   - To use an advanced search function, click **Find Options**, define the more detailed searching options and click **Find**. The search results are shown on Search Results field. Click an item on the list to locate it.

The finding function can also be started by pressing the shortcut keys CTRL+F.

5.2.9 Connecting signals

5.2.9.1 Connecting by dragging

1. Point to the graphical symbol of the signal or channel so that the hand cursor appears.
2. Drag the source signal or channel to the target.

5.2.9.2 Connecting using variables

With the variables, connections can be represented within a page and across pages or worksheets.

1. Right-click the function block signal or channel, and then click **Connect**.
2. Connect to a variable.
   - Click **New** to add a new variable.
   - Click **Existing Variable**, and in the **Variable** list, select the variable and click **Select**.

The Variable list can also be opened using the shortcut keys CTRL +SHIFT+V.

A connection to an existing or a new variable can also be created by selecting the signals and pressing the shorcut keys CTRL+SHIFT+E or CTRL+SHIFT+N.

5.2.10 Deleting objects and unconnected variables

The **Delete Option** dialog box allows deleting main applications, pages, Application Configuration symbols and unconnected variables from the configuration.

1. On the menu bar, click **Edit** and select **Delete Option**.
   The **Delete Option** dialog box opens.
2. Select the check box next to the item to be deleted.
   - To delete the unconnected variables from the configuration, select the **Delete all unconnected variables from the configuration** check box.
3. Click **Delete**.
4. To confirm the deletion, click **Yes**.

The selected items are deleted from the configuration.

5.2.11 Grouping symbols

In the configuration mode, the group feature allows combining the selected symbols to a single object.

1. Select the desired symbols.
2. Right-click any of the selected symbols and select **Group**.
   The symbols are highlighted in blue, indicating that they are grouped.

To exclude an element from a group, right-click the element, and in the shortcut menu, select **Exclude from Group**.

To ungroup the grouped symbols, right-click the group and select **Ungroup**.

5.2.12 Aligning and spacing symbols

The symbols can be aligned and spaced in Application Configuration.

1. Use the mouse to select the symbols.
   To select several symbols, hold down the CTRL key while selecting.
   The primary selected symbol is outlined with red color, and the secondary selected symbols are outlined with blue color.
2. On the menu bar, select **Format/Format Symbols**, point and click the wanted option.
   - Point to **Align** and select **Left/Right/Horizontal/Top/Bottom/Vertical** to arrange the symbols in relation to the primary selected symbol.
   - Point to **Align** and select **Detect overlapping FunctionBlocks** to find the overlapping function blocks in the configuration. The pages containing overlapping function blocks are listed on the **Output** window. To locate a page, double-click an item on the list.
   - Point to **Align** and select **Align overlapping FunctionBlocks** to align the overlapping function blocks in the configuration.
   - Point to **Horizontal Spacing** and select **Make Equal** to arrange the selected symbols horizontally with equal spaces between them.
   - Point to **Vertical Spacing** and select **Make Equal** to arrange the selected symbols vertically with equal spaces between them.

5.2.13 Locking and unlocking applications, pages, variables and function blocks

Application Configuration enables locking and unlocking applications, pages, variables and function blocks. Locking an application prevents creating or deleting graphical symbols and connections, moving graphical symbols and deleting main applications. Locking a page prevents inserting, deleting and moving the graphical symbols on the page. Locking a variable prevents moving, renaming and deleting the variable. Locking a function block prevents operations such as cutting, copying, pasting, moving and deleting the function block.

1. Select the item to be locked.
   - To lock a main application, click the main application tab.
   - To lock a page, go to the page.
   - To lock a variable, select the variable.
   - To lock a function block, select the function block.
2. In the **Object Properties** window set the value of the **Locked** field to **True**.
3. To unlock, set the value of the **Locked** field to **False**.
   A password is required for unlocking a main application. The password is set in **Tools/Options/Application Configuration.**

Locking and unlocking is also possible by right-clicking the particular item, and selecting **Lock** or **Unlock** from the shortcut menu.

5.2.14 Monitoring signal and channel values

The signal and channel values of a configuration can be continuously monitored in the online monitoring mode of Application Configuration. To online monitor the application configuration, the complete IED configuration must first be written to the IED.

1. On the toolbar, click the Work online button to start online monitoring.
   When the IED does not support online monitoring, the button is disabled.

Only when the application configuration in the IED and PCM600 are the same, the online monitoring starts.

2. On the toolbar, click the Watch window button.
   Use the watch window to monitor certain signals in a separate window. A signal can be added to the watch window by right-clicking the function block signal in Application Configuration, and then selecting **Add to watch window** from the shortcut menu.
3. On the toolbar, click the Work Offline button to stop online monitoring.

The Work online function is not supported if the split window is enabled.

5.2.15 Validating application configuration

Validating the application configuration enables detecting any errors that can prevent downloading the configuration to the IED.

- On the menu bar, select **IED** and click **Validate Configuration**.

The configuration is validated and the errors and warnings are listed in the **Output** window. To navigate to the problem area in the configuration, double-click the particular error or warning message.

5.2.16 Comparing application configuration

The existing application configuration in PCM600 and the configuration in the IED can be compared.

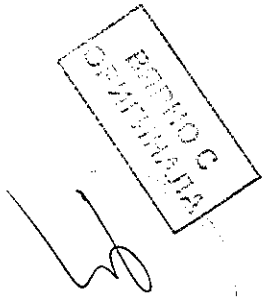
1. On the **IED** menu, click **Compare Configuration.**
   The function blocks can be compared based on their execution order and cycle time.
2. Click **OK** to start the comparing.

A report is created about the differences in function blocks. Also the missing blocks and connections are listed.

5.2.17 Working with templates

5.2.17.1 Creating main application templates

Main application configurations can be saved as templates and reused.



1. Click the **MainApp** tab to select the main application to be saved as a template.
2. On the **File** menu, select **MainApplication Template Manager.**
   The **MainApplication Template Manager** dialog box opens. The **IED type** combo box displays the current IED type.
   To save the a template in a custom location, clear the check box to select the destination.
3. Enter the template name and description and click **Save** to save the template.

The templates only have application configuration-related information, not parameters or communication-related information.

5.2.17.2 Inserting main applications from templates

Main application templates can be inserted into any configuration in Application Configuration.

1. On the **Insert** menu, click **MainApplication Template Manager.**
2. Select the template in the **Existing Templates** box and click **Insert.**
   The program also shows template migration details and allows managing hardware channels and variables.
3. Click **Close** to close the **MainApplication Template Manager** dialog box.

A new main application is created with the content of the template file.

5.2.18 Application Configuration shortcut keys

Table 3: Application Configuration shortcut keys

Shortcut key	Function
Page selected	
SHIFT+RIGHT ARROW	Backward navigation of the selected variables
SHIFT+LEFT ARROW	Forward navigation of the selected variables
CTRL+TAB	Go to the next main application
CTRL+SHIFT+TAB	Go to the previous main application
RIGHT ARROW	Move the selected objects to the right
LEFT ARROW	Move the selected objects to the left
UP ARROW	Move the selected objects up
DOWN ARROW	Move the selected objects down
CTRL+F	Open the Find dialog box
CTRL+SHIFT+V	Open the Variable List dialog box
CTRL+SHIFT+P	Insert a page
CTRL+SHIFT+D	Delete a page
PAGE UP	Scroll up the page
PAGE DOWN	Scroll down the page
CTRL+G	Open the Go To Page dialog box
CTRL+SHIFT+F	Insert a function block
CTRL+SHIFT+H	Insert a hardware channel
CTRL+P	Print worksheets or pages
CTRL+Z	Undo operation
CTRL+Y	Redo operation
DELETE	Delete the selected objects
CTRL+C	Copy the selected objects
CTRL+V	Paste the copied objects
CTRL+A	Select all objects

Table continues on next page

Shortcut key	Function
CTRL+X	Cut the selected objects
CTRL+S	Save the application configuration
F1	Open the PCM600 online help
CTRL+SHIFT+L	Lock a page
CTRL+SHIFT+U	Unlock a page
Application key	Open the shortcut menu of the page
Connection selected	
F1	Open the PCM600 online help
Function block selected	
F1	Open the PCM600 online help
F2	Set the user-defined name for the function block
CTRL+R	Replace the function block
CTRL+SHIFT+M	Manage signals for the function block
CTRL+SHIFT+L	Lock the function block
CTRL+SHIFT+U	Unlock the function block
Application key	Open the shortcut menu of the function block
Hardware channel selected	
F1	Open the PCM600 online help
F2	Set the user-defined name for the hardware channel
Application key	Open the shortcut menu of the hardware channel
Picture selected	
F1	Open the PCM600 online help
Application key	Open the shortcut menu of the picture
Signal selected	
F2	Set the user-defined name for the signal
CTRL+SHIFT+N	Insert new variable (on selection of signal)
CTRL+SHIFT+E	Insert existing variable (on selection of signal)
Application key	Open the shortcut menu of the signal
Text selected	
F1	Open the PCM600 online help
Application key	Open the shortcut menu of the text
Variable selected	
F1	Open the PCM600 online help
F2	Set the user-defined name for the variable
CTRL+SHIFT+L	Lock the variable
CTRL+SHIFT+U	Unlock the variable
Application key	Open the shortcut menu of the variable

5.3 Using Signal Matrix

The Signal Matrix tool is used for making connections between the physical input and output signals and function blocks, as well as for engineering the GOOSE signal inputs. After the connections are made, the matrix can be exported to an Excel sheet for easier verification.

1. In **Plant Structure**, select an IED.
2. On the **Tools** menu, click **Signal Matrix**.
   Signal Matrix opens in the tool window. Depending on the IED, there is a separate sheet for each possible combination.
3. Click the tab on the status bar to open the correct sheet.
4. Create connections between source and target objects in the IED configuration.
   - White cells are available for configuration.
   - Cells shaded in light red are not available for configuration.
   - Light blue cells are available for configuration, but the corresponding target object already has a connection with some other source object in the grid. In this case, the behaviour of the connection depends on whether or not glue logic is enabled in the grid.
     - If glue logic is not enabled, the existing connection is removed.
     - If glue logic is enabled, Signal Matrix attempts to combine the new source object with the existing source object using glue logic, and connect the output to the target object.
5. Click the Save button on the toolbar to save the connection changes.

Some of the Signal Matrix grids, such as binary inputs, binary outputs and function grids, support glue logic. Normally, only one source object can be connected to a target object. Glue logic enables connecting several source objects to the same target object: the outputs of multiple source objects are connected to the inputs of a simple boolean logic function, and the output of the boolean function is connected to the target object. The available boolean logic functions are AND and OR.

5.3.1 Connecting binary inputs

1. Click the **Binary Inputs** tab in the tool window.
   The availability and the appearance of the grid depend on the IED.
2. Create or delete connections between physical input channels and binary input signals.

- Double-left-click an empty cell to create a direct connection. The selected cell is marked with "X."
- Double-right-click an empty cell to create a connection with an inverter. The selected cell is marked with "I."
- Double-left-click or double-right-click a cell with a symbol X or I to remove a connection.

The **Binary Inputs** grid supports glue logic. This means that several optocoupler input channels can be connected to the same binary input signal.

3. Click the Save button on the toolbar to save the connection changes.

5.3.2 Connecting binary outputs

1. Click the **Binary Outputs** tab in the tool window.
   The availability and the appearance of the grid depend on the IED.
2. Create or delete connections between physical output channels and binary output signals.
   - Double-left-click an empty cell to create a direct connection. The selected cell is marked with "X."
   - Double-right-click an empty cell to create a connection with an inverter. The selected cell is marked with "I."
   - Double-left-click or double-right-click a cell with a symbol X or I to remove a connection.

   The **Binary Outputs** grid supports glue logic. This means that several binary output signals can be connected to the same output relay contact channel.
3. Click the Save button on the toolbar to save the connection changes.

5.3.3 Connecting analog input channels

1. Click the **Analog Inputs** tab in the tool window.
   The availability and the appearance of the grid depend on the IED.
2. Create or delete connections between current and voltage channels and the input signals of current and voltage function blocks.
   - Double-click an empty cell to create a connection.
   - Double-click a cell with a symbol X to delete a connection.

   Several analog input signals can be connected to the same physical analog input channel. But once an analog input signal is connected to a physical analog input channel, it cannot be connected to another physical analog input channel.
3. Click the Save button on the toolbar to save the connection changes.

5.3.4 Connecting analog output channels

1. Click the **Analog Outputs** tab in the tool window.
   The availability and the appearance of the grid depend on the IED.
2. Create or delete connections between analog output signals and current and voltage channels.
   - Double-click an empty cell to create a connection.
   - Double-click a cell with a symbol X to delete a connection.

   Several analog output signals can be connected to the same physical analog output channel. But once an analog output signal is connected to a physical analog output channel, it cannot be connected to another physical analog output channel.
3. Click the Save button on the toolbar to save the connection changes.

5.3.5 Connecting GOOSE receive signals

The GOOSE receive input signals are those signals that are communicated to one IED from another IED using the IEC 61850 GOOSE communication mechanism.

1. Click the **GOOSE** tab in the tool window.
   The availability and the appearance of the grid depend on the IED.
2. Create or delete connections between GOOSE receive signals and input signals.
   - Double-click an empty cell to create a connection.
   - Double-click a cell with a symbol X to delete a connection.

   The Signal Matrix connection rules prevent incompatible connections. Incompatible connection cells are disabled and shown in red.
3. Click the Save button on the toolbar to save the connection changes.

5.4 Using Graphical Display Editor

Graphical Display Editor is used for drawing the single-line diagram shown on the graphical display of the IED. The diagram with its components corresponds to the actual configuration.

1. In **Plant Structure**, select an IED.
2. On the **Tools** menu, click **Graphical Display Editor**.
   The presentation is empty when no page exists for the IED. If standard configurations are used, a default single-line diagram presentation is displayed.
3. In the **Symbol Library** box, select either IEC or ANSI.

The symbols in the display pages and in the symbol library are changed.
4. On the toolbar, activate the **Snap to grid** and **Show grid** functions.
5. Create the single-line diagram.

5.4.1 Creating single-line diagrams

1. Add primary equipment to the display page by dragging from the **Symbol Library**.
   - Rotate the symbols with the Rotate left and Rotate right buttons on the toolbar.
   - Select the size in the **Symbol Size** box.
2. Add junction symbols for connections.
3. Connect the symbols where necessary.
   3.1. Point to the symbol's connection point.
   3.2. Drag the connection from the source connection port to the target connection port.
   A connection line between the source and target connection ports is drawn.
4. Modify the symbol properties in the **Object Properties** window.
   4.1. Click an object in the **Display Page**.
   4.2. In the **Object Properties** window, modify the properties, such as, naming the symbol and placing the name.
5. Relate dynamic symbols to their source data.
   5.1. Right-click the symbol and then click **Select Input Signal**.
   5.2. Select the signal from the list.
6. Set the tab order of controllable objects in the **Object Properties** window.
   The tab order defines the order in which the controllable objects are selected when the **Select** button is pressed on the IED.
7. Click the Save button on the toolbar to save the diagram.

5.4.2 Exporting a template

Single-line diagrams created in Graphical Display Editor can be exported as templates and reused.

1. Create a single-line diagram in the **Graphical Display Editor** tool.
2. On the menu bar, point to **Graphical Display Editor** and select **Export Display Pages as a Template**, or on the **File** menu, point to **Display Editor Template** and click **Export**.
3. Once the display page is selected, click **Export**.
   The **File save** dialog box appears.
4. Browse the location to export the template and provide the file name.

By default, single-line diagram templates are saved in the drive where PCM600 is installed <Drive:> \PCMDataBases\GDE\Templates \<IED type folder>.

5.4.3 Importing a template

In Graphical Display Editor, an exported single-line diagram template can be imported to another IED.

1. On the menu bar, point to **Graphical Display Editor** and select **Import Display Pages from Template** or on the **File** menu, point to **Display Editor Template** and click **Import**.
   The **Import GDE Template** window appears with two sections, **List of Templates** and **Display Pages Preview**.
2. Click **Browse** to select the template files.
   The templates available in the folder appear in the **List of Templates** section.
3. Select a template file to preview the display pages available in the template file.
4. Once the display pages are selected, click **Import** to import the display page.

Multiple pages can be selected for the **Import** function.

5.5 Using IEC 61850 Configuration

The IEC 61850 Configuration tool is used for GOOSE and client-server data flow engineering between IEDs in a substation.

1. In **Plant Structure**, right-click **Substation, Voltage Level, Bay, IED Group** or **IED**, and then select **IEC 61850 Configuration**.
2. On the toolbar, select the configuration mode.
   - GOOSE Communication
   - Client-Server Communication

   Different parts of the IEC 61850 configuration can be edited depending on the selected configuration mode.
3. Click one of the tabs on bottom of the tool window to select the type of the configured data.
   - Data Sets
   - GOOSE Controls
   - Inputs
   - Report Controls

The type of the data available depends on the current configuration mode.

5.5.1 Sending and receiving data

In the Data Sets, GOOSE Controls, Report Controls and Sampled Value Controls tabs, it is possible to configure the sending or receiving of data. A check mark in the matrix means that the data on the row is sent to or received by the client in the column.

- To send or receive data, select a check box in the mapping matrix.
- To send data to all receivers, right-click the data to be sent and select **Send to All**.
- To receive all data, right-click a receiver and select **Receive All**.
- To receive the same data as another IED, right-click a receiver, select **Receive Same Data As** and select an access point from the pop-up menu.

When sending or receiving a data set, the corresponding control block is created automatically on the sending IED if it does not exist yet. When sending or receiving GOOSE or sampled value data, the inputs corresponding to the sent or received data set are created automatically on the receiving IED.

5.5.2 Creating new objects

New objects can be created in the Data Sets, GOOSE Controls, Report Controls, Sampled Value Controls and Subnetworks tabs.

- Create new objects in the **Data Sets**, **GOOSE Controls**, **Report Controls** or **Sampled Value Controls** tab.
  1. Open the dialog box for creating a new object in one of the alternative ways.
     - On the **Edit** menu, click **New**.
     - Click the New button on the PCM600 toolbar.
     - Press CTRL+ALT+N.
  2. Create a new object.
     - 2.1. In the tree on the left, select the logical node where to create the new object.
     - 2.2. Type or select the required information in the fields on the right.
     - 2.3. Click **OK** or press ENTER to create the object.
- Create new objects in the **Subnetworks** tab.
  1. Open the dialog box for creating a new object in one of the alternative ways.

     - On the **Edit** menu, click **New**.
     - Click the New button on the PCM600 toolbar.
     - Press CTRL+ALT+N.
  2. Create a new subnetwork.
     - 2.1. Enter a unique subnetwork name in the **Name** box (mandatory).
     - 2.2. Type a description in the **Description** box (optional).
     - 2.3. Click **OK** or press ENTER to create the object.

5.5.3 Editing data set entries

- Open the data set editor window in the **Data Sets** tab in one of the alternative ways.
  - Select the data set, and on the **Edit** menu, click **Details**.
  - Click the Details button on the PCM600 toolbar.
  - Right-click the data set and select **Details**.
  - Select the data set and click the Browse button of the **Entries** property in the **Object Properties** window.
  - Double-click the data set.
- Right-click a control block and select **Data Set Details** to open the data set editor window in the **GOOSE Controls**, **Report Controls** or **Sampled Value Controls** tab.
- Select the data.
  1. Select a logical device in the LD list.
  2. Select a logical node in the LN list.
     Logical nodes can be searched by entering the logical node name or part of it into the text field above the logical node list.
  3. Select a data object in the DO list.
  4. Select one or more functional constraints in the FC list or select one or more data attributes in the DA list.
- Append the selected data at the end of the **Data Set Entries** list by clicking the **Append** button or by pressing CTRL+ALT+A.
- Insert the selected data into the **Data Set Entries** list.
  1. Select the location to insert the data.
  2. Click **Insert** or press CTRL+ALT+I.
- Remove the entries from the **Data Set Entries** list.
  1. Select the entries to be removed.
  2. Click **Remove** or press DELETE.
- Move the entries up or down in the **Data Set Entries** list.
  1. Select the entry to be moved.
  2. Click **Up** or **Down** or press CTRL+ALT+UP ARROW or CTRL+ALT +DOWN ARROW.
- Click **OK** or press ENTER to apply the changes.

The current number and the maximum number of entries allowed in data set are displayed on top of the Data Set Entries list. How the current number of entries is calculated depends on the IEC 61850 edition of the IED. On IEC 61850 Edition 1 IEDs, one row in the Data Set Entries list can mean more than one entry depending on what kind of data it is. On IEC 61850 Edition 2 IEDs, one row in the Data Set Entries list means always one entry regardless of what kind of data it is.

Example: DR.RDRE1.RcdMade (ST) data is added to the Data Set Entries list. On Edition 1 IEDs this data means three entries because data object RcdMade contains three data attributes of ST type and the current number of entries is increased by three. On Edition 2 IEDs this data means only one entry and the current number of entries is increased by one.

Section 6 Glossary

ANSI	American National Standards Institute
ARP	Address Resolution Protocol
DA	Data attribute
DO	Data object
FC	Functional constraint
FTP	File transfer protocol
GOOSE	Generic Object-Oriented Substation Event
IEC	International Electrotechnical Commission
IEC 61850	International standard for substation communication and modeling
IED	Intelligent electronic device (protection and control relay)
LD	Logical device
LHMI	Local human-machine interface
LN	Logical node
MAC	Media access control
PC	1. Personal computer 2. Polycarbonate
PCM600	Protection and Control IED Manager
SCL	XML-based substation description configuration language defined by IEC 61850
UAC	User Account Control
WHMI	Web human-machine interface

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