Relion® Protection and Control

650 series ANSI
Engineering Manual

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ABB

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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 and ANSI C37.90. The DNP protocol implementation in the IED conforms to "DNP3 Intelligent Electronic Device (IED) Certification Procedure Subset Level 2", available at www.dnp.org .

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Section 1   Introduction

1.1   This manual

The engineering manual contains instructions on how to engineer the IEDs using the different tools in PCM600. 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 engineering of protection and control functions, LHMI functions as well as communication engineering for IEC 60870-5-103, IEC 61850 and DNP3.

1.2   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

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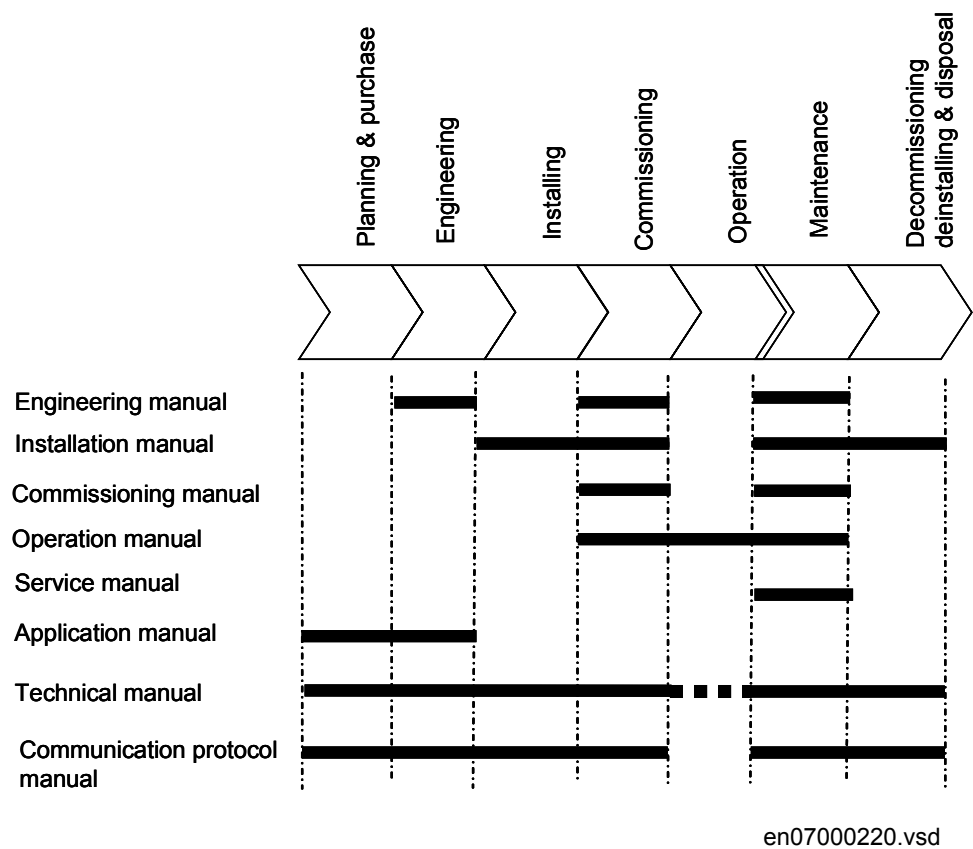
Figure 1:   The intended use of manuals in different lifecycles

The engineering manual contains instructions on how to engineer the IEDs using the different tools in PCM600. 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 engineering of protection and control functions, LHMI functions as well as communication engineering for IEC 60870-5-103, IEC 61850 and DNP3.

The installation manual contains instructions on how to install the IED. The manual provides procedures for mechanical and electrical installation. The chapters are organized in 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 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 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.

1.3.2 Document revision history

Document revision/date	History
-/March 2012	First release
A/June 2012	Minor corrections made

1.3.3 Related documents

650 series manuals	Identity number
Communication protocol manual, DNP3	1MRK 511 257-UUS
Communication protocol manual, IEC 61850–8–1	1MRK 511 258-UUS
Communication protocol manual, IEC 60870-5-103	1MRK 511 259-UUS
Cyber Security deployment guidelines	1MRK 511 268-UUS
Point list manual, DNP3	1MRK 511 260-UUS
Engineering manual	1MRK 511 261-UUS
Operation manual	1MRK 500 095-UUS
Installation manual	1MRK 514 015-UUS

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. Therefore, comply fully with all warning and caution 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

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.
  To navigate between the options, use ⬆ and ⬇.
- HMI menu paths are presented in bold.
  Select **Main menu/Settings**.
- LHMI messages are shown in Courier font.
  To save the changes in non-volatile memory, select `Yes` and press ↵.
- Parameter names are shown in italics.
  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.
- Dimensions are provided both in inches and mm. If it is not specifically mentioned then the dimension is in mm.

1.4.3 Functions included in 650 series IEDs

Table 1:   Main protection functions

IEC 61850 / Function block name	ANSI	Function description
T2WPDIF	87T	Transformer differential protection, two winding
T3WPDIF	87T	Transformer differential protection, three winding
REFPDIF	87N	Restricted ground fault protection, low impedance
HZPDIF	87	1Ph High impedance differential protection
GENPDIF	87G	Generator differential protection
ZQMPDIS	21	Five-zone distance protection, Quadrilateral and Mho characteristic
FDPSPDIS	21	Phase selection with load enchroachment, quadrilateral characteristic
FMPSPDIS	21	Faulty phase identification with load enchroachment for mho
ZDARDIR	21	Additional distance protection directional function for ground faults
ZDNRDIR	21	Directional impedance quadrilateral and mho
Table continues on next page		

IEC 61850 / Function block name	ANSI	Function description
PPLPHIZ		Phase preference logic
ZMRPSB	68	Power swing detection
ZCVPSOF		Automatic switch onto fault logic, voltage-and current-based
ZGCPDIS	21G	Underimpedance protection for generators and transformers
LEXPDIS	40	Loss of excitation
OOSPPAM	78	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
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
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
Table continues on next page		

IEC 61850 / Function block name	ANSI	Function description
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	59THD	100% Stator ground 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 grounding 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
Table continues on next page		

IEC 61850 / Function block name	ANSI	Function description
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
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
TimerSet		Configurable logic blocks, timer
AND		Configurable logic blocks, AND
Table continues on next page		

IEC 61850 / Function block name	ANSI	Function description
SRMEMORY		Configurable logic blocks, set-reset memory
RSMEMORY		Configurable logic blocks, reset-set memory
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
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
Table continues on next page		

IEC 61850 / Function block name	ANSI	Function description
I103EF		Function status ground-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
IEC61850-8-1		IEC61850 communication protocol
DNPSER DNPGEN RS485DNP DNPFREC CH1TCP - CH4TCP OPTICALDNP MSTSERIAL MST1TCP - MST4TCP RS485GEN OPTICALPROT RS485PROT		DNP3.0 for serial communication EIA485 DNP3.0 for TCP/IP communication protocol DNP3.0 for EIA-485 communication protocol DNP3.0 fault records for TCP/IP communication protocol DNP3.0 for TCP/IP communication protocol DNP3.0 for TCP/IP communication protocol DNP3.0 for optical RS-232 communication protocol DNP3.0 for serial communication protocol RS485 Operation selection for optical serial Operation selection for RS485
DNPFREC		DNP3.0 fault records for TCP/IP communication protocol
OPTICAL103		IEC60870-5-103 Optical serial communication
RS485103		IEC60870-5-103 serial communication for RS485
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
Table continues on next page		

IEC 61850 / Function block name	ANSI	Function description
ZCPSCH	85	Scheme communication logic with delta based blocking scheme signal transmit
ZCRWPSCH	85	Current reversal and weak end infeed logic for distance protection
ZCWSPSCH	85	Current reversal and weak end infeed logic for distance protection
ZCLCPLAL		Local acceleration logic
ECPSCH	85	Scheme communication logic for residual overcurrent protection
ECRWPSCH	85	Current reversal and weak end infeed logic for residual overcurrent protection

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
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 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.

> ℹ️ For performance reasons, do not insert more than 150 IEDs of 650 series type in one PCM600 project. In PCM600 version 2.3, the maximum number of IEDs is 60. 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

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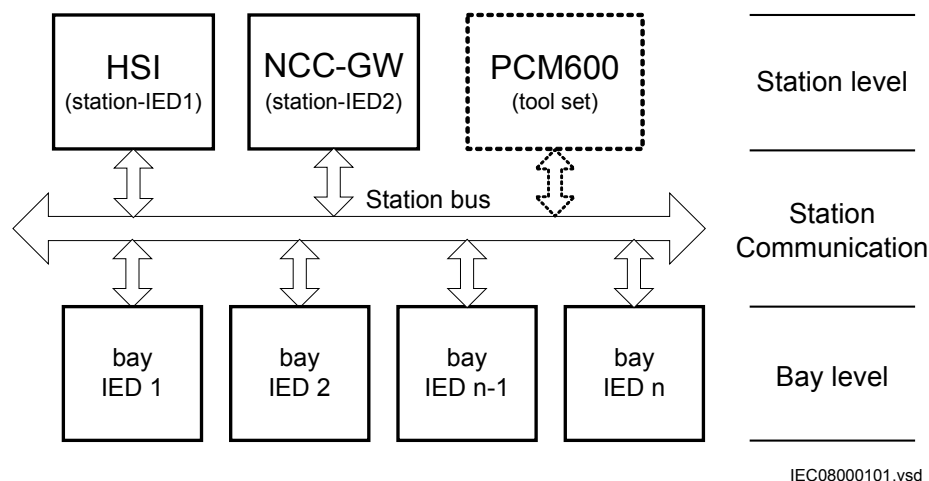
Figure 2:   Principle structure of a monitoring and control system for a substation

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 is done with a separate tool, IET600. PCM600 interacts with IET600 by importing and exporting SCL files.
  - 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.
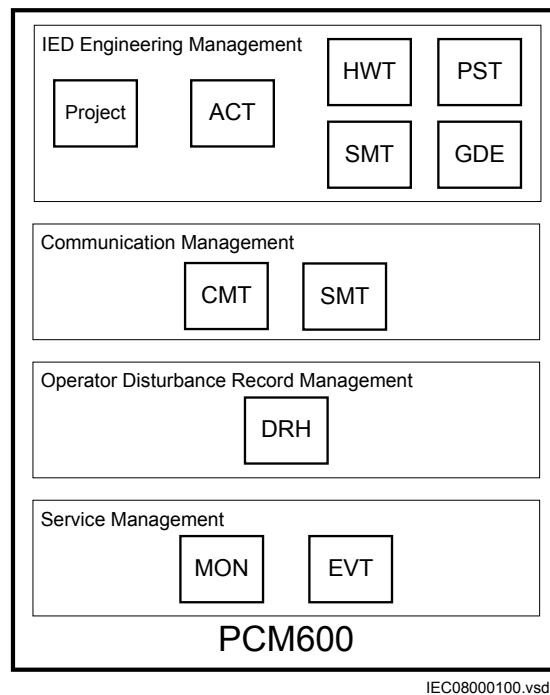

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Figure 3:   Organization of PCM600 in different management tasks

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
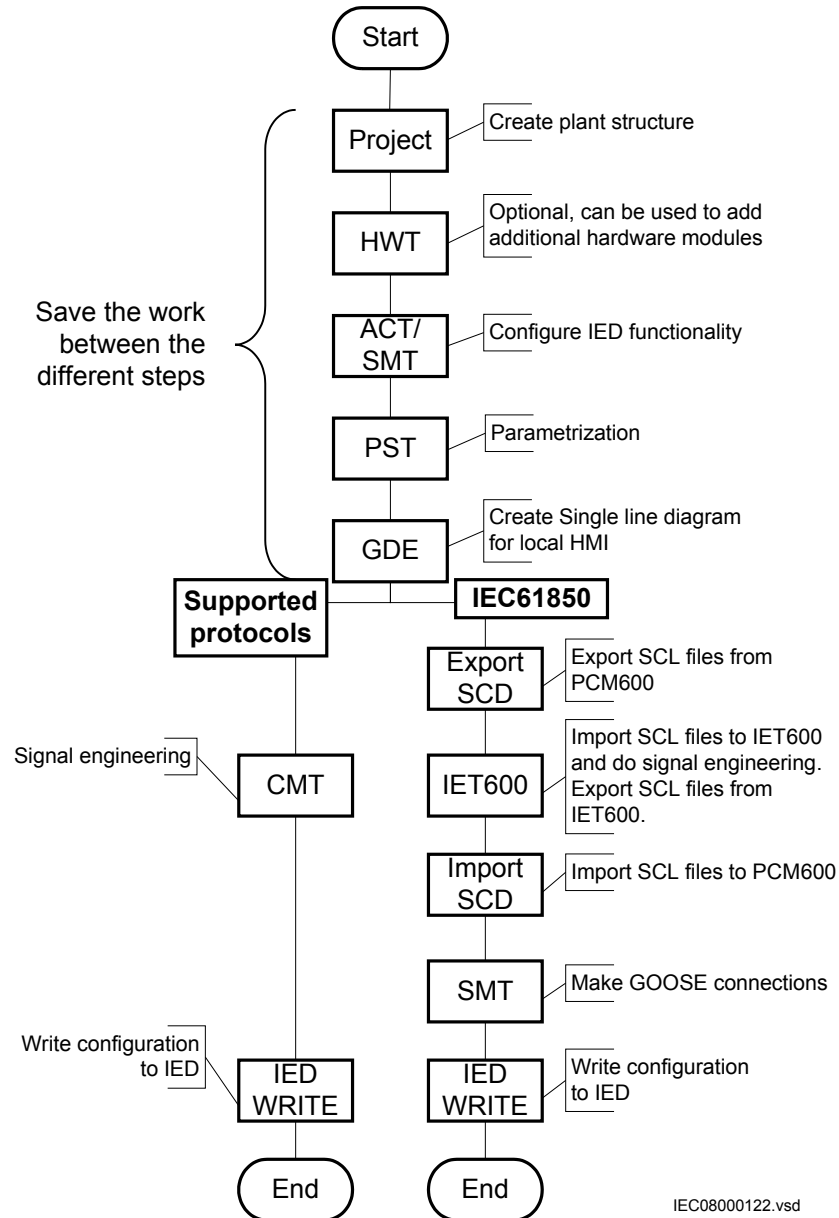
Figure 4:   *IED engineering workflow*

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 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 RE_650.exe* installation wizard.
2. Select the IED type(s) to install in the installation wizard window, for example *REL650 module 1.0.0 Module v.n.* (*n* = version number).The installation software guides the user through steps required to install the *IED Connectivity package base module* and the specific IED type modules. The IED specific module is

installed to same location as for IEDConnectivity package base module. The default directory is *C:/Program Files/ABB/Connectivity Packages/ IEDConnPackRE_650*.

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.

IEC09000378-1-en.vsd
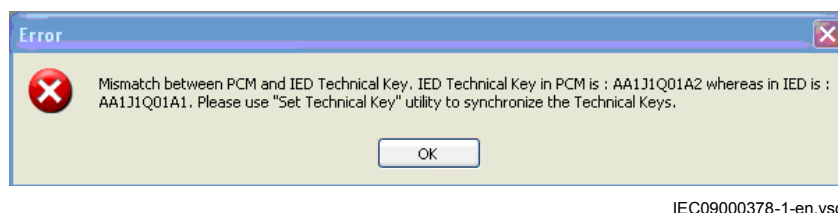
Figure 5:   *Error message due to mismatch between PCM600 and IED technical key*

> 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.
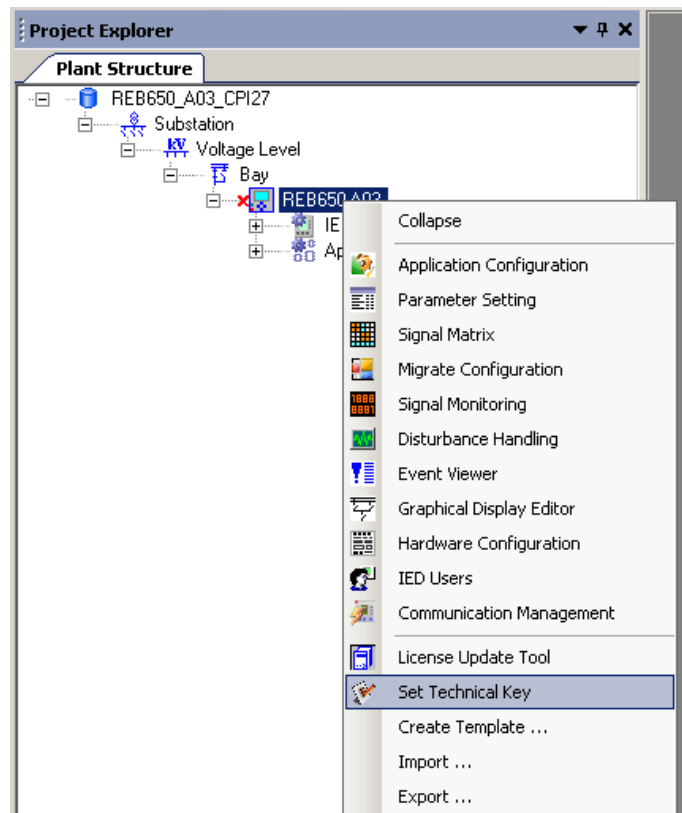
IEC09000667-2-en.vsd

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 .
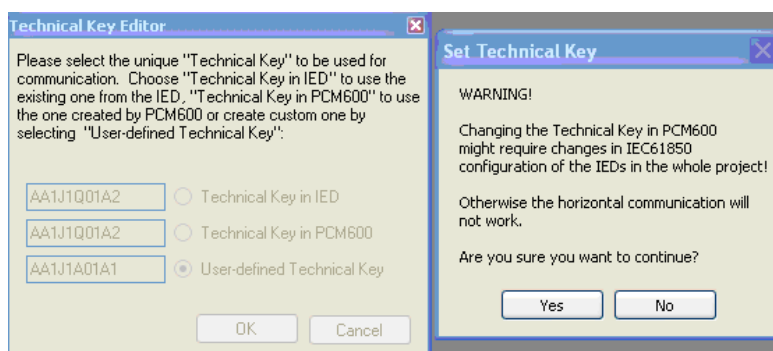
IEC09000380-1-en.vsd

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 and on the rear side. The Ethernet connector can 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/1:ETHFRNT**.
- The default IP address for the IED rear port is 192.168.1.10 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/1:ETHLAN1** and **Rear OEM - port CD**.

> The front and rear port IP addresses cannot belong to the same subnet or communication will fail. It is recommended to change the IP address of the front port, if the front and rear port are set to the same subnet.

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 should be about 2 m. The connector type is RJ-45.

IEC09000096-1-en.vsd
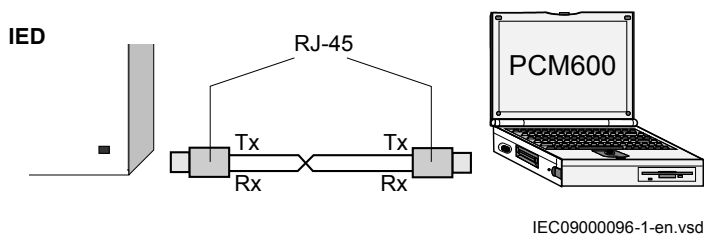
Figure 8:   *Point-to-point link between IED and PCM600 using a null-modem cable*

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 *Enabled* via the local HMI path **Main menu/Configuration/Communication/TCP-IP configuration/1:ETHFRNT/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 **Network Connections** in the PC.
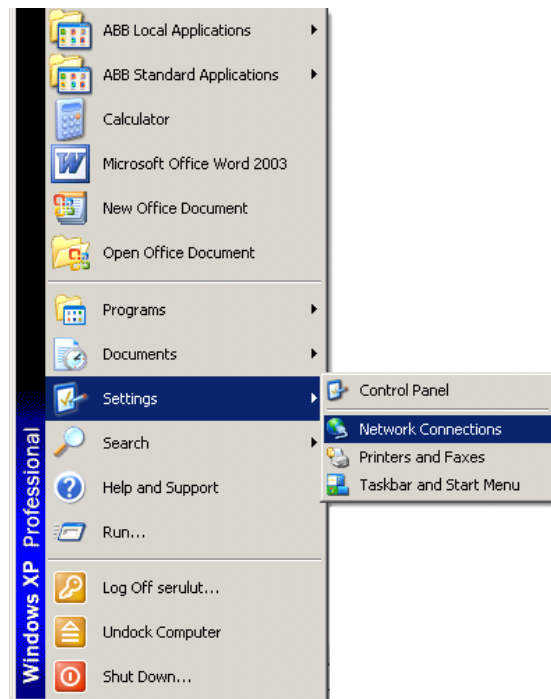
IEC09000355-1-en.vsd

Figure 9:   Select: Network connections

2. Select **Properties** in the status window.
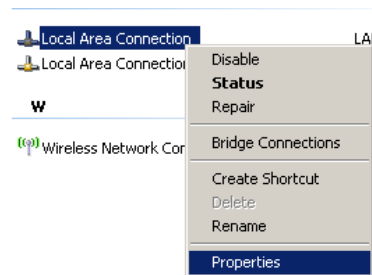
IEC09000356-1-en.vsd

Figure 10:   Right-click Local Area Connection and select Properties

3. Select the TCP/IP protocol from the list of configured components using this connection and click **Properties**.
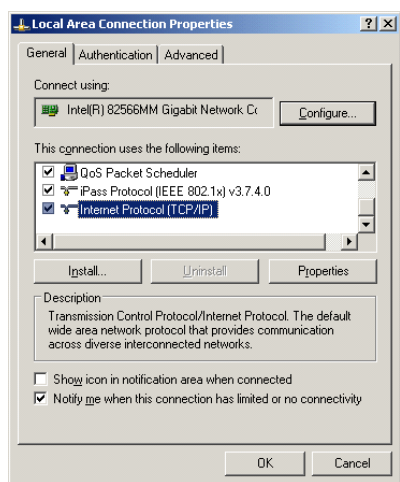
IEC09000357-1-en.vsd

Figure 11:   Select the TCP/IP protocol and open Properties

4.   Select **Obtain an IP address automatically** if the parameter *DHCPServer* is set
     to *Enabled* in the IED.
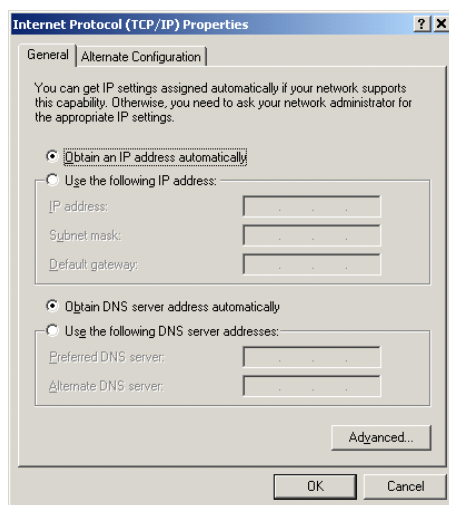
IEC09000358-1-en.vsd

Figure 12:   Select: Obtain an IP address automatically

5.   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 13. The IP address must be different from the IP address
     chosen for the IED.
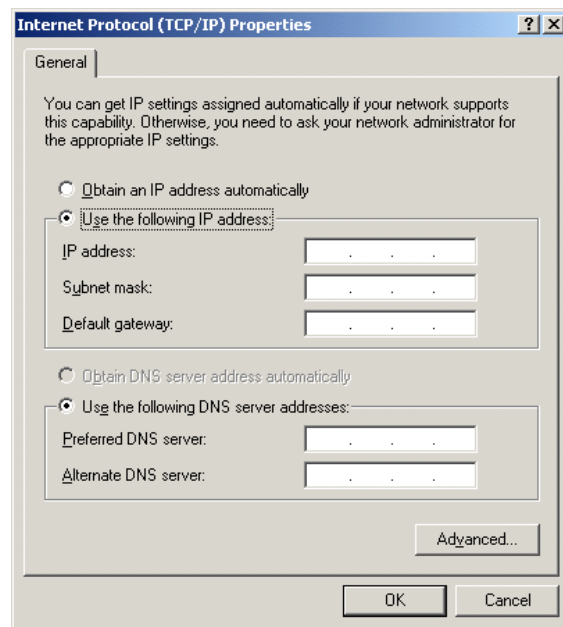
IEC09000658-1-en.vsd

Figure 13:   Select: Use the following IP address

6.   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

> ℹ️ 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 14.
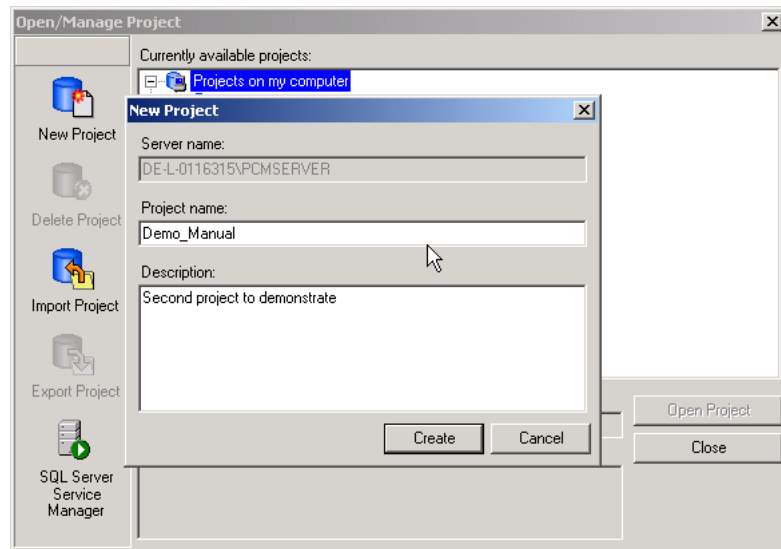
en05000609.vsd

Figure 14:   *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 = Center
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.

IEC08000365-2-en.vsd
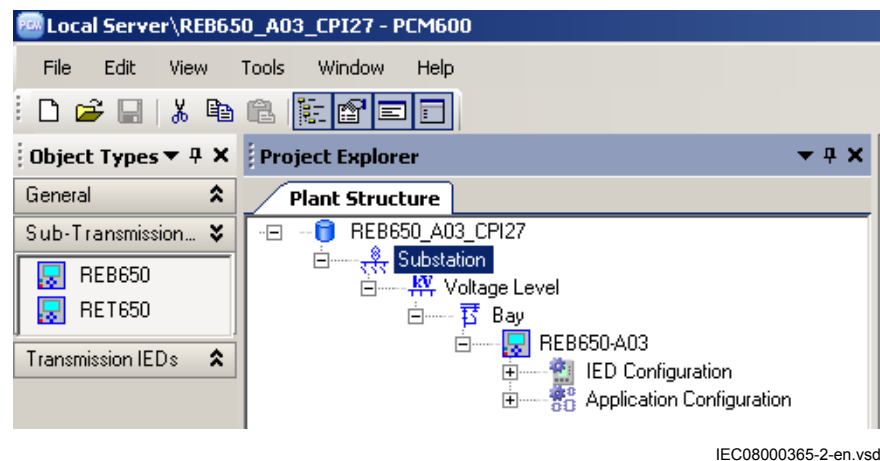
Figure 15:   PCM600: Set up a plant structure

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 15 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. This is contained in the attribute name as identification of each object. If this value is used as reference to an object, it is contained in an attribute name starting with a string denoting the reference target object type, and ending with the string *Name*. 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 16.

- 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.
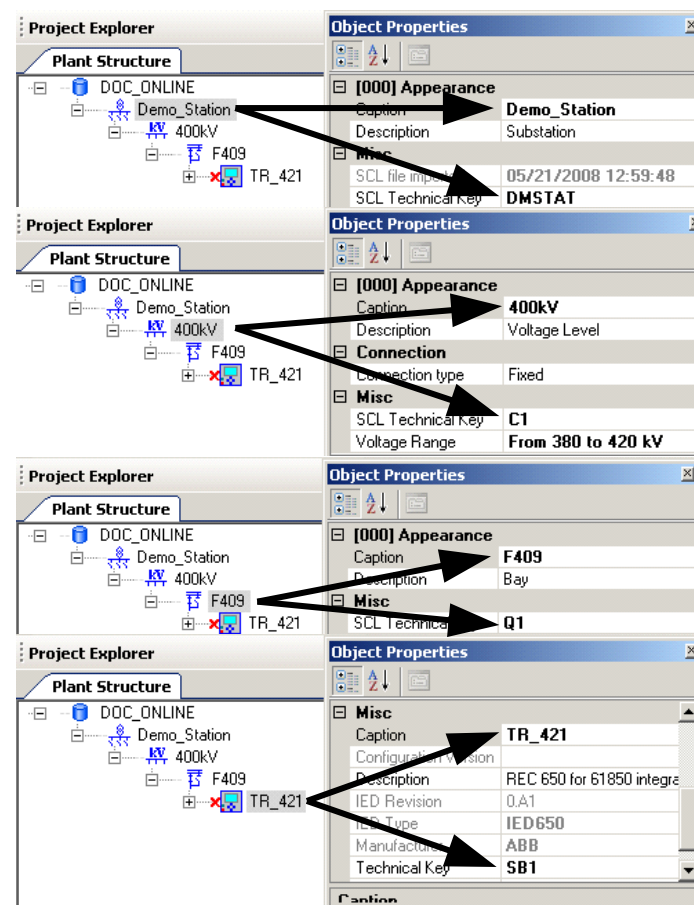
Figure 16:   PCM600: IEC 61850 signal designation concept

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.

> It is possible to judge whether the inserted IED is in offline mode or online mode from the plant structure. A red color cross before the IED symbol indicates the offline mode as shown in Figure 17.

IEC09000361-1-en.vsd
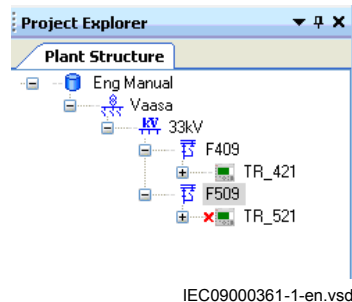
Figure 17:   Plant structure showing IED TR_421 in online mode and IED TR_521 in offline mode

*   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

For setting up an IED online, the IED must be connected to PCM600.

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.
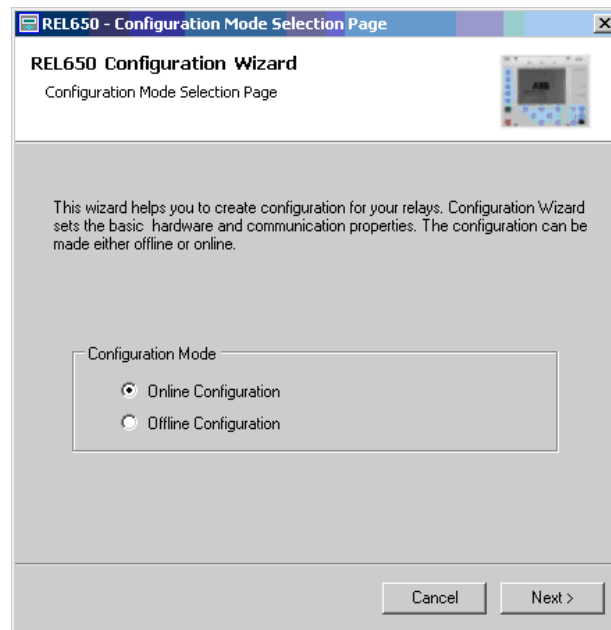
IEC09000660-1-en.vsd

Figure 18:   PCM600: Configuration mode selection wizard

4. Select the IED Communication protocol, see Figure 19.
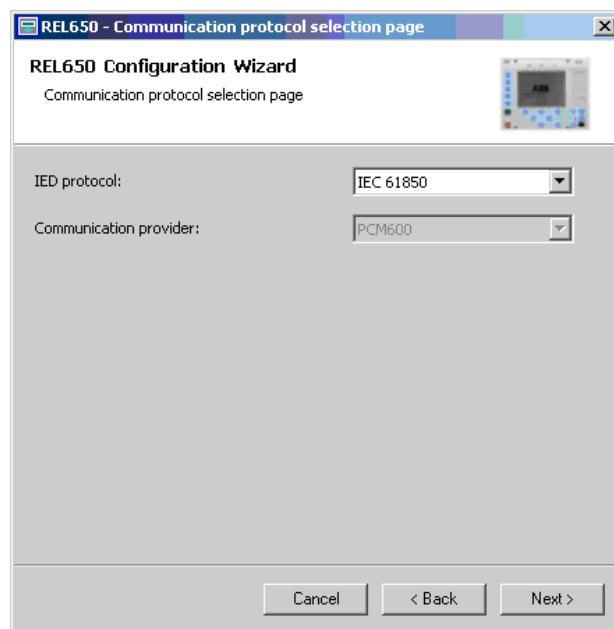
IEC09000661-1-en.vsd

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.

IEC09000662-1-en.vsd
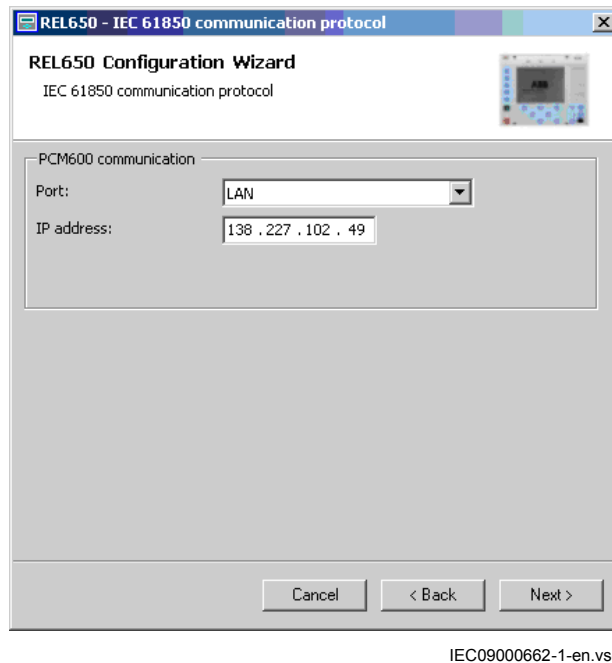
Figure 20:   PCM600: Communication port and IP address

6. Cross-check that the IED whose IP address has been inserted has been detected online by PCM600, see Figure 17.

> **i** 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.
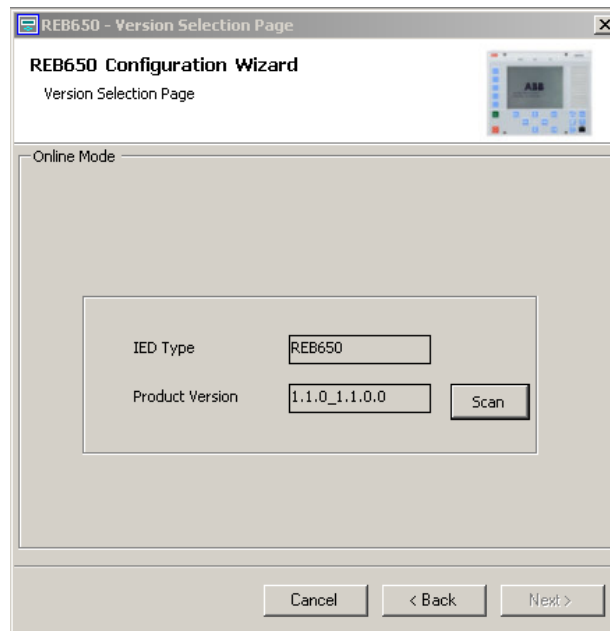
IEC09000663-2-en.vsd

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

IEC09000682-1-en.vsd
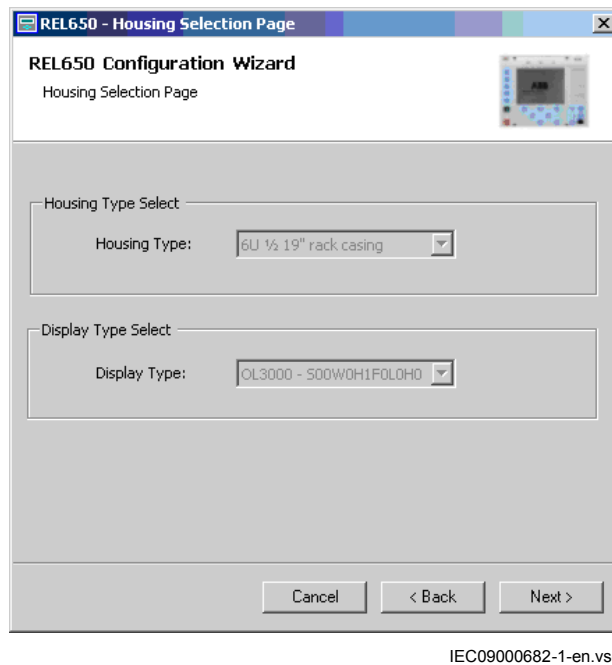
Figure 22:   PCM600: IED housing and display type detection

9. The *Setup Complete Page* dialog shows the summary of the
    IED Type, *IED Version*, *IP Address of IED* and *Order Number*,
    see . It is possible to *Cancel* the insertion or confirm the configuration
    and do the insertion with *Finish*
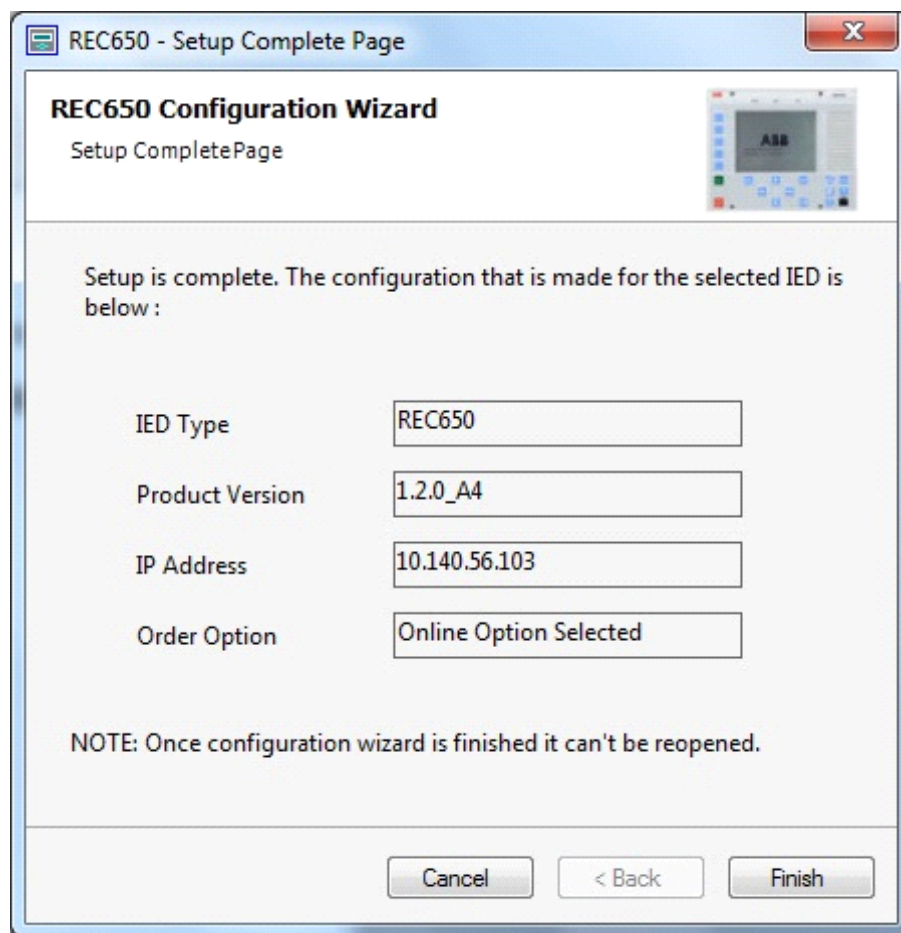
IEC09000664_3_en.vsd

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.

IEC09000665_4_en.bmp
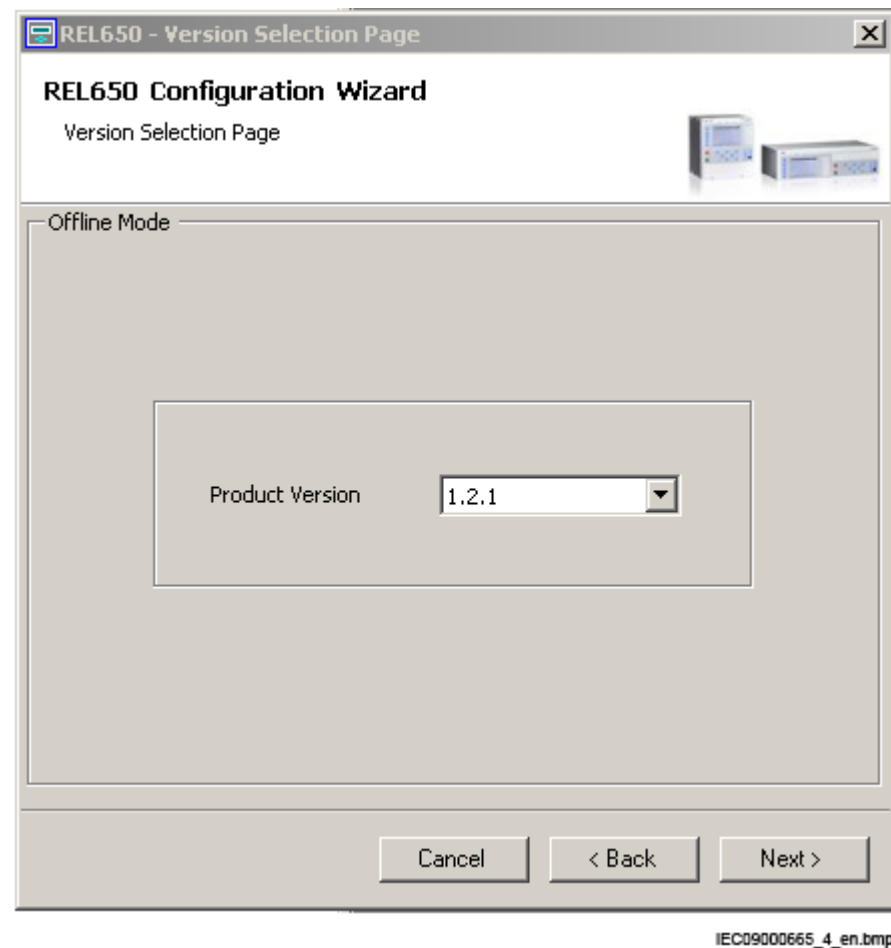
Figure 24:   *PCM600: IED Version selection*

IEC09000681 _2_en.psd
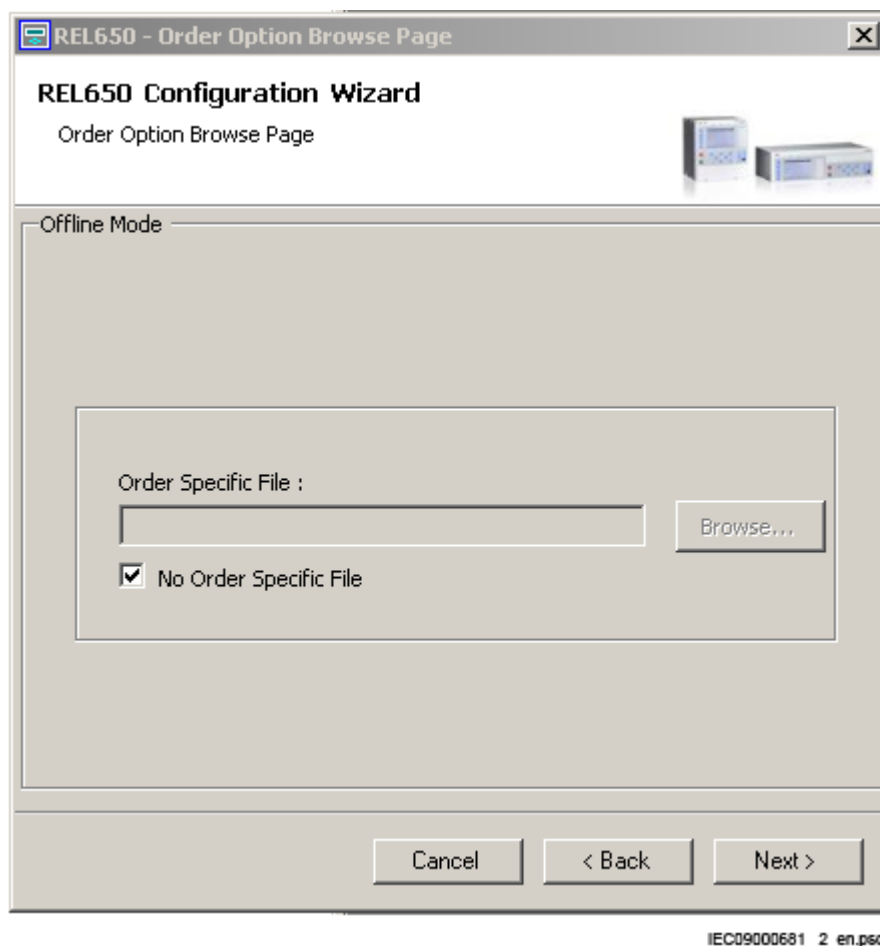
Figure 25:   *PCM600: IED Order code selection*

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.

In 650 series version 1.2.1 some hardware selections are possible to make even if they are not possible to order. It will not be possible to download an invalid hardware configuration to the IED. The tool will stop and an error message "License file is not matching" will be shown.

Hardware selections that are not available to order:

Housing variants:	6U ½ 19" rack casing
Display types:	IEC 6U ½ 19", Basic
	ANSI 6U ½ 19", Basic
Card Types	COM02

IEC12000178_1_en.psd
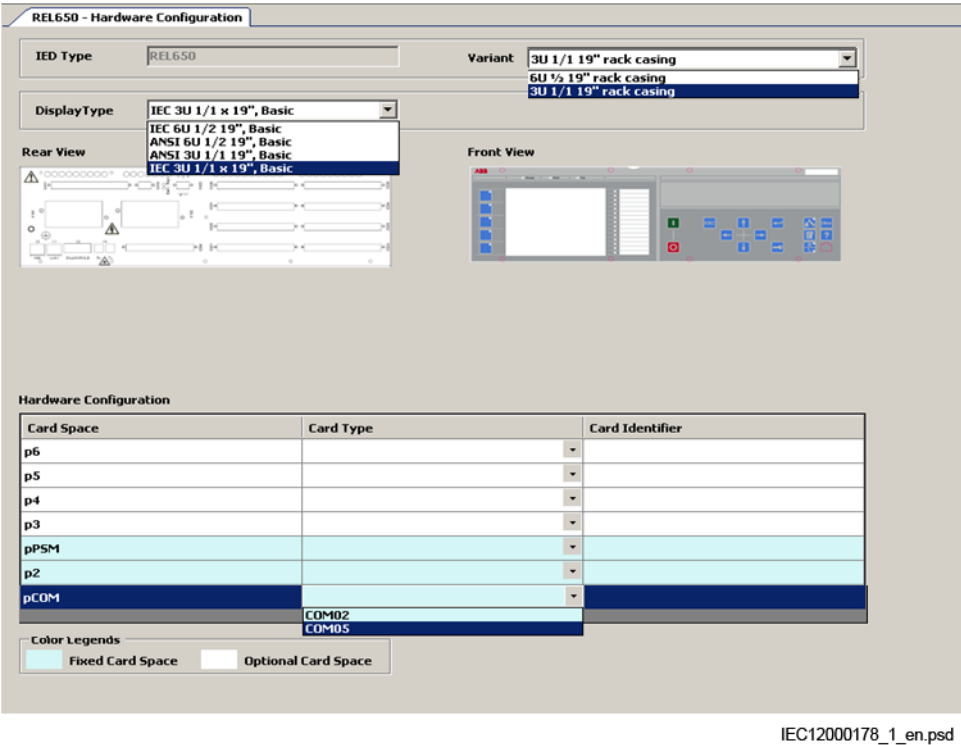
Figure 26:   *Hardware tool view of the IED*

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.

IEC08000366.vsd
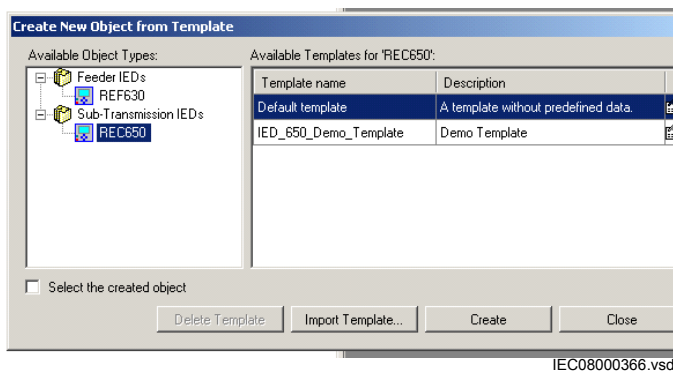
Figure 27:   *PCM600: Selecting IED from template library*

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.

IEC08000367.vsd
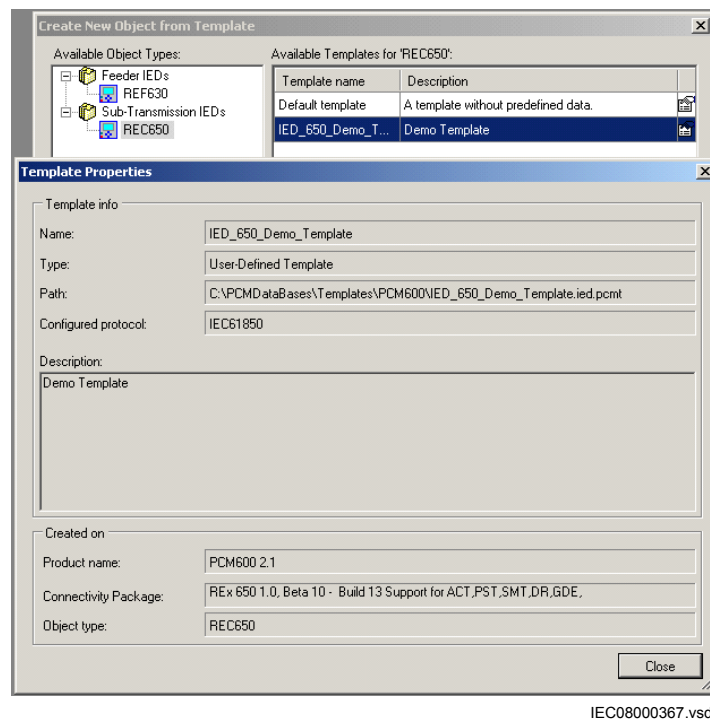
Figure 28:   *PCM600: IED Template Properties*

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.
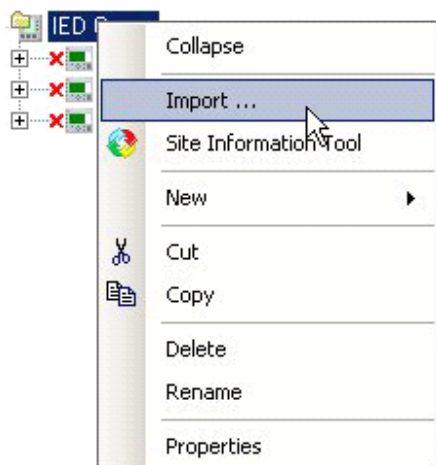
IEC09000644-1-en.vsd

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.
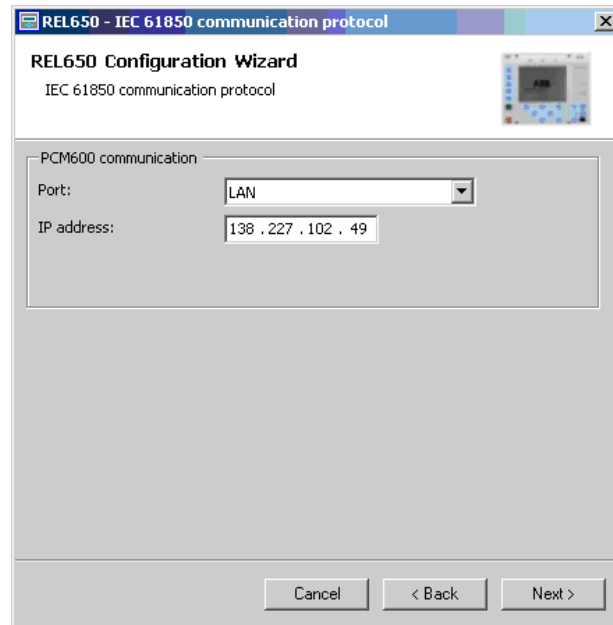
IEC09000662-1-en.vsd

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.
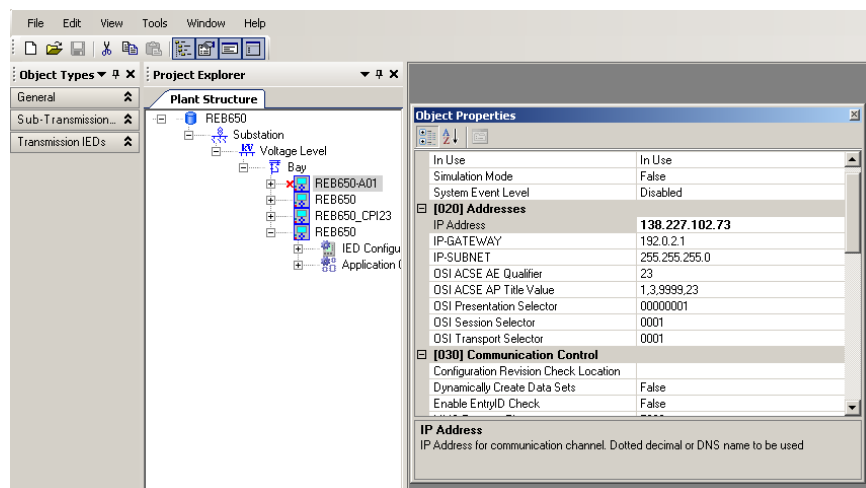
IEC08000121-2-en.vsd

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.
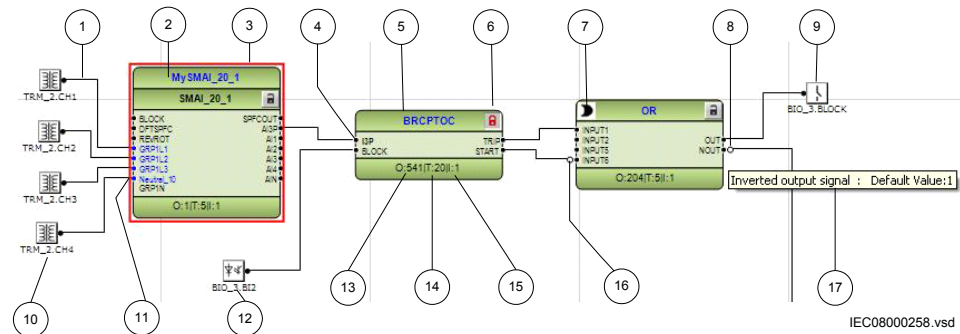
Figure 32:   ACT: Function block overview

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. The placement of the signals for a function block is from left to right. Input signals are placed on the left side and output signals are placed on the right side.

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.

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 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.

IEC08000269.vsd
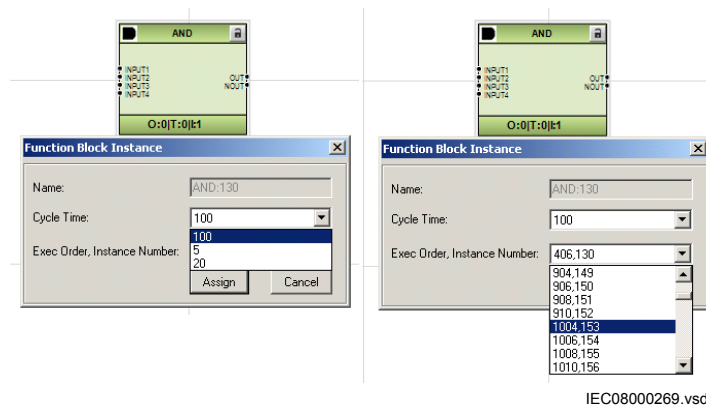
Figure 33:   ACT: function block organization parameters

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 .
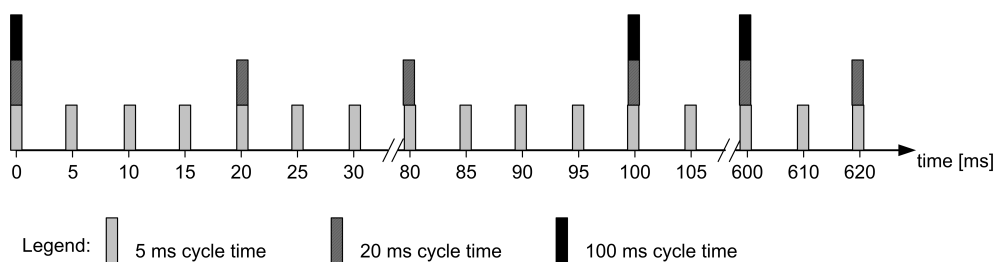
Figure 34:   ACT: Possible MainApplication cycle times

> 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 .
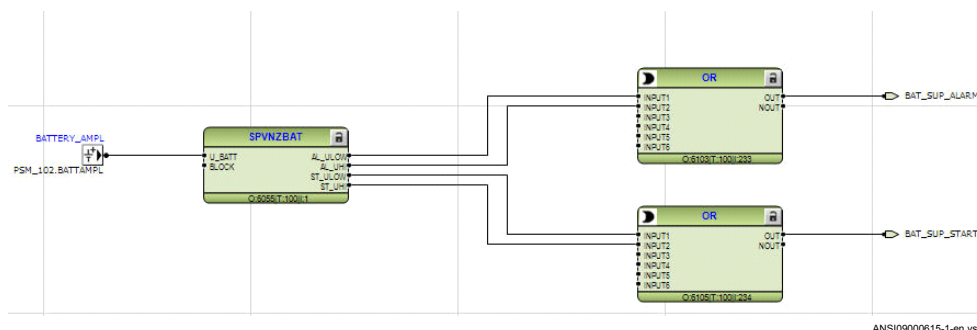
Figure 35:   Cycle time and execution order

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.
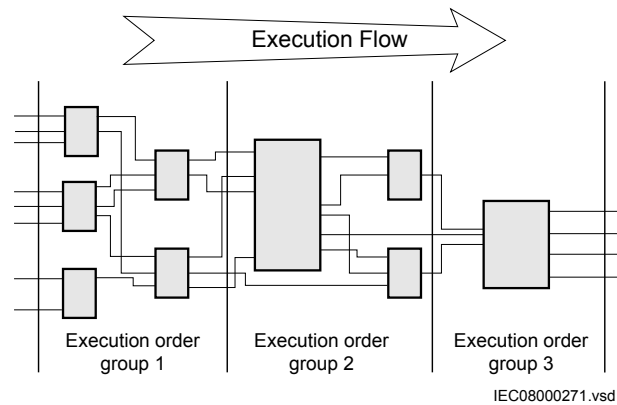
Figure 36:   ACT: Concept of Execution order sequence

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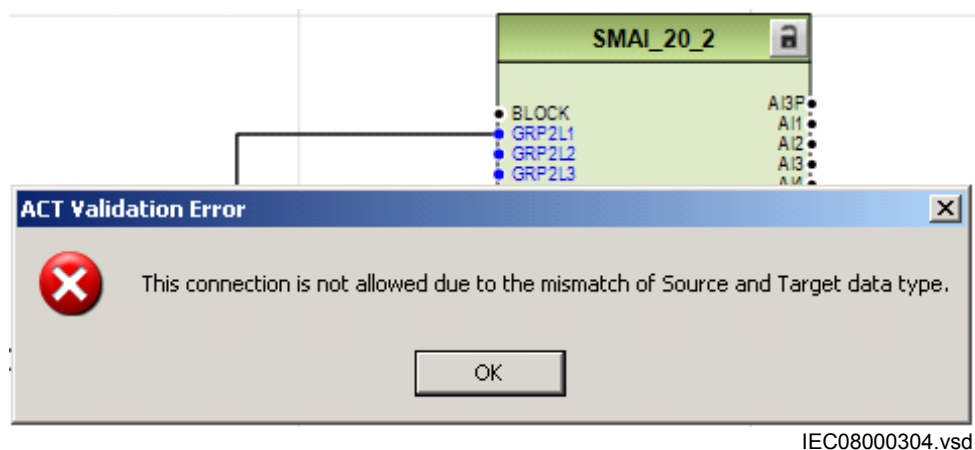
Figure 37:   *ACT: Warning message by signal mismatch for a connection*

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.
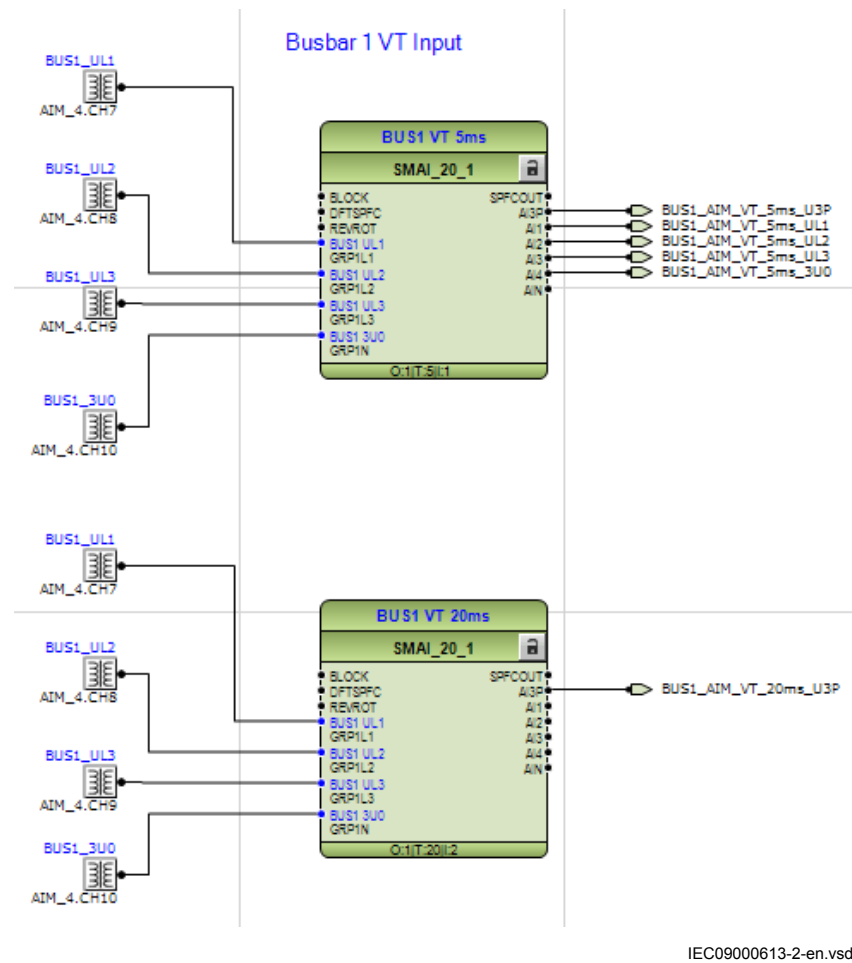
IEC09000613-2-en.vsd

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.
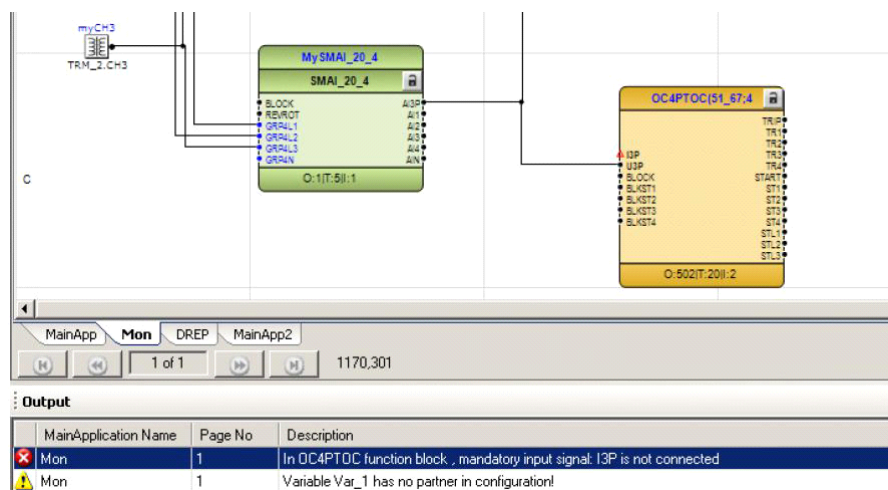
IEC09000614_2_en.vsd

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.

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.

Binary
Input

BIO

FBs

Binary
Output

BIO

FBs

Analog
Input

TRM

SMAI

GOOSE
Input blocks

GOOSE Inputs

IEC 61850

GOOSE FBs for
binary and analog
data, interlocking
communication
and voltage control

Hardware
IO interfaces
(X-direction)

Signal Matrix
FBs
(Y-direction)

IEC08000173_2_en.vsd
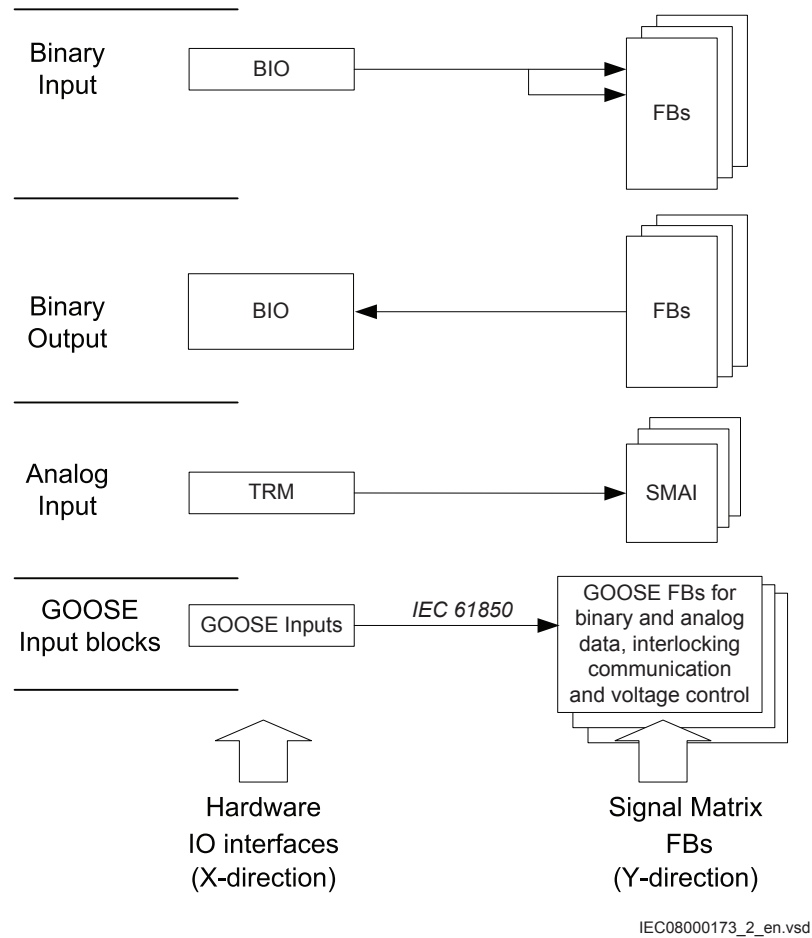
Figure 40:   SMT: Operation principles

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.
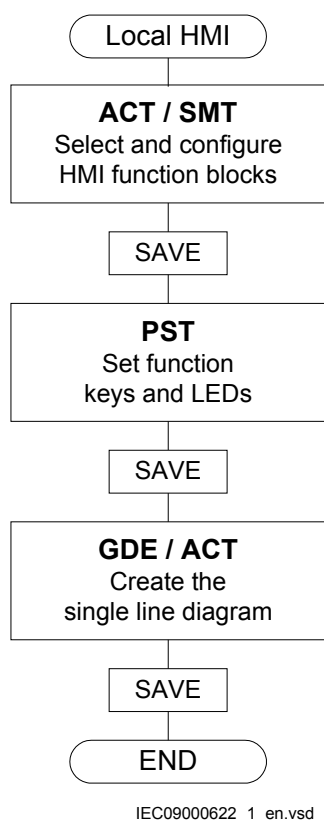
Figure 42:   *LHMI: Engineering process flowchart*

• 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.

ℹ️ 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 6 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].

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.
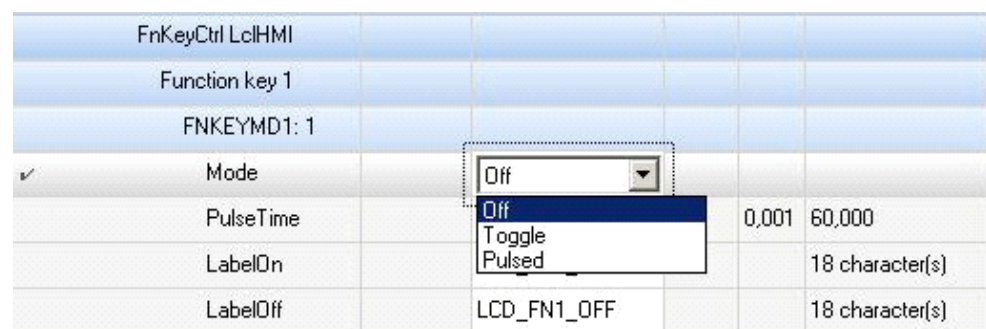
IEC09000656-1-en.vsd

Figure 43:   LHMI: Function key operation mode

The LEDs have a number of different operation modes, see Figure 44:

- 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.
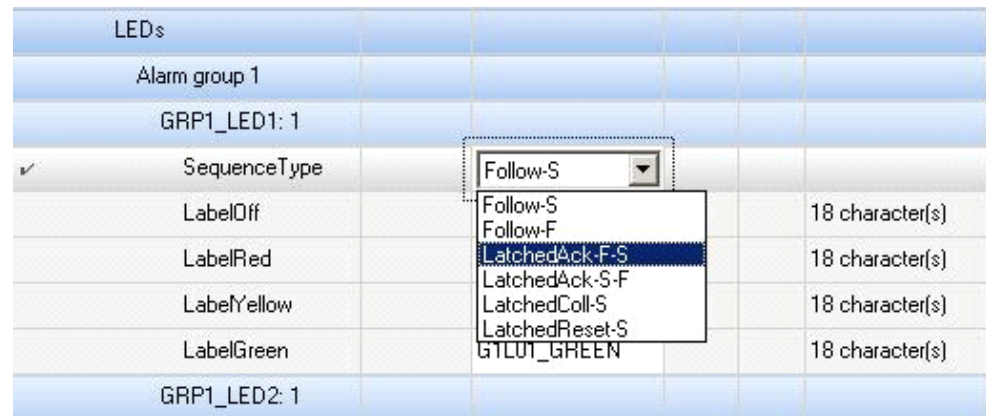
IEC09000657-1-en.vsd

Figure 44:   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

Illumination => ◯ = Steady ⊕ = Flash
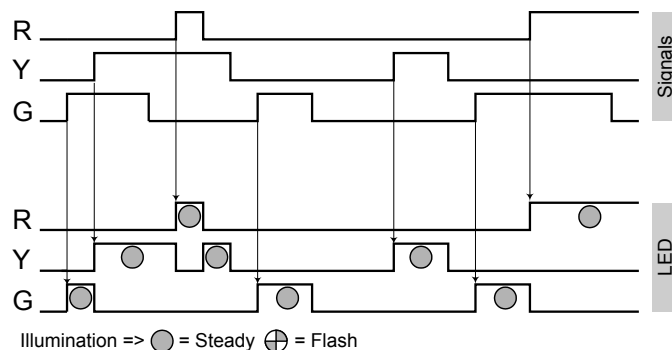
IEC08000395.vsd

Figure 45: *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 45 for the valid priority rules. The LED illuminates always in steady state.

LED operation mode Follow-F

Illumination => ◯ = Steady ⊕ = Flash
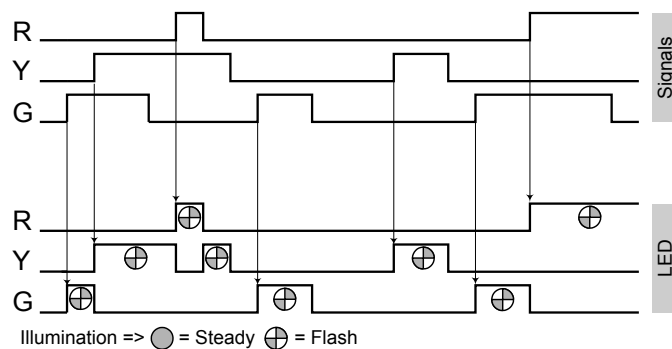
IEC08000396.vsd

Figure 46: *LHMI: LED operation mode Follow-F*

This is the same mode as Follow-S but the LED illuminates flashing, see Figure 46. This mode may be used to indicate that a tap changer or Petersen coil is moving.

LED operation mode LatchedAck-F-S
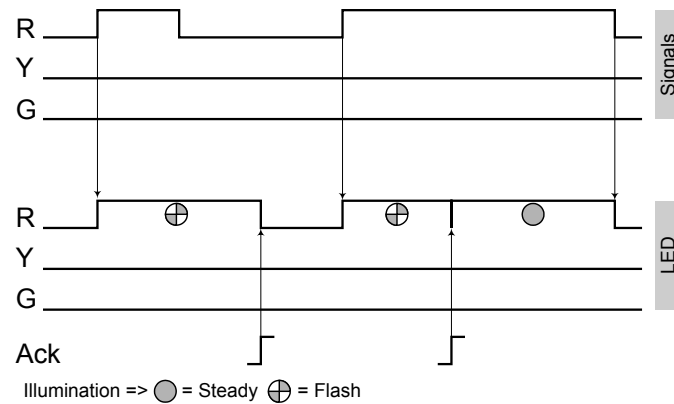
Figure 47:   LHMI: LED operation mode LatchedAck-F-S / Base

The classical mode to indicate incoming alarms or warnings, which the operator has not seen since the last acknowledgement, is presented in <u>Figure 47</u> 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.
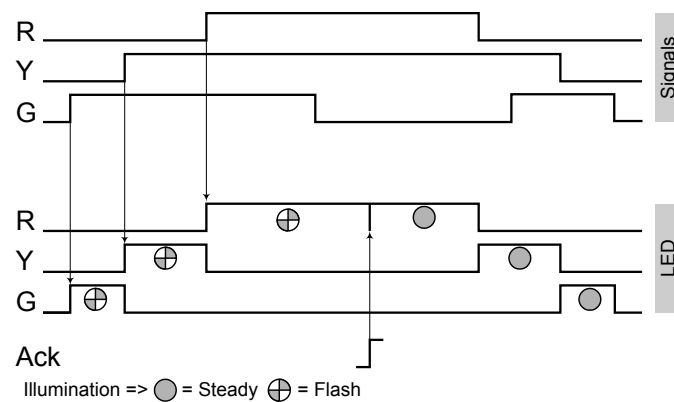
Figure 48:   LHMI LED operation mode LatchedAck-F-S Ack Prio / 1

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 48 and Figure 49 for these two principles.
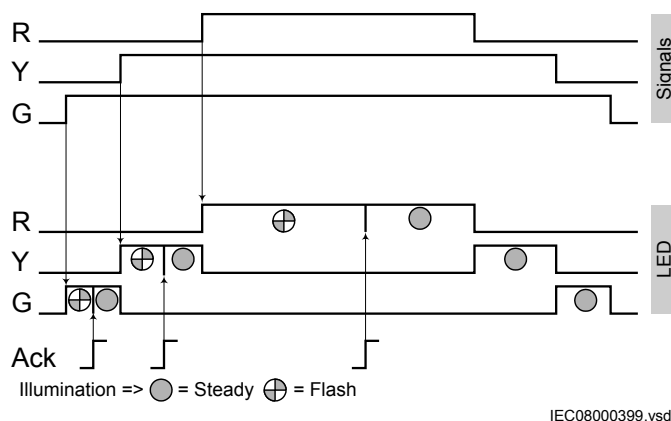
Figure 49:   *LHMI LED operation mode LatchedAck-F-S Prio / 2*

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
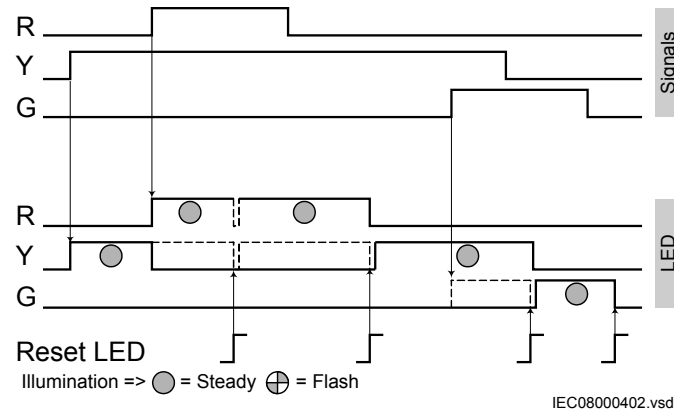
Figure 50: LHMI: LED operation mode LatchedColl-S

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 50 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
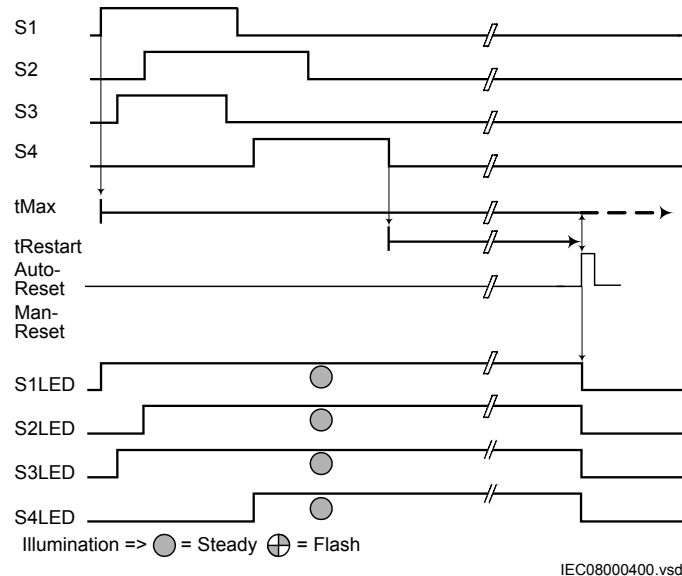
Figure 51:   *LHMI: LED operation mode LatchedReset-S*

This mode is useful to monitor signals that are involved in case of a disturbance, see Figure 51. 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 52, 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
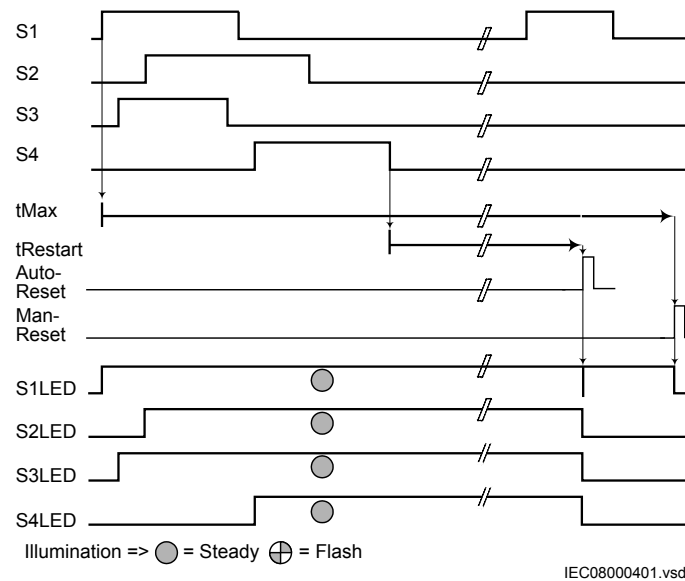
Figure 52:   *LHMI LED operation mode LatchedReset-S / 2*

6.2   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 53:

- Different GDE windows
- HMI display raster layouts
- Drawing lines (doing a Link)
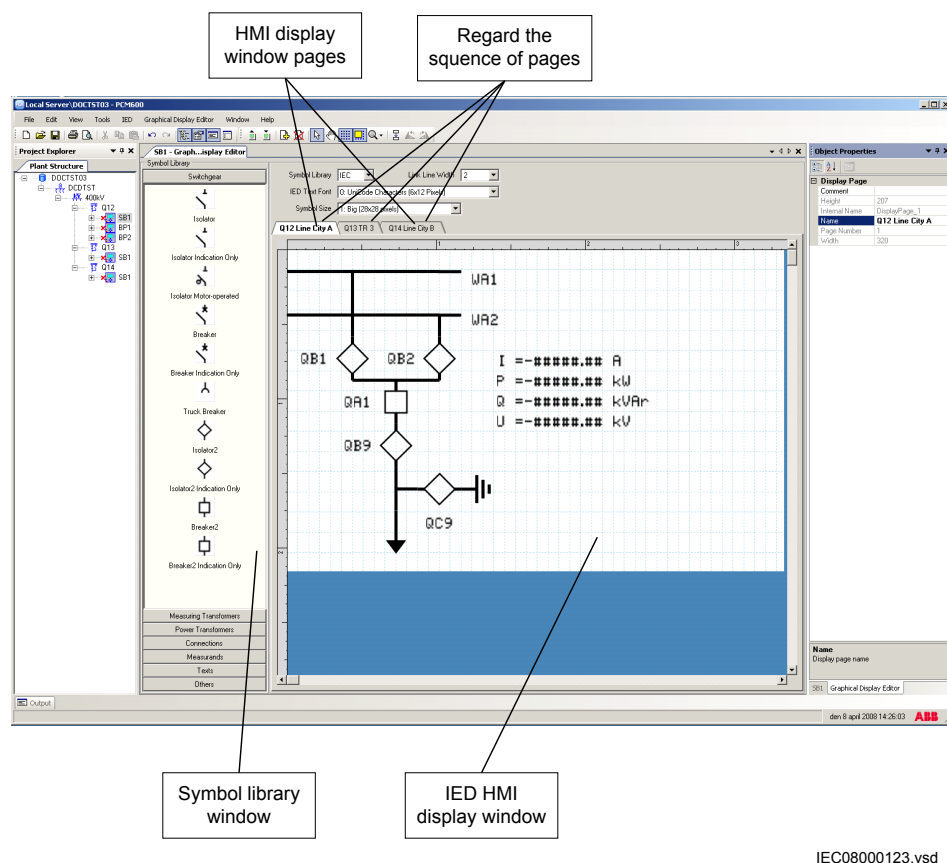
Figure 53:   *GDE: Screen image with active GDE*

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 is either valid for a single bit information or for a list of up to 32 different inputs. The corresponding function blocks in ACT are of type xxxGGIO.

- Select *Dynamic Text* and *Indication* to present the text for the actual value of the function block, see Figure 54.
- Click *Select Button* to select the value.
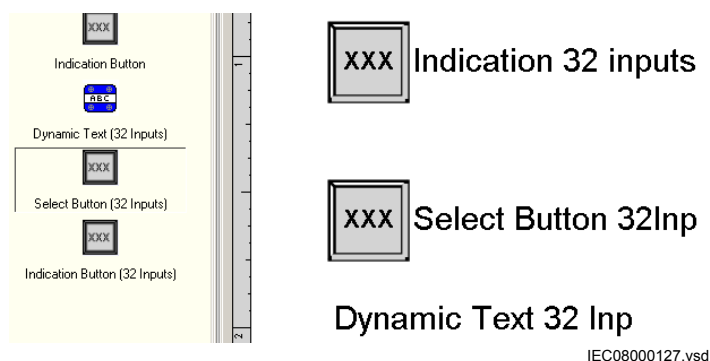
Figure 54:   GDE: Dynamic Text symbols

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 .

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.
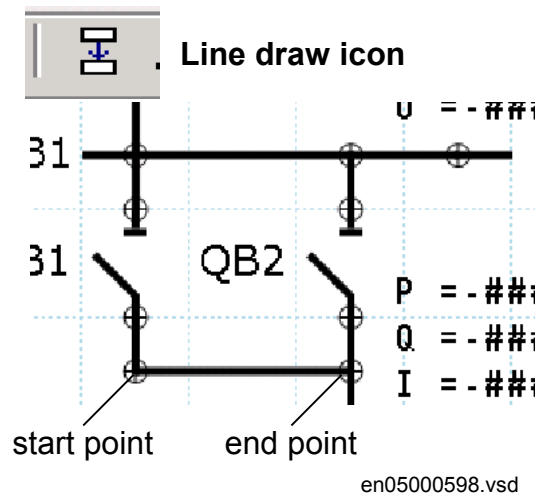
Figure 55:   *GDE: Drawing a line*

6.2.2   Supported single-line diagram symbols

Table 6:   *Supported symbols*

IEC Symbol Name	Node Type	IEC Symbol Definitions	ANSI Y32.2/ IEEE 315 Symbol Definitions	Category
Junction	1	.	.	Connections
Busbar junction	2	—	—	Connections
Ground	10			Connections
Feeder end	21			Connections
Current transformer	5			Measuring transformers
Voltage transf. 2 windings	6			Measuring transformers
Measurand	11	ABC	ABC	Measurands
Capacitor	7			Others
Surge arrestor	8			Others
Generator	9		GEN	Others
Reactor	14			Others
Motor	15		MOT	Others
Coil	18			Others
Transformer 2 winding	16			Power transformers
Transformer 3 winding	17			Power transformers
Autotransformer	23			Power transformers
Isolator, 00 = middle position	3	✕	✕	Switchgear
Table continues on next page				

IEC Symbol Name	Node Type	IEC Symbol Definitions	ANSI Y32.2/ IEEE 315 Symbol Definitions	Category
Isolator, 01 = Open	3			Switchgear
Isolator, 10 = Closed	3			Switchgear
Isolator, 11 = Undefined	3			Switchgear
Breaker, 00 = Middle position	4			Switchgear
Breaker, 01 = Open	4			Switchgear
Breaker, 10 = Closed	4			Switchgear
Breaker, 11 = Undefined	4			Switchgear
Truck, 00 = Middle position	22			Switchgear
Truck, 01 = Open	22			Switchgear
Truck, 10 = Closed	22			Switchgear
Truck, 11 = Undefined	22			Switchgear
Isolator indication only, 00 = Middle position	25			Switchgear
Isolator indication only, 01 = Open	25			Switchgear
Isolator indication only, 10 = Closed	25			Switchgear
Isolator indication only, 11 = Undefined	25			Switchgear
Breaker indication only, 00 = Middle position	26			Switchgear
Breaker indication only, 01 = Open	26			Switchgear
Breaker indication only, 10 = Closed	26			Switchgear
Breaker indication only, 11 = Undefined	26			Switchgear
Table continues on next page				

IEC Symbol Name	Node Type	IEC Symbol Definitions	ANSI Y32.2/ IEEE 315 Symbol Definitions	Category
Isolator motor operated, 00 = Middle position	27			Switchgear
Isolator motor operated, 01 = Open	27			Switchgear
Isolator motor operated, 10 = Closed	27			Switchgear
Isolator motor operated, 11 = Undefined	27			Switchgear
Isolator2, 00 = Middle position	32			Switchgear
Isolator2, 01 = Open	32			Switchgear
Isolator2, 10 = Closed	32			Switchgear
Isolator2, 11 = Undefined	32			Switchgear
Isolator2 indication only, 00 = Middle position	33			Switchgear
Isolator2 indication only, 01 = Open	33			Switchgear
Isolator2 indication only, 10 = Closed	33			Switchgear
Isolator2 indication only, 11 = Undefined	33			Switchgear
Breaker2, 00 = Middle position	34			Switchgear
Breaker2, 01 = Open	34			Switchgear
Breaker2, 10 = Closed	34			Switchgear
Breaker2, 11 = Undefined	34			Switchgear
Breaker2 indication only, 00 = Middle position	35			Switchgear
Breaker2 indication only, 01 = Open	35			Switchgear
Breaker2 indication only, 10 = Closed	35			Switchgear

Table continues on next page

IEC Symbol Name	Node Type	IEC Symbol Definitions	ANSI Y32.2/ IEEE 315 Symbol Definitions	Category
Breaker2 indication only, 11 = Undefined	35			Switchgear
Static text	0			Texts
Dynamic text	29			Texts
Select button, 00 = Middle position	30	XXX	XXX	Texts
Select button, 01 = Open	30	XXX	XXX	Texts
Select button, 10 = Closed	30	XXX	XXX	Texts
Select button, 11 = Undefined	30	XXX	XXX	Texts
Indication button, 00 = Middle position	31	XXX	XXX	Texts
Indication button, 01 = Open	31	XXX	XXX	Texts
Indication button, 10 = Closed	31	XXX	XXX	Texts
Indication button, 11 = Undefined	31	XXX	XXX	Texts

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 56.
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.

IEC09000666-1-en.vsd
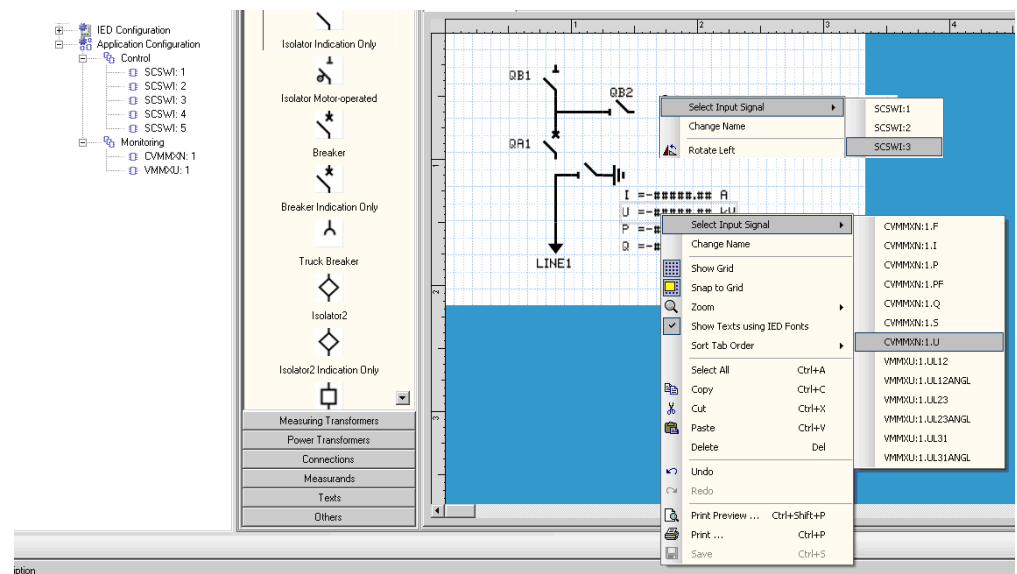
Figure 56:   *GDE: Establish a dynamic object link*

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 <u>Figure 57</u>.
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.
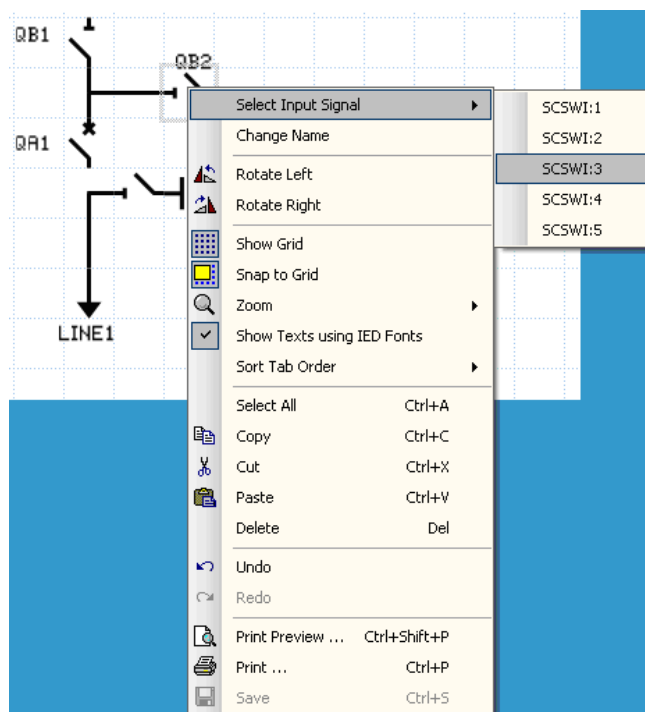
IEC08000125.vsd

Figure 57:   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.

en05000611.vsd
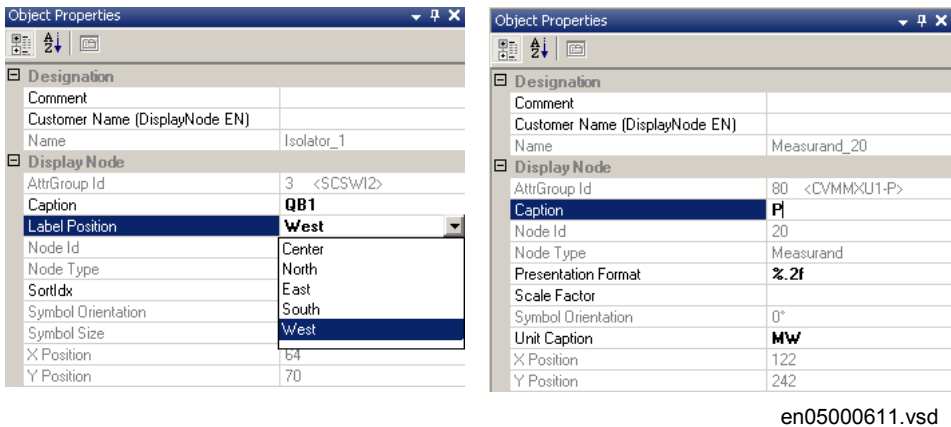
Figure 58:   *GDE: Object properties windows for text insertion*

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 59) 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

IEC10000174.vsd
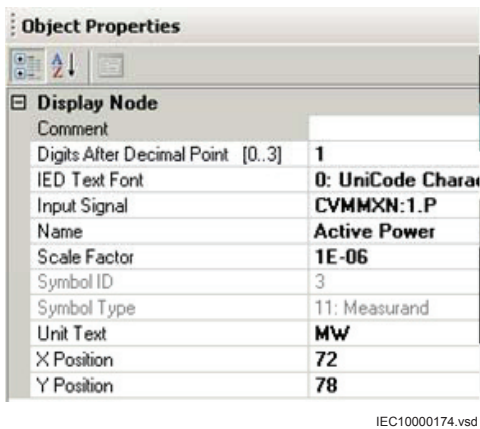
Figure 59:   *GDE: Object properties window for unit change*

6.3   Events and indications

To get IED events to the LHMI event list and indications for *Ready*, *Pickup* 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

> ℹ️ 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 60 for a principle view of the IEC 61850 logical node concept in the IED.

IEC08000364.vsd
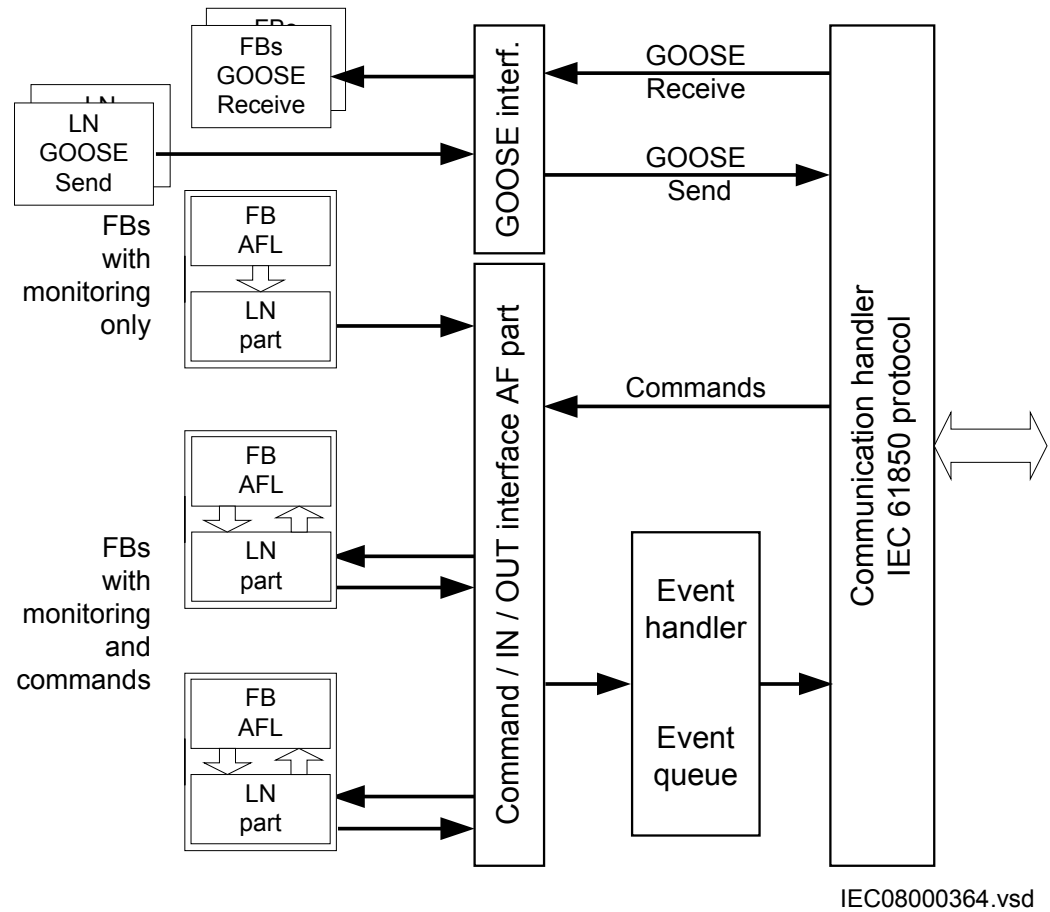
Figure 60: IEC 61850: Communication interface principle

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 60 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.

en05000830.vsd
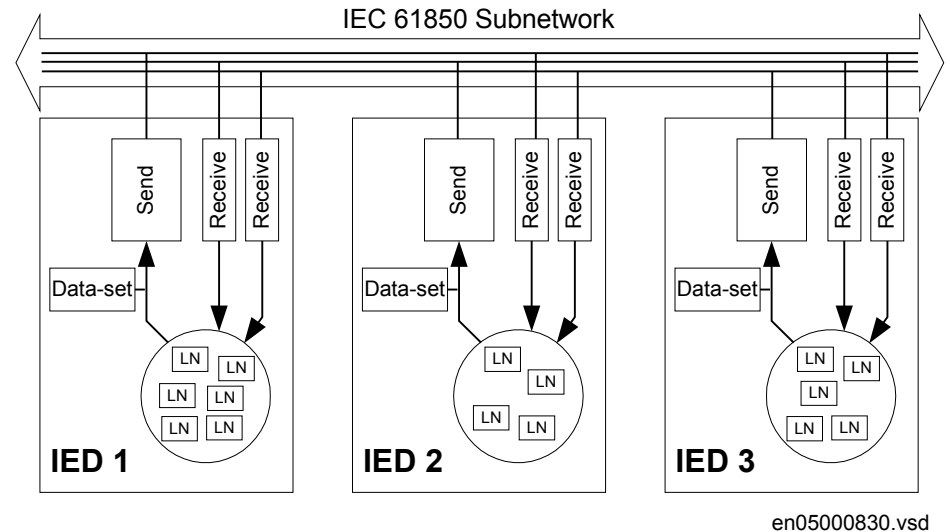
Figure 61:   *IEC 61850: Horizontal communication principle*

Figure 61 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 generated 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.

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

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 62 when a complete station is exported as a SCD file.

1. Export SCL files from PCM600. In the scenario in Figure 62 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 62 it is the updated SCD file.

IEC11000264.vsd
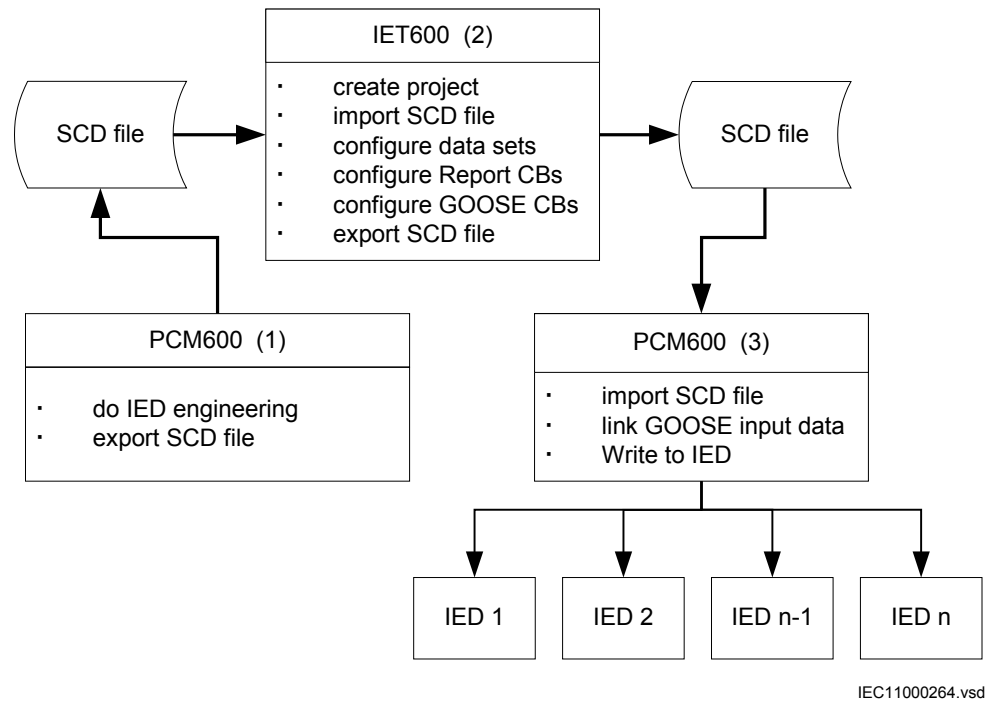
Figure 62:   IEC 61850: Signal engineering procedure flow

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 *Enabled*.

7.3.1 Exporting SCD files

Procedure to export the SCD file from PCM600:

1. Select the station in the plant structure, see Figure 63.
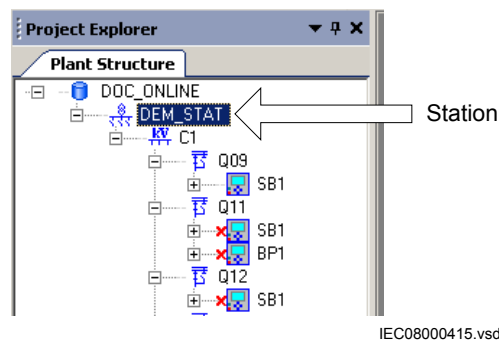
Figure 63:   IEC 61850: Export SCD step 1

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 64.
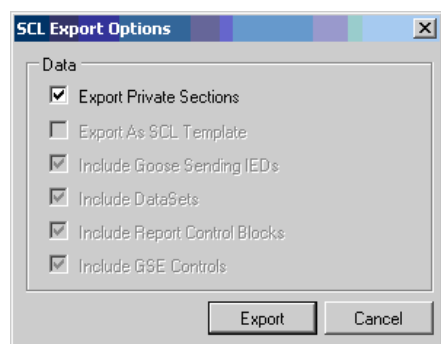
IEC09000627-1-en.vsd

Figure 64:   *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.
    *   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 65.
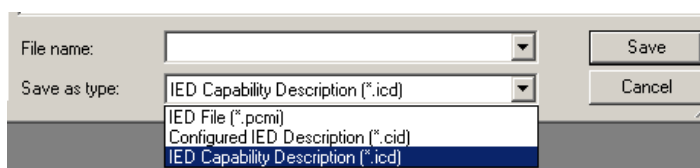
IEC08000416.vsd

Figure 65:   *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 66. Note that the options in *SCL Export Options* window according to Figure 66 is only available when an ICD file is exported.

IEC08000418.vsd
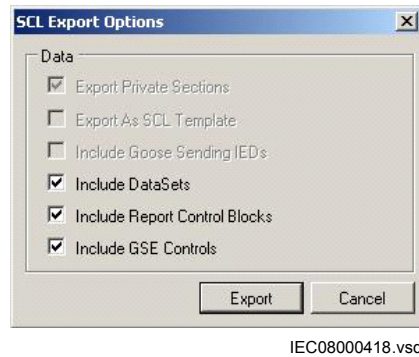
Figure 66:   *IEC 61850: Export IED file Options*

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.

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 pre-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 pre-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.

> **i** 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 attribute content of the data set according to the requirements.

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

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

> **i** Note that one data must only be included in one GOOSE data set.

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.

> **i** 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 .
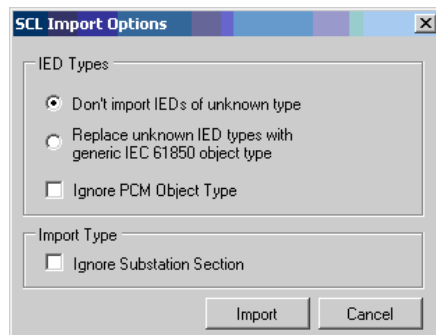
IEC09000631-1-en.vsd

Figure 67:   *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.
   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.

ℹ️ 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.

ℹ️ Be sure to set the setting *Operation* to *Enabled* 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 68.

ℹ️ Note that the engineered data is written to the IED when executing a common *Write to IED* operation.
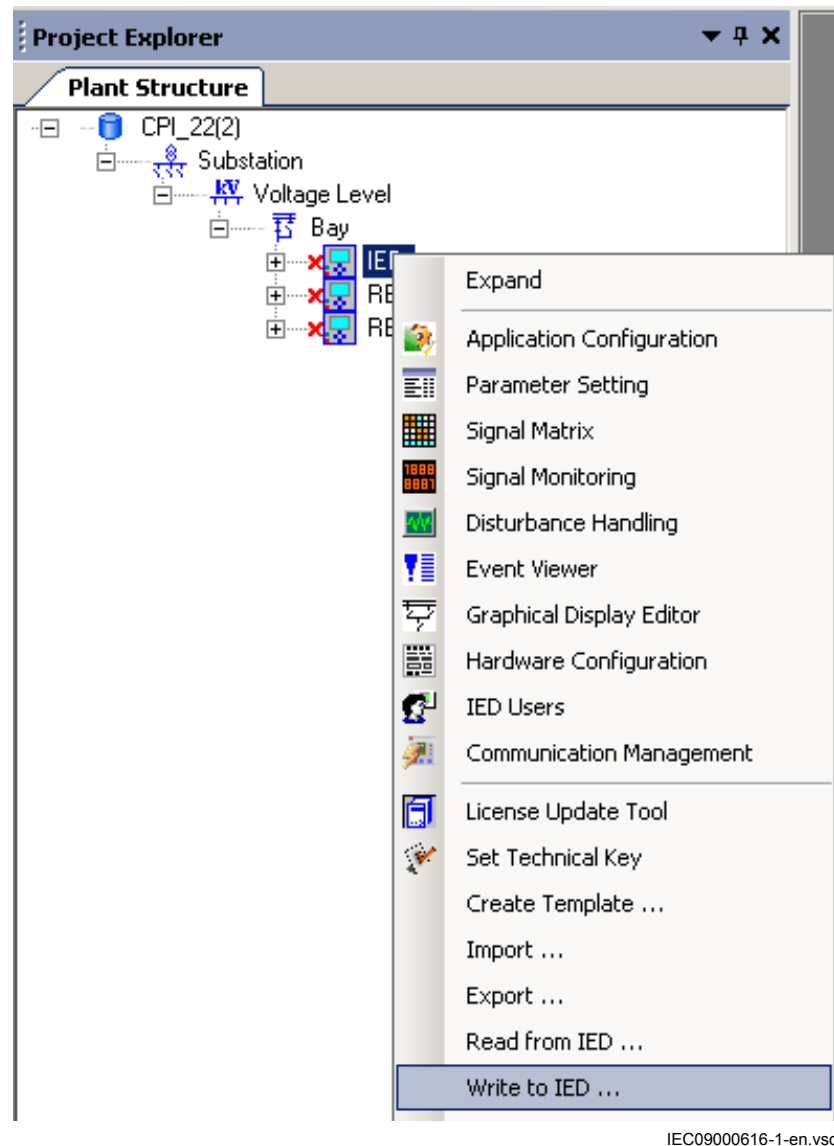
Figure 68:   *Common write menu*

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 69.

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.
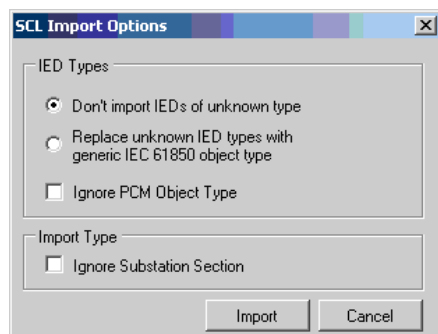
IEC09000631-1-en.vsd

Figure 69:   *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.
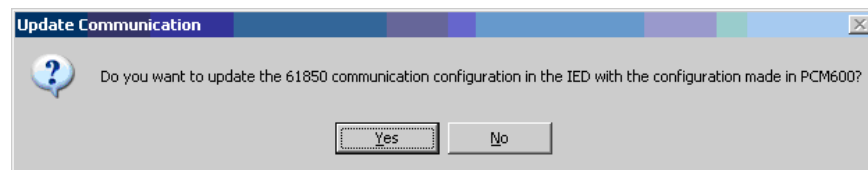
IEC09000729-1-en.vsd

Figure 70:   *Update the communication configuration in the IED with the configuration made in PCM600*

Section 8 IEC 60870-5-103 communication engineering

8.1 Engineering in PCM600

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

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

> The COM05 module is 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.

8.1.1.1 Selecting to communicate IEC60870-5-103 data via RS485 serial interface on COM05 module

1. In PST, navigate to the *RS485PROT* function block located in **MainMenu/ IEDConfiguration/Monitoring/RS485PROT:1**.
2. To enable the IEC60870-5-103 protocol on the RS485 port, select *IEC103* for setting *Operation*.
3. Navigate to the *RS485103* function block, found in **MainMenu/ IEDConfiguration/Communication/I103/RS485103:1**, to set IEC60870-5-103 communications port properties, such as baud-rate or master time domain.

8.1.1.2 Selecting to communicate IEC60870-5-103 data via optical serial interface on COM05 module

1. In PST, navigate to the *OPTICALPROT* function block located in **MainMenu/ IEDConfiguration/Monitoring/OPTICALPROT:1**.
2. To enable the IEC60870-5-103 protocol on the RS485 port, select *IEC103* for setting *Operation*.
3. Navigate to the *OPTICAL103* function block, found in **MainMenu/ IEDConfiguration/Communication/I103/OPTICAL103:1**, to set IEC60870-5-103 communications port properties, such as baud-rate or master time domain.

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 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 RS-485 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).
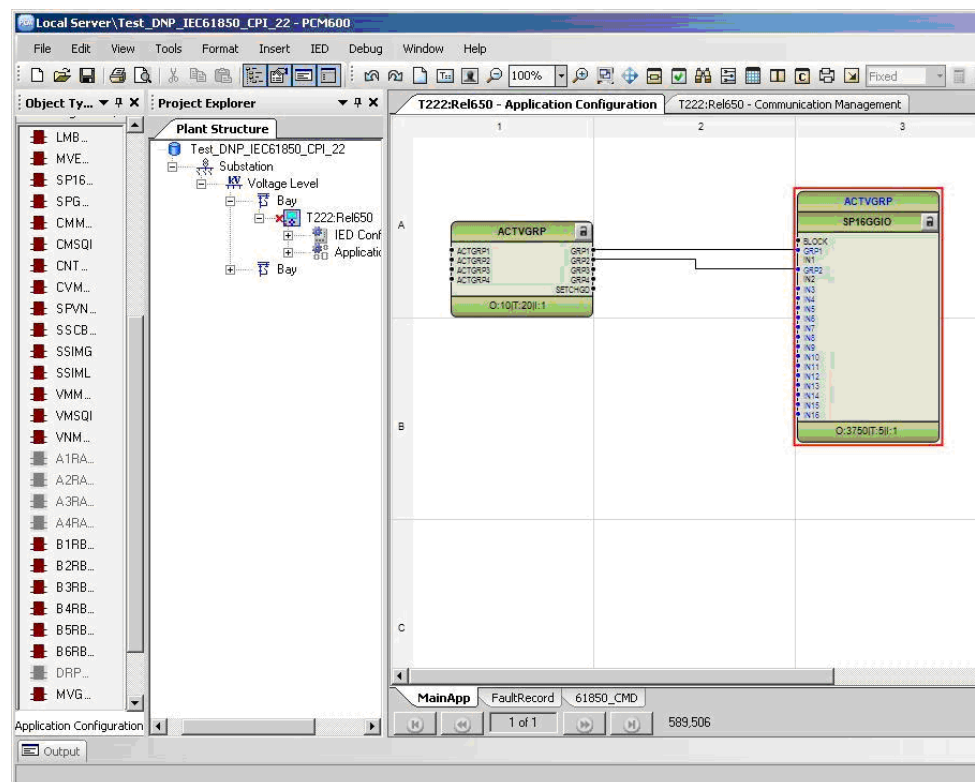
IEC11000423-1-en.vsd

Figure 71: *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.
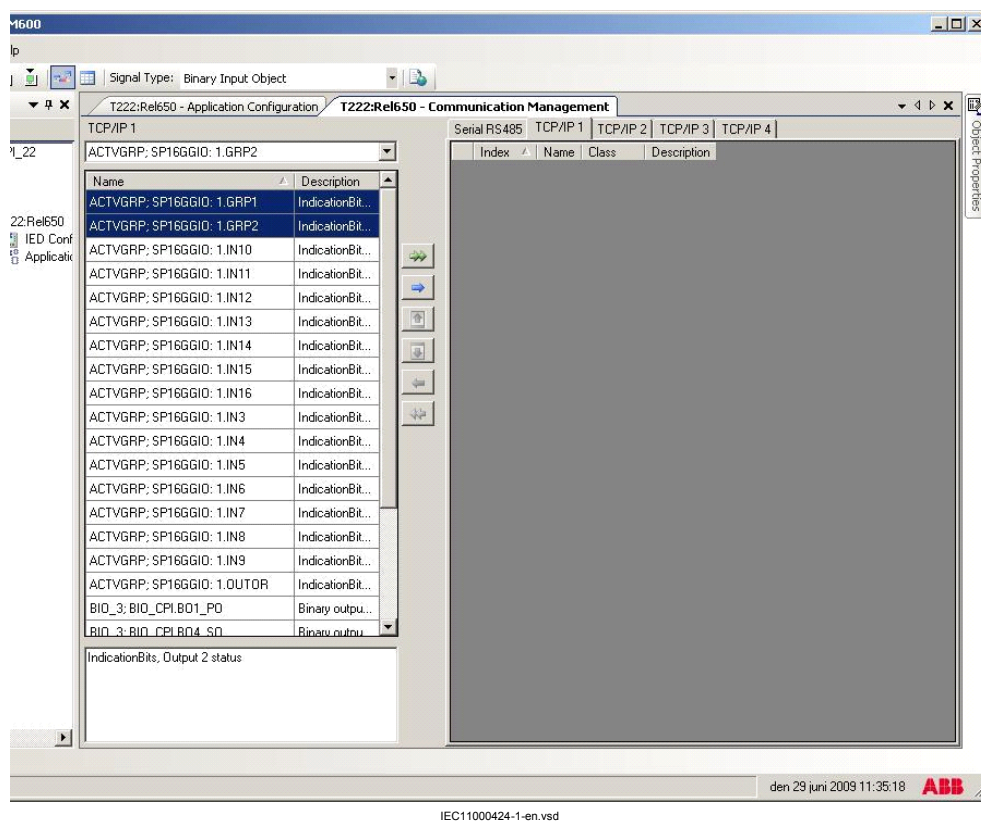
Figure 72: *Communication Management tool*

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.
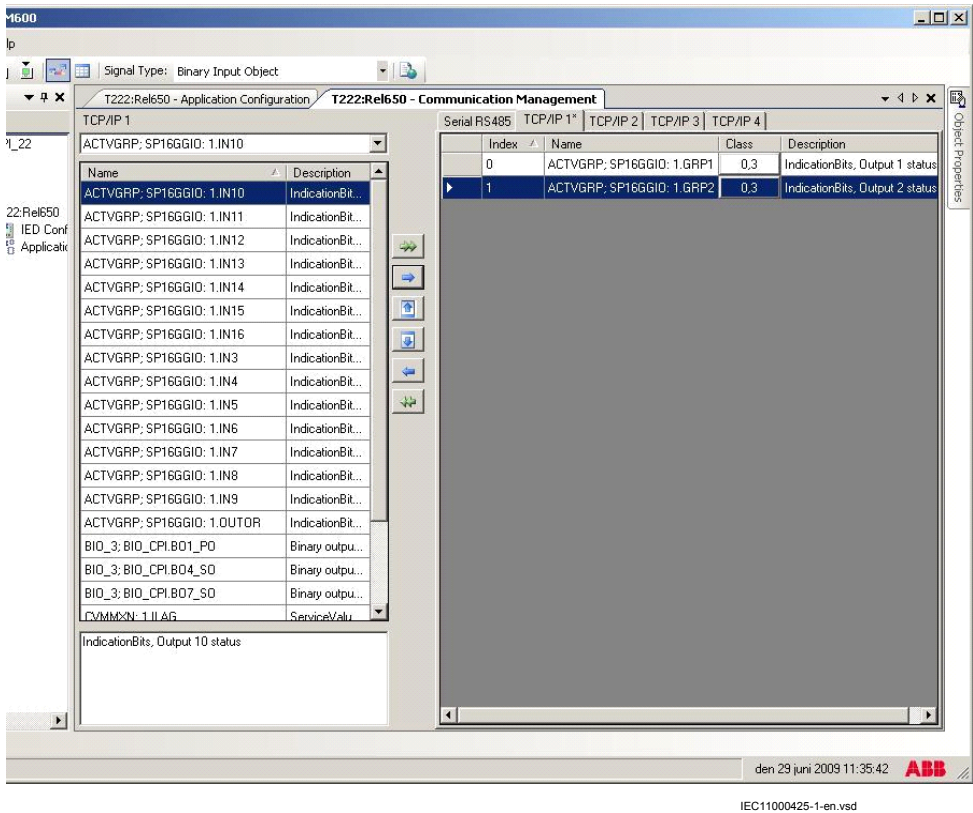
Figure 73:   *Selecting the signals into the DNP signal list*

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 74) appear in CMT (see Figure 75). Do
> not configure these hardware channels to be sent by DNP3, as they
> are not event-handled.

IEC10000172.vsd
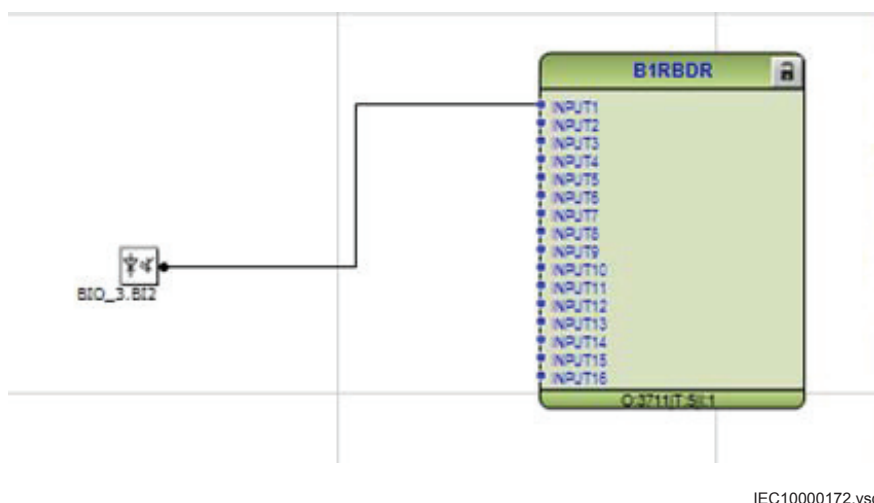
Figure 74:   *Configuring hardware channels directly to the function blocks*

IEC10000173.vsd

Figure 75:   *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 76 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 76.
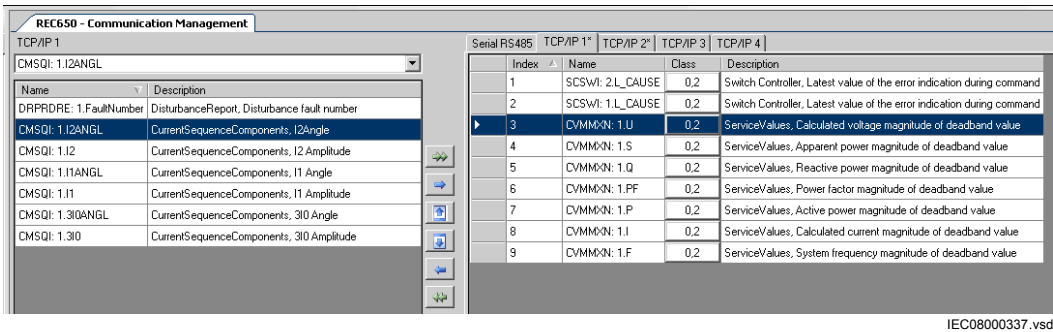
Figure 76: CMT: Container window design when selecting DNP3 protocol

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 77.
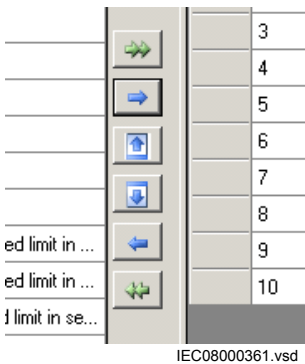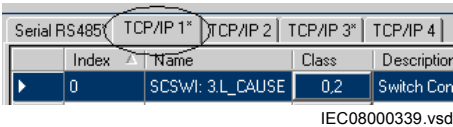
Figure 77: CMT: Move buttons

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 78. The star indicates that changes in the container have to be saved before leaving CMT.

IEC08000339.vsd

Figure 78: *CMT: Marker to indicate changes in the container*
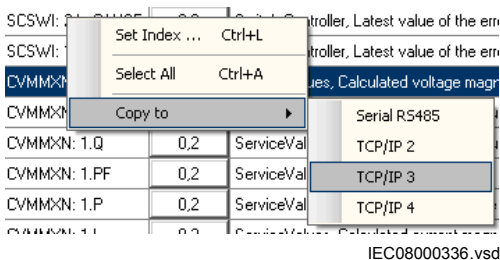
9.4 Setting DNP3 signal parameters

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 79.

IEC08000336.vsd

Figure 79: *CMT: Context menu in DNP3 window*

2. The selection window shows the number of signals selected, see Figure 80.

IEC08000363.vsd

Figure 80:   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 .

IEC08000338.vsd

Figure 81:   CMT: Select Class window
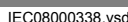
9.4.1   Configuring DNP3 class

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 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*.

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 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*.

Section 10   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 Common Format for Transient Data Exchange format for Disturbance recorder according to IEEE/ANSI C37.111, 1999 / IEC60255-24	
Contra-directional	Way of transmitting G.703 over a balanced line. Involves four twisted pairs, two of which are used for transmitting data in both directions and two for transmitting clock signals	
CPU	Central processor unit	
CR	Carrier receive	
CRC	Cyclic redundancy check	
CROB	Control relay output block	
CS	Carrier send	
CT	Current transformer	
CVT or CCVT	Capacitive voltage transformer	
DAR	Delayed autoreclosing	
DARPA	Defense Advanced Research Projects Agency (The US developer of the TCP/IP protocol etc.)	
DBDL	Dead bus dead line	
DBLL	Dead bus live line	
DC	Direct current	
DFC	Data flow control	
DFT	Discrete Fourier transform	
DHCP	Dynamic Host Configuration Protocol	
DIP-switch	Small switch mounted on a printed circuit board	
DI	Digital input	
DLLB	Dead line live bus	
DNP	Distributed Network Protocol as per IEEE/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	
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 IP20- Protected against solidforeign objects of12.5mm diameter andgreater.	
IP 40	Ingression protection, according to IEC standard, level IP40- Protected against solid foreign objects of 1mm diameter and greater.	
IP 54	Ingression protection, according to IEC standard, level IP54-Dust-protected,protected againstsplashing water.	
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
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
	Resistance for phase-to-ground 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/Wye 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.	
UTC	Coordinated Universal Time. A coordinated time scale, maintained by the Bureau International des Poids et Mesures (BIPM), which forms the basis of a coordinated dissemination of standard frequencies and time signals. UTC is derived from International Atomic Time (TAI) by the addition of a whole number of "leap seconds" to synchronize it with Universal Time 1 (UT1), thus allowing for the eccentricity of the Earth's orbit, the rotational axis tilt (23.5 degrees), but still showing the Earth's irregular rotation, on which UT1 is based. The Coordinated Universal Time is expressed using a 24-hour clock, and uses the Gregorian calendar. It is used for aeroplane and ship navigation, where it is also sometimes known by the military name, "Zulu time." "Zulu" in the phonetic alphabet stands for "Z", which stands for longitude zero.	
UV	Undervoltage	
WEI	Weak end infeed logic	
VT	Voltage transformer	
X.21	A digital signalling interface primarily used for telecom equipment	
$3I_O$	Three times zero-sequence current. Often referred to as the residual or the -fault current	

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

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