Relion® Protection and Control

630 series
Engineering Manual

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Document ID: 756800
Issued: 2011-05-18
Revision: C
Product version: 1.1

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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 IED is designed in accordance with the international standards of the IEC 60255 series.

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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

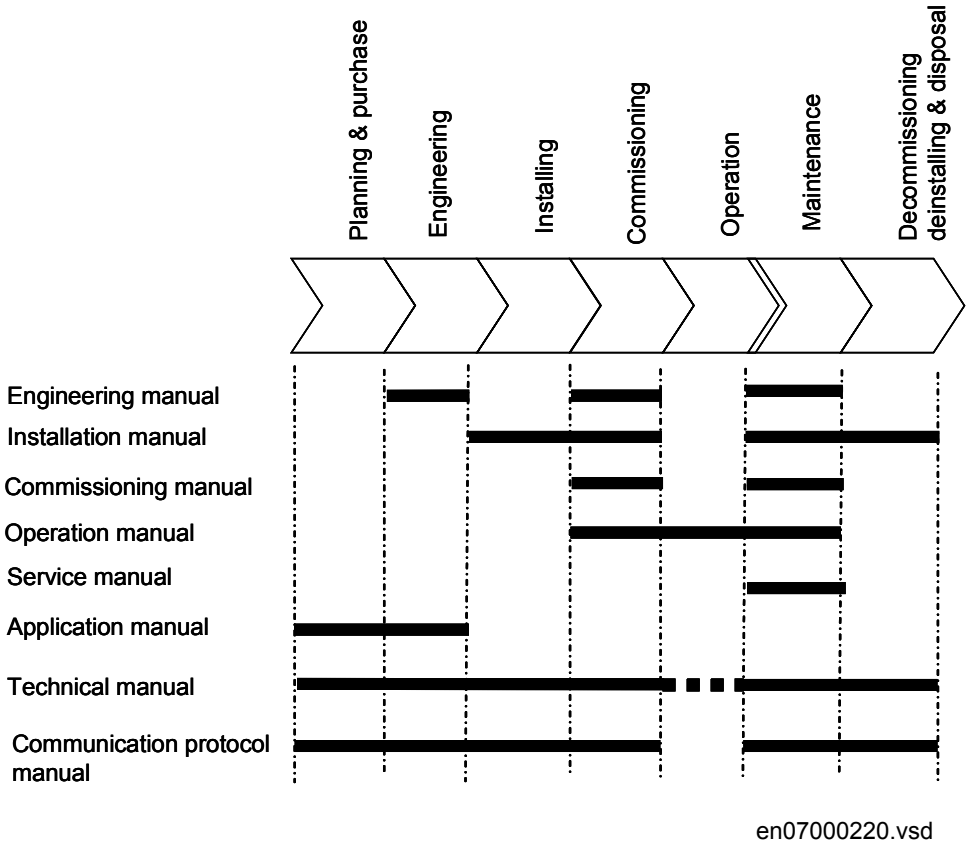

Figure 1: The intended use of manuals in different lifecycles

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 descriptions of preconfigurations. The manual can be used as a reference for configuring control, protection, measurement, recording and LED functions. The manual can also be used when creating configurations according to specific application requirements.

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

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

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

The service manual is not available yet.

1.3.2 Document revision history

Document revision/date	Product series version	History
A/2009-09-15	1.0	First release
B/2011-02-23	1.1	Content updated to correspond to the product series version
C/2011–05-18	1.1	Content updated

Download the latest documents from the ABB web site http://www.abb.com/substationautomation.

1.3.3 Related documentation

Product series- and product-specific manuals can be downloaded from the ABB web site http://www.abb.com/substationautomation .

1.4 Symbols and conventions

1.4.1 Safety indication symbols

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

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

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

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

1.4.2 Manual conventions

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

- Abbreviations and acronyms in this manual are spelled out in the glossary. The glossary also contains definitions of important terms.
- Push button navigation in the LHMI menu structure is presented by using the push button icons, for example:
  To navigate between the options, use  and  .
- HMI menu paths are presented in bold, for example:
  Select **Main menu/Settings**.
- LHMI messages are shown in Courier font, for example:
  To save the changes in non-volatile memory, select `Yes` and press  .
- Parameter names are shown in italics, for example:

The function can be enabled and disabled with the *Operation* setting.

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

1.4.3 Functions, codes and symbols

Table 1: Functions included in 630 series IEDs

Functionality	IEC 61850	IEC 60617	ANSI
Protection			
Three-phase non-directional overcurrent, low stage	PHLPTOC	3I>	51P-1
Three-phase non-directional overcurrent, high stage	PHHPTOC	3I>>	51P-2
Three-phase non-directional overcurrent, instantaneous stage	PHIPTOC	3I>>>	50P/51P
Three-phase directional overcurrent, low stage	DPHLPDOC	3I> →	67-1
Three-phase directional overcurrent, high stage	DPHHPDOC	3I>> →	67-2
Distance protection	DSTPDIS	Z<	21, 21P, 21N
Automatic switch-onto-fault logic	CVRSOF	SOTF	SOTF
Fault locator	SCEFRFLO	FLOC	21FL
Autoreclosing	DARREC	O → I	79
Non-directional earth-fault, low stage	EFLPTOC	I0>	51N-1
Non-directional earth-fault, high stage	EFHPTOC	I0>>	51N-2
Non-directional earth-fault, instantaneous stage	EFIPTOC	I0>>>	50N/51N
Directional earth-fault, low stage	DEFLPDEF	I0> →	67N-1
Directional earth-fault, high stage	DEFHPDEF	I0>> →	67N-2
Transient/intermittent earth-fault	INTRPTEF	I0> → IEF	67NIEF
Admittance-based earth-fault	EFPADM	Yo>->	21YN
Wattmetric earth-fault	WPWDE	Po>->	32N
Stabilised restricted earth-fault	LREFPNDF	dI0Lo>	87NL
High-impedance-based restricted earth-fault	HREFPDIF	dI0Hi>	87NH
Rotor earth-fault	MREFPTOC	Io>R	64R
Phase discontinuity	PDNSPTOC	I2/I1>	46PD
Negative-sequence overcurrent	NSPTOC	I2>	46

Table continues on next page

Functionality	IEC 61850	IEC 60617	ANSI
Negative-sequence overcurrent protection for motors	MNSPTOC	I2>M	46M
Phase reversal	PREVPTOC	I2>>	46R
Three-phase thermal overload protection for feeder	T1PTTR	3Ith>F	49F
Three-phase thermal overload protection for transformers	T2PTTR	3Ith>T	49T
Three-phase thermal overload protection for motors	MPTTR	3Ith>M	49M
Motor startup supervision	STTPMSU	Is2t n<	48,66,14,51LR
Motor load jam protection	JAMPTOC	Ist>	51LR
Emergency start	ESMGAPC	ESTART	ESTART
Loss of load supervision	LOFLPTUC	3I<	37
Three-phase current inrush detection	INRPHAR	3I2f>	68
Transformer differential protection for two-winding transformers	TR2PTDF	3dI>T	87T
High-impedance or flux-balance-based differential protection for machines	MHZPDIF	3dIHi>G/M	87GH/87MH
Stabilized differential protection for motors	MPDIF	3dI>M	87M
Three-phase overvoltage	PHPTOV	3U>	59
Three-phase undervoltage	PHPTUV	3U<	27
Positive-sequence overvoltage	PSPTOV	U1>	47O+
Positive-sequence undervoltage	PSPTUV	U1<	47U+
Negative-sequence overvoltage	NSPTOV	U2>	47O-
Residual overvoltage	ROVPTOV	U0>	59G
Frequency gradient	DAPFRC	df/dt>	81R
Overfrequency	DAPTOF	f>	81O
Underfrequency	DAPTUF	f<	81U
Load shedding	LSHDPFRQ	UFLS/R	81LSH
Overexcitation	OEPVPH	U/f>	24
Three-phase underexcitation	UEXPDIS	X<	40
Directional overpower	DOPPDPR	P>	32O
Three-phase underimpedance	UZPDIS	Z< GT	21GT
Circuit-breaker failure	CCBRBRF	3I>/I0>BF	51BF/51NBF
Tripping logic	TRPPTRC	I → O	94
Multipurpose analog protection	MAPGAPC	MAP	MAP
Protection-related functions			
Local acceleration logic	DSTPLAL	LAL	LAL
Communication logic for residual overcurrent	RESCPSCH	CLN	85N

Table continues on next page

Functionality	IEC 61850	IEC 60617	ANSI
Scheme communication logic	DSOCPSCH	CL	85
Current reversal and WEI logic	CRWPSCH	CLCRW	85CRW
Current reversal and WEI logic for residual overcurrent	RCRWPSCH	CLCRWN	85NCRW
Control			
Bay control	QCCBAY	CBAY	CBAY
Interlocking interface	SCILO	3	3
Circuit breaker/disconnector control	GNRLCSWI	I ↔ O CB/DC	I ↔ O CB/DC
Circuit breaker	DAXCBR	I ↔ O CB	I ↔ O CB
Disconnector	DAXSWI	I ↔ O DC	I ↔ O DC
Local/remote switch interface	LOCREM	R/L	R/L
Synchrocheck	SYNCRSYN	SYNC	25
Tap changer control with voltage regulator	OLATCC	COLTC	90V
Generic process I/O			
Single point control (8 signals)	SPC8GGIO		
Double point indication	DPGGIO		
Single point indication	SPGGIO		
Generic measured value	MVGGIO		
Logic rotating switch for function selection and LHMI presentation	SLGGIO		
Selector mini switch	VSGGIO		
Pulse counter for energy metering	PCGGIO		
Event counter	CNTGGIO		
Supervision and monitoring			
Circuit-breaker condition monitoring	SSCBR	CBCM	CBCM
Fuse failure supervision	SEQRFUF	FUSEF	60
Current circuit supervision	CCRDIF	MCS 3I	MCS 3I
Trip-circuit supervision	TCSSCBR	TCS	TCM
Station battery supervision	SPVNZBAT	U<>	U<>
Energy monitoring	EPDMMTR	E	E
Measured value limit supervision	MVEXP		
Tap position indication	TPOSSLTC	TPOSM	84M
Power quality			
Voltage variation	PHQVVR	PQMU	PQMV
Voltage unbalance	VSQVUB	PQMUBU	PQMUBV
Current harmonics	CMHAI	PQM3I	PQM3I
Voltage harmonics phase-to-phase	VPPMHAI	PQM3Upp	PQM3Vpp
Voltage harmonics phase-to-earth	VPHMHAI	PQM3Upe	PQM3Vpg

Table continues on next page

Functionality	IEC 61850	IEC 60617	ANSI
Measurement			
Three-phase current	CMMXU	3I	3I
Three-phase voltage (phase-to-earth)	VPHMMXU	3Upe	3Upe
Three-phase voltage (phase-to-phase)	VPPMMXU	3Upp	3Upp
Residual current	RESCMMXU	I0	I0
Residual voltage	RESVMMXU	U0	Vn
Power monitoring with P, Q, S, power factor, frequency	PWRMMXU	PQf	PQf
Sequence current	CSMSQI	I1, I2	I1, I2
Sequence voltage	VSMSQI	U1, U2	V1, V2
Disturbance recorder function			
Analog channels 1-10 (samples)	A1RADR	ACH1	ACH1
Analog channels 11-20 (samples)	A2RADR	ACH2	ACH2
Analog channels 21-30 (calc. val.)	A3RADR	ACH3	ACH3
Analog channels 31-40 (calc. val.)	A4RADR	ACH4	ACH4
Binary channels 1-16	B1RBDR	BCH1	BCH1
Binary channels 17-32	B2RBDR	BCH2	BCH2
Binary channels 33-48	B3RBDR	BCH3	BCH3
Binary channels 49-64	B4RBDR	BCH4	BCH4
Station communication (GOOSE)			
Binary receive	GOOSEBINRCV		
Double point receive	GOOSEDPRCV		
Interlock receive	GOOSEINTLKRCV		
Integer receive	GOOSEINTRCV		
Measured value receive	GOOSEMVRCV		
Single point receive	GOOSESPRCV		

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.

See PCM600 documentation for the recommended size of a project. Larger projects can be divided into several PCM600 projects.

It can be subdivided in the three main parts:

- Bay level IEDs
- Station communication
- Station level IEDs

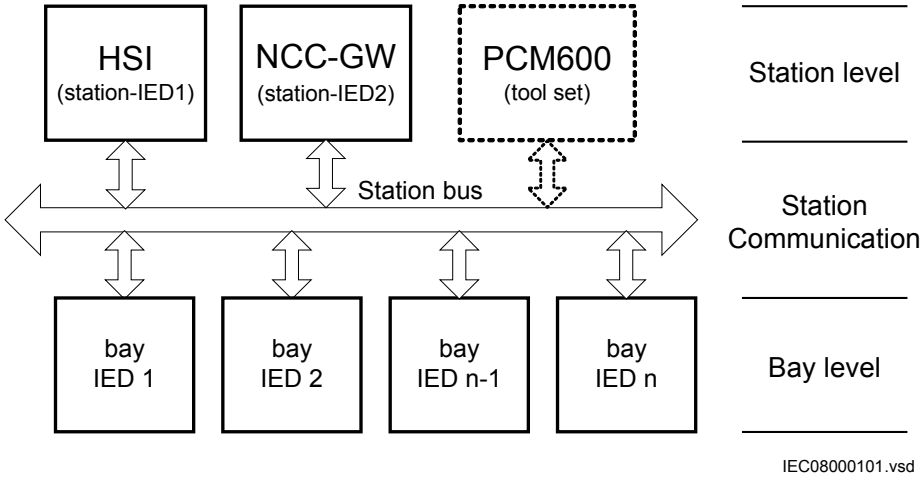

Figure 2: Principle structure of a monitoring and control system for a substation

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

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

PCM600 communicates with the bay IEDs via an Ethernet connection. The connection allows 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 630 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 630 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, for example, CCT600 or IET600. PCM600 interacts with CCT600 or 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 and process events by using the Event Viewer tool.

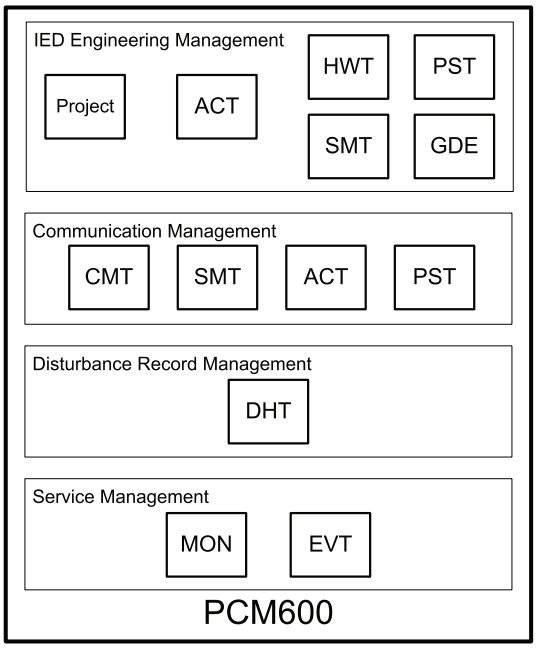

Figure 3: Organization of PCM600 in different management tasks

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

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

Once the engineering of the IED is done, the results must be written to the IED. Conversely some parts of the engineering information can be read 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

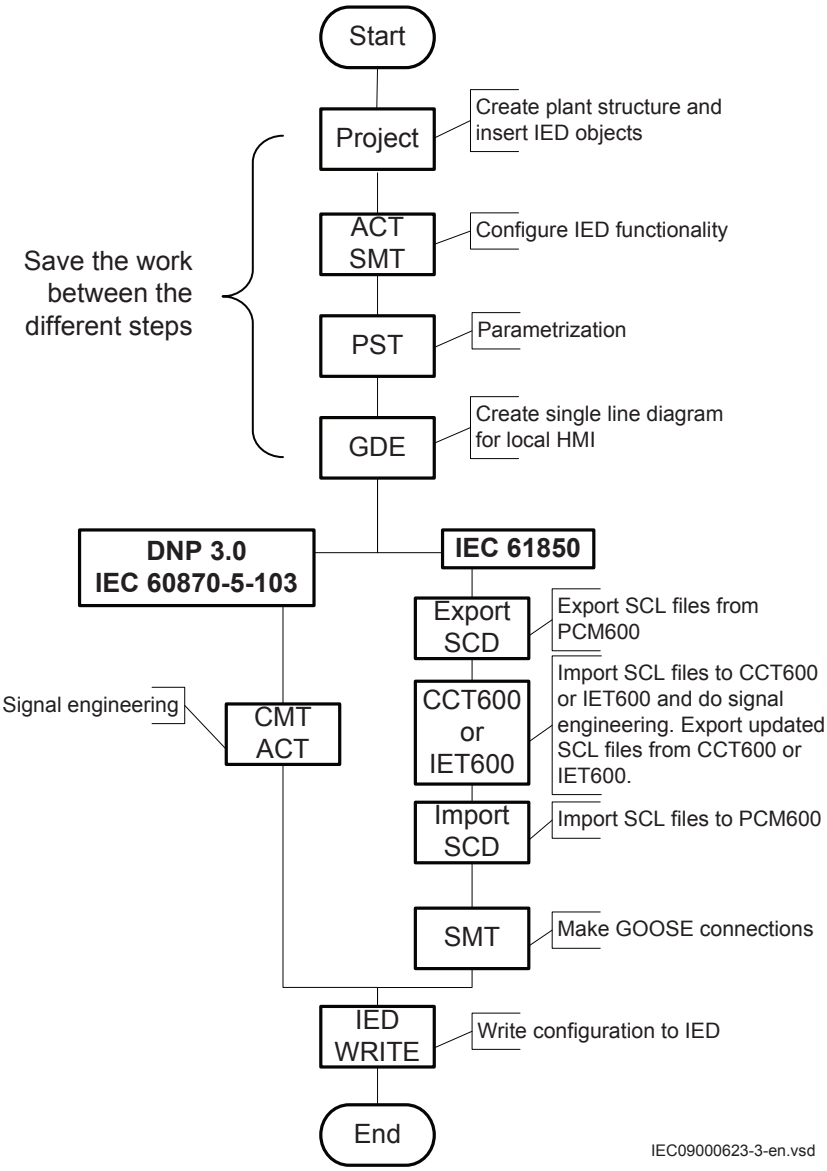

Figure 4: IED engineering workflow

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.

    

    See PCM600 documentation for the recommended size of a 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).

    

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

  - Rename the IED objects in PCM600 to the projects definitions.
- ACT Application configuration
  - Configure the protection and control functions, for example for a feeder, 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 of the switch yard.
  - 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 a station configuration tool, for example CCT600 or IET600, for IEC 61850 engineering.
  - Use the Application Configuration tool and Parameter Setting tool for IEC 60870-5-103 engineering.

After changing the parameters marked with ! (on LHMI), IEC 61850 data model, user management settings or general 60870-5-103 settings, the IED restarts automatically for the changes to take effect.

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. A Connectivity package is managed in a separate tool called *Update Manager*.

1. Close PCM600.
2. Run the *RE_630 Connectivity Package Ver. n.exe* installer. (n = version number)
3. To install the connectivity package, follow the steps in the installation software guide.

Activating installed connectivity packages

The IED connectivity package has to be installed before activating the connectivity packages.

1. Activate the appropriate connectivity package in the *Update Manager* after the installation. The *Update Manager* shows the IEDs that are compatible with the installed PCM600 version.
2. Select the *ABB IED Connectivity Package RE_630 Ver. n* (n = version number) to use 630 series products. It is recommended to always use the lates version of the connectivity package.

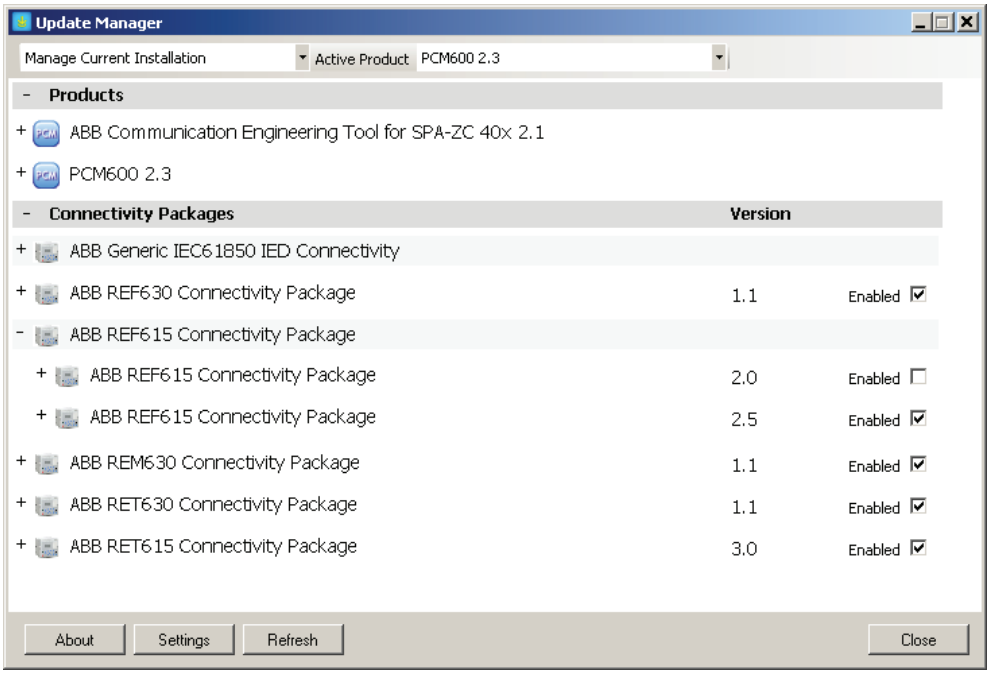

Figure 5: Activating the connectivity package

PCM600 recognizes the installed *Connectivity package(s)* during startup and the corresponding IED types are available in PCM600 when starting a new project.

4.3 Setting up communication between PCM600 and the IED

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

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

Each IED has an Ethernet interface connector on the front and on the rear side. Both Ethernet connectors 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.

For the connection of PCM600 to the IED, two basic variants have to 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 can be set via the LHMI for each available Ethernet interface in the IED. Each Ethernet interface has a default factory IP address when the complete IED is delivered.

- The default IP address for the IED front port is 192.168.0.254 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/Front port**.
- The default IP address for the IED rear port is 192.168.2.10 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/LAN1**.

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 point-to-point access to IEDs front port

The IED front port is a standard Ethernet interface with DHCP server functionality. When a PC is connected to the front port, the DHCP server automatically assigns the IP address from the same subnetwork.

See the operating system manual for details on how to obtain the IP address automatically.

1. Connect the PC network adapter to the IED front port.
2. Wait until the operating system automatically acquires the network address.
3. Check that the front port connector green status LED is lit.
4. Ping the IED to verify that the connection is correctly established. The default IP address of the front port is 192.168.0.254.

Use Ethernet crossover cables only for point-to-point connections. Modern network adapters contain logic for automatic detection if they are connected directly to another network adapter using a regular Ethernet cable.

Setting up the PC to access the IED via a network

This task depends on the used LAN/WAN network. The PC and the IED must belong to the same subnetwork.

4.4 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

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 6.

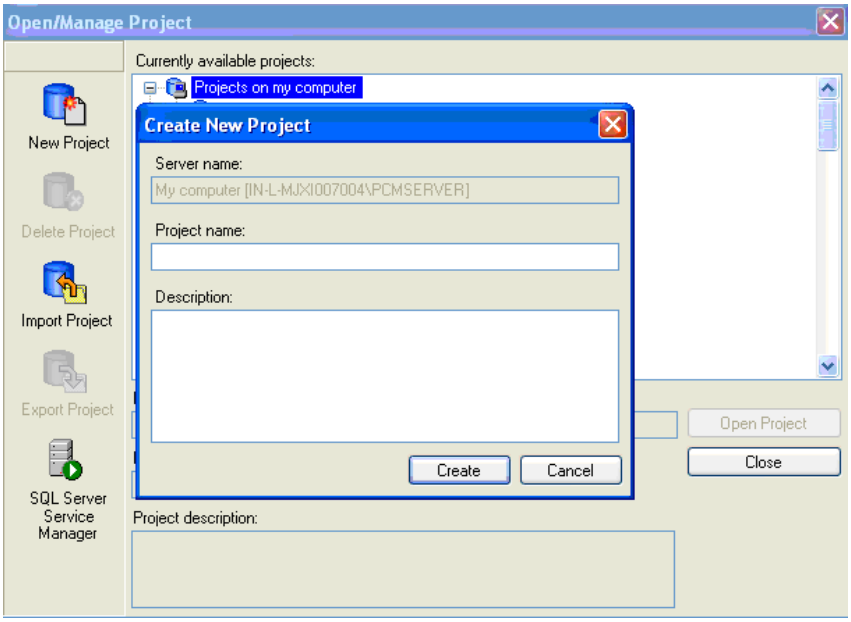

Figure 6: PCM600: Create a new project window

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*.

4.5 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.

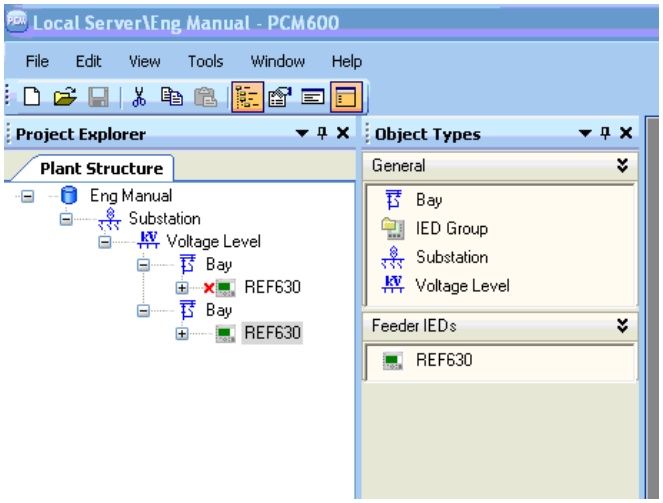

Figure 7: PCM600: Set up a plant structure

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 7 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.

4.5.1 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 is predefined by “AA1” where 1 is the index. To get the real station name that is used it is possible to rename the 'SCL Technical Key' for the station to the name used by the project. To minimize the word length take a short form, because this will be used also in the messages transmitted to identify the events etc. In the example = DMSTAT.
- The voltage level. In the example = 400kV and C1 selected from the drop down list below the SCL Technical Key.
- The bay and the IED are appended with the coding defined in the IEC 61346 standard and the substation definition lists. Bay = F409 and Q1. IED = TR_421 and SB1.

The user oriented textual designation is visible in the plant structure for each object. It is the name given by default or changed via the *Rename* possibility. See Figure 8, *Object Properties*, the row *Caption*.

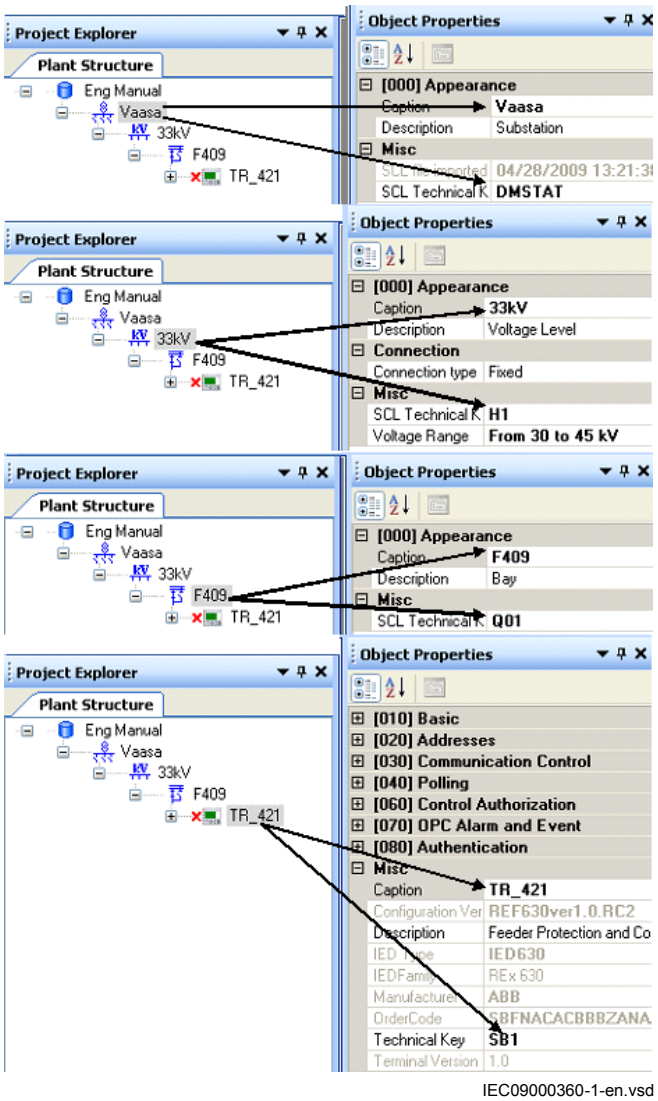

Figure 8: PCM600: IEC 61850 signal designation concept

Figure 8 shows the IED named in the example TR_421 in the object properties with the two designations TR_421 and SB1.

4.6 Inserting an IED

The context menu or the *Object Types* view shows the available 630 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 see 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 9.

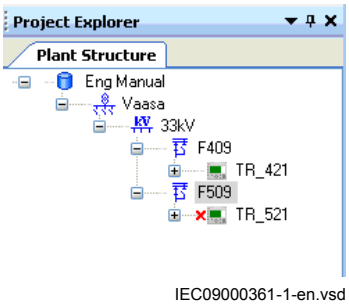

Figure 9: Plant structure showing IED TR_421 in online mode and IED TR_521 in offline mode

- Import a template IED available in the template library as a *.pcmt file.
- Import a pre-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 proper IED category.
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 10.

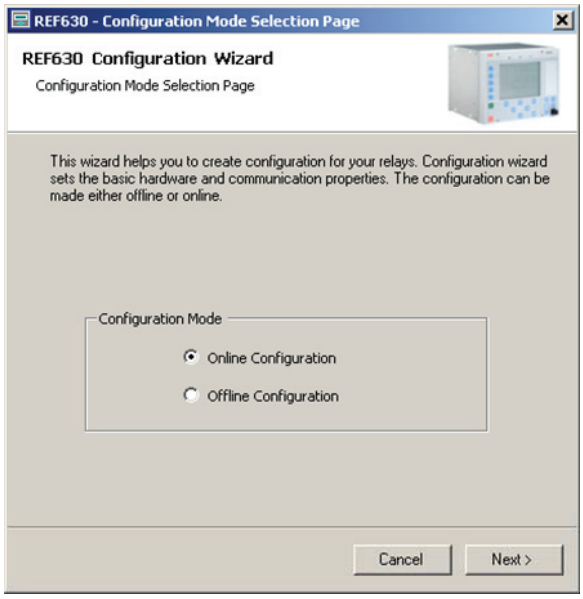

Figure 10: PCM600: Configuration mode selection wizard

4. Click *Next* > on screen presented below. No need for any selection.

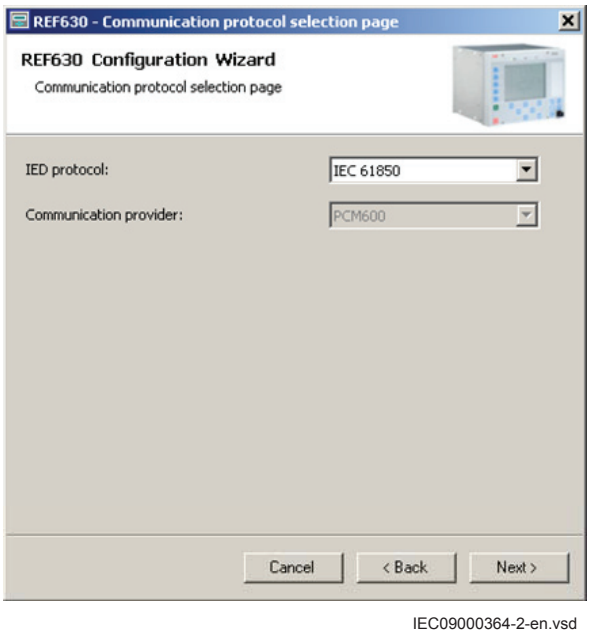

Figure 11: PCM600: Communication protocol selection wizard

5. Select the port and insert the IP address of the physical IED to configure, see Figure 12.

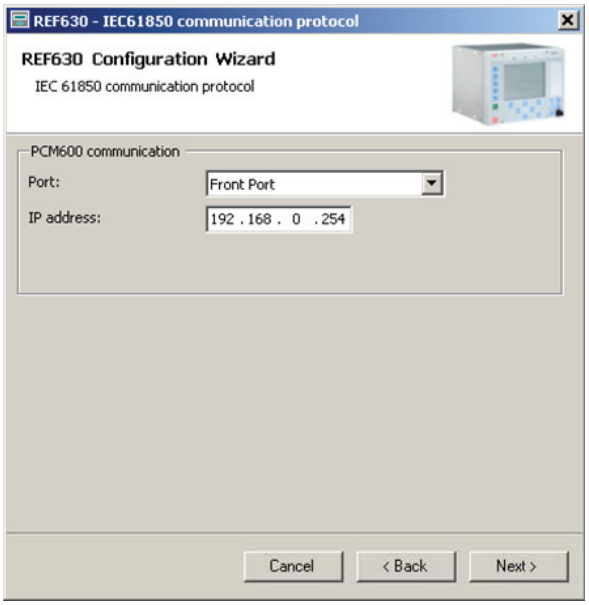

Figure 12: PCM600: Communication port and IP address

6. Cross-check that the IED whose IP address has been inserted has been detected online by PCM600, see Figure 9.

   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 13. After a successful scan, click *Next* to proceed.

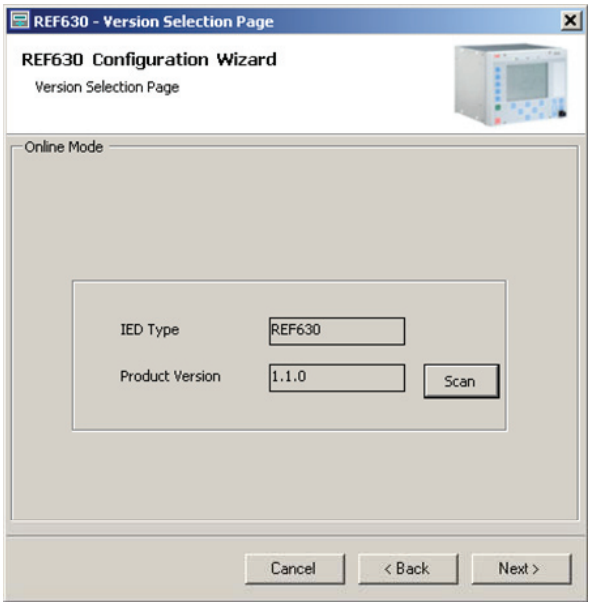

Figure 13: PCM600: IED Version detection

8. Click the *Scan* option to scan/read the Order Code of the IED, see Figure 14. After a successful scan, click *Next* to proceed.

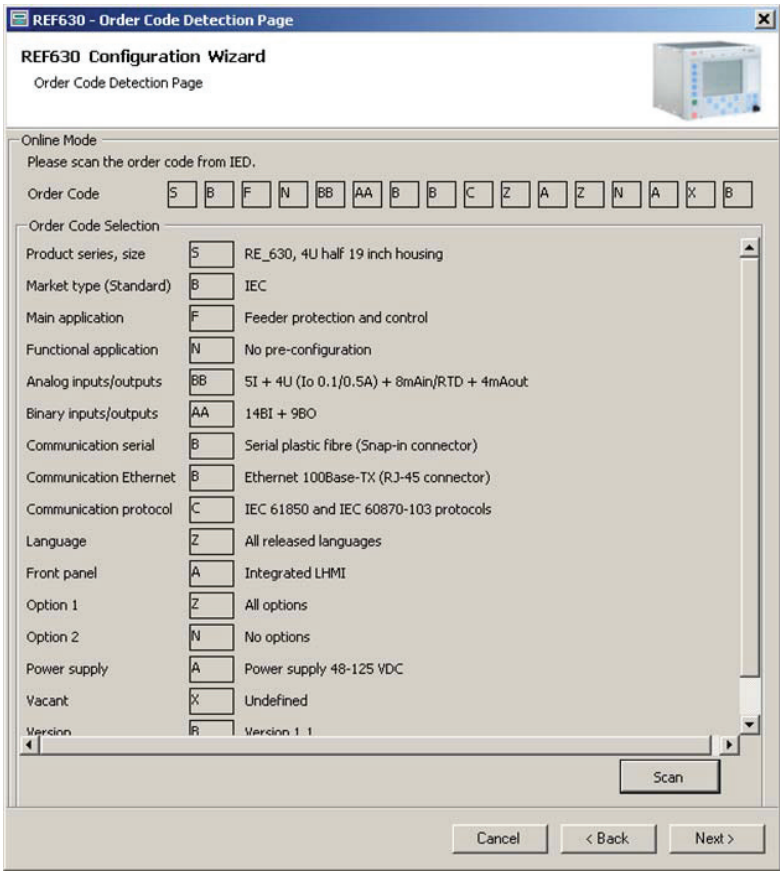

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Figure 14: PCM600: IED Order code detection

9. The *Setup Complete Page* dialog shows the summary of the *IED Type*, *IED Version*, *IP Address of IED* and *Selected Order Code*, see Figure 15. It is possible to *Cancel* the insertion or confirm the configuration and do the insertion with *Finish*

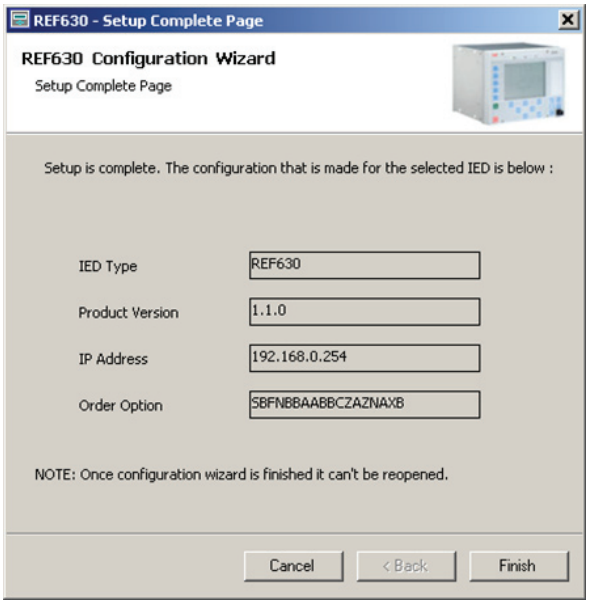

Figure 15: PCM600: IED Setup completion wizard

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.

The reading of IEC 61850 communication configuration is not supported when reading a configuration from an online 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 the order code need to be selected from the drop down menu as shown in Figure 16 and Figure 17.

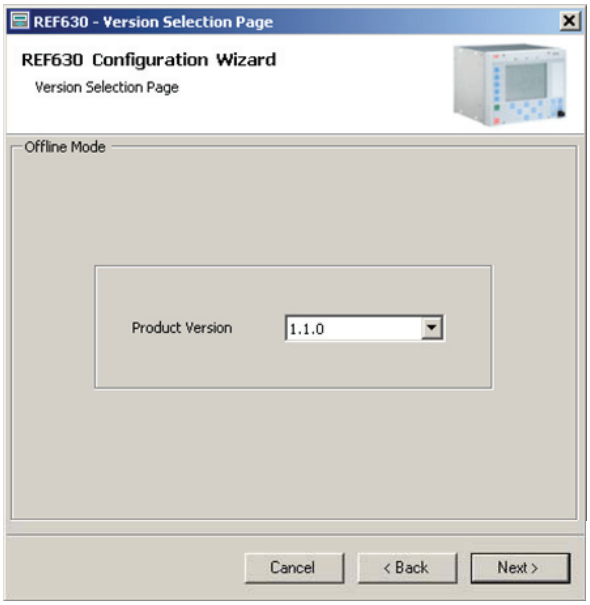

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Figure 16: PCM600: IED Version selection

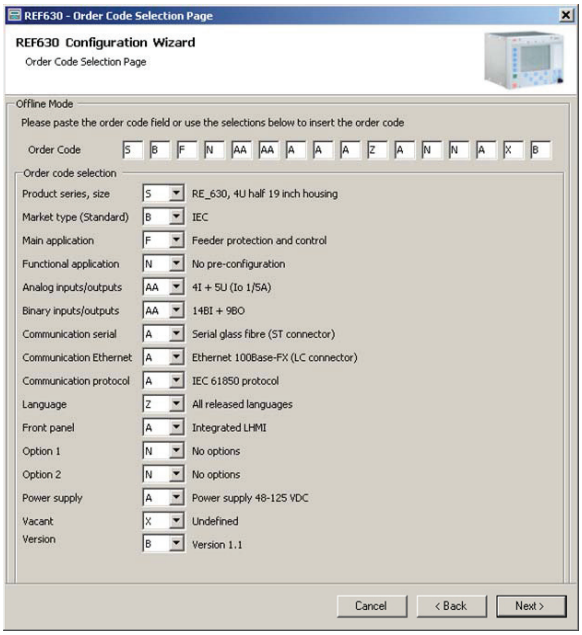

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Figure 17: PCM600: IED Order code selection

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 18.

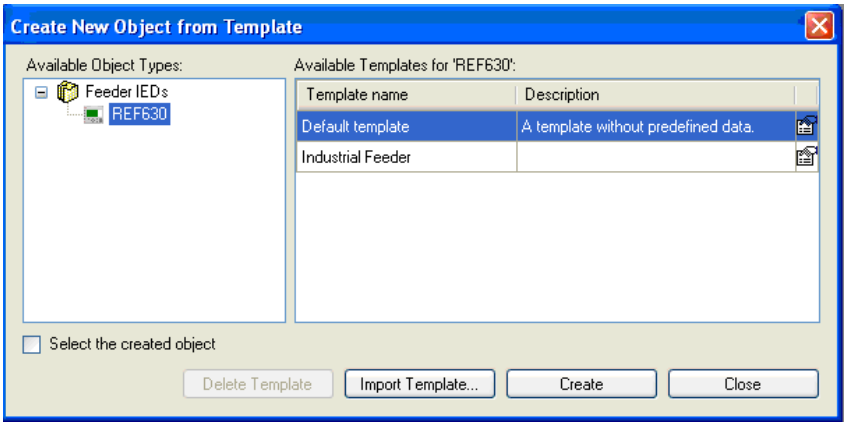

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Figure 18: PCM600: Selecting IED from template library

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 19 and click *Close* to close the window.

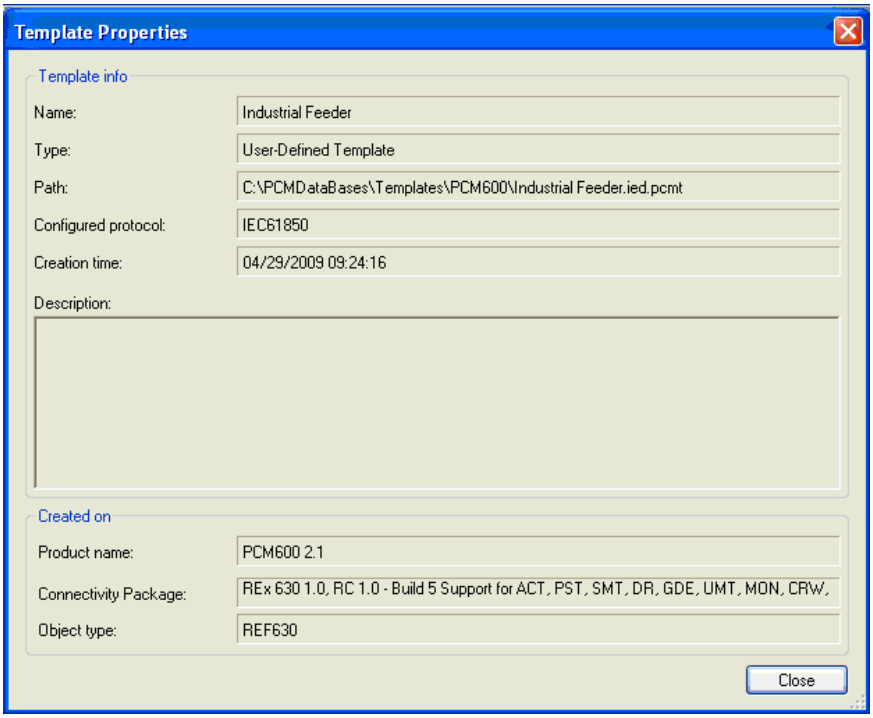

Figure 19: PCM600: IED Template Properties

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 18.

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 pre-configuration

Pre-configurations can be downloaded free of charge from the ABB website.

Pre-configurations in PCM600 are available as *.pcmi files and include all information that is related to the IED object in PCM600. The pre-configuration is bound to a specific hardware configuration.

A license update tool is needed to be run to ensure that the configuration is compatible with the ordered device.

Two alternatives to insert a pre-configuration:

- Use the pre-configuration 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 pre-configuration

1. Right-click the bay and select *Import ...* to select the IED configuration file (*.pcmi) that was downloaded from the ABB website, see Figure 20.

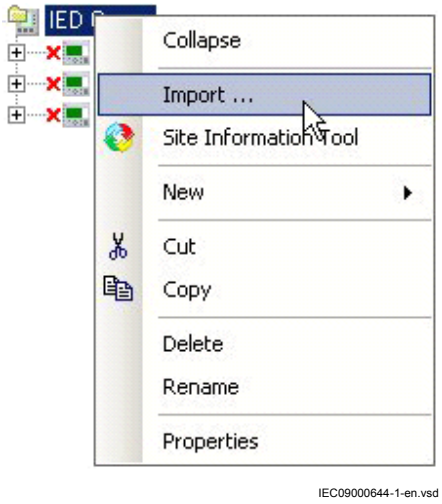

Figure 20: Import an IED from the context menu

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. Get the order code of the ordered IED, which is available in the order confirmation E-mail.
5. Open the *License update tool* from the IED context menu. Order code selection windows are presented in Figure 14 (online) and Figure 17 (offline).
6. Modify the configuration according to the needed application.
7. Write the configuration to the IED.

When the order code is entered, the tool compares the ordered hardware and software options to the previously imported configuration. If there is a difference in hardware or if the configuration uses functions that are not included in the license, the configuration can not be written to the IED. Mismatches in the license are shown in ACT. Functions that are not available in the license are shown in blue color in ACT. Hardware channels from changed hardware modules are unallocated and the user has to reallocate them.

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.

4.6.1 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 21.

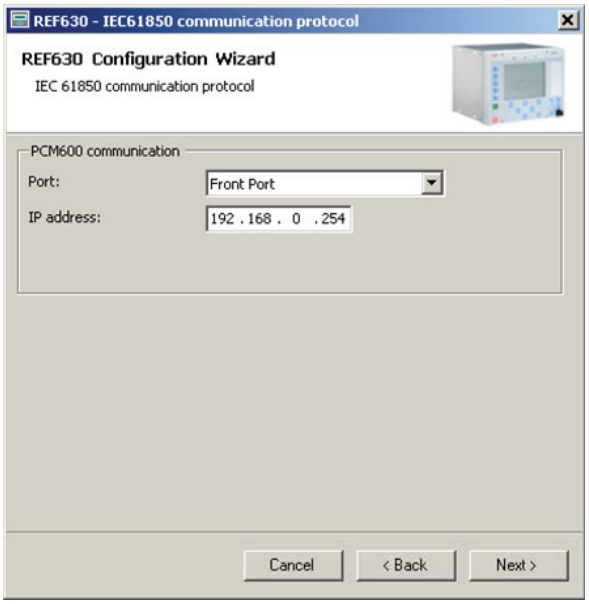

Figure 21: Alternative 1: IP address via first Wizard window

- Via the IP address property of the IED in the *Object Properties* window, see Figure 22.

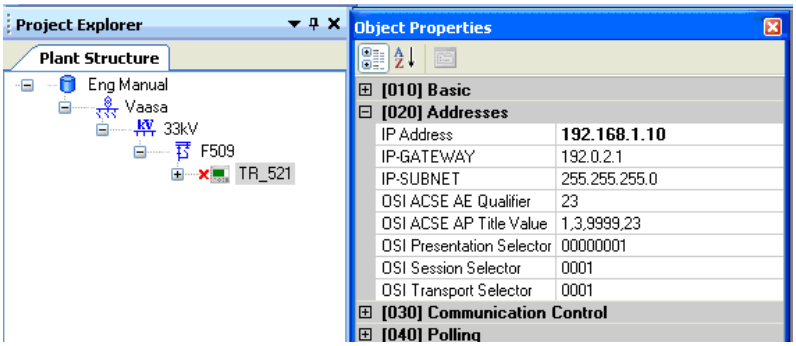

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Figure 22: Alternative 2: IP address via IED Object Properties window

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.

4.7 Setting technical key

The Technical Key Editor tool is used to synchronize technical keys in the PCM600 project and in an IED. These two technical keys have to be the same in order to communicate with the IED. The technical key has to be unique for each IED in the project.

PCM600 sets technical key values for inserted IEDs based on IEC 61850 naming conventions. The default value in the IED can be replaced either with the current value in PCM600 or with a user-defined value. The technical key in the PCM600 project can be edited in the IED properties panel.

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.

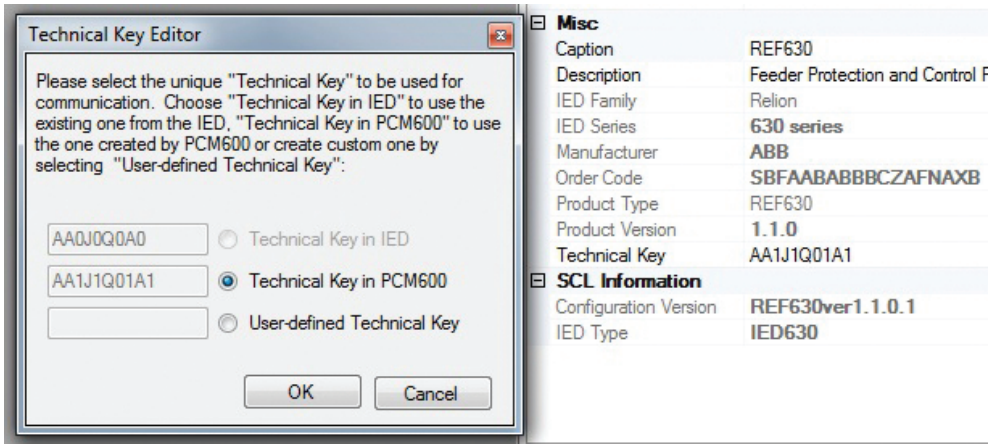


Figure 23: Technical key in Technical Key Editor and in properties panel

1. Select an IED in the plant structure.
2. Right-click and select the set technical key. A dialog window opens to inform about the technical key concept.
3. Click OK. The technical key is read from the IED and the Technical Key Editor window opens.
4. Select the way the technical key is defined.
   - Use the existing technical key in the IED.
   - Use the existing technical key defined for the IED object in PCM600.
   - Set a user-defined technical key, which changes the technical key for both the physical IED and IED object in PCM600.
5. 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.

4.8 Using 630 devices in COM600 project

The 630 Connectivity Package does not have support for SAB600. This means that the 630 series IED needs to be imported as a generic 61850 device. It is also possible to import a full PCM600 project including several 630 devices to SAB600. In this case PCM600 project information is imported to SAB600 using a SCD file.

Procedure

1. First create PCM600 project including several 630 devices, see Figure 24.

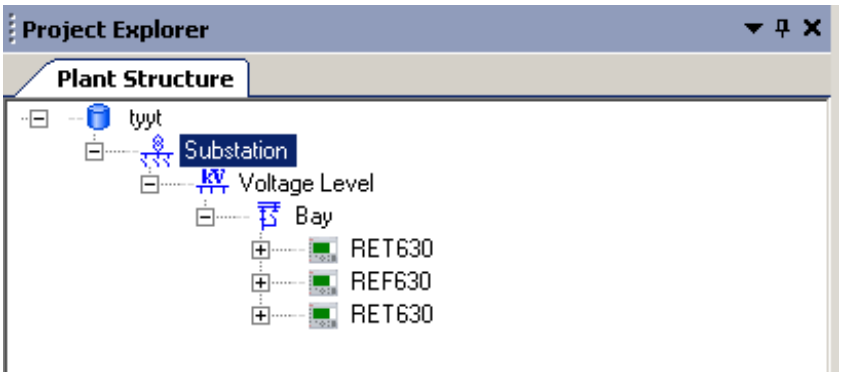


Figure 24: Create PCM600 project including several 630 devices

2. Export the SCD file from PCM600 and import it to SAB600, see Figure 25.

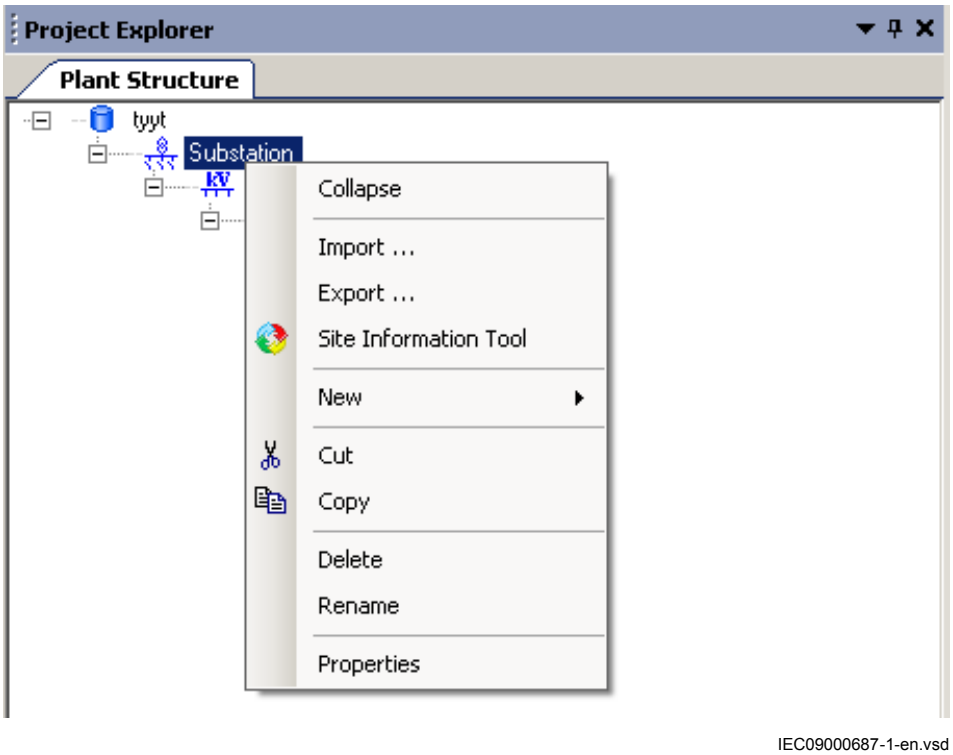


Figure 25: Export SCD file from PCM600 and import it to SAB600

3. Select the correct *IEC 61850 Client* identification in the IEC 61850 *OPC Server* properties to enable the event reporting for imported IEDs.
4. Create new generic device in SAB600 project, see Figure 26.

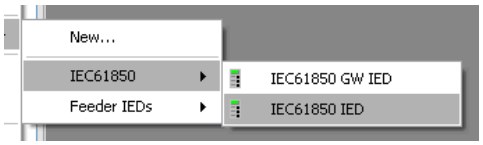


Figure 26: Create new generic device in SAB600 project

5. Export the CID file from PCM600 and import it for the created generic device, see Figure 27.

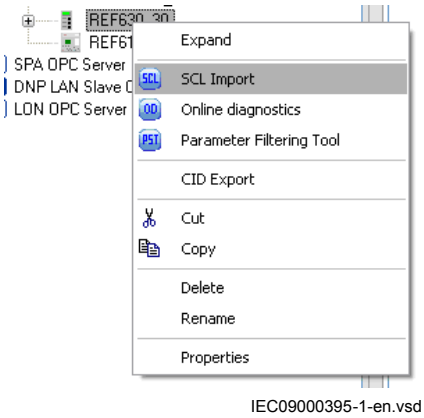


Figure 27: Import exported CID file for created generic device

Using 630 series device as a generic 61850 device supports the following functionality:

- Controlling switch gear
- Monitoring measured values
- Reading disturbance recordings

4.8.1 Enabling Web Server

Procedure to enable Web Server for parametrization from COM600.

1. Set two parameters in SAB600, see Figure 28:
   - Web Server Enabled
   - Web Server IP Address

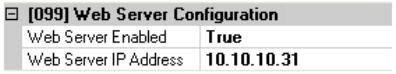


Figure 28: Enable Web Server for parametrization

2. After this, Web Server option is available in the COM600 Substation view and it opens the Web HMI for 630-series device, see Figure 29.

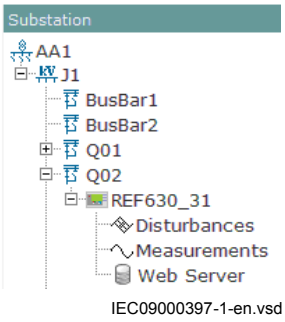


Figure 29: WEB Server available in COM600 substation view

4.9 Using the Web HMI

WHMI is disabled by default.

1. To enable the WHMI, select **Main menu/Configuration/HMI/Web HMI/Operation** via the LHMI.
2. To enable writing through the WHMI, select **Main menu/Configuration/HMI/Web HMI/Write mode** via the LHMI.
3. To open the WHMI, write the IED IP address to the address bar of the browser.

4.9.1 Logging in

If no users have been created with PCM600, both the default user ID and password is SuperUser.

1. Enter the username.
2. Enter the password.
3. Click **OK**.

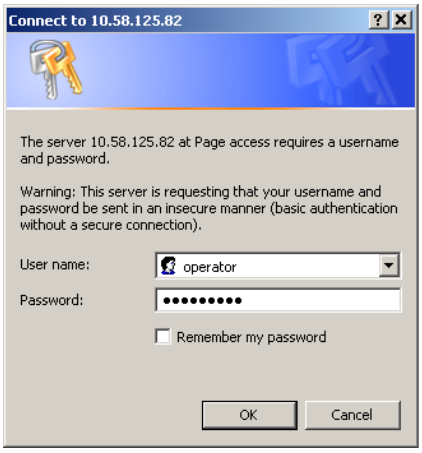


Figure 30: Entering username and password to use the WHMI

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 630 series Technical 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
- LEDs
- Function keys

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 31 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.

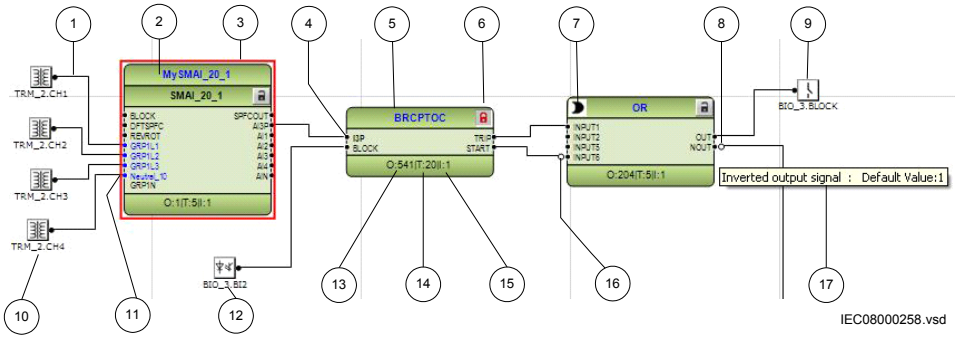


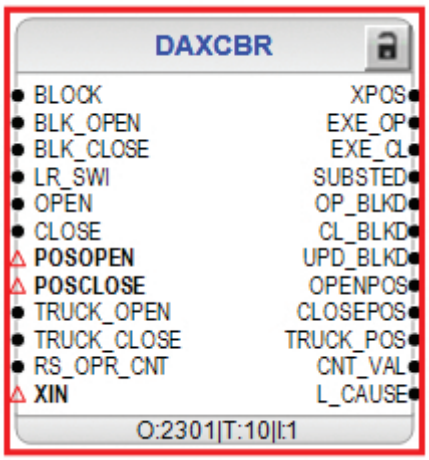
Figure 31: ACT: Function block overview

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.

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 32 shows an example how the drop down list could look like.

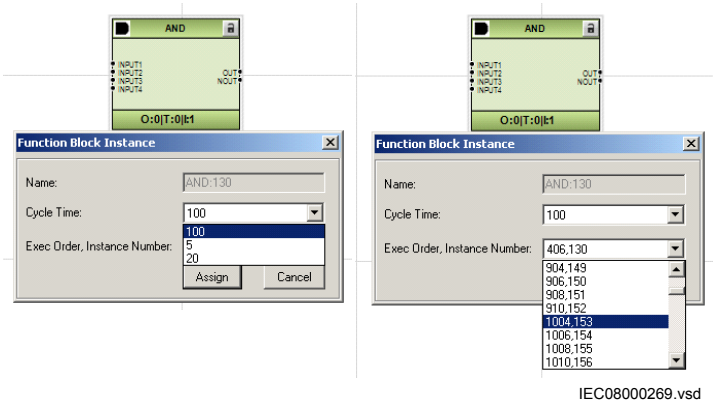


Figure 32: ACT: function block organization parameters

The *Cycle Time* can be selected to 3, 5, 10, 100 or 200 ms. Depending on function block type and the 630 series product only one or more possibilities may be available.

- REF630 and REM630 have functions running in 5, 10, 100 and 200 ms cycles.
- RET630 has functions running in 3, 10, 100 and 200 ms cycles.

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 application execution is organized in following time classes:

- 3 ms
  - For transformer differential protection and analog signal monitoring.
  - Binary I/O and circuit breaker control supporting the fast protection functions.
  - The task starts on data change given by the analog signal scanning
- 5 ms
  - For instantaneous protection functions.
  - Binary I/O and circuit breaker control supporting the fast protection functions.
  - The task starts on data change given by the analog signal scanning
- 10 ms
  - For time delayed protection functions, monitoring functions and fast control applications like disconnector control.
  - The task is started by the end trigger of the 5 ms task
- 100 ms and 200 ms

- For all other tasks mainly control and supervision functions
- The task is started periodically by the clock and the end trigger of the 20 ms task

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 630 series products is organized in four time classes, see Figure 33.

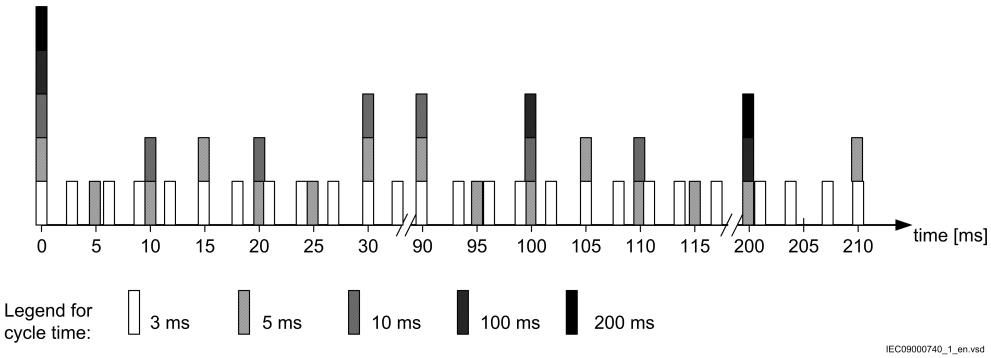


Figure 33: ACT: Possible MainApplication cycle times

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 34.

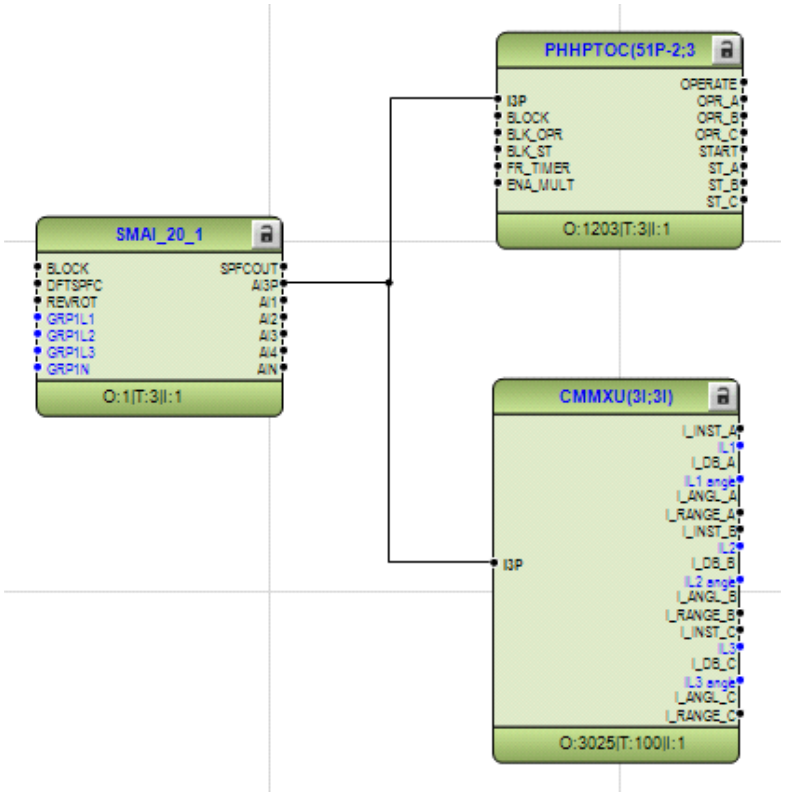


Figure 34: Cycle time and execution order

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.

See examples for 630 series:

In order to have full advantage of the fast 5 ms and 3 ms cycle times all function blocks in the signal chain need to have the same cycle time. Instantaneous protection function running in 3 ms cycle time needs to be connected to the preprocessing SMAI_20 function block that is also running at 3 ms task cycle. In addition logic function blocks used with these fast cycle protection functions need to have 3 ms task cycle. Same procedure needs to be followed for each cycle time.

SMAI_80 function included in REF630 product offers support for higher sampling frequency for analog inputs - 80 samples per line frequency cycle (4kHz in 50Hz network). This high sampling frequency is needed for the intermittent earth fault protection function INTRPTEF and analog group signal to it needs to be connected from SMAI_80 FB. Other functions can also use lower sampling frequency provided by SMAI_20 FB (20 samples per line frequency cycle).

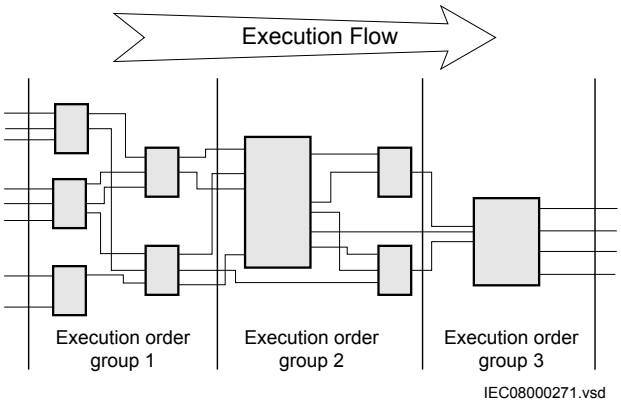


Figure 35: ACT: Concept of Execution order sequence

In the conceptual MainApplication example in Figure 35, 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

Only signals of same type can be connected, see Figure 36.

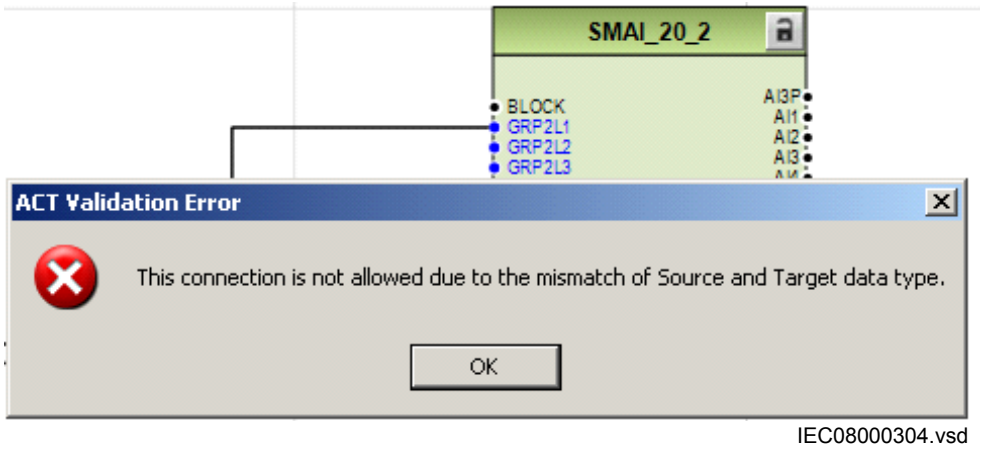


Figure 36: ACT: Warning message by signal mismatch for a connection

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 37. 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
- Analog output 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.

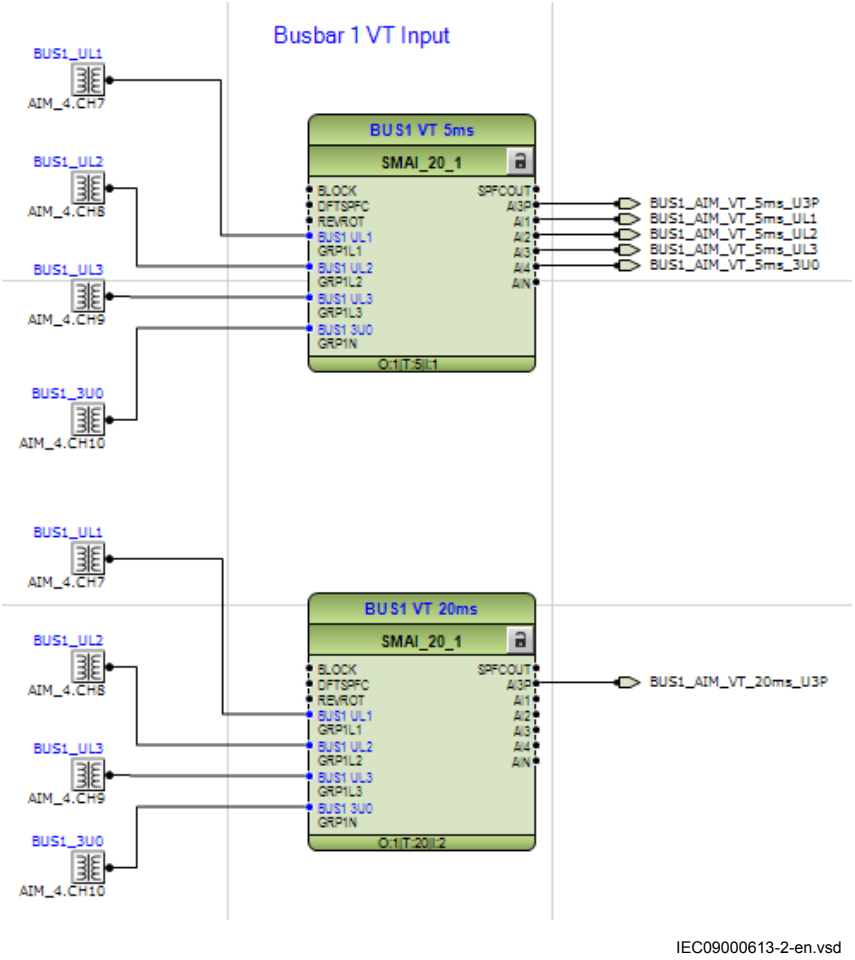


Figure 37: ACT: HW signal channels

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 38.

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.

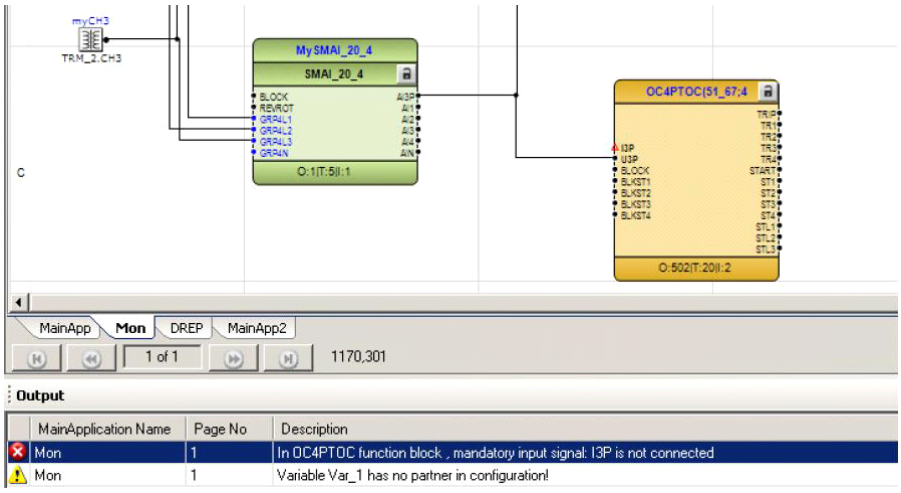


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Figure 38: ACT: Validation on demand

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.

It is possible to export parameters from PST in XRIO format.

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.

5.3 Connecting signals in SMT

SMT is used to do cross references, see Figure 39:

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

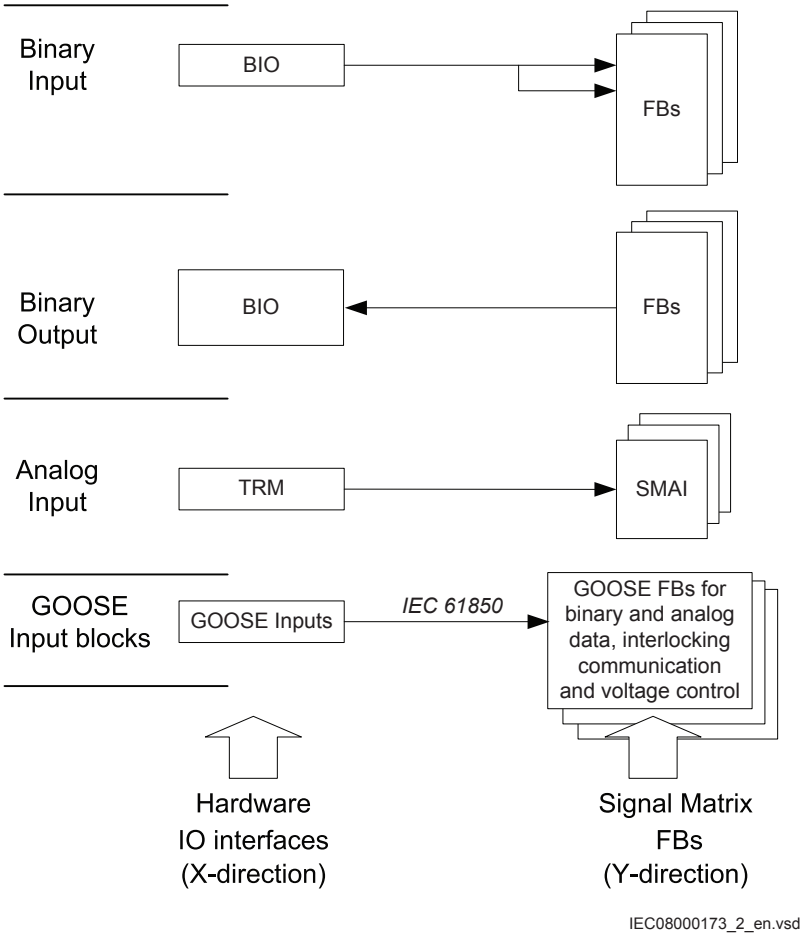

Figure 39: SMT: Operation principles

A binary input channel can be connected to one or several function block inputs, see Figure 40. 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.

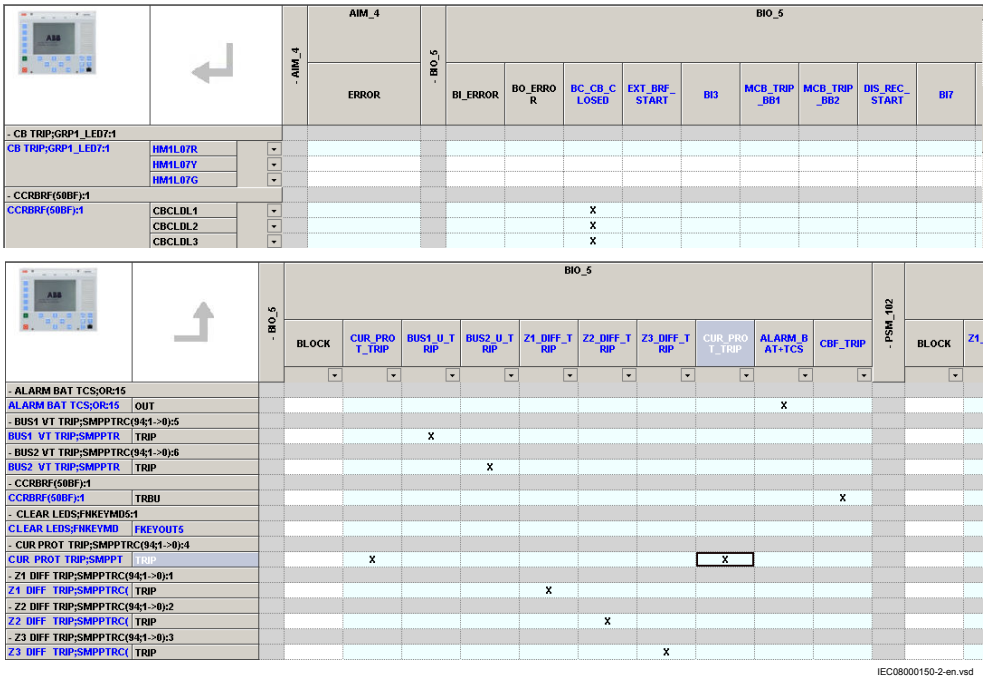

Figure 40: SMT Connection between binary input channels to binary input signals

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

The possible sheets are:

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

5.4 Engineering control functions

5.4.1 Introduction

The apparatus control function continuously supervises and controls circuit breakers, disconnectors and earth-switches within a bay. Permission to operate an apparatus is given after evaluation of conditions from other functions, such as interlocking, synchrocheck, operator place selection and external or internal blockings.

Figure 41 provides an overview from what places the apparatus control function receives commands. Commands to an apparatus can be initiated from the Control Center (CC), the station HMI or the local HMI on the IED front.

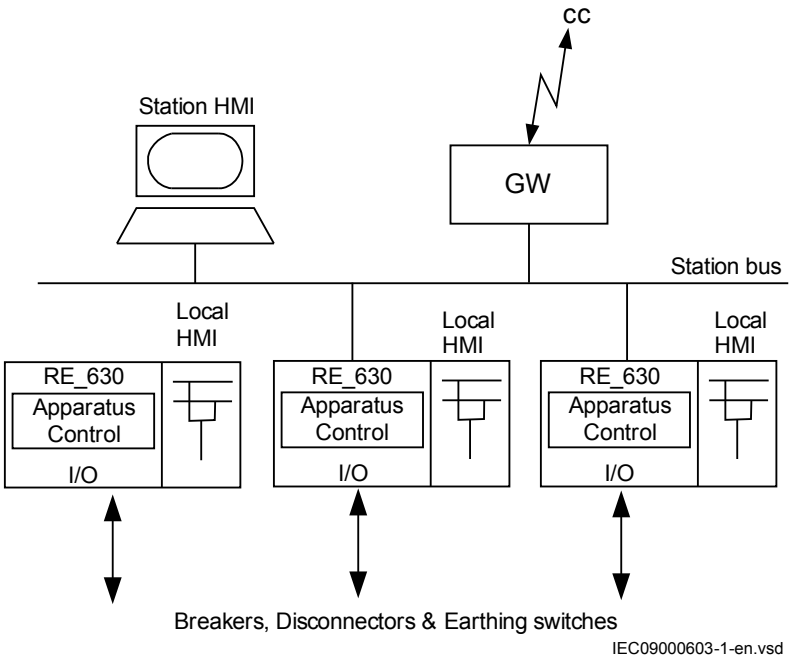

Figure 41: Overview of the apparatus control function

The apparatus control function has the following features:

- Operation of primary apparatuses
- Overriding of synchrocheck
- Select-Execute principle to give high reliability
- Selection and reservation function to prevent simultaneous operation
- Selection and supervision of operator place
- Command supervision
- Block/unblock of operation
- Block/unblock of updating of position indications

- Substitution of position indications
- Overriding of interlocking functions
- Operation counter

The apparatus control is realized by means of a number of function blocks designated:

- LocalRemote switch (LOCREM)
- Bay control (QCCBAY)
- Switch controller (GNRLCSWI)
- Circuit breaker (DAXCBR)
- Circuit switch (DAXSWI)

The three latter functions are logical nodes according to IEC 61850. The signal flow between these function blocks is shown in Figure 42. The detail description for all these functions can be found in technical manual. Logical node for interlocking (SCILO) in Figure 42 is the logical node for interlocking. Control operation can be performed from the local HMI.

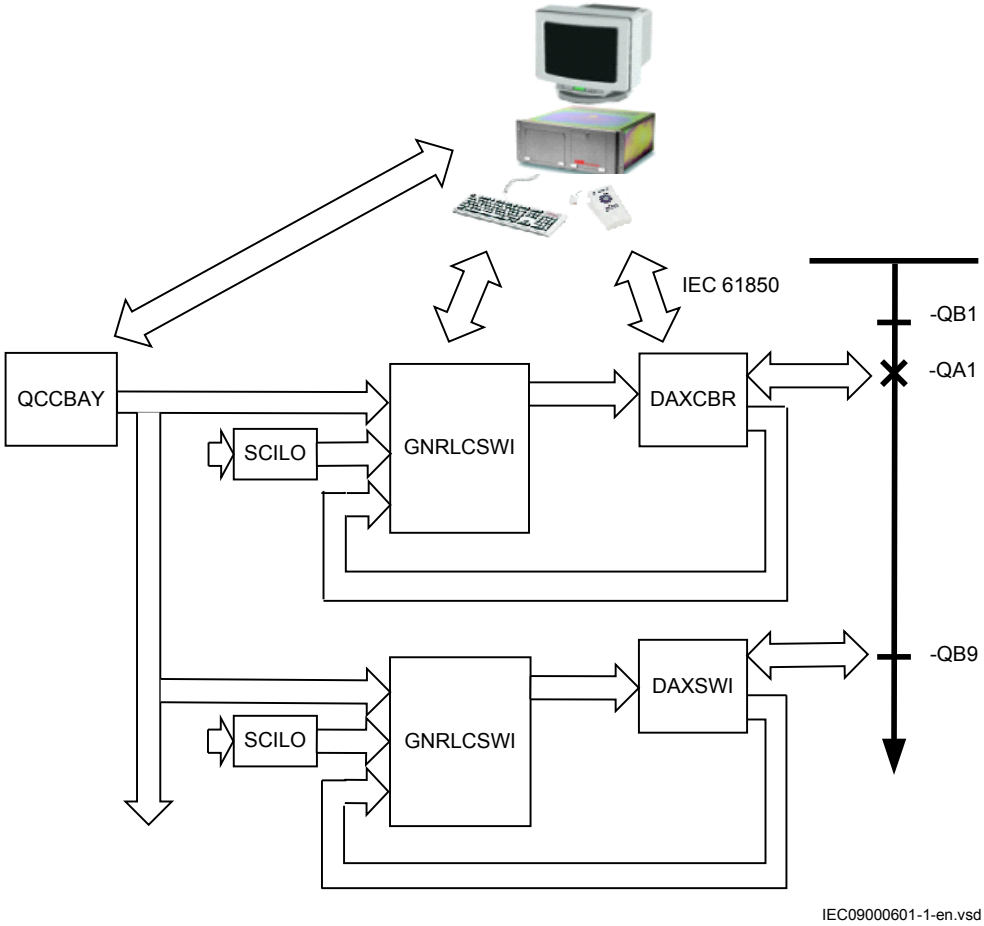

Figure 42: Signal flow between apparatus control function blocks

5.4.2 Remote/Local switch

The IED has Remote/Local (R/L) switch available on the local HMI. However, if it is required to use R/L switch externally, that is, to use switch other than available on local HMI, it is necessary to use Local remote (LOCREM) function in the configurations.

LOCREM function has the three following binary inputs - CTRLOFF, LOCCTRL and REMCTRL. The information from the external switch needs to be connected to LOCREM function via binary inputs.

Consider the example as shown in Figure 43, the three different positions available from the external R/L switch is connected to binary input card. These binary inputs are then connected to LOCREM function in Application Configuration Tool (ACT). It is also required that the setting Control mode of LOCREM function is set to External LR-switch switch.

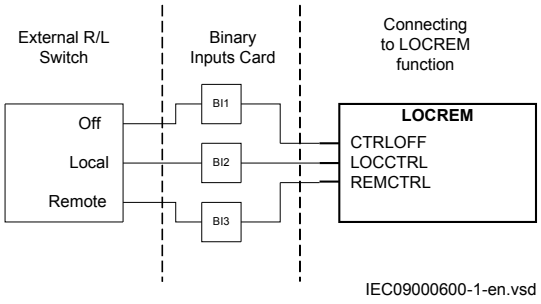

Figure 43: LOCREM Engineering

LOCREM function acts in OFF position, in case if more than one binary input is at logical TRUE, or if all are at logical FALSE due to some error in connection, or due to faulty external switch.

The indication about the position of R/L switch is available on local HMI.

5.4.3 Bay control

The Bay Control (QCCBAY), fulfils the bay-level functions for the apparatuses, such as operator place selection and blockings for the complete bay.

QCCBAY gives permission to operate from two types of locations either from Remote (for example, control center or station HMI) or from Local (local HMI on the IED). The Local/Remote switch position can also be set to Off, which means no operator place selected, resulting into no operation from local or remote. The connections between LOCREM and QCCBAY functions are not visible to the customer, they are internally connected. If LOCREM indicates that R/L switch is in REMOTE mode the same information is available to QCCBAY and function sends

information about the Permitted Source To Operate (PSTO) to other functions internally.

QCCBAY also provides blocking features that can be distributed to different apparatuses within the bay. There are two different blocking alternatives:

- Blocking of position indications
- Blocking of commands

It is not compulsory to use QCCBAY function in the configuration if one doesn't need to activate any of the above blocking functionality.

When blocking of position indications is activated, the change in position (close or open change) of the apparatus is ignored by the IED. Similarly, when blocking of command is activated, it will not allow to perform any close or open operation on the apparatus. The message that is displayed on the Display page when any operation is tried to perform with blocking of command connected to TRUE is as shown in Figure 44.

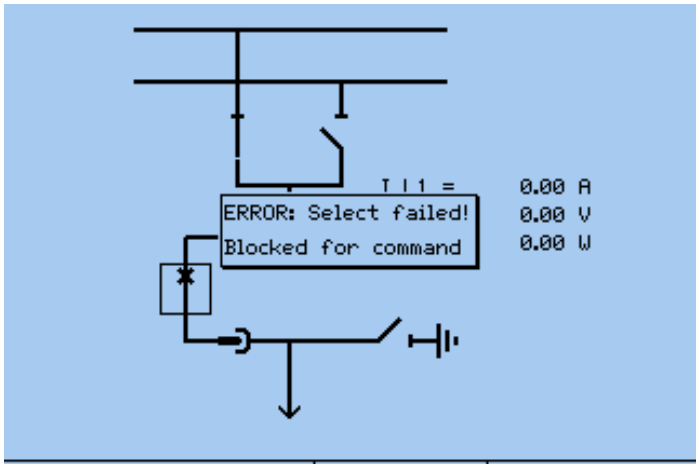

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Figure 44: Message displayed when controlling any power apparatus with BLK_CMD of QCCBAY connected to logical TRUE

Logical node for interlocking

Logical node for interlocking (SCILO) provides the information to the switching controller GNRLCSWI whether it is permitted to operate due to the switchyard topology. Customer need to prepare the interlocking conditions logics using OR/AND logics and this information is given to SCILO at OPEN_EN and CLOSE_EN inputs. Let's take an example, consider the switchyard topology as shown in Figure 45, the earth switch shown in the topology can be open or closed if (a) the circuit breaker is in open position OR (b) circuit breaker is in closed position AND both the disconnectors are in open position.

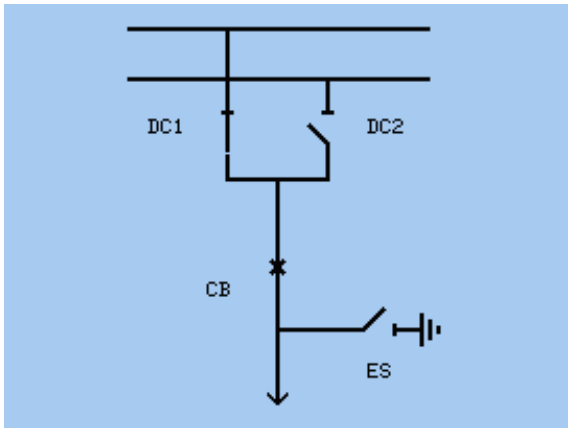

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Figure 45: Typical Power system topology

The interlocking logic for earth switch for the topology is shown in Figure 46.

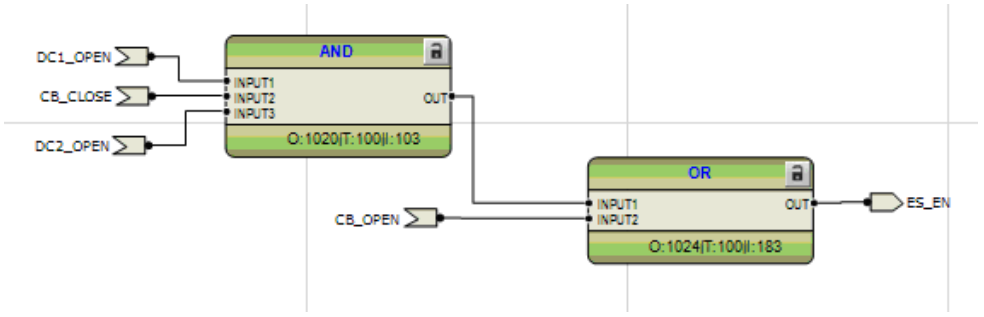

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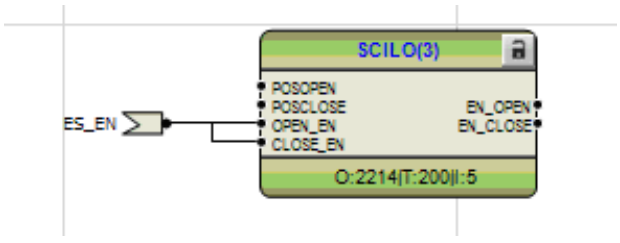
Figure 46: Interlocking condition for earth switch for power system topology

The output of this interlocking condition ES_EN, is connected to functional input of SCILO at OPEN_EN and CLOSE_EN as shown in Figure 47.



IEC09000607-1-en.vsd

Figure 47: Interlocking condition connected to SCILO

A situation may occur where power apparatus have different open and closing logic, for example, in case of circuit breaker, where any interlocking condition for opening may not exist, but closing may require some interlocking checks (like the spring is charged or there is a trip signal, for example). Under such circumstances,

logical TRUE may be connected to OPEN_EN and CLOSE_EN may be connected with condition obtained from the logic prepared.

The POSOPEN and POSCLOSE inputs of SCILO require the information about the current status of the apparatus for which the SCILO is used. For example, in the earth switch, the binary input indicating the information about the earth switch in open position and closed position is connected to POSOPEN and POSCLOSE inputs of the SCILO respectively. This information can be connected directly from the binary inputs containing earthswitch position information or may be connected as a feedback loop obtained from DAXCBR/DAXSWI function. Both possibilities for a SCILO handling circuit breaker are shown in Figure 48.

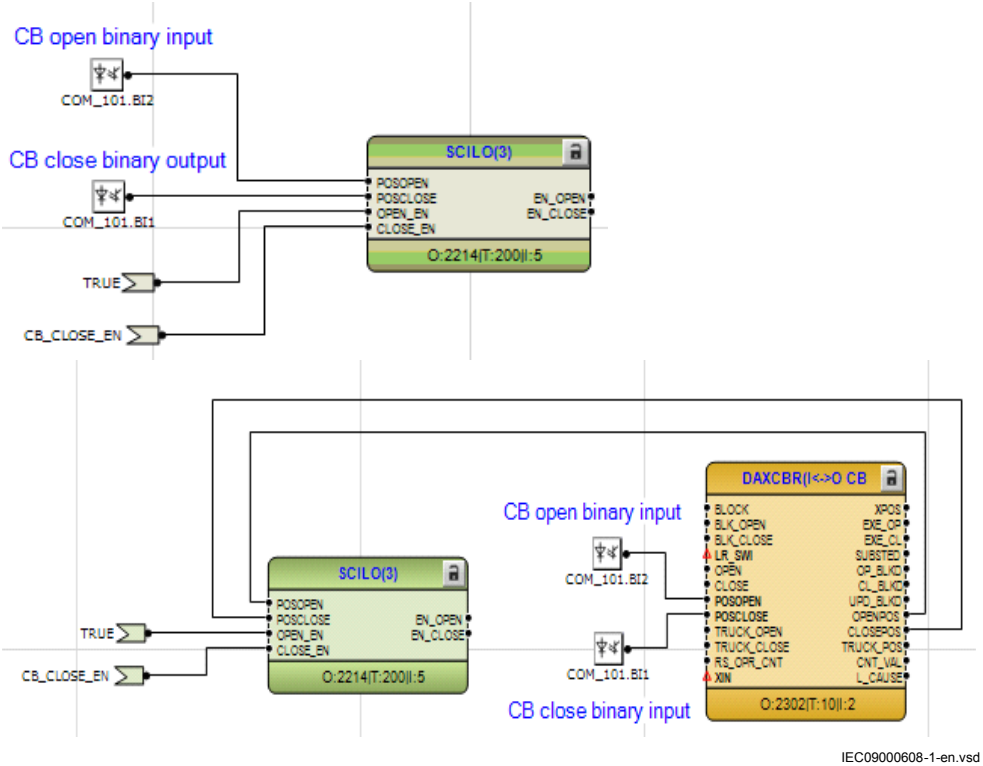


Figure 48: Possibilities for connecting position indications to SCILO

The outputs enable open and close from SCILO: EN_OPEN and SCILO: EN_CLOSE are connected directly to input enable open and close of GNRLCSWI: EN_OPEN and GNRLCSWI: EN_CLOSE, as shown in Figure 49.

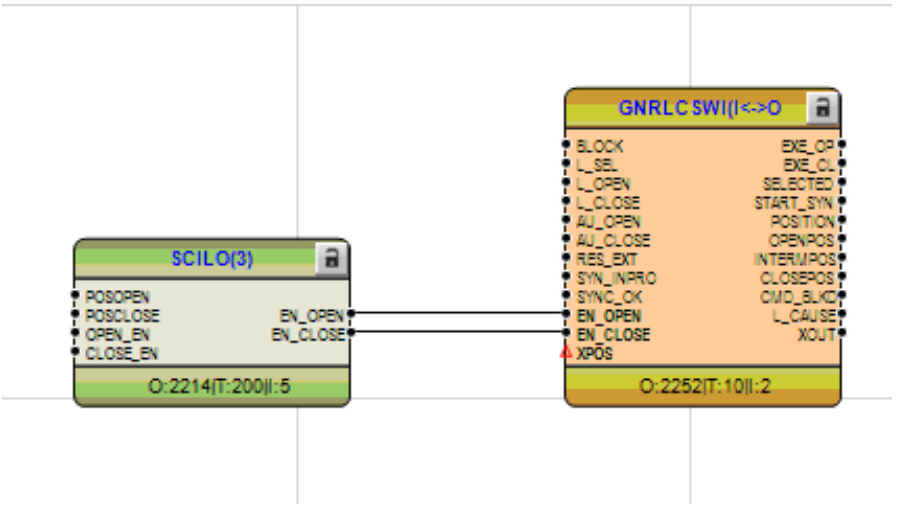


Figure 49: Connection of enable open and close connection between SCILO nd GNRLCSWI

5.4.4 Switch control

The Switch controller, GNRLCSWI, initializes all operations for one apparatus and performs the actual switching and is more or less the interface to the drive of one apparatus. It includes the position handling as well as, the control of the position. GNRLCSWI initializes and supervises all functions to properly select and operate primary switching devices.

After the selection of an apparatus and before the execution, the switch controller performs the following checks and actions:

- A request initiates to reserve other bays to prevent simultaneous operation.
- Actual position inputs for interlocking information are read and evaluated if the operation is permitted.
- The synchrocheck/synchronizing conditions are read and checked, and performs operation upon positive response.
- The blocking conditions are evaluated.
- The position indications are evaluated according to given command and its requested direction (open or closed).

At error, the command sequence is cancelled.

An apparatus can be controlled (open/close) with the help of GNRLCSWI function in the following different ways:

- By using local automation function that is, AU_OPEN, and AU_CLOSE inputs
- From the Local panel L_SEL, L_OPEN and L_CLOSE inputs
- Directly by selecting the apparatus from the Display page and using Open/ Close button available on local HMI.

When local automation functions are used for opening or closing operation the opening and closing command from such local automation should be connected to AU_OPEN and AU_CLOSE input of the GNRLCSWI function. GNRLCSWI evaluates whether the condition for opening or closing are fulfilled and the operation is performed.

Similarly, if local panel is used for opening or closing operation, the inputs which deal with opening and closing are connected to L_OPEN and L_CLOSE respectively. However, with this mode of control it is required that before performing any operation the local select input L_SEL is activated. Activation of only L_OPEN or L_CLOSE will not result into opening or closing of apparatus. L_SEL is first activated and then L_OPEN is activated for performing opening operation, Similarly, L_SEL is first activated and then L_CLOSE is activated for performing closing operation.

The switch controller GNRLCSWI works in conjunction with the synchrocheck and synchronizing function SYNCRSYN. It is assumed that the synchrocheck function operates continuously and activates the SYNC_OK signal when all synchronizing conditions are satisfied to the switch controller GNRLCSWI. The result from the synchrocheck function is evaluated during the close execution. If the operator overrides the synchrocheck, the evaluation of the synchrocheck state is omitted. When there is a positive confirmation from the synchrocheck function, the switch controller sends a close signal EXE_CL to the switch breaker function DAXCBR.

When there is no positive confirmation from the synchrocheck function, the switch controller sends a start signal START_SYN to the synchronizing function. The function sends a closing command to the switch function when the synchronizing conditions are fulfilled, as shown in Figure 50. If no synchronizing function is included, SYNC_OK input should be connected to TRUE and SYN_INPRO to FALSE.

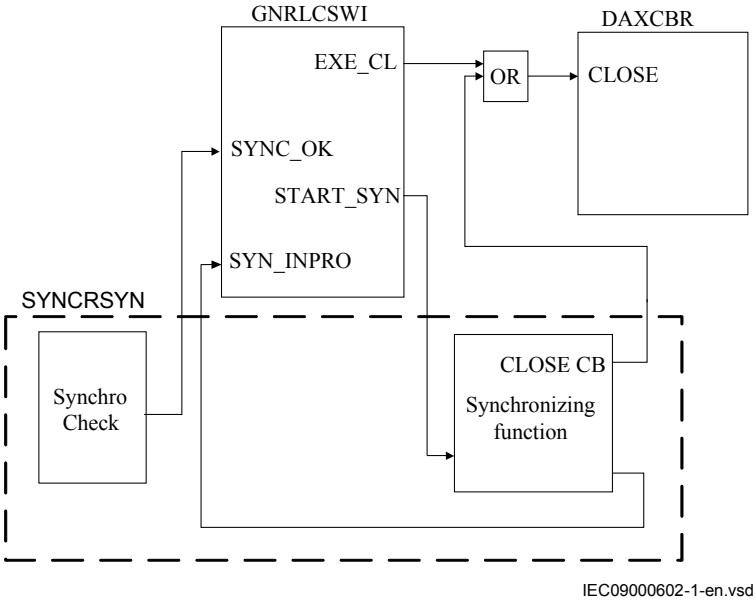


Figure 50: Example of interaction between GNRLCSWI, SYNCRSYN (synchrocheck and synchronizing function) and DAXCBR functions

RES_EXT input deals with the reservation functionality. The purpose of the reservation functionality is primarily to transfer interlocking information between IED's in a safe way and to prevent double operation in a bay, switchyard part, or complete substation. Reservation can be done from the bay in which IED is located or may be from another bay. It is only possible to reserve the function if it is not currently reserved. When RES_EXT is activated for a particular apparatus the apparatus is reserved and it cannot be operated from the IED. If RES_EXT is activated and a simultaneous attempt is made to open/close the apparatus from the local HMI, the message that will be displayed on the display is as shown in Figure 51.

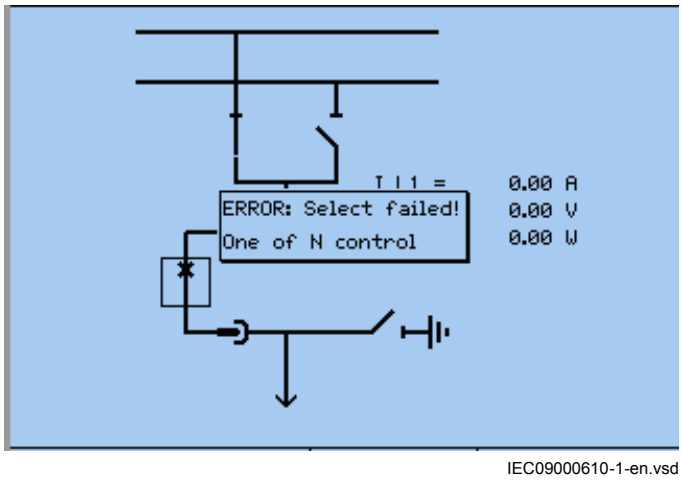


Figure 51: Example of interaction between GNRLCSWI, SYNCRSYN (synchrocheck and synchronizing function) and DAXCBR functions

The present status information of the apparatus, that is, open or closed or intermediate stage is available to GNRLCSWI function from the switch function DAXCBR/DAXSWI via XPOS input. The XPOS input of GNRLCSWI is connected to XPOS output of DAXCBR/DAXSWI. The same information is also available at the GNRLCSWI binary outputs at OPENPOS, INTERMPOS, and CLOSEPOS. The output POSITION indicates the same information in integer form.

The EXE_OP and EXE_CL are the execution command for opening and closing operation. Once all the required conditions for an opening or closing operation are fulfilled, GNRLCSWI generates the execution command; these outputs are directly connected to OPEN and CLOSE inputs of the switch function DAXCBR/DAXSWI.

When an apparatus is selected either from local HMI or by L_SEL input, output SELECTED is activated, indicating the selection has been made and now waiting for the opening or closing command. The blocking of execution of command if any by QCCBAY function is reflected at CMD_BLKD output.

Depending on the error that occurs during the command sequence, the error signal is set with a value. An output L_CAUSE on the function block indicates the latest value of error during the command.

5.4.5 Circuit breaker/Circuit switch

The functional block, DAXCBR acts as an interface module for circuit breaker and DAXSWI acts as an interface module for disconnectors and earth-switch. The binary input information indicating the status of the apparatus is connected to POSOPEN and POSCLOSE input of DAXCBR/DAXSWI function. In case of circuit breaker with truck arrangement, the truck positions are also connected to DAXCBR function at TRUCK_OPEN and TRUCK_CLOSE inputs. The status is also available at binary output OPENPOS and CLOSEPOS output of DAXCBR/DAXSWI function. In case of DAXCBR the truck position information is available at TRUCK_POS output in integer form.

Binary input signal LR_SWI is included in this function to indicate local or remote switch position from the switchyard provided via I/O board. If the signal is set to TRUE, changes of position are only allowed from switchyard level. If the signal value is FALSE, commands from IED or higher level are permitted. When the signal value is set to TRUE, all commands are rejected from internal IED clients.

The function can be blocked by activation of BLOCK input. Similarly, it is also possible to block individually the open and closing operation by activating BLK_OPEN and BLK_CLOSE input respectively. The group of execution information XOUT from the GNRLCSWI is connected to XIN input of DAXCBR/DAXSWI function.

The binary output responsible for opening or closing of the circuit breaker or the disconnector or earth switch is connected to EXE_OP and EXE_CL output of the DAXCBR/DAXSWI function.

If the function is blocked to perform opening or closing operation, the same will be indicated as OP_BLKD and CL_BLKD outputs. The blocking of execution of position updates if any by QCCBAY function is reflected at UPD_BLKD output. CNT_VAL indicates the number of closing and opening operation performed by the apparatus, the same can be reset via RS_OPR_CNT input.

Depending on the error that occurs during the command sequence, the error signal is set with a value. An output L_CAUSE on the function block indicates the latest value of error during the command.

Example

A typical example is shown in Figure 52, indicating the interconnection between SCILO, GNRLCSWI and DAXSWI functions:

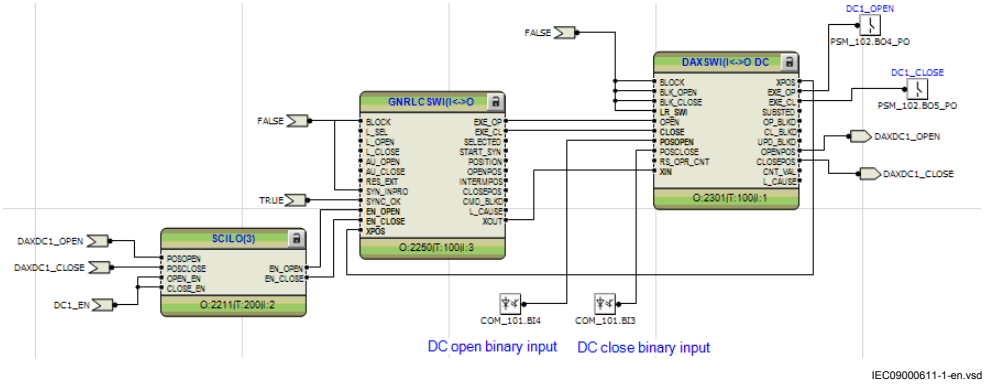


Figure 52: Example of interaction between SCILO, GNRLCSWI, and DAXSWI functions

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 53 presents the pre-engineering step, the main steps in the engineering process and the required sequences.

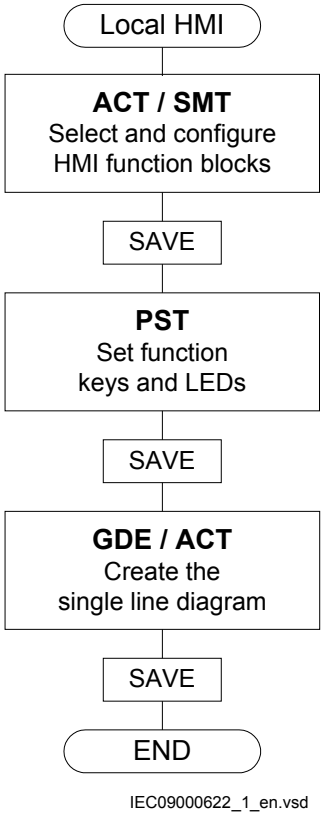


Figure 53: LHMI: Engineering process flowchart

- 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 display for LHMI keys and LEDs.
- Graphical Display Editor with assistance of Application Configuration tool, for example
  - to make the single line diagram of the primary process part.
  - to make the dynamic links for the apparatus.
  - to make the dynamic links for measurements.

Application Configuration tool and local HMI function blocks

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

See the technical manual for more information about function blocks.

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

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

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

Figure 54 describes the basic LHMI and the operation element groups. These are the 15 LEDs and their belonging text elements on the display [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 display [B].

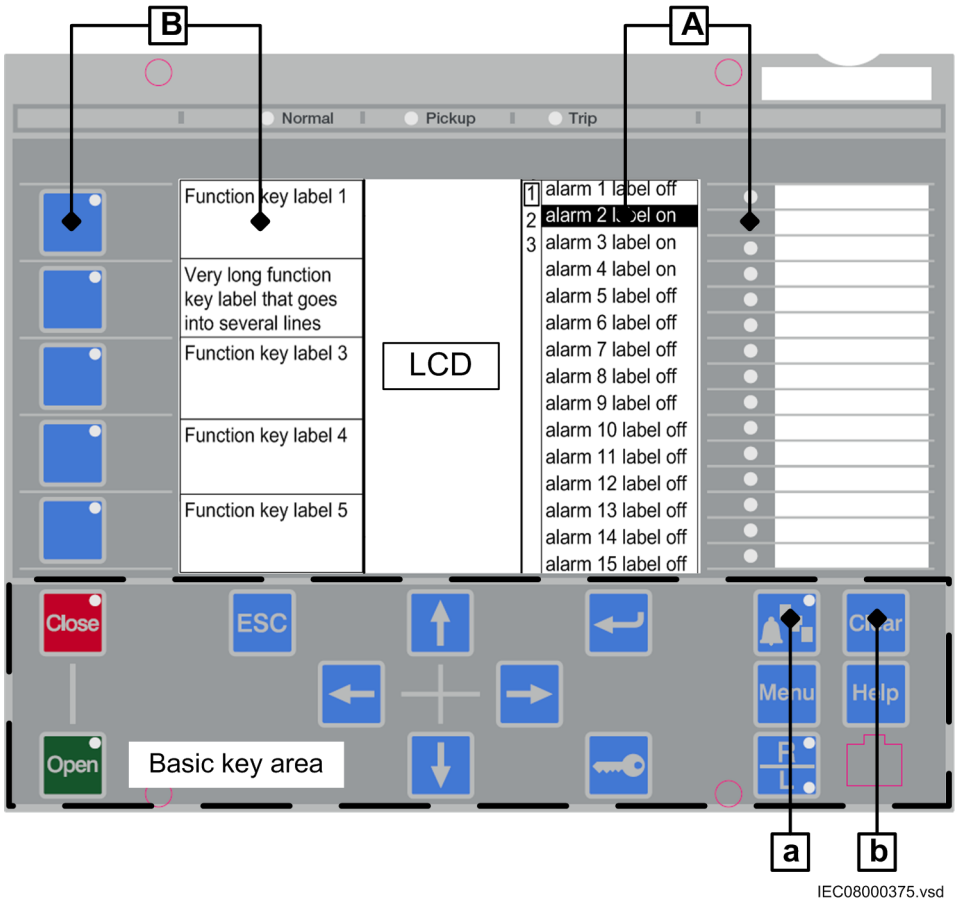


Figure 54: Local HMI: Placement of local HMI operation elements

Function block LEDGEN

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

Function block GRP1_LED1 to GRP3_LED15

- The 15 LEDs on the right side of the display 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 display [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 display. No execution of the function is done. So the first push is used to activate the presentation only.
- The next key push is handled as activate function and the output signal of the function block is set.
- The operation mode of the function key is defined in Parameter Setting tool (pulse, toggle).

Parameter Setting tool and function block configuration

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

The function key can operate as:

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

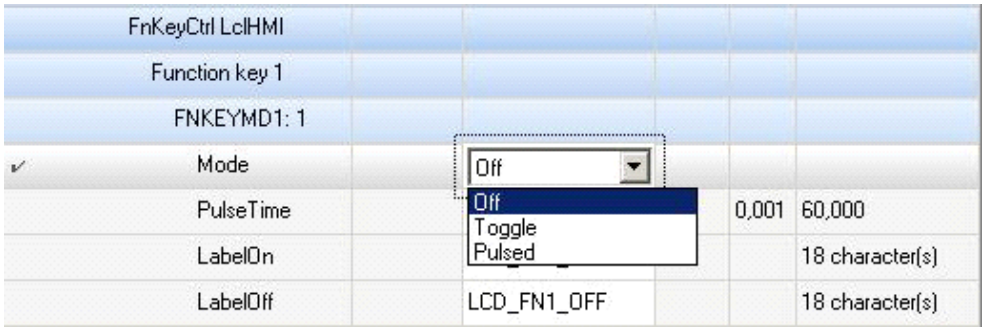


Figure 55: LHMI: Function key operation mode

The LEDs have a number of different operation modes, see Figure 56:

- General definitions
  - Each LED can illuminate in one of three colors: RED, YELLOW, GREEN.
  - Only one color is illuminated at a time.
  - The priority for illumination and the color is linked.
    - Prio 1 = RED
    - Prio 2 = YELLOW
    - Prio 3 = GREEN
    - When RED and YELLOW are ON at the same time, the LED will illuminate in RED.
  - The operator's acknowledge for the LED signals is done for all three signals (RED, YELLOW, GREEN) of the LED.
  - A reset of the LLEDs operates also on all three signals of the LEDs.

- Follow-S
  - The LED illumination follows the status of the signal. The LED illuminates steady (S).
- Follow-F
  - The LED illumination follows the status of the signal. The LED illuminates flashing (F).
- LatchedAck-F-S
  - The LED latches the signal change OFF-ON and flashes (F) until it is acknowledged.
  - When the signal is still ON at the time the signal is acknowledged the LED changes to steady (S) mode.
  - When the signal has already changed to OFF before the time it is acknowledged, the LED turns to OFF.
- LatchedAck-S-F

- The same as LatchedAck-F-S but the LED starts with steady state and flashes after acknowledgment.

- LatchedColl-S
  - The LED illuminates in all cases in steady mode only
  - The LED latches a signal change from OFF-ON until it is acknowledged by the operator.
  - The LED stays in steady mode when it is reset and the signal is still in ON state.
  - The LED is OFF only after the signal has changed to OFF state AND it is reset by the operator via 'Clear' operation.
- LatchedReset-S
  - This mode is used for all LEDs that are used to indicate a disturbance. The LEDs will stay in the last state after the disturbance run time until they are reset after a defined time.
  - The timers are set in Parameter Setting tool in the function block LEDGEN.

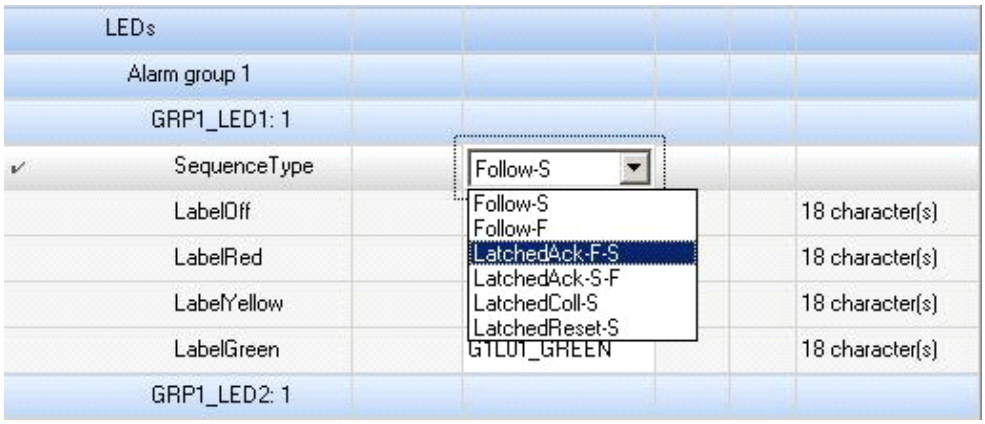


Figure 56: LHMI: LED operation mode

6.1.2 LED operation modes

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

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

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

LED operation mode Follow-S

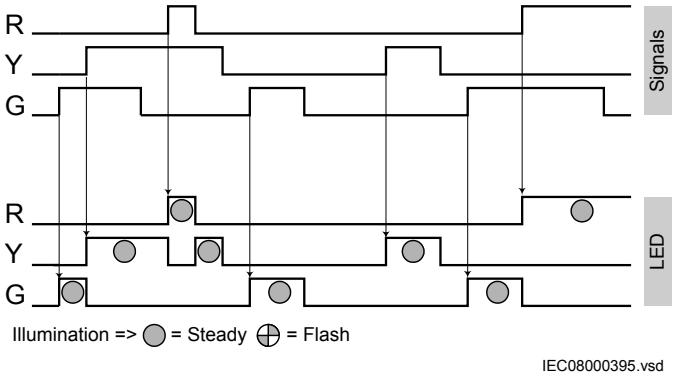


Figure 57: LHMI: LED operation mode Follow-S

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 57 for the valid priority rules. The LED illuminates always in steady state.

LED operation mode Follow-F

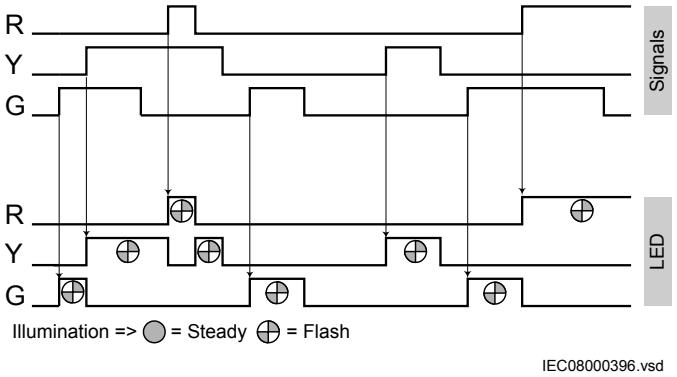


Figure 58: LHMI: LED operation mode Follow-F

This is the same mode as Follow-S but the LED illuminates flashing, see Figure 58. This mode may be used to indicate that a tap changer or Petersen coil is moving.

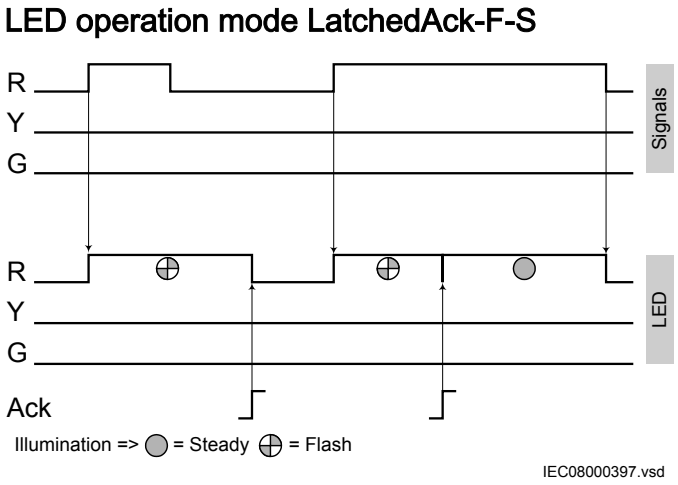


Figure 59: LHMI: LED operation mode LatchedAck-F-S / Base

The classical mode to indicate incoming alarms or warnings, which the operator has not seen since the last acknowledgement, is presented in Figure 59 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.

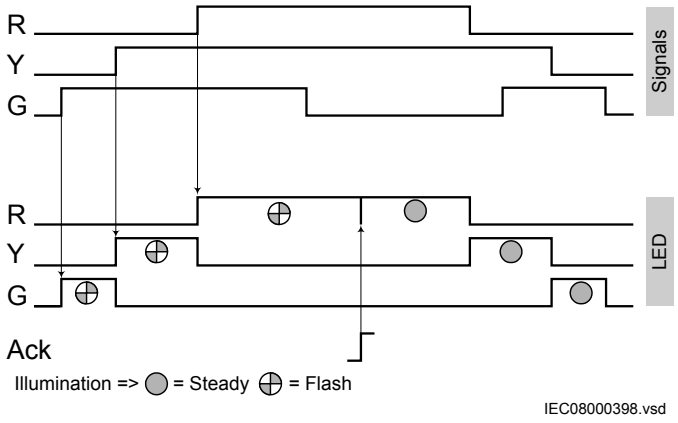


Figure 60: LHMI LED operation mode LatchedAck-F-S Ack Prio / 1

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 60 and Figure 61 for these two principles.

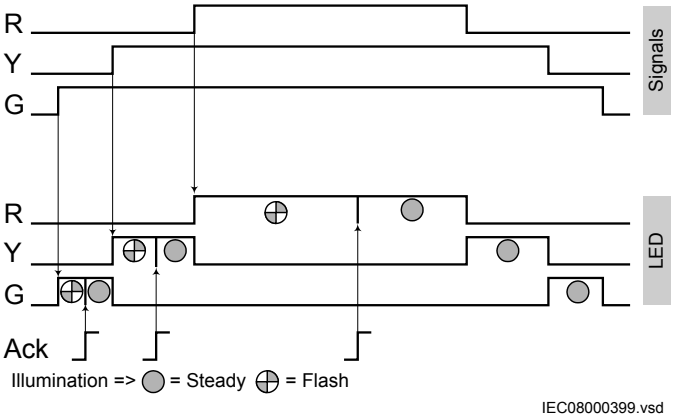


Figure 61: LHMI LED operation mode LatchedAck-F-S Prio / 2

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

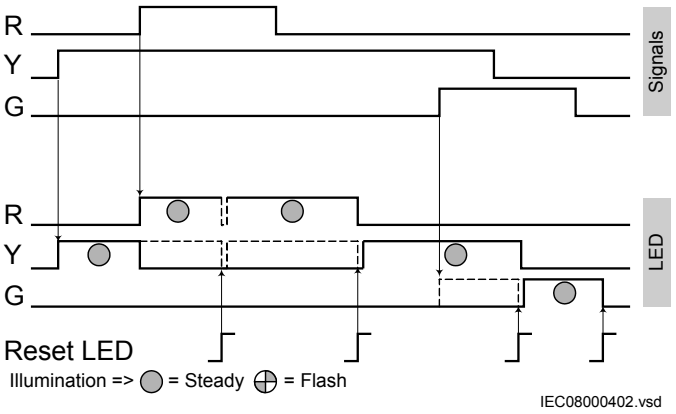


Figure 62: LHMI: LED operation mode LatchedColl-S

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 62 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

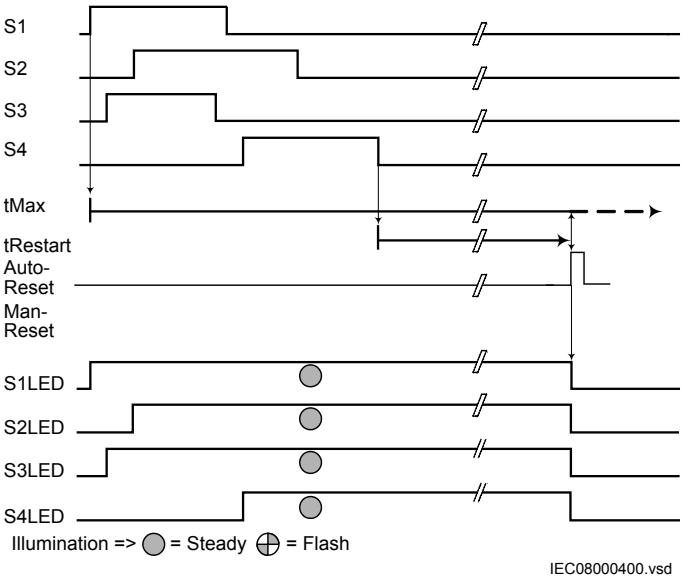


Figure 63: LHMI: LED operation mode LatchedReset-S

This mode is useful to monitor signals that are involved in case of a disturbance, see Figure 63. 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 64, 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

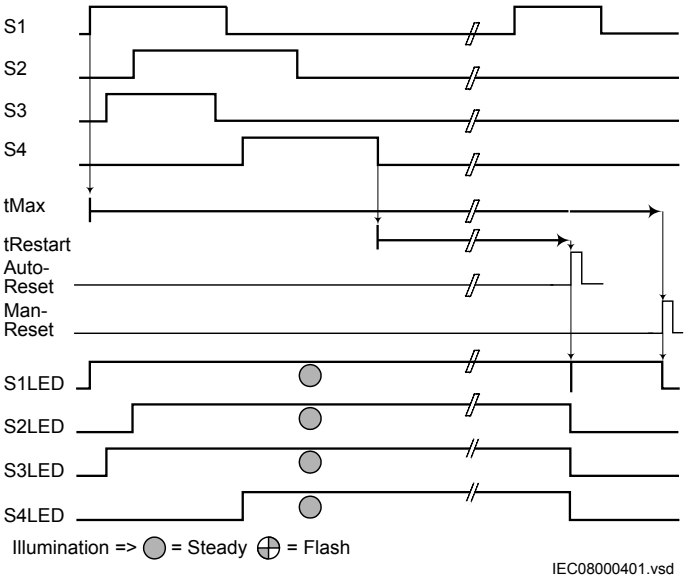


Figure 64: LHMI LED operation mode LatchedReset-S / 2

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 65:

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

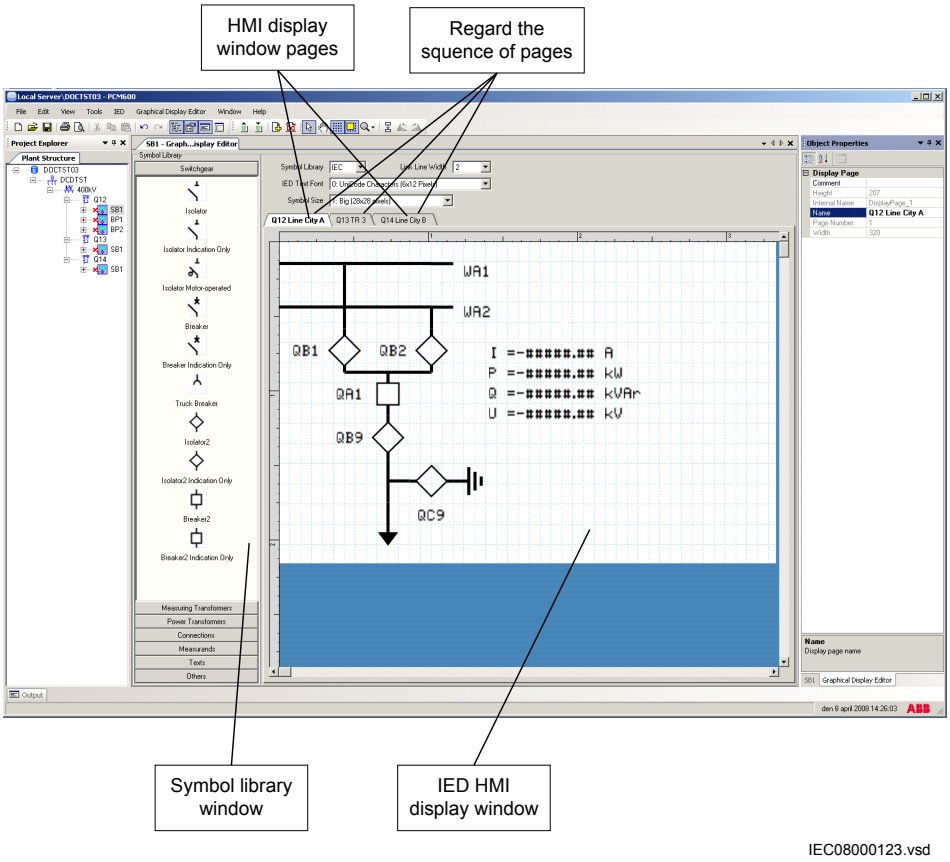


Figure 65: GDE: Screen image with active GDE

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

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 VSGGIO and SLGGIO.

- Select *Dynamic Text* and *Indication* to present the text for the actual value of the function block, see Figure 66.
- Click *Select Button* to select the value.

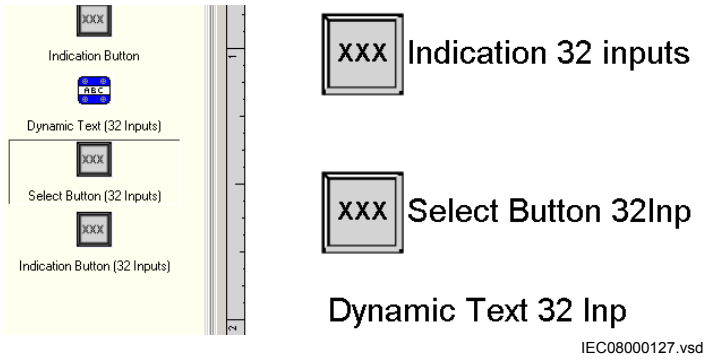


Figure 66: GDE: Dynamic Text symbols

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), or
- 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 icon *Snap to grid* must be enabled to place a symbol. The description text for an apparatus object can be placed in all four directions around the symbol. The description is part of the apparatus object. It is possible to place the symbols not under assistance of *Snap to Grid*.

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 name and the unit of a measurement or text symbol can be changed either by double click the symbol or via the object 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.

Procedure to draw lines when the apparatus symbols are placed, see Figure 67:

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.

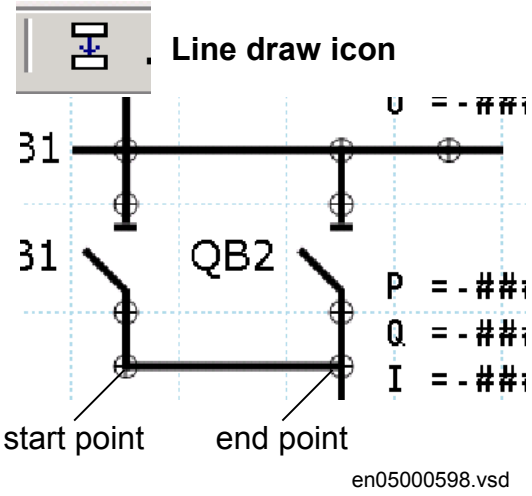


Figure 67: GDE: Drawing a line

6.2.2 Supported single-line diagram symbols

Table 2: 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
Earth	10			Connections
Feeder end	21			Connections
Current transformer	5			Measuring transformers
Voltage transf. 2 windings	6			Measuring transformers
Measurand	11			Measurands
Capacitor	7			Others
Surge arrestor	8			Others
Generator	9			Others

Table continues on next page

IEC Symbol Name	Node Type	IEC Symbol Definitions	ANSI Y32.2/ IEEE 315 Symbol Definitions	Category
Reactor	14			Others
Motor	15			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
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

Table continues on next page

IEC Symbol Name	Node Type	IEC Symbol Definitions	ANSI Y32.2/ IEEE 315 Symbol Definitions	Category
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
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

Table continues on next page

IEC Symbol Name	Node Type	IEC Symbol Definitions	ANSI Y32.2/ IEEE 315 Symbol Definitions	Category
Breaker2 indication only, 00 = Middle position	35			Switchgear
Breaker2 indication only, 01 = Open	35			Switchgear
Breaker2 indication only, 10 = Closed	35			Switchgear
Breaker2 indication only, 11 = Undefined	35			Switchgear
Static text	0			Texts
Dynamic text	29			Texts
Select button, 00 = Middle position	30			Texts
Select button, 01 = Open	30			Texts
Select button, 10 = Closed	30			Texts
Select button, 11 = Undefined	30			Texts
Indication button, 00 = Middle position	31			Texts
Indication button, 01 = Open	31			Texts
Indication button, 10 = Closed	31			Texts
Indication button, 11 = Undefined	31			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 68.
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 to IED.

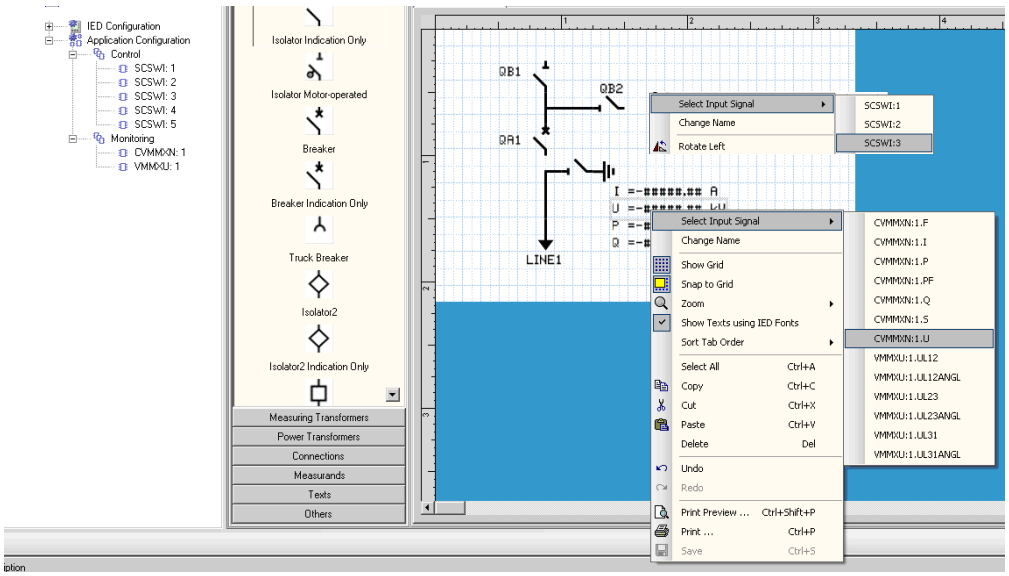


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Figure 68: GDE: Establish a dynamic object link

Linking process objects

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

Three tools are involved for the described steps:

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

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

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

Procedure

1. Right-click the apparatus symbol and select *Select Input Signal*. A list of engineered switch control application function blocks opens, see Figure 69.
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.

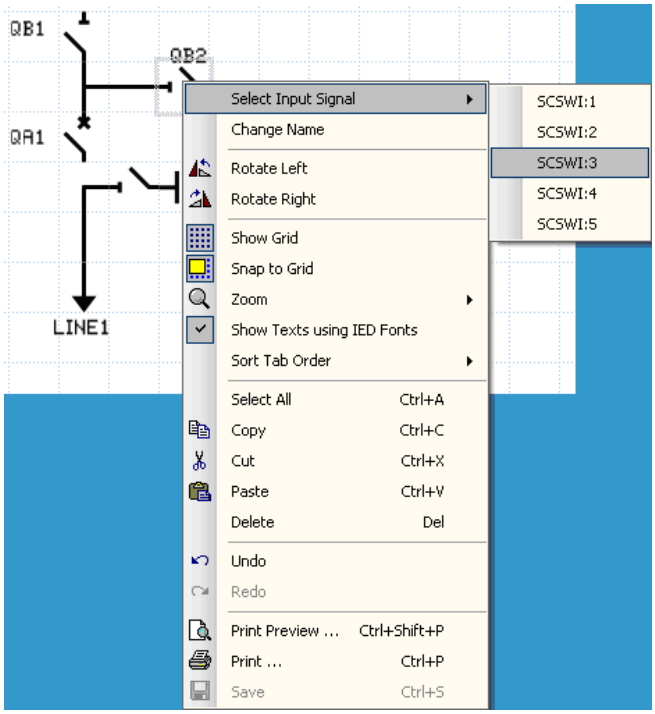

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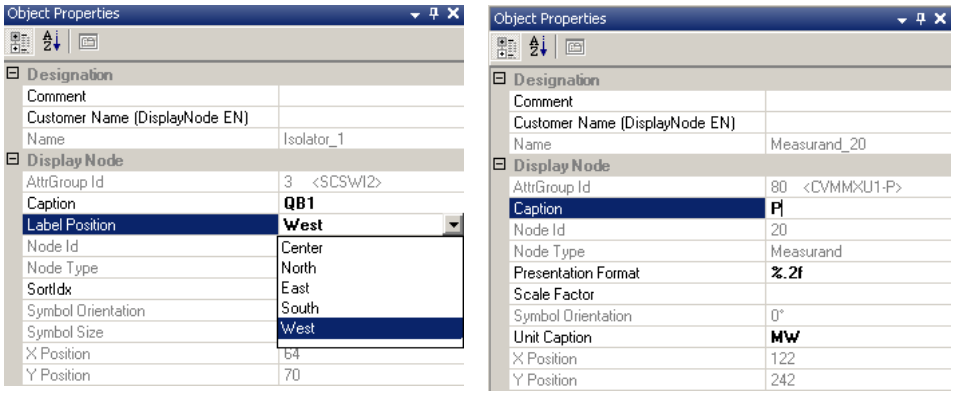
Figure 69: GDE: Input signal selection

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 70: 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 71) to display values in more readable units (for example MW). Be sure to write the proper unit under the *Unit Text* field.

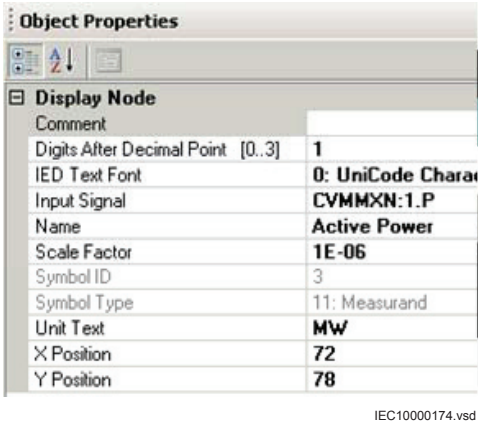


Figure 71: GDE: Object properties window for unit change

6.3 Events and indications

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

Detailed information about disturbance report subfunctions is found in the 630 series Technical manual.

Section 7 IEC 61850 communication engineering

7.1 IEC 61850 interface in the IED and tools

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

7.1.1 Function view for IEC 61850 in PCM600

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

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

7.1.2 IEC 61850 interface in IED

See Figure 72 for a principle view of the IEC 61850 logical node concept in the IED.

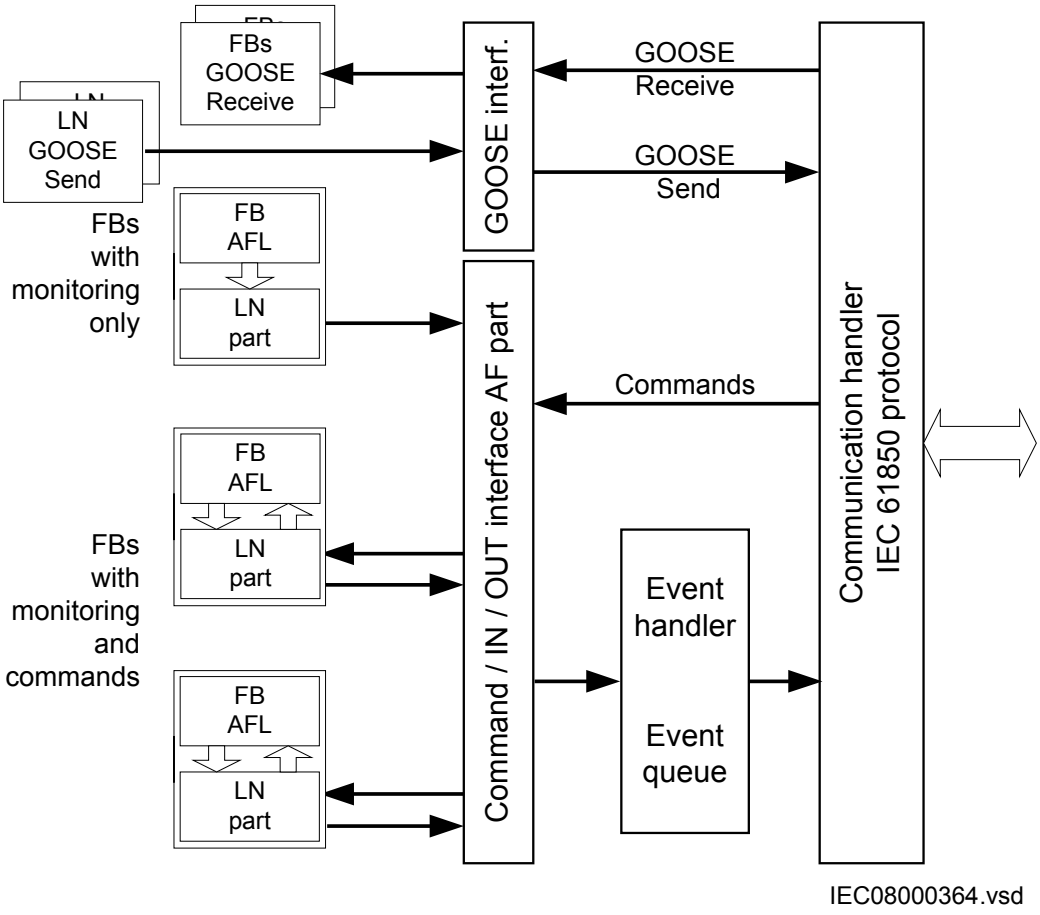


Figure 72: IEC 61850: Communication interface principle

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 72 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 multicast telegrams over the Ethernet. Whoever needs the information detects the telegram by its destination address and will read the telegram and deals with it. The telegrams are multicast sent and not acknowledged by the receiver.

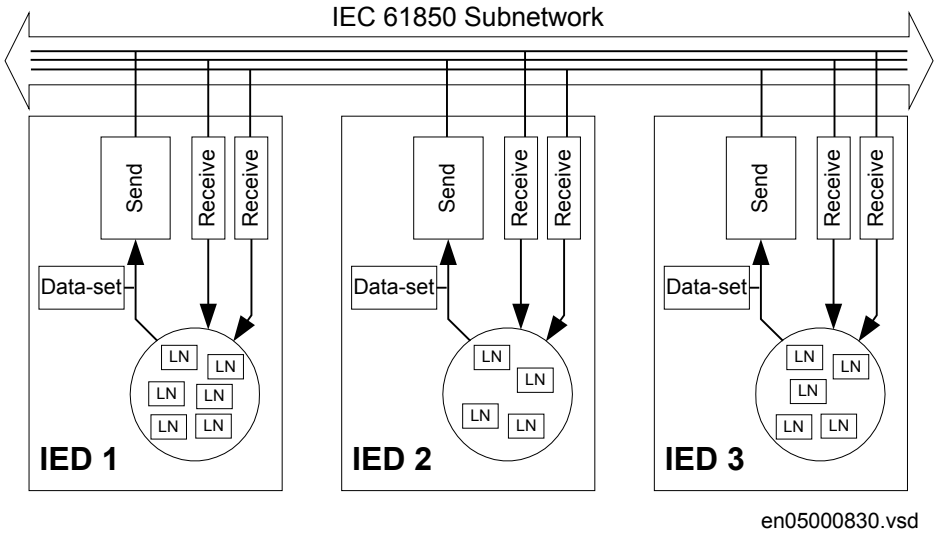


Figure 73: IEC 61850: Horizontal communication principle

Figure 73 shows an example with three IEDs where each one communicates with all the others.

GOOSE message is defined by configuring the data set and the GOOSE control block (GoCB). This engineering process is done in a station configuration tool, for example CCT600 or IET600. 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 CCT600 or IET600 (or any other 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
  - 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 CCT600 or IET600.
- 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 reading 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 CCT600 or IET600 is used as system configuration tool.

A short form of a typical sequence is shown in Figure 74 when a complete station is exported as a SCD file.

1. Export SCL files from PCM600. In the scenario in Figure 74 it is a SCD file. Other SCL file types are possible to export.
2. Configure horizontal and vertical communication in the station configuration tool, for example CCT600 or IET600.
3. Import SCL files to PCM600 project. In the scenario in Figure 74 it is the updated SCD file.

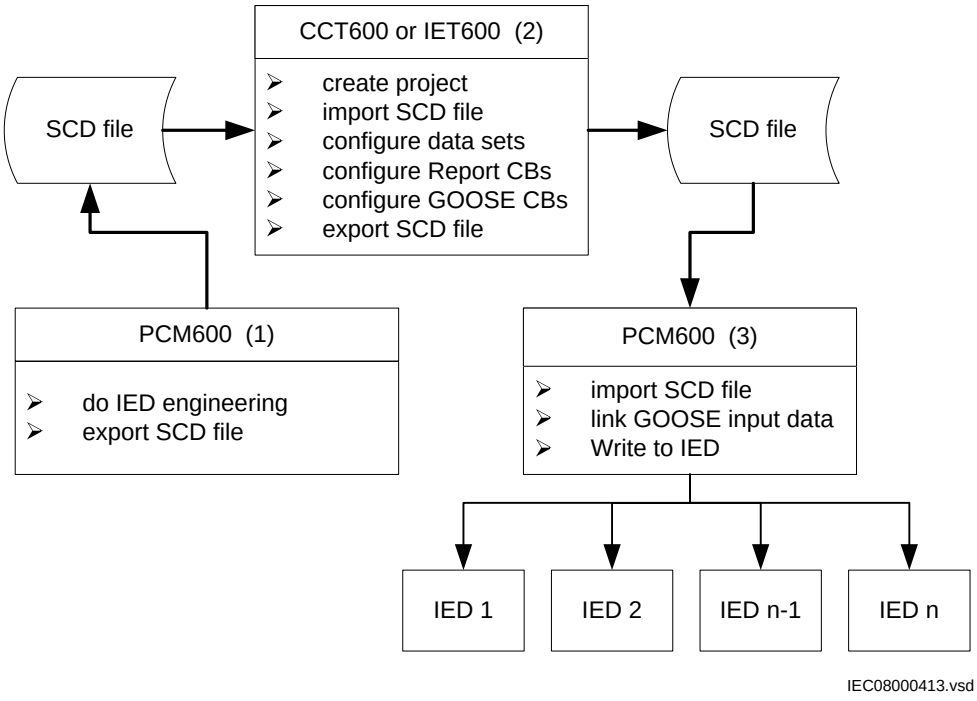


Figure 74: IEC 61850: Signal engineering procedure flow

7.3 Exporting SCL files from PCM600

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

7.3.1 Exporting SCD files

Procedure to export the SCD file from PCM600:

1. Select the station in the plant structure, see Figure 75.

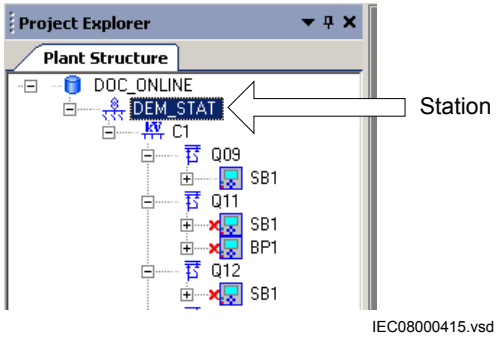


Figure 75: IEC 61850: Export SCD step 1

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 76.

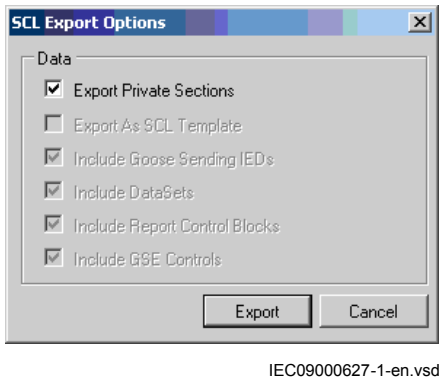


Figure 76: IEC 61850: SCL Export Options

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 77.

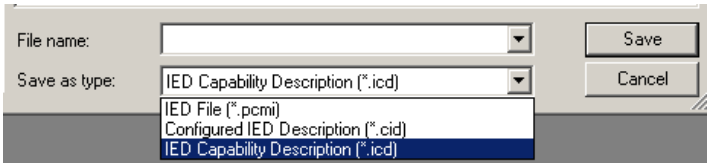


Figure 77: IEC 61850: Export IED file type selection

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 78. Note that the options in *SCL Export Options* window according to Figure 78 is only available when an ICD file is exported.

Figure 78: IEC 61850: Export IED file Options

7.4 Engineering of vertical and horizontal communication in CCT600/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 CCT600 or IET600:

1. Create a project in CCT600 or IET600.
2. Import the SCD file created by PCM600.
3. Do vertical communication engineering (monitoring direction).
   3.1. Check the default data sets.
   3.2. Configure and/or re-configure the default data sets.

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

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

3.3. Configure additional Report Control Blocks when needed for each data set used for vertical communication.
3.4. Link the IED clients to the Report Control Blocks.

Up to 5 report clients can be configured.

4. Do horizontal communication engineering.
   4.1. Configure GOOSE control blocks for each data set configured for GOOSE messages.

Note that one data may be included in a GOOSE data set only once.

   4.2. Link the IEDs to the GOOSE control block that shall receive the GOOSE control block.
5. Update the data flow.
6. Export the updated SCD file.

All data sets, all Report Control Blocks and GOOSE control block must be located at LD0 / LLN0.

7.5 Importing SCL files to PCM600

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

7.5.1 Importing SCD files

Procedure to import a SCD file to PCM600:

1. Select the station in the plant structure.
2. Right-click the station and select *Import ...*
3. Select the file to be imported from the open standard Windows menu and start the reading.
4. A *SCL Import Options* window opens, which queries how the file should be handled during import, see Figure 79.

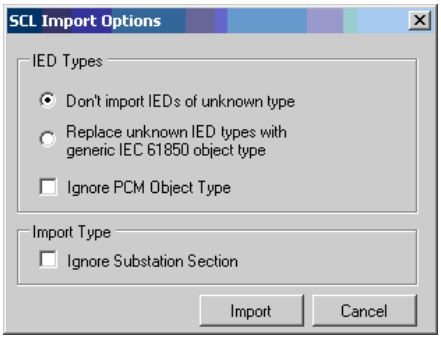


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Figure 79: IEC 61850: Import SCD file

   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.

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

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

6. Write the configuration to the IED, see Figure 80.

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

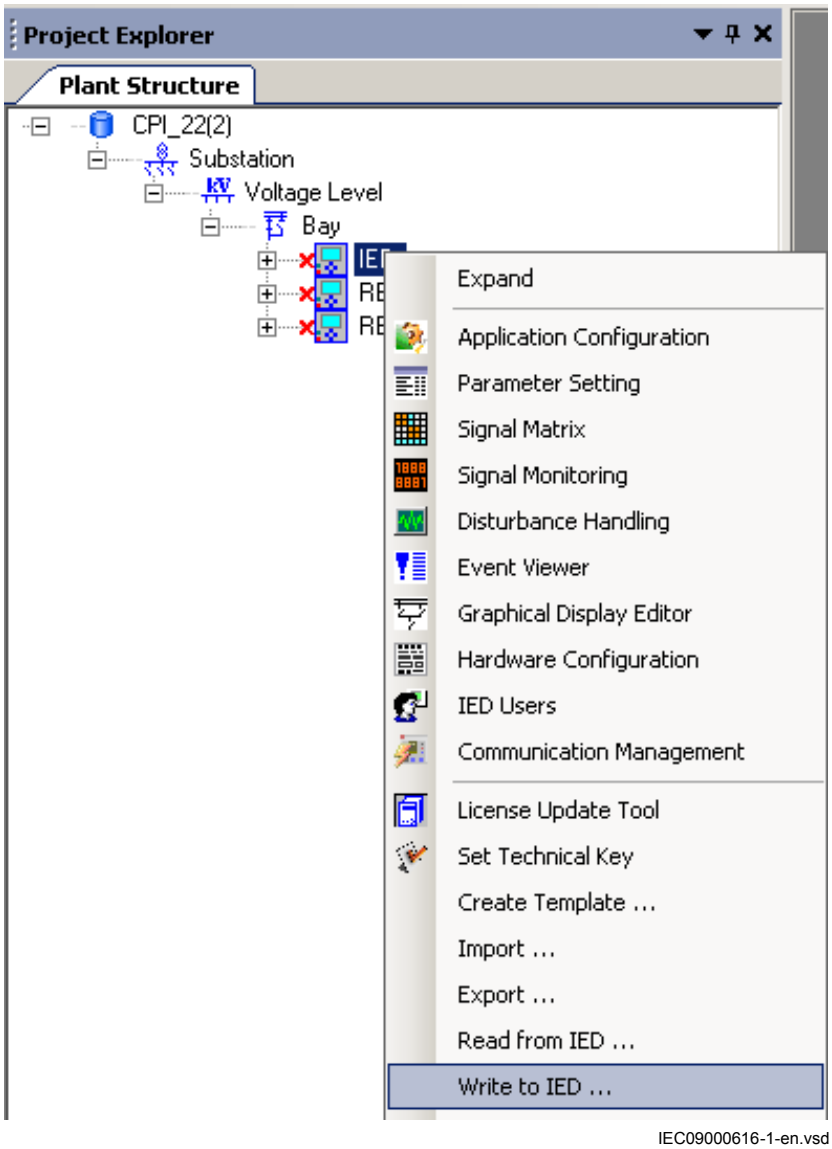

Figure 80: Common write menu

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 81.
   - 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.

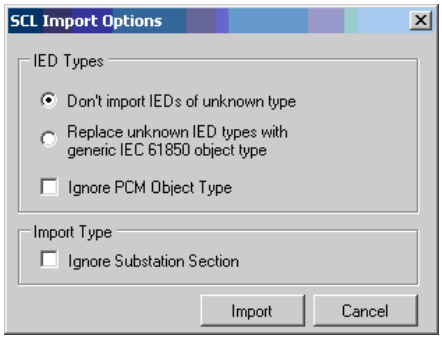

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Figure 81: IEC 61850: SCL Import option

7.6 Writing communication configuration to IED

IEC 61850 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.

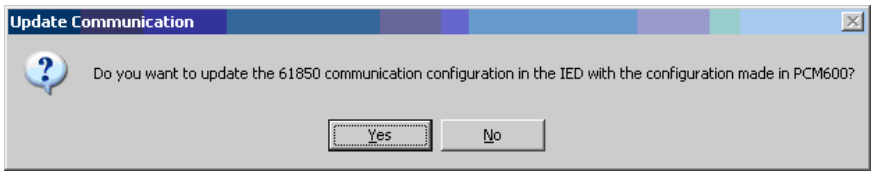

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Figure 82: Update the communication configuration in the IED with the configuration made in PCM600

7.7 CCT600 engineering

After the IED configuration is prepared in PCM600, IEC 61850 communication is engineered in the Communication Configuration tool, where the user can configure the IEC 61850 substation section part, horizontal GOOSE communication and connections between IEDs and event reporting clients (SCADA, gateway). The chapter gives a brief introduction how project will be engineered in CCT600. It is required that latest version of CCT600 is installed on the computer along with PCM600 Engineering. Further in this chapter it is assumed that the configuration is already engineered and is ready in PCM600.

7.7.1 Creating conducting equipment in CCT600

Procedure

1. Click *View* and select *Unhide Panel* to open the *Project Navigator* window.
2. Expand the *Substation Section* in the *Project Navigator* window.
3. Right-click *Q1* and select *Create new Conducting Equipment*, see Figure 83.

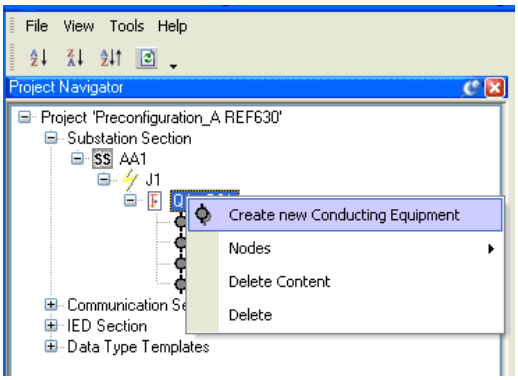

Figure 83: CCT600: Creating new conducting equipment

4. Click *Create new Conducting Equipment* to create new conducting equipment that has the default name *NewConductingEquipment1*.
   The number of new conducting equipment in the project will be equal to the number of circuit breakers, disconnectors and earthswitch in the configuration, which is prepared in PCM600.
   The default name of the conducting equipment needs to be changed as per requirement.
5. Right-click *NewConductingEquipment1* to open the *Properties* window.
6. Expand the *Naming Attributes* section and rename the *Functional Name* and the *Customer Name* of the equipment as shown in Figure 84.

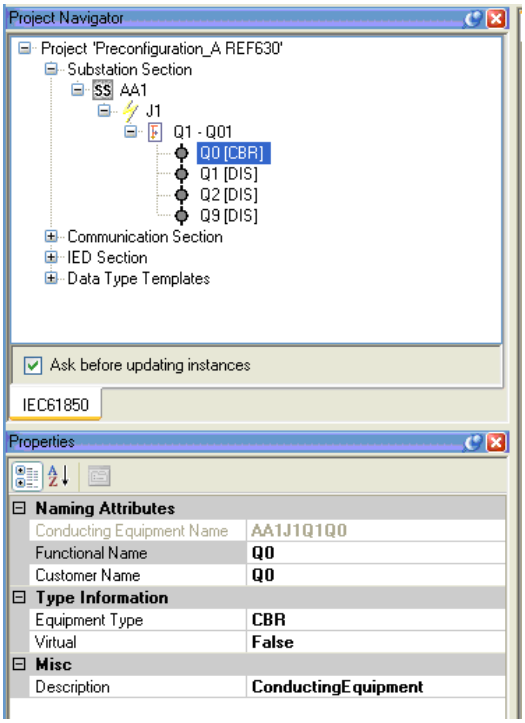

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Figure 84: CCT600: Property window for conducting equipment

7. Expand the *Type Information* section and select the properties for *Equipment Type*, that is
   CBR for circuit breaker and *DIS* for disconnector and earthswitch, for example.
8. Select *False* for *Virtual*.
9. Repeat the above steps for all new conducting equipment.
   Figure 84 shows four conducting equipments Q0 as CBR, Q1, Q2 and Q9 as DIS.

7.7.2 IEC61850 object mapping

Procedure

1. Select the *IEC61850 Object Mapping* option from the main window.
2. Select *LN - Primary Devices* at the bottom of the *IEC61850 Object Mapping* option as shown in Figure 85.

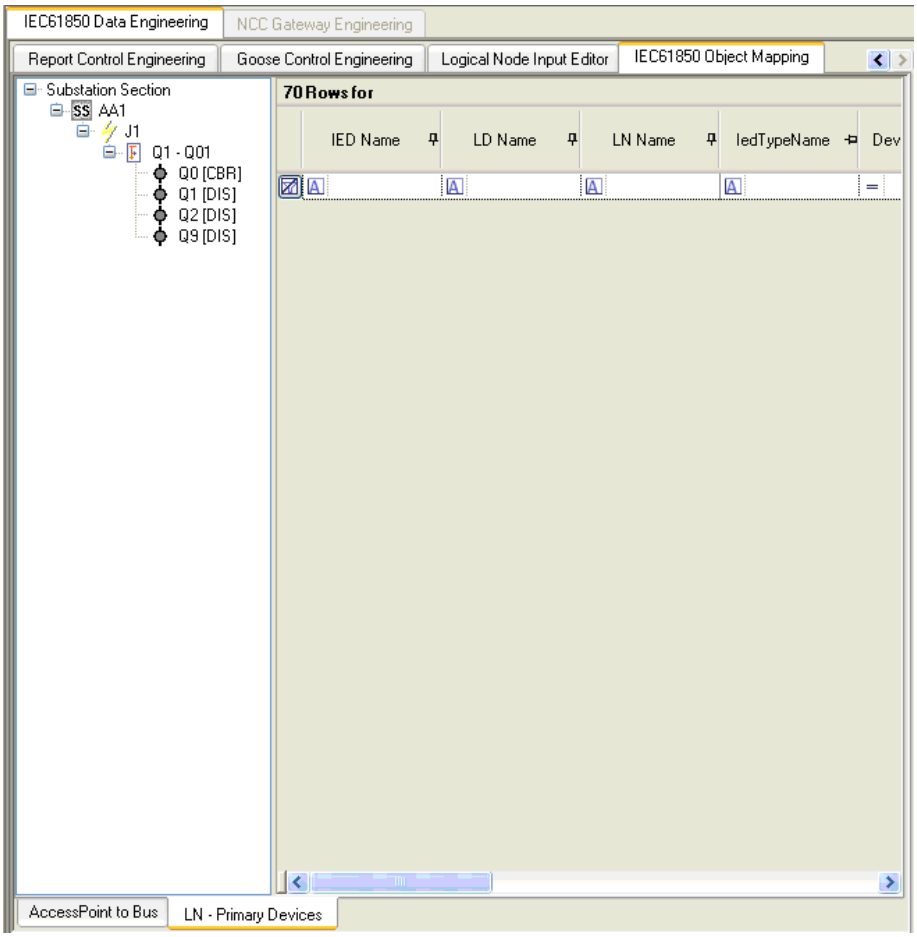

Figure 85: CCT600: IEC61850 object mapping

3. With the *IEC61850 Object Mapping* window open, go to the *Project Navigator* window and select *IED Section*.
4. Expand the *IED Section* to see all the Logical Nodes (LN) names of the functions available in the configuration as shown in Figure 86.

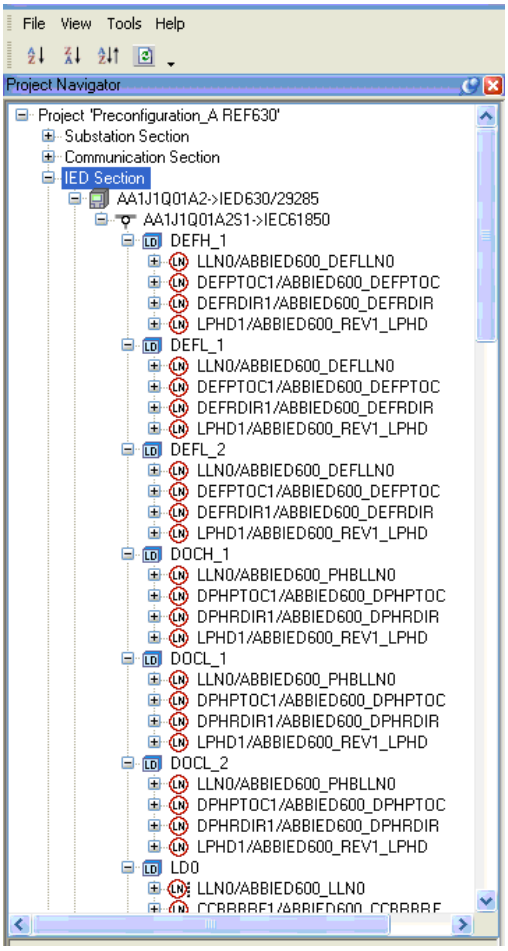

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Figure 86: CCT600: Expanded IED section window

5. Drag and drop all logical nodes into the *IEC61850 Object Mapping* under *Conducting equipment* or *Bay*.
   For example: Conducting equipment *Q0* is a circuit breaker. The functions associated with *Q0* in the configuration are interlocking function (SCILO1), Switch control (GNRLCSWI1) and Circuit breaker (DAXCBR1). So these functions need to be dragged from the *IED Section* and dropped under *Q0*. The logical nodes related to *Q0* are shown in Figure 87

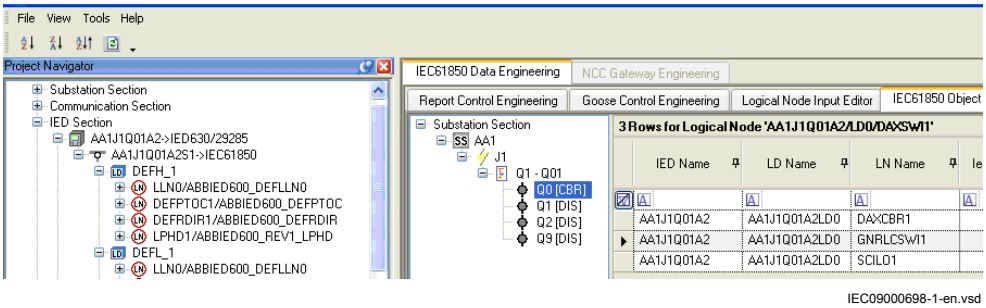


Figure 87: CCT600: Logical nodes for conducting equipment Q0 configured as circuit breaker

Normally the logical nodes associated with circuit breakers are SCILO, GNRLCSWI and DAXCBR whereas the logical nodes associated with disconnector or earthswitch are SCILO, GNRLCSWI and DAXSWI.

6. Drag and drop the logical nodes associated with other conducting equipment, that is Q1, Q2 and Q9.
   Figure 88 shows the logical nodes dropped in Q1, Q2 and Q9 conducting equipment.

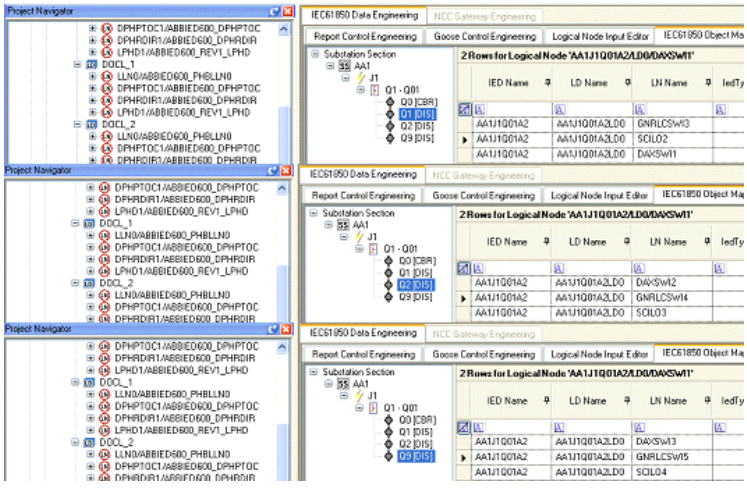


Figure 88: CCT600: Logical nodes for conducting equipment Q1, Q2 and Q9 configured as disconnector

7. Drag and drop all remaining logical nodes in the *Bay*, that is *Q1-Q01*.
8. Logical nodes can be deleted from the *IEC61850 Object Mapping* window. Select the row that contains the logical nodes to be deleted and press delete (from the keyboard).

7.7.3 Report control engineering

Procedure

1. Open the *Report Control Engineering* option in the main window in CCT600.
2. Go to the *Project Navigator* window and select *IED Section*.
3. Expand the *IED Section* to see all the logical nodes available in the configuration.
4. Select *LLNO*, the logical node that has 4 vertical dots, from the list as shown in Figure 89

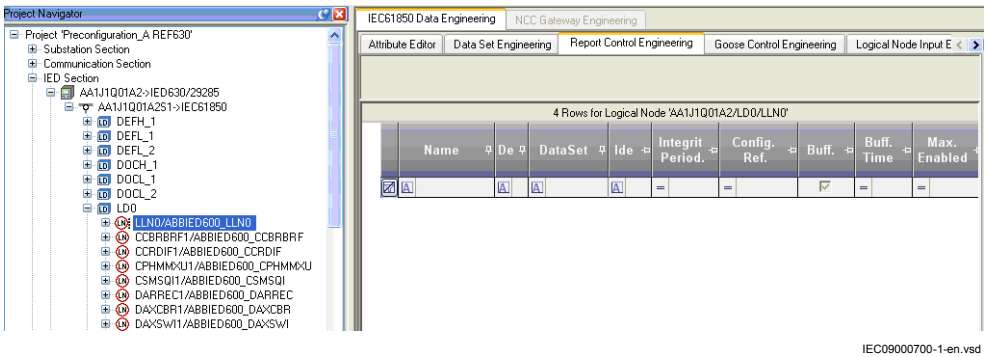


Figure 89: CCT600: Report control engineering

5. Click the *Add ... Report Control* button at the bottom of the *Report Control Engineering* window to add the report control to the *Report Control Engineering* window as shown in Figure 90

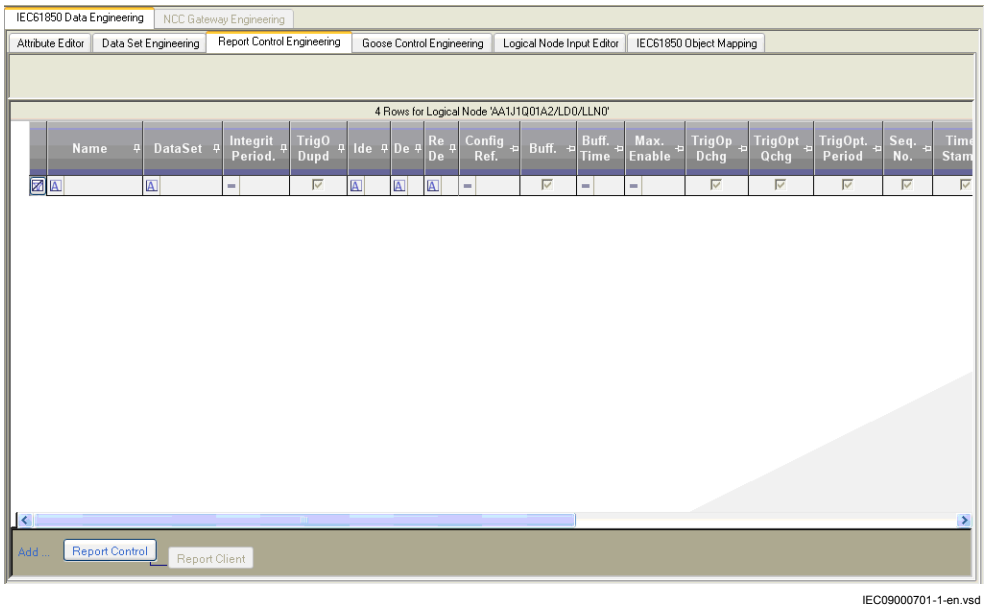
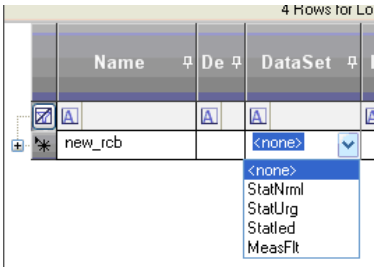


Figure 90: CCT600: Add report control blocks

6. Add for example 4 report control blocks for the 4 existing data sets, that is *StatNrml*, *StatUrg*, *Statled* and *MeasFlt* as shown in Figure 91.

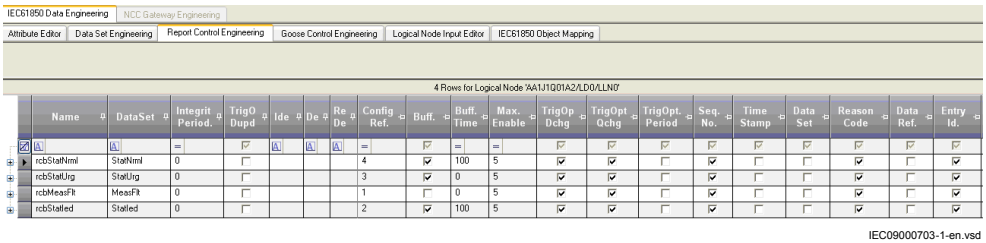
The number of report control blocks to be added depends on the data set available in the project (configuration).



IEC09000702-1-en.vsd

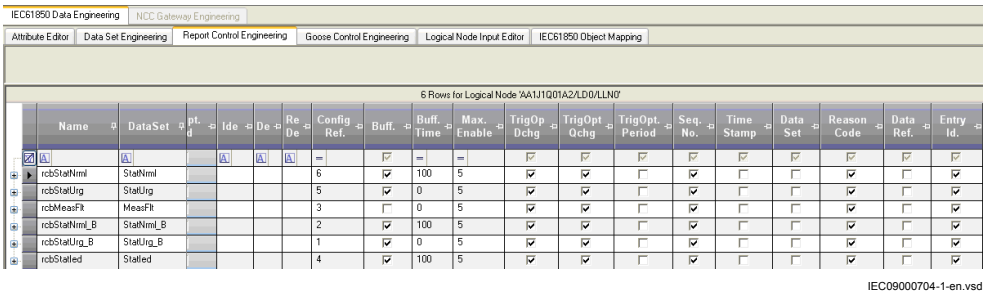
Figure 91: CCT600: Drop down menu indicating DataSet available in the configuration

7. Right-click the report control block to rename it for each data set, for example *rcb'DataSet'*.
8. Check the checked box under *Buff.* for report control blocks related to *DataSet* as per requirement, as shown in Figure 92 and Figure 93.
9. Set the *Buff.Time* as required, as shown in Figure 92 and Figure 93.
   The *Buff.Time* for *StatNrml* and *Statled* is *100*.
10. Set *Max Enable* to *5* for all data sets to complete the report control engineering.



IEC09000703-1-en.vsd

Figure 92: CCT600: Report Control block for configuration having four DataSet



IEC09000704-1-en.vsd

Figure 93: CCT600: Report Control block for configuration having six DataSet

7.7.4 Horizontal communication engineering

Configure *GOOSE Control Blocks* for each data set configured for GOOSE messages.

Procedure

1. Select first *LD0->LLN0* in the project navigator window and then select the *Goose Control Engineering* tab.
2. Click *Add->GSE Control* and select the proper dataset from the *DataSet* drop down list.
3. Name the GSE control and define a unique *Identifier* as shown in Figure 94

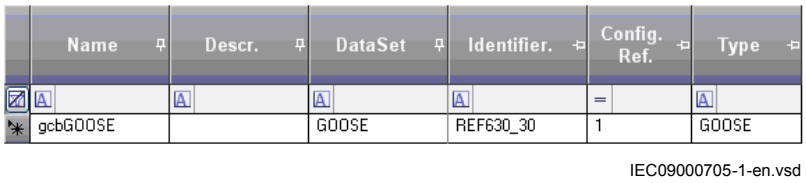


Figure 94: CCT600: GOOSE control block

4. Click the *Address Definition* button, then click the *MAC* address field on *Address Definition* table and finally click *New->GSE Application* on the opened dialog to fill in the following information and see Figure 95.
   - *MAC* address to which the specific GOOSE data is sent. The address range for *GOOSE Multicast* addresses is 01-0C-CD-01-00-00 to 01-0C-CD-01-01-FF.
   - *APPID* (Application Identifier, "goID"), which must be a unique *HEX* value for sending the GoCB within the system. Its value ranges from *0000* to *3FFF*.
   - *VLAN-ID* and *VLAN-PRIORITY* properties can be used in the networks supporting virtual LANs.
   - *MinTime* indicates the maximum response time in milliseconds to data change. The recommended value for 630 series is *4 ms*. This time can be used by the receiver to discard messages that are too old. *MaxTime* indicates the background heartbeat cycle time in milliseconds; the default value is *10 000 ms*. If there are no data changes, the IED still re-sends the message with the heartbeat cycle, to enable the receiver to detect communication losses, that is the communication is supervised.

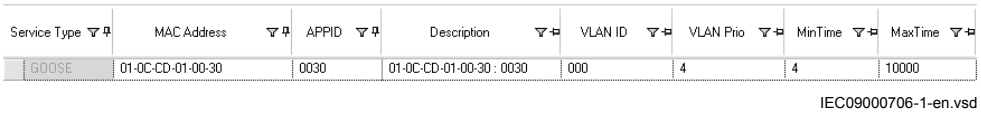


Figure 95: CCT600: GOOSE application definition

Note that one data may be included in a GOOSE data set only once.

5. Drag the data receiving IED to *GSE Control* under *Goose Control Engineering* and drop it.
   The dragged and dropped IED is a GOOSE receiver as shown in Figure 96.

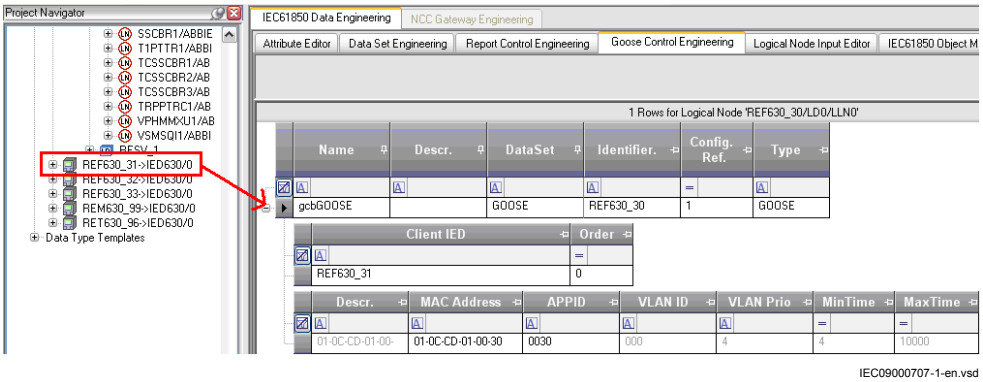


Figure 96: CCT600: Linking IEDs to GOOSE control

7.8 IET600 engineering

After the IED configurations are prepared in PCM600, IEC 61850 communication is engineered in an IEC 61850 system configuration tool, where the substation section part, horizontal GOOSE communication and connections between IEDs and event reporting clients (SCADA, gateway) can be configured.

In PCM600 Ver. 2.4 or later the recommended IEC 61850 system configuration tool is IET600, which is also included in the PCM600 Engineering Pro package. See IET600 documentation for more detailed description of the features.

7.8.1 Managing projects

- Create a new project.
  1. Click the round button on the top of the left corner of the IET600 window.
  2. Select **Manage Projects**.
  3. Click **New** button in the **Projects** dialog box.
  4. Type the name of the project.

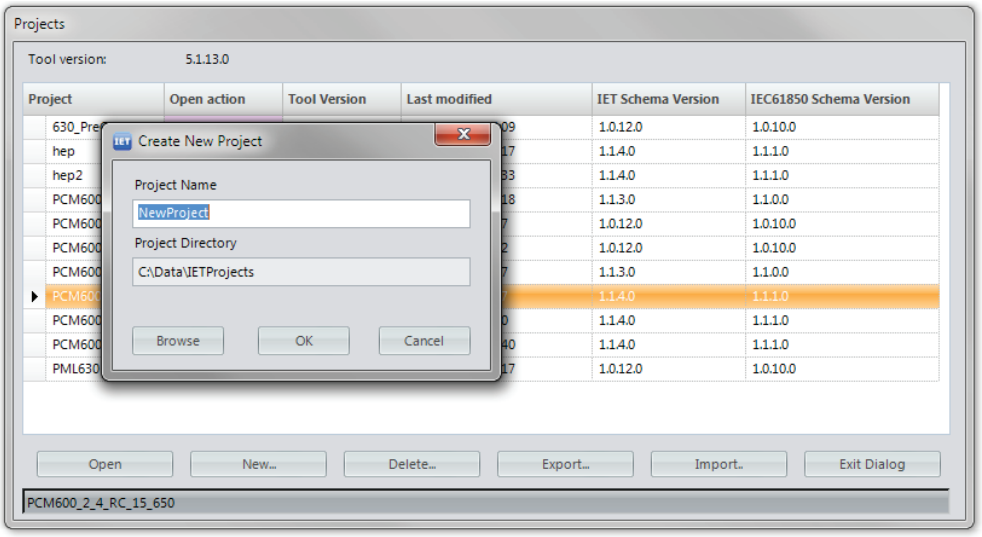


Figure 97: Creating a new project in IET600

- Import an SCD file exported from PCM600.
  - Choose **Import SCL File** from the shortcut menu of the project object.
  - Click the **Import** button.

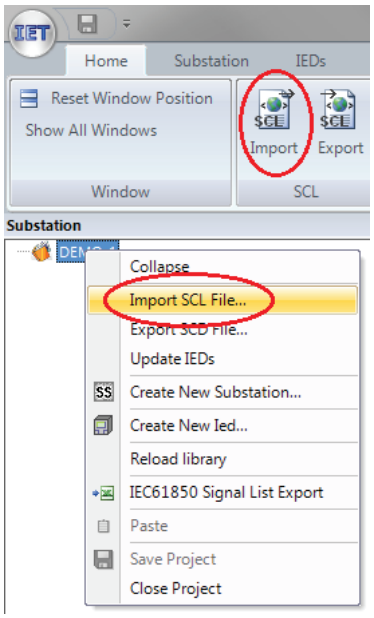


Figure 98: Importing an SCD file in IET600

An SCD file can be imported to a project only once. If another IED needs to be later added to the configuration, it must be first created with the **Create New IED** function. Import the related CID or ICD file with the **Update IED** function. Another alternative is to create a new project in IET600, and to

import the whole SCD file from PCM600 again. All existing IEC 61850 configuration including GOOSE remains if the changes made in IET600 are already imported to PCM600.

If IED configuration has been changed in PCM600 after importing the SCD file to IET600, the project can be updated using **Update IED** function in IET600. The function first compares the IET600 project and the selected SCL file, and removes the old content of the updated IED(s) and creates new IED content based on the updated file.

- Export the SCD file for PCM600 by clicking the **Export** button.
  When comparing to CCT600, in IET600 there is no need for manual data flow updates, since IET600 updates all related data automatically while working with different editors.

7.8.2 Importing a new IEC 61850 client

IED SCL export from PCM600 for 630 series preconfigurations contains five default client definitions, “Client1”...”Client5”, which are used by all the RCBs. For example MicroSCADA and COM600 clients are able to use these client definitions directly. If other clients need to be added to the IET600 project, the ICD file describing the client data model has to be imported.

Adding a new IEC 61850 client to an IET600 project is a two-step operation. The client must be first created using the **Create New IED** function, after which the **Update IED** function can be used to import the related ICD (or CID) file.

1. To create an IED, click the **IEDs** tab in the navigation pane.
2. Click the root node in the IED tree.
3. Right-click the node and click **Create New IED** on the shortcut menu.

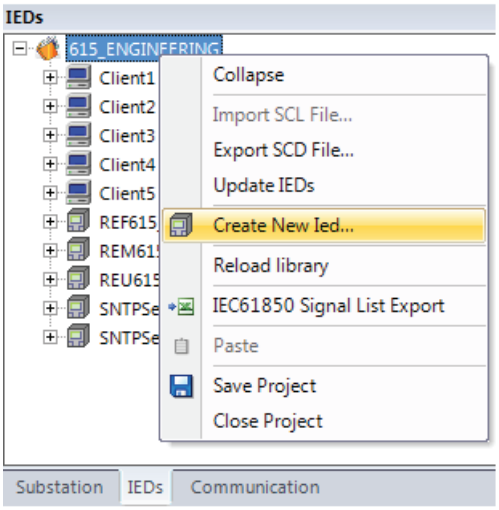


Figure 99: Creating a new IED

4. Type the name of the client IED as it is in the file to be imported. Click **OK**.

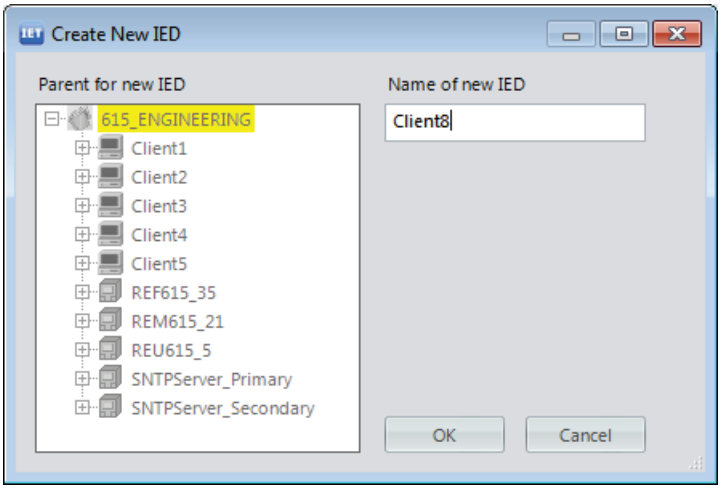


Figure 100: Naming the new IED

5. Right-click on the created IED and click **Update IED** on the shortcut menu.

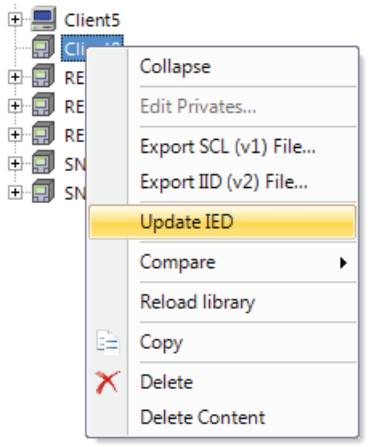


Figure 101: Choosing a SCD file for updating the IED

6. Select any valid SCL file (SCD, ICD, CID or IID) and click **Open** from the file selection dialog box.
7. IET600 automatically matches IEDs with the same name in IET600 and in the file. To import the IED from the file, click **OK**.

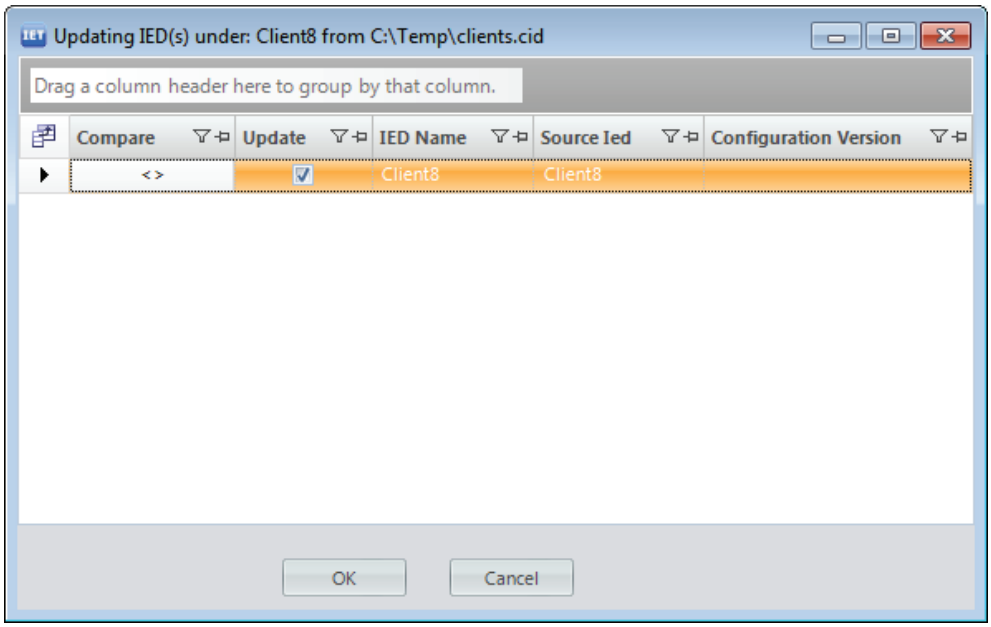


Figure 102: Updating the IED

The procedure used in configuring IEC 61850 clients can be used to create and/or update any IED, also several IEDs at the same time.

7.8.3 Attaching IEC 61850 clients to a bus

All IEDs and report clients must be connected to a subnetwork to enable proper configuration. For example after creating a new IEC 61850 client it must be manually attached to a subnetwork.

1. Click the **Communication** tab in the navigation pane.
2. Click the **Subnetworks** tab in the editor pane.
3. In the Subnetworks grid, select the bus from the Subnetwork list to attach the IEC 61850 client to the bus.
   An alternative way is to drag and drop the client in the **Communication** tab to the correct subnetwork.

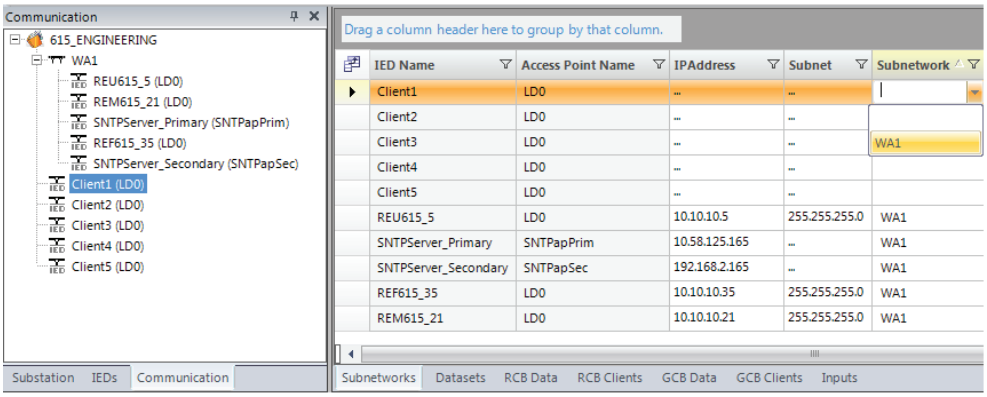


Figure 103: Defining bus connection properties for IEC 61850 clients

7.8.4 IET600 user interface

IET600 user interface is divided into sections, that is, panes for navigating and displaying the project data.

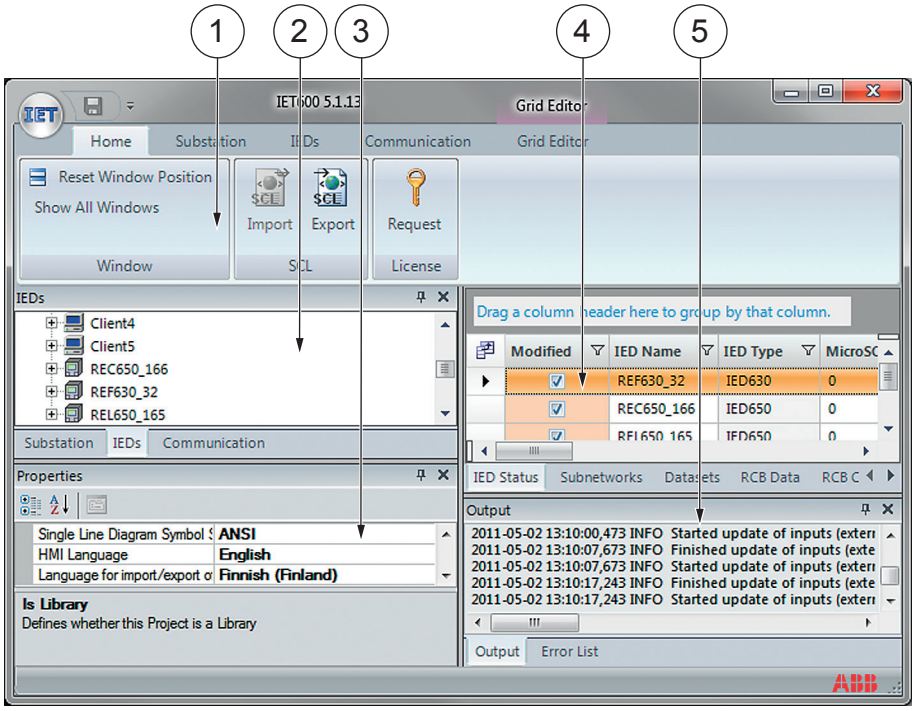


Figure 104: IET600 user interface

1 Menu on the top of the user interface
2 Navigation pane for context-oriented navigation and filtering the various editors
3 Properties pane for detailed properties of the selected element in the navigation pane
4 Editors for detailed design and engineering of the substation, IEDs and IEC 61850 communication
5 Logging and messaging (output) pane

The navigation pane provides context-oriented navigation of the editors. It has three tabs, which correspond to three different context views.

- **Substation** – Full substation topology and primary equipment nodes
- **IEDs** – IED nodes and corresponding functionality
- **Communication** – Subnetworks and connected IED access points

The editor pane is the main working area of the IET600 user interface. It is organized to various tabs for detailed substation design and engineering. The visible tabs depend on the node type selected in the navigation pane. For example, the IED node in the navigation pane shows the detailed views related to each engineering step.

- Dataset editor
- RCB editor
- RCB clients

- GCB editor
- GCB clients
- Inputs

Available editor tabs depend on the selected node type, not on the selected navigation tab. Choose any available context view to do the needed engineering tasks.

Choose upper or lower level in the structure to see the data of single, many or all IEDs at the same time in the editor pane.

7.8.4.1 Setting visibility of columns in grid editors

Most editors are implemented as tables. These grid editors provide features like setting column visibility, filtering, sorting, automatic data filling, copying and pasting, finding and replacing and exporting to Excel.

Most tables include columns which are hidden by default.

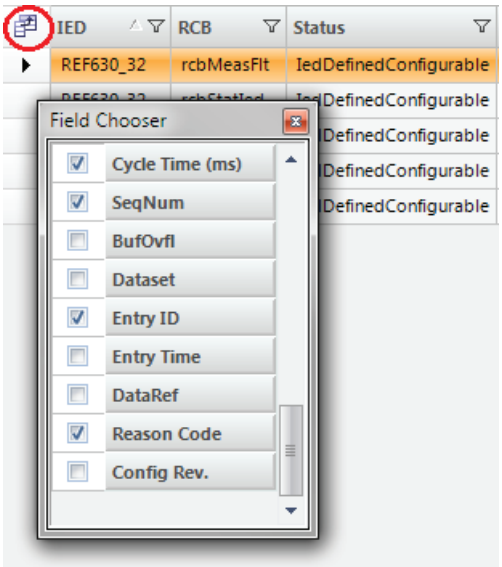


Figure 105: Setting column visibility in a grid editor

1. To set the visibility of the columns, click the top left icon of the table.
2. Enable/disable the columns from the **Field Chooser** dialog box.

7.8.4.2 Filling down multiple cells

The fill down feature in a grid editor allows filling multiple cells in a sequence automatically.

1. Click the first column in the selection.
2. Press and hold, then click the last column in the selection.
3. Right-click and choose **Fill Down** from the shortcut menu.

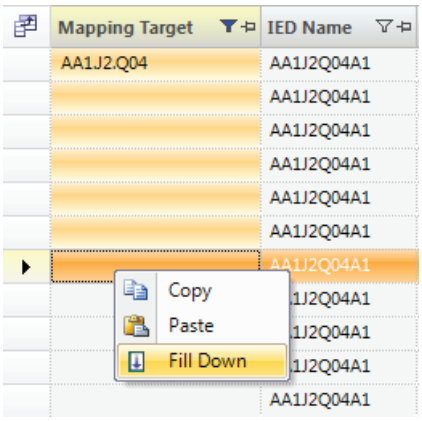


Figure 106: Filling down multiple cells

Fields in between are filled with the content of the first row in the selection.

7.8.5 Substation section configuration

Substation topology consists of the substation, voltage level and bay nodes. Bay nodes include also the conducting (primary) equipment, which corresponds to the switches (circuit breakers, disconnectors, earth switch) of the configured IED. Substation topology is initially built by importing the SCD file from PCM600.

The SLD editor is a graphical editor for the configuration of the substation section in IET600. It provides tools to draw the primary equipment and the interconnection between the equipment in the bay. Also, the bay equipment can be connected to the busbar to define a complete single-line diagram for a voltage level.

7.8.5.1 Creating conducting equipment for a bay

1. Select a bay node in the substation navigation pane, for example **Q02**.
2. Click **SLD** tab in the editor pane.
3. Click the primary equipment icon, for example circuit breaker.
4. Move the pointer to the bay drawing area and click to add the equipment.
5. Enter the name for the equipment in the **Naming** dialog box, for example **Q0**.
6. Draw all primary equipment similarly.

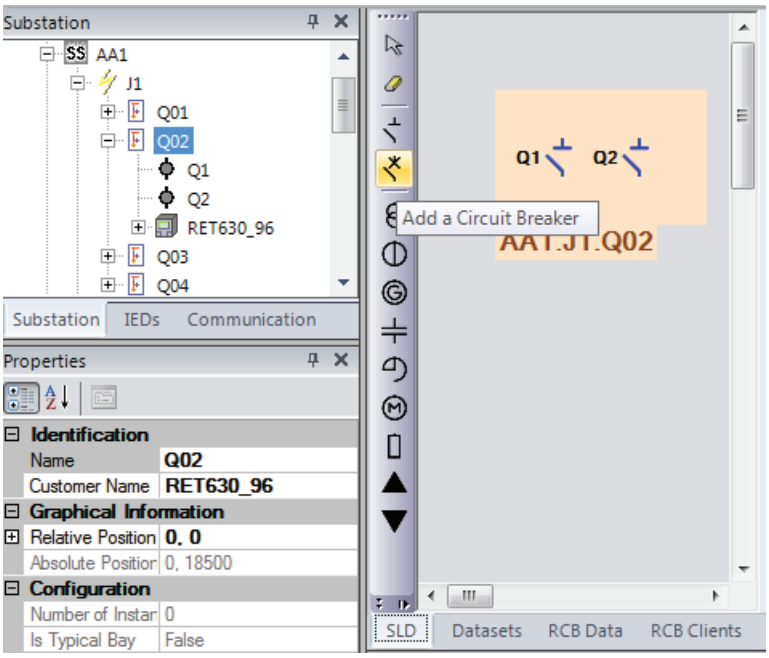


Figure 107: SLD editor

7.8.5.2 Mapping logical nodes

In addition to the substation topology configuration, LNs (logical nodes) of the IEDs need to be mapped to proper objects, for example to support automatic bay configuration via SCL files in a SCADA system. According to IEC 61850 standard, any LN in any IED can be mapped to any node in the substation structure. However, in practice there are restrictions between LN types and equipment types, but all LN types can be mapped to the bay level.

LNs related to the conducting equipment are mapped first, and then all the unmapped LNs are connected to the bay level.

LNs associated with circuit breakers are SCILO, GNRLCSWI and DAXCBR, and LNs associated with disconnectors or earth switches are SCILO, GNRLCSWI and DAXSWI.

1. Select the bay node in the substation navigation pane, for example **Q02**.
2. Click **SLD** tab in the editor pane.
   On the right of the SLD is the LN mapping editor. The first column shows the mapping target and the remaining columns to the right show the available LNs and their properties.
3. In the first column choose a substation item (bay or equipment) to map to that LN.

To select the LN mapping target, either type in the target, select it from a shortcut menu, or use the **Fill Down** function to fill multiple rows automatically.

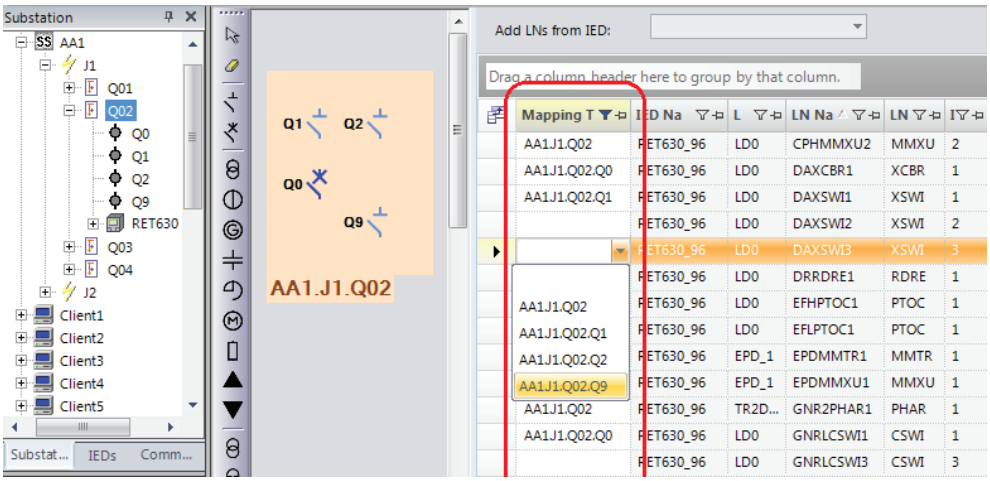


Figure 108: LN mapping editor

7.8.6 Creating data sets

Data sets are created or modified using the Dataset editor, which consists of three parts.

- Grid for existing data sets (data set creating, deleting and renaming)
- List of data set entries for selected data set (viewing, deleting)
- Selection lists for adding new entries to a selected data set

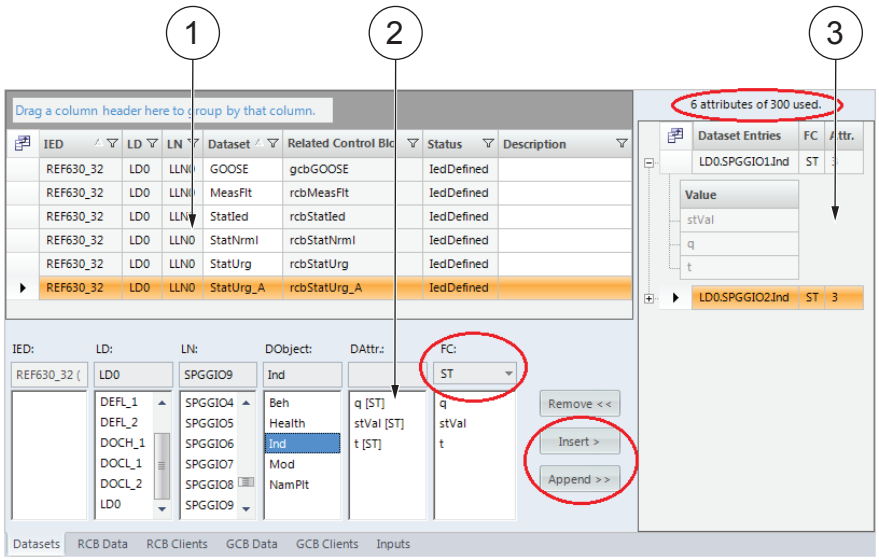


Figure 109: Dataset editor

1 Grid
2 Selection lists
3 List of data entries

1. Select an IED node in the IEDs navigation pane.
2. Click the **Datasets** tab in the editor pane.
3. Right-click the area containing data set names and select **Insert new row**.
4. Define the LN where the data set is to be placed (preselected **LD0/LLN0** is recommended) and the name for the new data set.
5. Click **Append>>** to add data items to the end of the data set or click **Insert>** to add data items above the selected row in the data set entries list.

Above the data set entries list is shown how many attributes it is possible to add to the data set and how many are already added.

Select a proper FC (functional constraint) value for the data attributes to be added to a data set. If none is selected (“(all)” is shown on the list), it is not possible to add attributes to the data set.

Normally, data set entries for vertical reporting are selected using the data object level, and entries for GOOSE using the data attribute level.

7.8.7 Creating report control blocks

Configuration properties (attached data set, buffering options, triggering options, and so on) of the RCBs are defined in the RCB editor. A predefined RCB configuration of a preconfigured IED is a proposed default configuration, which can be adapted according to the requirements.

1. Click an IED node in the IEDs navigation pane.
2. Click **RCB Data** tab in the editor pane.
3. Right-click on the area containing RCB names and select **Insert new row** on the shortcut menu.
4. Define the LN where the RCB is to be placed (preselected **LD0/LLN0** is recommended) and the name for the new RCB.
   Use the field chooser to show or hide the wanted properties. For example, **SeqNum**, **Entry ID** and **Reason Code** options (set in preconfigurations) are hidden by default.

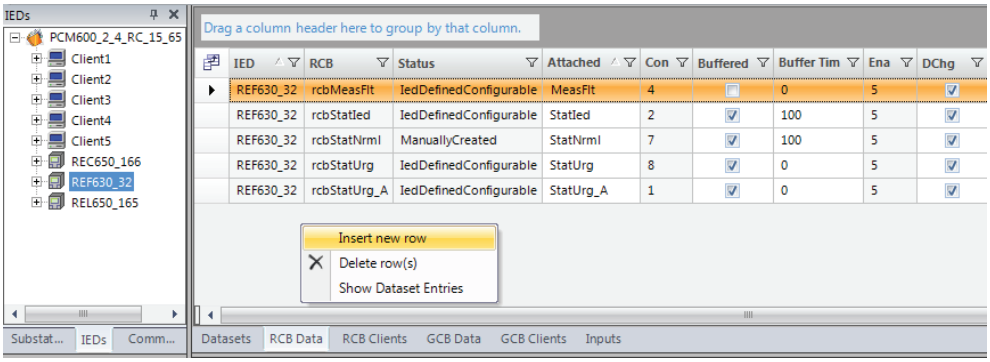


Figure 110: RCB editor

Conf.Rev cannot be manually edited. IET600 updates it automatically to the next multiple of 100 when the configuration changes.

Deleting an RCB does not totally remove it from IET600. Instead, its status is set to “Deleted”, and it is not exported to SCL files. Removing a data set automatically puts the related RCB in to a “Deleted” state.

An RCB cannot be renamed. To rename an RCB, delete it and create a new RCB with a new name.

7.8.8 RCB client configuration

To succeed with an RCB client configuration, the potential clients and their communication configuration should be known. Therefore, add the IEDs and configure them to the subnetworks before configuring the RCB client.

The rows of the RCB client editor show IEDs and RCBs and the columns show the available client IEDs.

If a client IED is not on the same subnetwork as a server IED or RCB, it cannot be configured as a client.

IED Name	LD	LN	RCB	Attached Dataset	Client1 (LD0)	Client2 (LD0)	Client3 (LD0)	Client4 (LD0)	Client5 (LD0)
REF630_32					1	2	3	4	5
REF630_32	LD0	LLN0	rcbMeasFlt	MeasFlt	1	2	3	4	5
REF630_32	LD0	LLN0	rcbStatIed	StatIed	1	2	3	4	5
REF630_32	LD0	LLN0	rcbStatNrml	StatNrml	1	2	3	4	5
REF630_32	LD0	LLN0	rcbStatUrg	StatUrg	1	2	3	4	5
REF630_32	LD0	LLN0	rcbStatUrg_A	StatUrg_A	1	2	3	4	5

Datasets RCB Data RCB Clients GCB Data GCB Clients Inputs

Figure 111: RCB client editor

Different keys can be used when editing the cells.

- PLUS SIGN (+), asterisk (*) or X key to add an additional client to the existing ones
- Numbers to change the client sequence or add clients
- MINUS SIGN (-), SPACEBAR or DELETE to delete existing clients
- Double-clicking with the mouse to add or delete clients

RCB client editor supports both manual and semi-automatic client configuration.

7.8.8.1 Configuring RCB clients semi-automatically

On the right in the RCB client editor there are option buttons to choose whether to show IEDs (for defining default clients) or RCBs or both together.

There are also buttons to allow semi-automatic configuration of default clients and RCB clients.

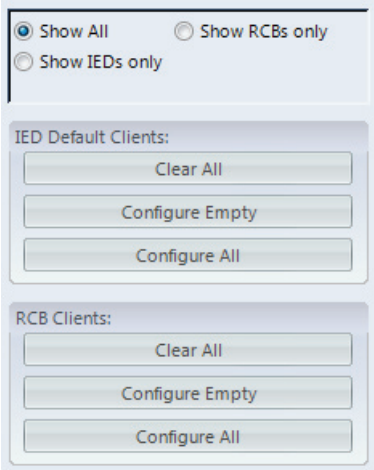


Figure 112: Semi-automatic configuring of RCB clients

1. Configure the default clients which are used by the rule-based RCB generation to automatically configure RCB clients.
   Use buttons on the RCB client editor.
   - **Clear All** removes all default clients
   - **Configure Empty** fills out only default clients for those IEDs that have no clients configured yet
   - **Configure All** deletes all existing default clients and fills them out afterwards
2. Configure the RCBs clients.
   The default clients must be configured before configuring RCB clients otherwise the automatic RCB client configuration does not work. Use buttons on the RCB client editor.
   - **Clear All** removes all RCB clients
   - **Configure Empty** copies the default client configuration of this IED to its RCBs (only for those RCBs that have no clients configured yet)
   - **Configure All** deletes the existing RCB clients and copies the default client configuration of this IED to its RCBs

IET600 updates the *Enabled Clients* configuration value of the RCBs automatically based on the configuration made in the RCB client editor. In addition, IET600 always reserves one extra engineering client. For example, when configuring three RCB clients, the *Enabled Clients* value of that RCB is “4”.

7.8.9 Horizontal communication engineering

Creating and handling data sets and GOOSE control blocks (GCBs) is similar to data set and RCB handling for vertical communication. GCBs are created and configured in the GCB editor.

One data may be included in a GOOSE data set only once.

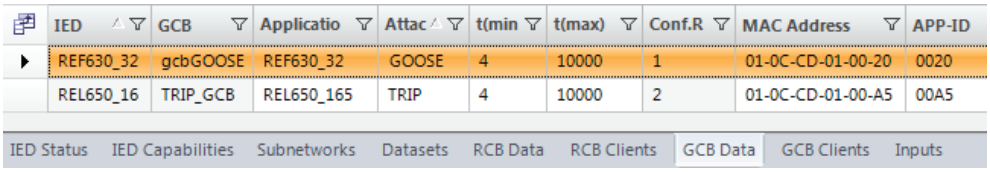


Figure 113: GCB editor

GCB configuration properties:

- *MAC address* is the address to which the specific GOOSE data is sent. The address range for GOOSE multicast addresses is from 01-0C-CD-01-00-00 to 01-0C-CD-01-01-FF.
- *APP-ID* (application identifier) must be a unique HEX value for sending the GCB within the system. It identifies the purpose of this particular data set. Its value ranges from 0000 to 3FFF.
- *Application* (appID) (“goID”) is a unique GoID for each GCB in the system. Recommendation is to define a device-specific value and not to use the default empty value.
- *VLAN-ID* and *VLAN Priority* properties can be used in the networks supporting virtual LANs.
- *t(min)* (“MinTime”) indicates the maximum response time in milliseconds to data change. The recommended value for 630 series is 4 ms. This time can be used by the receiver to discard messages that are too old.
- *t(max)* (“MaxTime”) indicates the background heartbeat cycle time in milliseconds. The default value is 10 000 ms. If there are no data changes, the IED still resends the message with the heartbeat cycle to enable the receiver to detect communication losses.

Configuration of GCB clients is done with the GCB client editor.

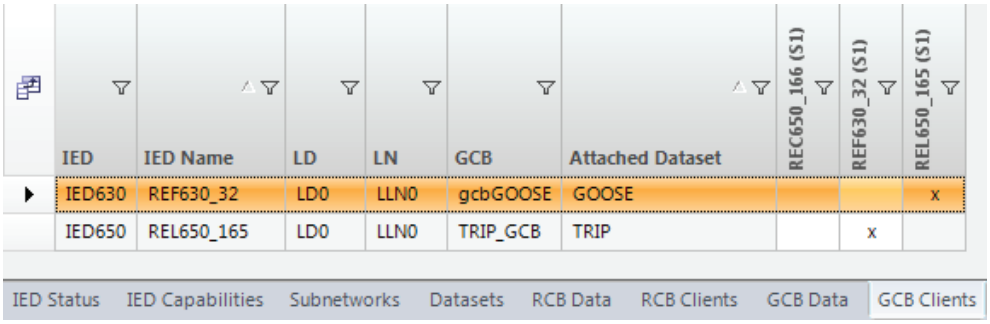


Figure 114: GCB client editor

The rows of the GCB client editor show GCBs, that is, senders and the columns show the IEDs available as GOOSE clients, that is, receivers. If the client IED is not on the same subnetwork as the GCB sender, it cannot be configured as a client.

Different keys can be used when editing the cells.

- PLUS SIGN (+), asterisk (*) or X key to add an additional client to the existing ones
- MINUS SIGN (-), SPACEBAR or DELETE to delete existing clients
- Double-clicking with the mouse to add or delete clients

Upon adding or removing clients, the corresponding input sections are updated automatically.

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 parameters for IEC 60870-5-103 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 630 series.

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, and serial communication RS-485 is not 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.

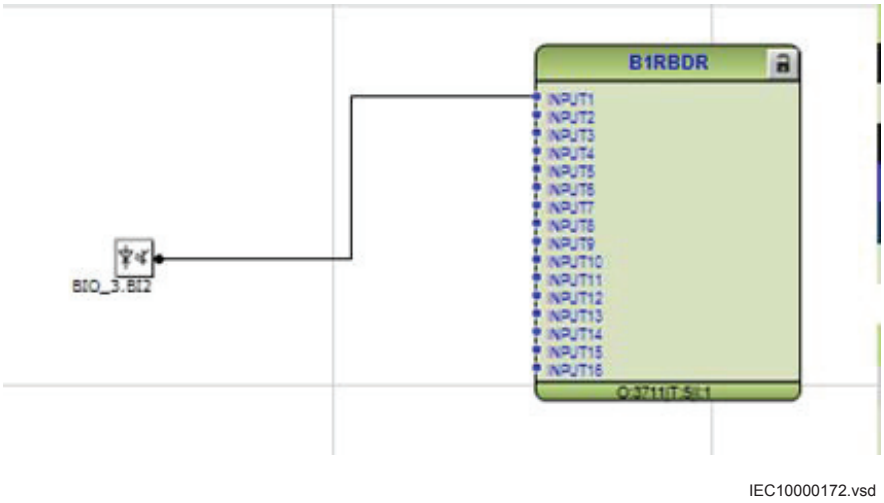
Only for analog measurements additional configuration parameters are shown to do signal scaling to DNP3 protocol presentation. This can be done when the *Configuration Table View* is selected.

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

9.2 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 115) appear in CMT (see Figure 116). Do not configure these hardware channels to be sent by DNP3, as they are not event-handled.



IEC10000172.vsd

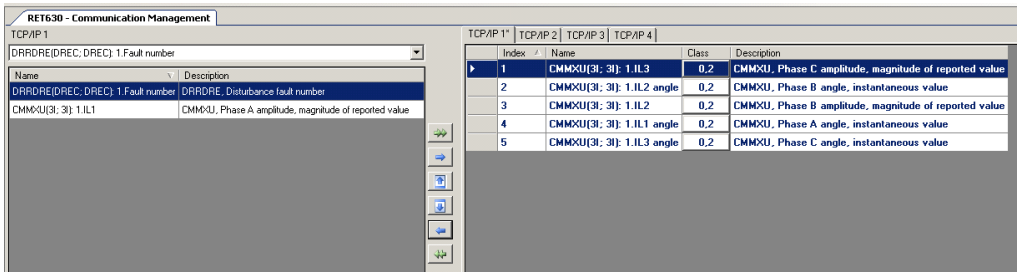
Figure 115: Configuring hardware channels directly to the function blocks

IEC10000173.vsd

Figure 116: 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 117 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 117.

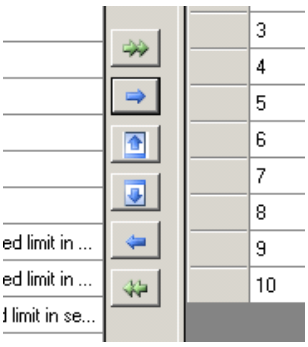


IEC09000689-1-en.vsd

Figure 117: 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 118.



IEC08000361.vsd

Figure 118: 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 119. The star indicates that changes in the container have to be saved before leaving CMT.

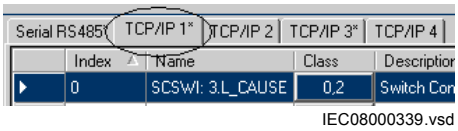


Figure 119: CMT: Marker to indicate changes in the container

9.3 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 120.

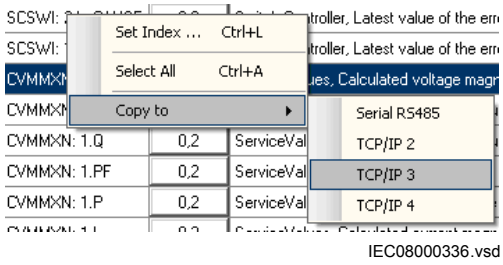


Figure 120: CMT: Context menu in DNP3 window

2. The selection window shows the number of signals selected, see Figure 121.

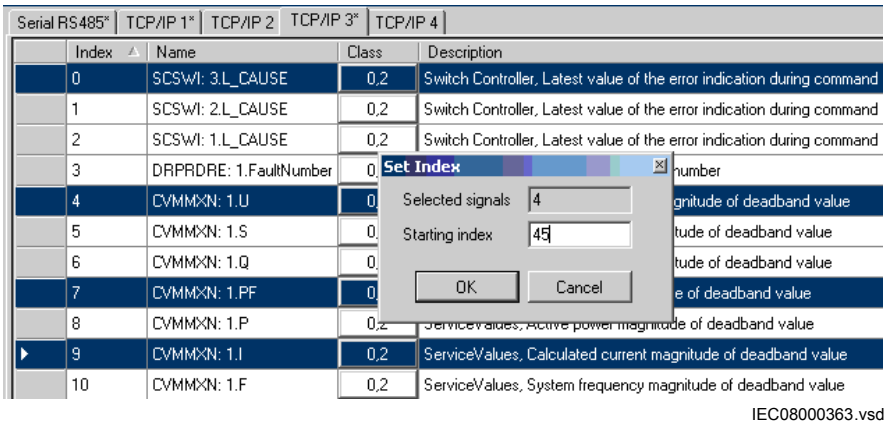


Figure 121: CMT: Set Index menu

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

Procedure to set class configuration:

1. Click in the class field of the signal to change the class configuration.
2. The *Select Class* window opens.
3. Make the selection according to the definitions in the project and click *OK* to close the window and get the new configuration, see Figure 122.

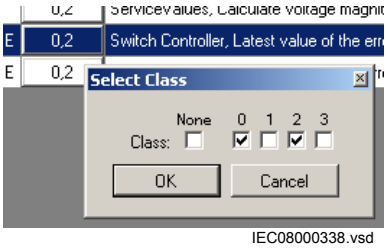


Figure 122: CMT: Select Class window

9.3.1 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.

Section 10 Configuration migration

10.1 Migrating the configuration to a later version

PCM600 Ver. 2.3 or later and 630 series Connectivity Package Ver. 1.1 support migration from 630 series Ver. 1.0 to 630 series Ver. 1.1. However, due to changes in the functions, reengineering is necessary.

- Make sure that the new function versions in the updated product fulfil the requirements.
- Be careful when replacing functions, signals or parameters that were removed at migration.

The actual migration is done by IED Configuration Migration in PCM600. Updating the complete configuration requires updates in the tools too, such as Application Configuration tool, Parameter Setting tool and Graphical Display Editor.

10.1.1 Creating a backup

Since the migration process is not reversible, export a copy of the project for backup.

1. Select **Open/Manage project**.
2. Select the project to be exported and click **Export Project**.

10.1.2 Creating a reference IED project

At migration, some functions, signals and parameters are removed, and they have to be reengineered. Having an original IED object as a reference helps in reengineering. Create a PDF file of the original Application Configuration tool configuration for easy comparision.

1. Create a new IED Group to the PCM600 project.
2. Copy the original IED object and paste it to created IED Group.
3. Rename the reference IED object to identify it easily when tools are open for both IEDs.
   The reference IED object can be used while reengineering the IED configuration. All PCM600 tools can be opened to separate tabs for both the migrated and the reference IED.

10.1.3 Migrating the IED configuration

1. Select the IED to be migrated and right-click **Migrate Configuration**.
2. Select the version to migrate to, for example 1.1, in the dialog and click **Continue**.
   A summary of the migration is displayed.

Obsolete Functions and Hardwares	All the functions that cannot be migrated. The corresponding function blocks are removed from the configuration. Some of these functions are part of the fixed instances found under the IED configuration in the plant structure, and these functions will be instantiated automatically, for example, for the DNP3 functions, but their parameters will be reversed to default values.
Versioned Functions and Hardwares	All functions that have been replaced in the configuration, that is, migrated to a new function version.
Functions instance is changed due to change in creation rule	The functions that, for example, have changed the execution order or application cycle, but the function version is the same in both the two product versions. Further information on the migration of these functions is displayed in the log window after migration.

   The functions that are not mentioned in any of the lists have the same version in both the products. Reengineering is not necessary for those functions.
3. Click **Show Migration Report** to print or save the list.
   The list is useful later when updating the configuration.
4. Click **OK** when report is printed or saved.
   A double progress bar shows up. The migration takes a few minutes.
   The log window contains valuable information from three different parts of the migration.
   - Implications of Execution order changes gives information about functions that have changed execution order, which will affect the data flow in the IED.
   - Non-migrated parameters are printed as warnings. Later on these parameters have to be updated manually.
   - Non-migrated 61850 signals from datasets are also displayed in the output window.
5. Copy and save all the content in the migration log window.
6. Check for any exceptions or errors.

10.1.4 Updating the license

When the configuration is migrated, the IED license is still inherited from the previous product version. All correct functions are available in PCM600 only after a succesful license update.

Collect the order code information for the migrated configurations before starting the license update.

1. Save and close Application Configuration tool when the configuration migration is completed.
2. Run License Update tool from the IED context menu.
3. Optionally, create a backup of the IED before starting the license.
   This is not required if a backup of the project has been created earlier.
4. Select online or offline mode for migration.
   In the online mode, the order code information is read from the IED. In the offline mode, the user can paste the order code from the clip board or select the options manually.
5. Select order options for the IED and finish the process.

The new license also comprises the optional software used in the original configuration.

10.2 Reengineering

10.2.1 Reengineering in the Application Configuration tool

Review reported changes in a migration report and in an output log window. If a function has been removed, it indicates that the function has been replaced by another function or the migration has not been possible for other reasons. If a signal has been removed, it indicates that the particular signal has a new functional meaning. Study the technical manual to ensure how the functions are used correctly. Even if the function has a new version number, the actual change in the function itself might be very minor. See Table 3 for list of functions that might require actions after the migration.

1. In the Application Configuration tool, update the configuration for the listed functions.
2. Save the configuration.
3. Run Validate Configuration.
4. Examine the report in the log window, and update the configuration accordingly.
5. Save the Application Configuration tool configuration again and exit.

10.2.2 Reengineering in the Parameter Setting tool

Parameter values remain unchanged for all the functions listed in **Versioned Functions and Hardwares** or **Functions instance is changed due to change in creation rule**. Parameter values remain unchanged also for the functions not listed in the migration report, that is, the functions that have the same version in both the product versions.

- Set the parameter values again for all the needed functions.

1. All functions listed in **Obsolete Functions and Hardwares**.
2. All parameters for which the migration failed. See the migration log window for failed parameters.
3. Note that some functions may have new settings.
4. Parameters of the DNP3-related functions that are reset to default values in migration. Restore the original parameters.

10.2.3 IEC 61850 reengineering

Before exporting the SCD file and doing the IEC 61850 reengineering in CCT600 or IET600, other IEDs in the PCM600 project have to be also migrated.

The IEC 61850 configuration remains unchanged at migration for all unchanged data attributes.

IEC 61850 engineering has to be done separately for data attributes and logical nodes or data objects with changed names. These signals are listed in the migration log window. Export the SCD file again and redo the SCL engineering for the data attributes removed at migration.

The names of the signals, data objects and logical nodes may have changed. Verify therefore with the documentation that the IEC 61850 configuration is valid.

- After the migration, the IEC 61850 configuration is partly unchanged, partly reverted back to default, and possibly partly invalid. Therefore, carefully verify and modify the IEC 61850 configuration.
  - Verify that there are no empty data sets. Add signals to data sets, or remove empty data sets.
  - Contents of the default data sets might have changed due to function block replacing.
  - Data set naming and amount might have changed. Check also corresponding report control blocks.
  - Verify the substation section, because the references to LNs of replaced function blocks are not automatically added back.
- Import the SCD file when the engineering is done.
- Open the Signal Matrix tool and check connections.

Other IEDs also need update of incoming GOOSE signals from the migrated IEDs in the Signal Matrix tool.

10.2.4 Updating DNP3 points in the Communication Management tool

If DNP3 is used, the configured DNP3 points must be updated. All DNP3 points from the migrated functions are removed from the configuration.

1. Open the Communication Management tool.
   Some of the earlier configured DNP3 points are struck through in the list.
2. Select the signals on the left side corresponding to the struck-through signals.
3. Click the blue arrow to the right to add the signals.
4. Update the index numbers of the signals.
   Updating is necessary to be able to keep the configuration in the DNP3 master unchanged. The index number should match the one of the struck-through signal.
5. Remove the struck-through signals, when the update of signals is finished.
6. Repeat the procedure for all signal types and all configured DNP3 masters (TCP 1-4).
   - Analog input objects
   - Binary input objects
   - Binary output objects
   - Counter object
   - Counter bit indication object

10.2.5 Mapping in Graphical Display Editor

- In Graphical Display Editor, map all mappings to functions that have been manually reinstantiated in the Application Configuration tool.
  Map again all functions included in the Obsolete Functions and Hardware list of the IED configuration migration report.

10.2.6 Updating Signal Matrix

- Update connections between hardware and software functions.
  - Update connections of obsolete functions.
  - Update connections if a signal connected to hardware of a replaced function has been removed or if its meaning has changed.
- Verify and update the configuration if any of the changed functions has been connected directly to hardware.

10.2.7 Changed functions

Table 3: Functions changed in the configuration after the migration from 630 series Ver. 1.0 to 630 series Ver. 1.1

Function	Implication
SCILO[1)]	All instances are removed from ACT.
SPGGIO[1)]	All instances are removed from ACT.
DPGGIO[1)]	All instances are removed from ACT.
PSM_BATSUP[1)]	The function is removed from the Application Configuration tool. The signal is now available in the PSM module analog inputs.
PSM_TCS[1)]	The function is removed from the Application Configuration tool. The signal is now available in the PSM module analog inputs.
A3RADR[1)]	The function is removed from the Application Configuration tool. The signal is now available in the PSM module analog inputs.
DEFLPDEF	New setting Base value Sel phase added.
DEFHPDEF	New setting Base value Sel phase added.
INTRPTEF	Setting Ground start value renamed to Voltage start value.
SCEFRFLO	Amount of recorded data banks increased.
DARREC	CB closed Pos status setting default value changed to 0.
DSTPDIS	Setting Voltage Mem time added.
CVRSOF	Minimium values for Operate time delay, Dead line time and Cur voltage Det time and step resolution for all time settings.
MNSPTOC	DO type corrected.
LREFPNDF	Removal of setting Base value Sel Res. Now internal minimum current levels are also based on phase base values.
RESCPSCH	Harmonized default value for setting Scheme type with the default of the same setting in DSOCPSCH.
GNRLCSWI	Changed default for input SYNC_OK to TRUE.
SSCBR	DOs PosOpn and PosCls removed from the default data set.
CSMSQI	The time quality for mandatory data SeqA.c3 (showing always zero amplitude) is corrected.
VSMSQI	The time quality for mandatory data SeqV.c3 (showing always zero amplitude) is corrected.

1) The function must always be reassigned if it has been used in the earlier configuration.

Section 11 Glossary

AC	Alternating current
ACT	Application Configuration tool in PCM600; Trip status
ANSI	American National Standards Institute
CB	Circuit breaker
CCT600	Communication Configuration tool in PCM600
CID	Configured IED description
CMT	Communication Management tool in PCM600
COM600	An all-in-one communication gateway, automation platform and user interface solution for utility and industrial distribution substations
COMTRADE	Common format for transient data exchange for power systems. Defined by the IEEE Standard.
Connectivity package	A collection of software and information related to a specific protection and control IED, providing system products and tools to connect and interact with the IED
CT	Current transformer
DHCP	Dynamic Host Configuration Protocol
DNP3	A distributed network protocol originally developed by Westronic. The DNP3 Users Group has the ownership of the protocol and assumes responsibility for its evolution.
DO	Data object
EMC	Electromagnetic compatibility
Ethernet	A standard for connecting a family of frame-based computer networking technologies into a LAN
FC	Functional constraint
GCB	GOOSE control block
GDE	Graphical Display Editor in PCM600
GoCB	GOOSE control block
GOOSE	Generic Object-Oriented Substation Event
HMI	Human-machine interface

Horizontal communication	Peer-to-peer communication
HW	Hardware
I/O	Input/output
ICD	IED capability description
IEC	International Electrotechnical Commission
IEC 60870-5-103	Communication standard for protective equipment; A serial master/slave protocol for point-to-point communication
IEC 61850	International standard for substation communication and modeling
IED	Intelligent electronic device
IET600	Integrated Engineering Toolbox in PCM600
IP	Internet protocol
IP address	A set of four numbers between 0 and 255, separated by periods. Each server connected to the Internet is assigned a unique IP address that specifies the location for the TCP/IP protocol.
LAN	Local area network
LED	Light-emitting diode
LHMI	Local human-machine interface
LN	Logical node
Logical node	Also known as LN. The smallest part of a function that exchanges data. An LN is an object defined by its data and methods.
MicroSCADA	Substation automation system
NCC	Network control center
PC	Personal computer; Polycarbonate
PCM600	Protection and Control IED Manager
PSM	Power supply module
PST	Parameter Setting tool in PCM600
R/L	Remote/Local
RCB	Report control block
REF630	Feeder protection and control IED
REM630	Motor protection and control IED
RET630	Transformer protection and control IED
RS-485	Serial link according to EIA standard RS485

SAB600	Substation automation builder tool
SCADA	Supervision, control and data acquisition
SCD	Substation configuration description
SCL	Substation configuration language
SMT	Signal Matrix tool in PCM600
Station	Network node or a device connected to a network
TCP/IP	Transmission Control Protocol/Internet Protocol
VT	Voltage transformer
WAN	Wide area network
WHMI	Web human-machine interface

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